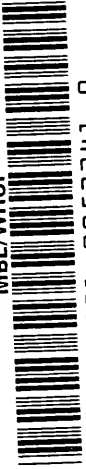






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With the regards of  
Wesley R. Col







NEMERTEANS OF THE PACIFIC  
COAST OF NORTH AMERICA

PART II





# NEMERTEANS OF THE PACIFIC COAST OF NORTH AMERICA

## PART II

BY WESLEY R. COE, PH.D.



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### INTRODUCTION

SINCE the publication of the report on the Nemerteans collected on the Harriman Alaska Expedition,<sup>1</sup> I have had an opportunity of studying extensive collections of this group of worms from Alaska and from other portions of the Pacific coast of North America. The report on these collections is soon to appear in the *Bulletin of the Museum of Comparative Zoölogy*. I have also found opportunity to spend a summer on the coast of California,<sup>2</sup> where I obtained a considerable

<sup>1</sup>Published in *Proc. Wash. Acad. Sci.*, III, pp. 1-110, pls. 1-XIII, March, 1901.

<sup>2</sup>To Dr. Wm. E. Ritter, of the University of California, for the hospitality of the Marine Laboratory at San Pedro, and to Dr. C. H. Gilbert, of Stanford University, for similar privileges at the Hopkins Seaside Laboratory at Pacific Grove, the writer wishes to express his most cordial thanks. The writer is also indebted to Professor C. B. Wilson, of Westfield, Mass., for numerous specimens and very valuable notes on California Nemerteans; and to Mr. J. F. Abbott, formerly of Stanford University, for numerous important notes and drawings from specimens collected at Monterey Bay, Calif.

number of species which were not collected on the Harriman Expedition, and a large proportion of which have proved to be new to science.

A study of the Nemerteans of the California coast reveals the fact that a number of the Alaska species extend southward throughout the whole length of the State, and that many others occur as far south as Monterey Bay. We may thus expect that many of those forms which I have more recently found in California may range northward into Alaska, so that their incorporation in the report on the Alaska species can by no means be out of place.

In the following pages I shall not attempt to describe all the species which have come into my hands from the Pacific coast, but shall here confine myself to those forms which I had an opportunity of collecting personally and studying while they were still alive. The specific descriptions can thus be made far more precise and exhaustive than when preserved material only is to be had. In all cases, however, serial sections have been carefully studied to determine the anatomical peculiarities of each species recorded.

The most strikingly colored forms were drawn as nearly as possible in their natural colors, and an attempt was made to reproduce the natural shape and characteristic position of the body when alive.

A single species (*A. paulinus*) has been described by Punnett<sup>1</sup> from the Pribilof Islands, Bering Sea, since the first portion of this report appeared. A brief description of this species will be found on p. 155.

At the time of publishing the first portion of the report, I was unfortunately unaware that a preliminary paper by the late B. B. Griffin on Some Marine Nemerteans of Puget Sound and Alaska<sup>2</sup> had appeared since the death of this enthusiastic young investigator. Several of the species very briefly described by Griffin were through this oversight redescribed by me in my previous paper with names which must be now relegated to synonymy. Griffin's drawings, notes, and collections have recently

<sup>1</sup> Proc. Zool. Soc. London, p. 92, 1901.

<sup>2</sup> Ann. New York Acad. Sci., XI, pp. 193-217, 1898.

been placed in my hands, so there can be no doubt as to the identity of these forms. They are :

1. *Carinella dinema* Coe = *C. scxlineata* Griffin.
2. *C. speciosa* Coe = *C. rubra* Griffin.
3. *Carinoma griffini* Coe = *C. mutabilis* Griffin.
4. *Amphiporus leuciodus* Coe = *A. imparispinosus* Griffin.
5. *A. exilis* Coe = *A. formidabilis* Griffin.

Griffin's paper includes twelve named species besides two forms which are not designated by specific names. The geographical distribution of these is as follows :

1. *Carinella scxlineata* Griffin. Puget Sound ; Sitka, Alaska.
2. *C. rubra* Griffin. Puget Sound ; Sitka, Alaska.
3. *Carinoma mutabilis* Griffin. Puget Sound ; Strait of Juan de Fuca. Varieties : *argillina*, in hard blue clay ; *vasculosa*, in sand between tides.
4. *Emplectonema viride* Stimpson = *E. gracile* (Johnston) Verrill. Southern Alaska ; Puget Sound.

5. *E. violaceum* Griffin, (*non* Bürger) = *E. bürgeri* Coe. This form, which Griffin considers identical with Bürger's species from the coast of Chile,<sup>1</sup> was found on piles at Port Townsend, Puget Sound. Griffin's description is substantially as follows : Body extremely flattened, ribbon-like ; head rounded in front, directly continuous with body ; eyes numerous. Color somewhat variable, with fairly constant pattern on dorsal surface which is densely flecked with purple or brown upon a pale yellowish brown ground color ; ventral surface yellowish white. Length probably 50 cm., although it was difficult of measurement because the body remained coiled up in tangled knots in an enormous amount of slime which the worm secretes. These characters agree in the main with the brownish variety of *E. bürgeri*, but differ widely from Bürger's *E. violaceum*, which is dark brownish violet above and pale rose-violet on ventral surface even after preservation. Griffin considers the internal anatomy to agree 'more or less closely' with Bürger's *E. violaceum*. My own preparations, however, prove conclusively that the two species are specifically distinct, for they differ decidedly in the only really specific anatomical character which Bürger gives ;

<sup>1</sup> Zool. Jahrb., Abth. d. Syst., ix, p. 272, 1896.



viz., in *E. violaceum* the cerebral sense organs are very small, and lie far in front of brain, while in *E. bürgeri* they are remarkably large for the genus and lie only slightly in front of brain.<sup>1</sup> The practical absence of cephalic glands is in accord with most species of the genus. Neither Bürger nor Griffin makes any statements in regard to the proboscis, which usually presents the most tangible specific characters.

6. *Amphiporus imparispinosus* Griffin. Sitka, Alaska; Puget Sound.

7. *A. formidabilis* Griffin. Alaska and Puget Sound

8. *A. brunneus* Griffin. Port Townsend, Puget Sound. Presents the following peculiarities: Length in alcohol 3.3 cm.; width 5 mm. Color in life dark brown or smoky black dorsally, greenish or yellowish white ventrally; on each side of neck is a pale, angular spot. Cephalic glands moderately developed; cephalic sense organs considerably in front of brain. Intestinal cæca reach nearly to brain. Basis of central stylet long; two lateral pouches with two (or three ?) stylets each.

In some respects this description agrees with the characters of *Paranemertes peregrina*, which is common in Puget Sound, but on the following page (p. 213) the species is represented as bearing "a more or less general resemblance to *A. angulatus*." There can hardly be said to be the slightest resemblance between *P. peregrina* and *A. angulatus*, so that even with Griffin's notes and material at hand, there being no specimens of this form it is impossible to determine to which, if any, of the described species this *A. brunneus* belongs. For the present it is necessary therefore to consider it as a distinct species.

9. *A. angulatus* (Fabr.) Verrill. Sitka and Redout Bay, Alaska. Doubtfully referred to this species by Griffin; several varieties obtained. This species is abundant along the whole coast, from Bering Strait to Puget Sound.

10. *A. drepanophoroides* Griffin. No locality given. Length 4-5 cm. or less; form short and stout; color red above, white beneath; eyes numerous, in rows along antero-lateral margins of head. Cephalic and submuscular glands prominent. Cerebral sense organs large, situated beside brain and extending pos-

<sup>1</sup>Coe, Proc. Wash. Acad. Sci., III, p. 26, 1901.

teriorly behind dorsal ganglia; canals open in front of ventral commissure. Differs from all the preceding species in smallness of rhynchocœl, which is enclosed in a thick muscular sheath in which longitudinal and circular muscles are interwoven. No intestinal cœcum; circular muscle-layer quite thick.

The species is known only from the above description, and is truly remarkable because of the absence of the intestinal cœcum. No specimens or slides showing any such peculiarity were contained in Griffin's collections, however, when they were turned over to the writer.

11. *Lineus striatus* Griffin. Puget Sound. Color notes and drawings lost by shipwreck. "Color brownish red on dorsum, sharply marked off laterally from the much lighter ventral portion. Dorsum marked by numerous creamy white transverse bands which cease at demarcation-line between the dorsal and ventral coloring. Tip of head brilliant red. Length probably not over 4 cm." Nephridia have numerous efferent ducts.

These characters resemble those of very small individuals of *M. verrilli* in many respects, and the two species may possibly be identical. Perhaps Griffin's form is more closely similar to Stimpson's *Cerebratulus impressus* (= *Micrura impressa*) from Bering Strait.

12. *Cerebratulus marginatus* Renier. Puget Sound.

13. *Lineus* sp.? Puget Sound. Smoky black with greenish tinge dorsally, grayish brown ventrally. Probably = *Lineus viridis* (Fabr.) Johnston, which is recorded from southern Alaska (Coe, *loc. cit.*, p. 65).

14. *Cerebratulus* sp.? A very large, dark species with flesh-colored margins; fragments measuring nearly 20 mm. in diameter after preservation. No locality given, but the species is in all probability *C. herculeus* Coe, which is also recorded from southern Alaska.

Careful comparison of Griffin's notes, drawings, and material indicates that eight of the twelve above-named species were new at time of publication. Five of the eight must be retained in place of five of my own names, as stated above. Two other new species (*Amphiporus brunneus* and *A. drepanophoroides*) cannot be referred to any forms which have come into my

hands, and must stand as new for the present. One other species (*E. bürgeri* Coe), although undescribed at the time, was incorrectly referred to *E. violaceum* Bürger. Three of the four remaining forms were correctly identified with European species, while the one species remaining, *Lincus striatus*, is possibly identical with *M. impressa* (Stimpson), as stated above.

#### ALASKA SPECIES FOUND ON THE COAST OF CALIFORNIA

Of the species recorded in the first part of this report (pp. 1-110), the following were collected in the summer of 1901 on the California coast in the localities indicated below.

#### Paleonemertea.

1. *Carinella capistrata* Coe. Monterey Bay.
2. *C. sexlineata* Griffin (= *C. dinema* Coe). Monterey Bay; San Pedro.
3. *Carinoma mutabilis* Griffin (= *C. griffini* Coe). San Pedro.
4. *Cephalothrix linearis* (Rathke) Oersted. Monterey Bay; San Pedro; San Diego.

#### Hoplonemertea.

5. *Emplectonema gracile* (Johnston) Verrill. Monterey Bay.
6. *Paranemertes peregrina* Coe. Monterey Bay; San Pedro.
7. *Amphiporus bimaculatus* Coe. Monterey Bay.
8. *A. angulatus* (Fabr.) Verrill. Monterey Bay; San Pedro.
9. *A. imparispinosus* Griffin (= *A. leuciodus* Coe). Monterey Bay; San Pedro; San Diego.
10. *A. formidabilis* Griffin (= *A. exilis* Coe). Monterey Bay.

#### Heteronemertea.

11. *Micrura verrilli* Coe. Monterey Bay.
12. *M. alaskensis* Coe. San Pedro; Monterey Bay.
13. *Cerchratulus marginatus* Renier. San Pedro.
14. *C. albifrons* Coe. San Pedro

In the first portion of this report 32 species were enumerated. Nearly half of these, or the above 14 species, were found also on the California coast during a single summer. Eleven of

these forms, which are common both to the California coast and to Alaska, were found at Monterey Bay, ten at San Pedro or in the deep water in the vicinity, while only two were collected at San Diego, and these were both common in the other two localities. At San Diego, however, the opportunities for collecting were comparatively limited, and but a short time was spent at that place. Of the ten Alaska species found at San Pedro, five only were collected at Monterey Bay, although in all probability the others will be found to occur there.

There can be no doubt that future collections will add materially to the number of forms whose range extends from Alaska at least as far southward as Monterey Bay or even to Point Conception. And while this is a considerable range geographically, yet the environmental conditions of the marine forms are not greatly different between Monterey Bay, Puget Sound, Sitka, and the eastern Aleutian Islands. The temperature of the water is but a few degrees different, and in some seasons of the year is actually warmer on the coast in portions of Alaska than it is in Puget Sound or even in the deeper water off the California coast.

#### SPECIES NEW TO WEST COAST OF NORTH AMERICA

In addition to the species recorded in the previous paper (pp. 1-110), the following forms have since been studied, and are described in this article. In accord with Bergendal's recommendation<sup>1</sup> the orders Protonemertea and Mesonemertea of Bürger are placed together under the older order Paleonemertea proposed by Hubrecht.

##### Paleonemertea.

1. *Carinella frenata* sp. nov. San Pedro, Calif. Not common.
2. *C. albocincta* sp. nov. Off San Pedro, Calif., in 50-100 fms. Common.
3. *C. cingulata* sp. nov. Monterey Bay, Calif., in 14 fms. Not common.

##### Hoploneemertea.

4. *Nemertopsis gracilis* sp. nov. Monterey Bay, Calif. Not common.

<sup>1</sup>Kongl. Vetenskaps-Akad. Förhandlingar, pp. 721-742, 1900.

5. *Paranemertes californica* sp. nov. Southern coast of California. Not uncommon.
6. *Carcinonemertes epialti* Coe. Parasitic on the crab, *Epialtus productus*. Monterey Bay, Calif.
7. *Amphiporus cruentatus* Verrill. San Pedro and Monterey Bay, Calif. Rather common.
8. *Tetrastemma signifer* sp. nov. San Pedro, Calif. Not very common.
9. *T. nigrifrons* sp. nov. Monterey Bay, Calif. Abundant.
10. *T. bilineatum* sp. nov. San Diego, Calif. Common.
11. *T. quadrilineatum* sp. nov. San Pedro, Calif. Rather common.
12. *T. (Ærstedtia) dorsale* (Abildgaard) McIntosh. Monterey Bay, Calif., in 20 fms. Not very common.
13. *T. (Ærstedtia) reticulatum* sp. nov. San Pedro, Calif. Common.

#### Heteronemertea.

14. *Teniosoma punnettii* sp. nov. Off San Pedro, 50 fms.; Monterey Bay, Calif., 5-20 fms. Common.
15. *Zygucapolia littoralis* C. B. Thompson. San Pedro, Calif. Common.
16. *Lincus rubescens* sp. nov. San Pedro and Monterey Bay, Calif. Not common.
17. *L. flavescens* sp. nov. Low water to 50 or more fms., off San Pedro, Calif. Common.
18. *L. pictifrons* sp. nov. San Pedro, Calif. Rather common.
19. *L. albolineatus* sp. nov. Off San Pedro and in Monterey Bay, Calif. Not common.
20. *L. wilsoni* sp. nov. Monterey Bay, Calif. Common.
21. *Micrura nigrirostris* sp. nov. San Pedro, Calif. Not common.

Besides those mentioned in the above list, which includes only species which have not been hitherto recorded from the Pacific coast of North America, a considerable number of forms described in the first part of this paper (pp. 11-84) as occurring in Alaska have since been found in other localities, notably on the



California coast, as mentioned above, and have thus had the range of their distribution greatly extended.

DISTRIBUTION OF ALL SPECIES KNOWN FROM THE WEST COAST  
OF NORTH AMERICA

Including the foregoing and those which are described on the following pages, 57 species of Nemerteans are at present known from the Pacific coast, and their distribution as far as recorded (including my own observations during the summer of 1901 and the study of several other collections) is as follows:

**Paleonemertea.**

1. *Carinella rubra* Griffin. Whole Pacific coast of Alaska to Vancouver Island, B. C.
2. *C. sexlineata* Griffin. Sitka, Alaska, to San Pedro, Calif.
3. *C. capistrata* Coe. Prince William Sound, Alaska, to Monterey Bay, Calif.
4. *C. frenata* sp. nov. San Pedro, Calif.
5. *C. albocincta* sp. nov. Off San Pedro, Calif.
6. *C. cingulata* sp. nov. Monterey Bay, Calif.
7. *Carinoma mutabilis* Griffin. Vancouver Island, B. C., to San Pedro and San Diego, Calif.
8. *Cephalothrix linearis* (Rathke) Oersted. Whole Pacific coast of Alaska to southern coast of California; New England; northern coasts of Europe; Mediterranean Sea.

**Hoplonemertea.**

9. *Emplectonema gracile* (Johnston) Verrill. Whole Pacific coast of Alaska to Monterey Bay, Calif.; northern coasts of Europe; Mediterranean Sea; Madeira.
10. *E. bürgeri* Coe. Southern coast of Alaska to Puget Sound.
11. *Zygonemertes thalassina* Coe. Sitka, Alaska.
12. *Z. albida* Coe. British Columbia.
13. *Nemertopsis gracilis* sp. nov. Monterey Bay, Calif.
14. *Paranemertes peregrina* Coe. Whole Pacific coast of Alaska to southern coast of California.
15. *P. pallida* Coe. Pacific coast of Alaska.

16. *P. carnea* Coe. Pacific coast of Alaska and British Columbia.
17. *P. californica* sp. nov. Southern coast of California.
18. *Carcinonemertes epialti* Coe. Parasitic on *Epialtus*. Monterey Bay, Calif.
19. *Amphiporus angulatus* (Fabr.) Verrill. Bering Strait to Puget Sound; New England to Greenland.
20. *A. bimaculatus* Coe. Southern Alaska; Puget Sound to Monterey Bay, Calif.
21. *A. tigrinus* Coe. British Columbia.
22. *A. nebulosus* Coe. Pacific coast of Alaska Peninsula.
23. *A. cruentatus* Verrill. Monterey Bay and San Pedro, Calif.; southern coast of New England.
24. *A. imparispinosus* Griffin. Pacific coast of Alaska to southern coast of California.
25. *A. formidabilis* Griffin. Aleutian Islands, Alaska, to Monterey Bay, Calif.
26. *A. paulinus* Punnett. Pribilof Islands, Bering Sea.
27. *A. brunneus* Griffin. Puget Sound.
28. *A. drepanophoroides* Griffin. Puget Sound.
29. *Tetrastemma signifer* sp. nov. San Pedro, Calif.
30. *T. nigrifrons* sp. nov. Monterey Bay, Calif.
31. *T. bicolor* Coe. Kadiak, Alaska.
32. *T. aberrans* Coe. Pacific coast of Alaska.
33. *T. cæcum* Coe. Kadiak, Alaska.
34. *T. bilineatum* sp. nov. San Diego, Calif.
35. *T. quadrilineatum* sp. nov. San Pedro, Calif.
36. *T. (Ærstedtia) dorsale* (Abildgaard). Monterey Bay, Calif.; northern coasts of Europe; Mediterranean Sea; east coast of United States.
37. *T. (Ærstedtia) reticulatum* sp. nov. San Pedro, Calif.

#### Heteronemertea.

38. *Taniosoma princeps* Coe. Southeastern coast of Alaska.
39. *T. punnetti* sp. nov. Monterey Bay and San Pedro, Calif.
40. *Zygucpolia littoralis* C. B. Thompson. San Pedro, Calif.; New England (Woods Hole, Mass.).

41. *Lineus viridis* (Fabr.) Verrill. Southeastern coast of Alaska.
42. *L. torquatus* Coe. Pacific coast of Alaska.
43. *L. rubescens* sp. nov. Monterey Bay and San Pedro, Calif.
44. *L. flavescens* sp. nov. Southern coast of California.
45. *L. pictifrons* sp. nov. San Pedro, Calif.
46. *L. wilsoni* sp. nov. Monterey Bay, Calif.
47. *L. albolineatus* sp. nov. Monterey Bay and San Pedro, Calif.
48. *Micrura nigrirostris* sp. nov. San Pedro, Calif.
49. *M. verrilli* Coe. Pacific coast of Alaska to Monterey Bay, Calif.
50. *M. impressa* (Stimpson) Coe. Bering Strait; Puget Sound (?)
51. *M. alaskensis* Coe. Pacific coast of Alaska.
52. *Cerebratulus herculeus* Coe. Southeast coast of Alaska; Puget Sound.
53. *C. marginatus* Renier. Southeastern coast of Alaska to southern coast of California; New England to Greenland; northern coasts of Europe; Mediterranean Sea.
54. *C. occidentalis* Coe. Pacific coast of Alaska to British Columbia.
55. *C. longiceps* Coe. Yakutat Bay, Alaska.
56. *C. montgomeryi* Coe. Aleutian Islands, Alaska, to Puget Sound.
57. *C. albifrons* Coe. Southeastern coast of Alaska to southern coast of California.

Of the above 57 species known from the Pacific coast of North America, only 7 have been recorded in other parts of the world. Of these seven species three — *Cephalothrix linearis*, *Tetrastemma dorsale* and *Cerebratulus marginatus* — occur also both on the east coast of North America and in Europe; three others — *Amphiporus angulatus*, *A. cruentatus* and *Zygeupolia littoralis* — are found in New England, but are not known from Europe; while a single species — *Emplectonema gracile* — is common in Europe, but has not been recorded from the east coast of America.

Although such a large proportion of the species are peculiar to the Pacific coast, yet in general they belong to common European genera, and the Nemertean fauna as a whole resembles that of Europe and the Mediterranean far more closely than it does that of the Atlantic coast of North America. This has been observed in regard to the general invertebrate fauna of Puget Sound by Harrington and Griffin,<sup>1</sup> and Griffin noted the same in regard to the Nemerteans. The abundance of species of *Carinella*, the presence of *Nemertopsis* and of *Emplectonema gracile*, and the close resemblance of a number of species of *Tetrastemma*, *Amphiporus*, *Lineus*, *Micrura* and *Cerebratulus* to closely related European forms, are instances of this similarity of faunas.

Certain other collections which are being studied will doubtless yield further light on the distribution of the species and their relationships, as well as the resemblance of the Nemertean fauna of the Pacific coast to that of other parts of the world.

The distribution of Nemerteans on the Pacific coast of North America so far as now known is represented in the following table :

NUMBER OF SPECIES KNOWN FROM VARIOUS LOCALITIES ON THE  
PACIFIC COAST

Genus.	Alaska.	Puget Sound.	Central California.	Southern California.	Total.
<b>PALEONEMERTEA.</b>					
<i>Carinella.</i>	3	3	3	3	6
<i>Carinoma.</i>	—	1	1	1	1
<i>Cephalothrix.</i>	1	1	1	1	1
<b>HOPLONEMERTEA.</b>					
<i>Emplectonema.</i>	2	2	1	—	2
<i>Zygonemertes.</i>	1	1	—	—	2
<i>Nemertopsis.</i>	—	—	1	—	1
<i>Paranemertes.</i>	3	2	2	2	4
<i>Carcinonemertes.</i>	—	—	1	—	1
<i>Amphiporus.</i>	6	7	4	2	10
<i>Tetrastemma.</i>	3	—	2	4	9
<b>HETERONEMERTEA.</b>					
<i>Taniosoma.</i>	1	—	1	1	2
<i>Zygeupolia.</i>	—	—	—	1	1
<i>Lineus.</i>	2	—	3	4	7
<i>Micrura.</i>	3	?	2	2	4
<i>Cerebratulus.</i>	6	5	2	2	6
Total.	31	22	24	23	57

<sup>1</sup>Trans. New York Acad. Sci., p. 161, 1897.

The total number of species already recorded from the region covered by this report is surprisingly large, considering the few attempts at their collection. And it should be remarked that we find in this region not only a large number of species, but also a surprising abundance of individuals of the species represented. It now seems probable that this coast will eventually be found to possess more species of Nemerteans than any other region of equal size on the globe. And certainly I know of no locality where so large a proportion of the invertebrate animals found in a miscellaneous collection belong to the Nemerteans as on the northwest coast of North America.

KEY TO THE PACIFIC COAST NEMERTEANS DESCRIBED ON THE FOLLOWING PAGES

This key is arranged for use in connection with the one published in the former portion of this report (pp. 7-11), and is likewise based mainly on superficial and easily distinguishable characters.

Order **Paleonemertea**.<sup>1</sup>

Body remarkably long, soft, fragile. Head distinctly marked off from body, usually broader than neck, often flattened dorso-ventrally ..... *Carinella*.

1. Body large, rather firm, only moderately slender, attaining a length of 50 cm. or more, pale yellowish or rosy, sometimes with greenish tinge; with three longitudinal velvety, blackish lines and a series of narrow rings of similar color.

*C. frenata*, p. 129.

2. Body firm, rather stout, upwards of 30 cm. long, deep red with a series of narrow white rings..... *C. albocincta*, p. 136.

3. Body slender, subcylindrical, 15 cm. or more in length, deep brown, with a series of white rings and four longitudinal white lines, of which two are lateral, while the other two divide dorsal surface of body into three equal parts... *C. cingulata*, p. 138.

Order **Hoplonemertea**.

- I. Body very slender, almost filiform, somewhat flattened; with four large ocelli; with central stylet and two pouches of accessory stylets. Proboscis sheath about one-third as long as body.

*Nemertopsis*.

<sup>1</sup>As stated above, Bürger's orders *Protonemertea* and *Mesonemertea* are here united into the older order *Paleonemertea* Hubrecht.



1. Length 15 cm. or more ; very pale brown or whitish, with two longitudinal dorsal stripes of deep brown ; proboscis provided with eight nerves ..... *N. gracilis*, p. 112.
- II. Body moderately elongated ; proboscis sheath about one-half to three-fourths the length of the body ; central stylet well developed.....*Paranemertes*.
  1. Four or six pouches of accessory stylets ; proboscis with ten large nerves. Translucent, pale orange anteriorly, flesh color, grayish or very pale salmon posteriorly, color much obscured by deep green of intestinal tract.....*P. californica*, p. 144.
- III. Body very small and slender ; two ocelli ; proboscis but little developed, central stylet minute ; no accessory stylets ; parasitic on crabs .....*Carcinonemertes*.
  1. Only 4-6 mm. long when sexually mature ; color orange or reddish ; parasitic on the egg masses of *Epialtus* and perhaps other crabs.....*C. epialti*, p. 151.
- IV. Body rather short and thick ; proboscis sheath reaches nearly or quite to posterior end of body ; proboscis large, central stylet well developed.
  - aa.* Ocelli do not extend posteriorly beyond the brain ; basis of central stylet usually rounded posteriorly.
  - b.* Body not very small. Ocelli usually numerous.
 

*Amphiporus*.

    1. Rather slender, 10-25 mm. in length ; yellow ; very conspicuous red blood vessels ; five to ten ocelli in single row on each side of head ; basis very slender, about same length as stylet..... *A. cruentatus*, p. 154.
    2. Slender, 50-90 mm. in length ; proboscis sheath about six-sevenths the length of body ; proboscis with fifteen nerves ; basis of same length as stylet ; ocelli numerous.
 

*A. paulinus*, p. 155.
  - bb.* Body very small. Ocelli few ; usually four well developed ocelli arranged in a rectangle .....*Tetrastemma*.
    1. Rather slender, 15-25 mm. in length, reddish-brown both above and below, except head, which is white with sharply marked wreath of deep brown color on dorsal surface. Blood corpuscles red.
 

*T. signifer*, p. 156.
    2. Usually 20 to 70 mm. in length ; head provided with two pairs of very conspicuous, lateral, oblique furrows. Color very variable, except head which is

white with shield-shaped or triangular marking of deep brown color on dorsal surface. Body deep purple, deep brown with white dorsal longitudinal band, reddish with brown flecks, pale brownish or buff on dorsal surface; of similar color, but paler, and often with white longitudinal band on ventral surface. Blood corpuseles red.

*T. nigrifrons*, p. 159.

3. Only 5 to 10 mm. in length, flesh color, creamy or grayish, with two deep brown longitudinal stripes on dorsal surface.....*T. bilineatum*, p. 164.
4. Usually 8 to 12 mm. in length; whitish, with four deep brown longitudinal stripes, of which two lie on lateral margins and two on dorsal surface.

*T. quadrilineatum*, p. 166.

5. Firm, cylindrical, slender, body only 8 to 15 mm. in length; flesh color or yellowish, mottled, especially on dorsal surface, with brownish blotches and dots of various shades, often mainly collected into a series of transverse bands.

*T. (Oerstedtia) dorsale*, p. 169.

6. Firm, cylindrical, slender, 8 to 15 mm. in length. White, with large rectangular and longitudinal, dark brown markings almost covering dorsal surface. Often with sixteen pairs rectangular marks and pair of lateral brown lines in addition to bilobed marking on dorsal surface of head. In some varieties markings fuse together.

*T. (Oerstedtia) reticulatum*, p. 170.

#### Order Heteronemertea.

- A. Head without deep, lateral, longitudinal furrows. Proboscis musculature of two layers, an outer circular and inner longitudinal layer, without muscular crossings .....*Teniosoma*.
  1. Body large, soft, flabby, 40 to 60 cm. or more in length. Color brownish red or mahogany; tip of snout darker brown with terminal white border ..*T. punnetii*, p. 173.
- AA. Head without deep, lateral, longitudinal furrows. Cerebral sense organs open into pit on margins of acutely pointed head. Proboscis musculature of two layers, outer longi-

- tudinal and inner circular layer, with muscular crossings.  
 Caudal cirrus present ..... *Zygeupolia*.
1. Rather slender, 5 to 8 cm. in length; head pure white, acutely pointed; esophageal region whitish, pale yellow or flesh color; intestinal region rose, pale yellow, light brown or chocolate brown from color of intestinal canal. Caudal cirrus slender, white. No retractor muscle to proboscis ..... *Z. littoralis*, p. 177.
- AAA. Head with deep, horizontal furrows. Proboscis of three muscular layers, outer longitudinal, circular, and inner longitudinal layers, or of the two former only; muscular crossings usually present.
- a. Caudal cirrus absent. Body long and slender, rounded or flattened; very contractile ..... *Lineus*.
1. Slender, small, usually 10 to 15 mm. long. A single row of two to four (rarely six to eight) irregular ocelli on each antero-lateral margin of head. Pink or rosy flesh color, sometimes with tinge of blue; deep flesh color to purplish brown in intestinal region; head white ..... *L. rubescens*, p. 179.
2. Up to 12 cm. in length; usually three to seven irregularly fragmented ocelli on each side of snout. Yellow, sometimes with decided tinge of orange, deep ochre or pale yellow ..... *L. flavescens*, p. 184.
3. Large, soft and flabby, up to 50 cm. in length; cephalic furrows remarkably long. Ocelli wanting. Dark brown of various shades of color, velvety; a series of narrow, pale yellow rings, expanded to diamond-shaped spots on dorsal surface, usually encircle body, but may be very inconspicuous. Dorsal surface usually corrugated longitudinally with series of very delicate, inconspicuous, longitudinal yellow lines. Tip of snout white, usually with two small orange-colored spots situated in an area of pale yellow on dorsal surface.  
*L. pictifrons*, p. 188.
4. Length 10 to 15 cm. or more; head broad; ocelli wanting. Dark brown with conspicuous median dorsal white or light yellowish stripe which expands on head to form a broad, pear-shaped marking. Usually a faint reddish line extends along each lateral margin of body ..... *L. albolineatus*, p. 193.



5. Body rather stout, flattened in intestinal region, fragile; length up to 15 cm. or more; head long and slender, with long cephalic furrows; ocelli wanting. Brownish, dark drab or purplish brown, with a series of very fine white rings, often much obscured; tip of head and borders of cephalic furrows white.

*L. wilsoni*, p. 195.

- aa. Caudal cirrus present. Body rather firm, not provided with thin lateral margins in intestinal region; incapable of swimming ..... *Micrura*.

1. Of small size, 4 to 8 cm. in length; ocelli wanting. Deep blood red, sometimes with tinge of purple; head of same color, with narrow, transverse, white crescent near tip of snout which has a small terminal black or dark brown spot surrounded by red continuous with that of ventral surface.

*M. nigrirostris*, p. 198.

#### SYSTEMATIC DISCUSSION OF NEW SPECIES

In the following pages those species recently found on the Pacific coast of North America which have proved to be new to science are described in detail from a study of both living specimens and prepared sections. Only those anatomical features are discussed, however, which offer peculiarities not found in most related species or which are of special interest from a morphological standpoint.

Included with the species new to science are certain forms which have not previously been recorded from the Pacific coast of North America. Of these only the most striking anatomical peculiarities are mentioned.

Descriptions of only those genera which were not represented in the collections described in Part I of this report are given place here. For the remaining generic descriptions the reader is referred to Part I, previous article.

#### 1. CARINELLA FRENATA sp. nov.

pl. xv, figs. 5, 6; pl. xxii, figs. 2, 3.

In general shape of body this species resembles those which are most typical of the genus, as *C. superba*, *C. capistrata*, *C. sexlineata*, and which have rather firm, moderately slender bodies. Head much broader than body, rounded or emarginate in front, much flattened dorso-ventrally, sharply marked off from body by deep, lateral, trans-

verse grooves. Head commonly quite as wide as long, but shape liable to the greatest variation. Proboscis pore and mouth as in related species. The color and markings on body are very characteristic and widely different from those of any described species of the genus.

*Size*.—Length of body 50 cm. or more, width 2–3 mm.

*Color*.—General color of body grades from a yellow cream or ochre in anterior third of body to a sage green in intestinal region. When filled with ripe ova the greater portion of dorsal surface of intestinal region becomes a rosy but opaque flesh color or dull rose color. On this ground color is arranged a series of remarkably sharp, deep brown, transverse and longitudinal lines and bands. There are three longitudinal, very distinct, dark brown or black lines throughout the length of the body, except on the head. One of these lies in the dorso-median line, while the other two are symmetrically placed on, or a little beneath, the lateral margins (pl. xv, fig. 5).

The color of the markings is beautiful and has a velvety luster; in some lights it appears somewhat iridescent and sometimes shows a rich, dark blue reflection. Of the three longitudinal lines the median dorsal line is much broader than the others. It commences on the extreme tip of snout, where it joins a narrow transverse terminal line of the same color. On the head it is broader than elsewhere and occupies about one-fifth the diameter of head. It continues through the transverse bands or rings, usually expanding a little where the rings are joined. In many cases the line can be traced directly through the transverse bands by a deeper color, as if the two markings had been painted the one over the other. In the intestinal region the median line occupies perhaps one-seventh the diameter of body. The two lateral or marginal lines each commence at the broad neck band (the first transverse band).

These lateral lines are scarcely more than one-third as wide as the median line; they are very sharp and clear cut in the anterior portion of body, but become more irregular in outline in the intestinal region. They are never wholly interrupted however. They are cut more sharply ventrally than dorsally, for on their dorsal side they sometimes fade out gradually into the general color of body. Like the median line, the lateral lines broaden out somewhat where they join the transverse bands, and, as is also true of the median line, they often show corresponding thickenings in places where the transverse bands are not formed or are very imperfect. A thickening of one line is almost always accompanied by a corresponding thickening of the other two, showing clearly where the transverse band would lie if it were present.

On the anterior third of body these longitudinal lines are situated directly in the yellow ground color, but in the intestinal region the median line is separated from the rose-colored ground color of the mature females by an irregular border of sage green thickly flecked with whitish dots. This sage green color probably represents the general ground color of the worms when the sexual products are absent; while the rose color, which seems to make up the general color of the dorsal surface of intestinal region, is due to the thickly-placed sacs of ova, which are of a pale rose color. In some regions these rose-colored spots are separated by a continuous green ground color, as shown in fig. 5, pl. xv.

The transverse markings are very numerous and are of various widths from the first two bands, which are more than half as wide as the body, down to the finest possible lines. Many are extremely fine, and many others incomplete. As a rule, the wider bands are separated by one or two much finer ones, and seldom, or never, are two of the wider bands immediately adjoining. The first transverse marking borders the extreme tip of head and is narrow and barely visible both on ventral and on dorsal surface. It extends laterally from end of median longitudinal line about half way to the posterior border of head. The second transverse marking occurs on the neck just back of the lateral furrows which separate the head from the body. This marking is broad and shield-shaped on dorsal surface, but is narrower laterally, while on the ventral surface it is interrupted by the mouth, which lies exactly in the region which would be occupied by the band if it were continued. The first band is about half as wide as body. The second is separated from the first by a distance about equal to twice the diameter of body, and is a little broader than the first on the dorsal surface. It forms a continuous band around the whole body, but on ventral surface it is not much more than half as broad as on median dorsal surface. The third band is separated from the second by a distance less than that between the first and second, and is somewhat narrower than either of these. The fourth is separated from the third by a greater distance than in any other case; it is as broad as the second, and is as wide ventrally as on the dorsal surface. The fifth is very narrow, the sixth broad, seventh narrow, eighth broad. Then come two imperfect narrow bands, and then a fairly broad one, and so on, through the remainder of the body, with a broad band usually followed by one or two narrow or imperfect ones. An individual measuring 50 cm. in length shows from seventy to one hundred of these transverse bands. In general the bands decrease in width toward the

posterior end of body. Many of the broader bands show a number (three to twelve) of fine, pore-like, pale dots in midst of dark band between the median and lateral longitudinal lines. Transverse bands often broaden out as they join the longitudinal lines (pl. xv, fig. 5), but a few are interrupted just ventral to the lateral longitudinal lines.

Ventral surface anteriorly same as dorsal surface in color, but with a more conspicuous flecking of minute whitish dots. In intestinal region the yellow color gradually assumes a more greenish tone, until imperceptibly a shade of sage green, or very light olive green, is reached, and this color extends through to the end of the body. The green color is more or less tempered and obscured by an irregular coating of very fine whitish dots which cover ventral surface irregularly, except near the median line; similar white flecks are scattered over the dorsal surface also.

After preservation in formalin or in alcohol the portion of the body situated immediately posterior to the third black ring becomes deep slaty blue or blackish in color. This dark color is sharply demarcated anteriorly, but fades out gradually after extending about as far as the ninth ring (pl. xv, fig. 6).

The pale ochre color with deep black rings and longitudinal lines is retained even in cedar oil and in paraffin. The colors, markings and shape of anterior end of body after preservation are strikingly suggestive of the abdomen of the yellow-jacket wasp (*Vespa*).

Proboscis pore is situated just below anterior end of median dorsal black line. Mouth, as stated above, lies in first transverse band.

In midst of lateral, longitudinal black line, and at the anterior border of the fourth transverse band (or in it) is a rather conspicuous, colorless, oval pore, representing the lateral sense organ, or 'side organ.'

Intestinal canal is usually greenish in color — sometimes sage green.

Body often shows a tendency to become constricted through the transverse black bands, and when broken the rupture takes place in these bands, as has been noted in other species of the genus.

*Cephalic glands* but little developed, appearing only as scattered gland cells lying beneath and beside the rhynchodæum. No glands whatever are to be found between the cephalic blood lacunæ and the basement layer of the integument. The integumental gland cells, on the other hand, are very highly developed, and form an unusually massive layer beneath the ordinary superficial glandular and ciliated cells. The secretion of these deeper glands of the integument is apparently of the same nature as that of the true cephalic glands, which in all probability serve merely to supplement the supply furnished by the in-

tegument. The few glands about the rhynchodæum do not extend back as far as the brain.

*Integument* of body remarkably thick and closely packed with glands. In the intestinal region the glands are vastly more abundant on the dorsal than on the ventral surface. It is in this layer that the pigment which gives the body its characteristic transverse and longitudinal dark markings is situated. Unless stained too deeply the position of the markings is distinctly seen in each transverse section.

*Proboscis*.—Of small size, yellowish or ochre in color. Muscular and epithelial layers as in other species of genus; fibrous layer, situated externally, unusually strong; proboscis nerves, beneath internal epithe-

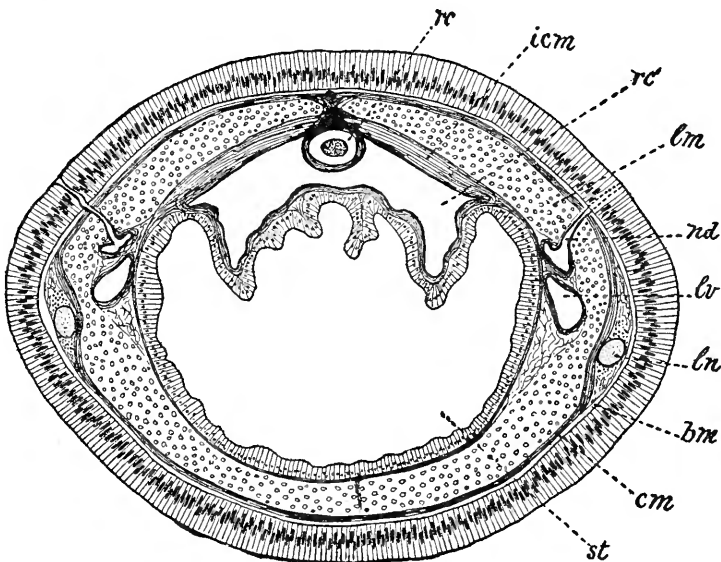


FIG. 17. *C. frenata*. Transverse section of body in region of nephridiopores.  $\times 25$ .

lium, remarkably large and conspicuous. Proboscis sheath well developed. In the exact region of the efferent nephridial ducts the cavity of the proboscis sheath becomes divided. A very small chamber, situated dorsally (text-fig. 17, *rc*), passes backward for some distance, and in this the retractor muscle of the proboscis extends to the posterior attachment; while the ventral chamber (*rc'*), which is very much the larger, passes backward but for a short distance where it ends in a broad, blind sac. The retractor muscle is attached to the dorsal wall of the smaller dorsal chamber a little distance back in the intestinal region, and



the proboscis sheath itself does not extend backward behind the anterior third of the intestinal region.

*Body musculature* consists of the usual circular and longitudinal layers, and presents few peculiarities save that the inner circular layer, which is found in the esophageal region, is remarkably thin, and does not exhibit distinct dorsal or ventral crossings with the outer circular layer, as is the case in several other species of the genus. Immediately in front of the nephridial openings the inner circular layer becomes several times as thick as it is anteriorly, while it disappears almost entirely just at the beginning of the intestinal region. The circular muscles of the proboscis sheath present a similar increase in strength in the same region, and are directly continuous with the inner circular muscles of the body wall (text-fig. 17, *icm*). These thickenings correspond in nature and position with the enormously thickened internal circular muscles in *Carinoma*.

*Blood System.*—Lacunæ in head and lateral vessels present no peculiarities. The pair of vessels situated within the proboscis sheath originate anteriorly just behind the mouth and extend back nearly half way to the intestinal region, being connected with the lateral vessels at frequent intervals. Their walls are thickened, much convoluted, and appear to be somewhat glandular in nature.

*Nephridia.*—The nephridial tubules are limited to about the third quarter of the esophageal region. They do not extend forward quite as far as the posterior ends of the proboscis sheath vessels. Their anterior branches are numerous, but of small size. They project inward from the lateral walls of the lateral blood vessels, very much as in *Carinoma*. The main longitudinal canals are large, and are situated in the parenchyma above the lateral vessels, and slightly separated from them. There is a single main longitudinal canal on each side, and this is usually about half the diameter of the lateral vessel in the same region. At its posterior end each of the longitudinal canals enlarges somewhat, and as usual sends off a large efferent duct (*nd*, text-fig. 17) to the dorso-lateral aspect of the body.

*Nervous System and Sense Organs.*—The cerebral sense organs are well developed for the genus, although they are not distinctly separated from the other nervous tissues, as in the case of *C. rubra*.<sup>1</sup> Yet there is a distinct ciliated canal leading from a specialized lateral furrow into the nervous tissues above and beside the dorsal brain lobe. The inner end of this ciliated canal (pl. xxii, fig. 2, *cc*) passes within

<sup>1</sup> Coe, Proc. Wash. Acad. Sci., III, p. 13, pl. x, fig. 2, 1901; also previous article, pagged identically.

the basement membrane and outer fibrous layer, and is thus well removed from the integument. Here it lies in close contact with the dorsal surface of the brain, and is closely surrounded by large nerves (Pl. XXII, fig. 2, *sn*) from the dorsal ganglia. Externally it terminates on a slight papilla in the middle of the distinct, though short, lateral groove with which the side of the head is provided. The epithelium of the groove is also unquestionably sensory in its nature, and lies in close proximity to the brain, from which it is supplied with numerous small nerves.

The lateral sense organs, or side-organs, are situated immediately behind the efferent nephridial ducts, as in other species. They are rather conspicuous in life, when they appear as colorless oval spaces in the midst of the lateral longitudinal black lines, and at the anterior border of the fourth transverse band. They are not very extensive, but possess a remarkable degree of specialization. The sensory cells are less than half as high as the neighboring cells of the integument, so that each of these sense organs appears as a conspicuous oval depression exactly on the lateral margin. The cells, too, are rendered still more conspicuous from the fact that the secretions situated deep among the cells assume a deep blue stain with hæmatoxylin and orange, while the integumental cells always take on more or less of the orange color, and are partially obscured by the dark body pigment. The relation of the sense organ to the other tissues is shown in Pl. XXII, fig. 3.

The brain and lateral nerves present no striking peculiarities. There are two dorso-median nerves as in several other species of the genus. The upper nerve lies in the median line, just external to the outer circular muscular layer, while the lower, or inner, lies directly beneath the former and just outside the inner circular muscular layer.

*Reproductive Organs.*—Sexual products are mature in August. The eggs are opaque and rose-colored, and give the characteristic rose coloring to the bodies of the females at this season. They develop in pouches in the parenchyma above the lateral nerves, and each pouch, containing from 20 to 50 or more ova, opens directly to the dorso-lateral surface of body. The oviducts are completely formed in advance of the deposition of the eggs, and are in all cases lined with a distinct layer of small, closely placed epithelial cells. Even before the eggs are fully mature the small pouches in which the ova of the following year are to develop are already established. Several ovarian pouches are encountered in each transverse section.

*Habitat*.—Several feet below low-water mark on piles of wharf, San Pedro Harbor, Calif.; not common. Only sexually mature females were obtained.

2. *CARINELLA ALBOCINCTA* sp. nov.

pl. xvi, figs. 4, 5.

Body rather stout for genus, but can become much more elongated than the figures indicate; not much flattened, rather firm, less soft than in *C. rubra* or *C. frenata*. Head of moderate size, of variable shape, broader than neck, from which it is demarcated by an annular constriction. When body is strongly contracted, however, the anterior portions become much swollen and wrinkled, and the head withdrawn into the body until it is partially hidden from view from above. A pair of very shallow transverse grooves lie on the lateral margins of head, just in front of neck. Esophageal region rounded, intestinal region not much flattened, posterior extremity not slender.

Proboscis pore subterminal; proboscis rather small. Mouth situated just back of annular constriction marking the neck, of variable size according to state of contraction of body.

*Color*.—General color of body usually a beautiful cherry red, sometimes inclining to brick red, and sometimes to purplish red, with a series of narrow, pure white rings. These rings are all very narrow, hardly thicker than a thread, though some are much finer than others and are merely indicated as very delicate hair lines. They are placed at varying intervals throughout the length of the worm, and most of them completely encircle the body. There may be 50–100, or more, in a large individual.

Tip of snout provided with a narrow, terminal border of white, which reaches back along the lateral margins of head for a little distance. This terminal white border extends to ventral surface, where it is fully as conspicuous as from above. When head is extended and obtusely pointed the white marking is angular, and extends back on the lateral margins for about half the length of the head. In the angle of the marking, on the ventral surface, lies the proboscis pore. When head is contracted strongly the terminal white border appears merely as a short transverse marking on each side of the proboscis pore.

The first white ring lies on the constricted neck portion, and is interrupted by the mouth (pl. xvi, fig. 5), so that it is incomplete ventrally. The second ring is commonly separated from the first by two to three times the width of the body. This ring is short and complete, but is thinner ventrally than on the dorsal surface. The third ring is about half as far behind the second as the latter is from the first. Then



follows a long series of similar rings separated from each other by an average distance of a little less than the diameter of body in moderate extension. Of course the separation of the rings depends largely on the state of contraction of body, for when strongly contracted they are less than a quarter as far apart as when extended. Nearly all the rings are complete, but many are thinner ventrally than above. Some are extremely fine, and others consist of double lines separated by a very thin line of the red color of body.

The general color of body becomes gradually lighter in intestinal region, which often has a slightly yellowish tinge. Ventral surface is of a lighter shade than dorsal, and has a grayish tinge.

After preservation in formalin or in alcohol the body assumes a dull reddish brown or purplish color, with very faint white rings. An abrupt change in color usually occurs at the second white ring, the parts anteriorly commonly being brownish, while those immediately behind the ring are often deep purple. The white terminal border on the head remains conspicuous when the worm is not strongly contracted.

*Size.*—Largest specimen observed was about 30 cm. long and 4 mm. in width, although others were less than half this size.

In internal anatomy the species presents few deviations from that described for related species of the genus.

*Proboscis* of rather large size for genus, with muscular layers and pair of large nerves as in other species.

*Musculature.*—Fibrous crossings between the external and internal muscular layers of the body walls are but little developed.

*Cephalic glands* are voluminous, and occupy a great portion of the tissues of the head in front of the brain.

*Alimentary canal* presents no striking peculiarities.

*Blood System.*—Cephalic blood lacunæ of large size. Their branches pass posteriorly as large lateral vessels, or lacunæ, which send off unusually numerous branches about the esophagus. These esophageal lacunæ pass ventrally well beneath the esophagus, and exhibit abundant anastomoses as in some species of *Cerebratulus*.<sup>1</sup> The rhynchocœl vessels originate some distance behind the mouth region, though not as far posteriorly as in *C. cingulata* (p. 141). As in the latter species, these vessels are short and of much less extent than in many related forms.

*Nephridia.*—The excretory tubules are limited to about the third and fourth fifths of the esophageal region. Anteriorly there are several canals which branch profusely among the lateral and esophageal blood

<sup>1</sup> Notably *C. lacteus*; Coe, Trans. Connecticut Acad. Sci., ix, p. 493, 1895.

vessels. Farther back these branches unite into about five to eight longitudinal canals on each side, which lie above the lateral blood lacunæ and do not join until they are near the efferent ducts. Here they unite to form a rather large lacuna, as in *C. cingulata*, from the dorsal wall of which the efferent duct leads to the dorso-lateral aspect of the body.

*Nervous System and Sense Organs.*—Brain and lateral nerves as in other species. Cephalic nerves numerous and of large size. Median dorsal nerve small. Cerebral and lateral sense organs are less well developed than in the other species described from the Pacific coast.

*Habitat.*—Rather common in 50–100 fathoms between San Pedro and Catalina Island, Calif. The worms live among red algæ, having almost exactly the same color, so that they are not easily discovered among the contents of the trawl. They are found associated with *Tæniosoma punnetti* and exhibit a similar tenacity of life.

### 3. CARINELLA CINGULATA sp. nov.

pl. xiv, figs. 2–4.

Body long, slender, subcylindrical, resembling *C. superba* in general appearance, and not strikingly different from *C. sexlineata* and *C. capistrata*, which are also found on the California coast. In general color of body, as well as in being furnished with narrow longitudinal and transverse white markings, there is considerable resemblance. The markings on body, however, are arranged in a very characteristic manner, and differ from those of any known species.

The head is considerably broader than neck, rounded, truncate or emarginate in front, flattened dorso-ventrally. It is marked off from body by a distinct annular constriction.

Body often shows constrictions in the annular white lines described below. Proboscis pore subterminal. Mouth large, situated on the constricted portion spoken of as the neck.

Length 15 cm. or more; width about 3–4 mm.

*Color.*—General tone of body is deep brown, varying sometimes to chocolate and sometimes to cinnamon brown. When filled with ripe genital products the general effect of the intestinal region is only pale brownish. Head much paler than body in color, with two narrow, transverse, terminal, dark markings—one on either side of the tip of the snout (pl. xiv, figs. 2–4). In certain states of contraction, these markings almost meet just dorsally to the proboscis pore.

On the neck is a darker brown transverse marking about one-fourth as wide as diameter of body dorsally, but which becomes narrower

laterally. Below the lateral margin it is quite narrow, and continues ventrally as a thin line which joins the one from the other side just at the posterior border of the mouth. This dark nuchal band is bordered posteriorly by a distinct white band of about the same diameter (pl. xiv, figs. 2-4).

On the ground color of the body are four longitudinal white bands, extending with more or less distinctness throughout the length of the body. These are situated symmetrically, two very near the lateral margins of body, and the other two dividing the dorsal surface into three equal parts. The lines all terminate anteriorly in the first white ring, situated just behind the dark nuchal band mentioned above. Anteriorly the lines are narrow, but on the approach to the intestinal region, broaden out very irregularly. Those on the dorsal surface encroach so greatly on the general brown ground color as to limit it to a narrow, brown, median dorsal stripe, and two other narrow brown stripes on lateral margins. The two lateral lines come to lie ventrally to the lateral margins, and become so wide as to occupy almost the whole ventral surface—the brown color being largely replaced by the brownish white of the longitudinal bands. This may be true of the worms only at the time when the sexual products are mature, for the pouches of reproductive elements are light in color and partially obscure the brown color of body. At other seasons the white lines would doubtless appear narrower, and the brown color of intestinal region would be more pronounced.

The body is divided transversely into unequal segments by a series of narrow white rings, situated at irregular intervals from the head to the posterior end of the body, as in *C. superba*. Most of these white rings are very narrow, but are rendered more conspicuous by being bordered, sometimes on both sides, and sometimes only on one, by fine brown rings which are continuous with the general ground color, but of a darker hue. These brown rings are often more conspicuous than the narrow white ring beside them, so that some of the annular markings appear dark, rather than lighter in color (pl. xiv, figs. 2-4). The brown rings pass through and interrupt the longitudinal pale bands. The color of the white markings, especially the longitudinal ones, appears to be superficial and applied in small, confluent spots, and not homogeneously.

The segment included between the first and second and that between the second and third white rings are each fully twice as great as any other segments. The rings are otherwise fairly regular in position, but are often interrupted or wanting on ventral surface. Prof. C. B. Wilson,

to whom I am indebted for specimens of this and other species of California nemerteans, states in his notes that "in some specimens the alternate white rings extend only to the lateral white longitudinal lines, and do not go entirely around the body."

After preservation in formalin, the region between the second and third white rings is much darker in color, as commonly occurs in the genus. As usual the contrast in color is very marked anteriorly, but shades off gradually beyond the third white ring.

A rather conspicuous rounded pit, of much paler color, situated exactly on the lateral margin of the body just dorsal to the longitudinal white band, and on the anterior border of the third white ring, marks the position of the lateral sense organ on each side.

The worms are prone to break up when captured, the fragmentation taking place at the white rings, where the body often shows constrictions.

*Proboscis*.—Proboscis sheath extends only a comparatively short distance into intestinal region, but is well developed throughout the esophageal region. Just in the vicinity of the nephridiopores the rhynchocœl becomes sharply divided into a smaller posterior cavity and an enlarged anterior chamber. The anterior chamber continues ventrally for a few sections as a blind sack beneath the smaller dorsal cavity into which the posterior end of the proboscis continues. These features are similar to those described for *C. frenata* (p. 133), but are less pronounced. Proboscis becomes separated from its sheath in the region of the mouth, and therefore some little distance behind the brain. It is provided with two large nerves which arise from the ventral ganglia at points of origin of the unusually large ventral commissure. The nerves pass dorsally and immediately enter the proboscis sheath, in the tissues of which they extend posteriorly for a few sections, when they enter the proboscis at its attachment to the sheath. The arrangement of the epithelial and muscular layers is as in related species.

*Musculature and integument* present no marked peculiarities. The basement layer beneath the integument is unusually well developed. Dorsal crossing of fibers between the internal and external muscular layers is much better developed than in any of the other known species from the Pacific coast.

*Cephalic Glands*.—In addition to the highly developed, deep-staining masses of glands in the integument of the head, a thick layer of similar glands is found around the rhynchodæum. These extend backward nearly to the brain, and are very conspicuous from their secretions, which stain deep purple in hæmatoxylin. The condition

in this species is intermediate between that described above for *C. frenata*, where these glands occur in the integument only, and *C. rubra*,<sup>1</sup> where they occur not only in the integument and around the rhynchodæum, but are thickly massed in the cephalic musculature as well.

*Blood and Nephridial Systems.*—Cephalic blood lacunæ and lateral vessels as in other species. Rhynchocœl vessels peculiar in that they do not appear in the anterior fourth of the esophageal region, and extend for only a short distance, terminating posteriorly in front of the anterior end of the nephridial system. During their short extent, however, they show numerous connections with the lateral vessels. The nephridia are of the normal type for the genus, with a main canal above the lateral blood vessel on each side. Anteriorly the canal branches out on the wall of the blood vessel as usual. The nephridia are of very limited extent, and occupy less than the middle third of the esophageal region. Posteriorly each of the main canals exhibits a sac-like enlargement, with highly columnar epithelium, from the dorsal wall of which the efferent duct leads to a dorso-lateral aspect of the body as usual. The efferent duct is not an open tubule, however, but spreads out in the external circular muscular layer into a broad, spongy meshwork, from which a small duct leads to the surface.

*Nervous System.*—Ventral commissure of brain even more massive than in most related species. Large and numerous cephalic nerves extend throughout the tissues of the head. Dorsal and buccal nerves are also of large size.

*Cerebral Sense Organs.*—Much less highly differentiated than in any other species of the genus yet described from the region. Ciliated canals wanting, the sense organ consisting simply of an oval area with differentiated sensory cells of smaller size and with longer cilia than elsewhere, and provided with a rather large nerve from the dorsal ganglion which lies adjacent, and just beneath the well-developed basement layer. The region is always conspicuous by the absence of the deeply staining glands which are found elsewhere on the body. Thus the cerebral sense organs differ but slightly in their histological features from the lateral sense organs found in the vicinity of the nephridiopores.

*Lateral Sense Organs.*—Small, but very sharply defined. They are situated on the lateral margins of the body immediately posterior to the nephridiopores. The sensory epithelium is made up of slender

<sup>1</sup>Coe, Proc. Wash. Acad. Sci., III, p. 14, Pl. IX, fig. 1, 1901; also previous article, pagged identically.

cells, which present a sharp contrast to the neighboring cells of the integument because of their comparative freedom from secretion. The general appearance of the sense organ is similar to that figured for *C. frenata* (Pl. XXII, fig. 2).

*Reproductive Organs.*—Sexual products mature in September. Sexual pouches are usually situated dorsally to the lateral blood vessel, and open on the dorsal aspect of the body.

*Habitat.*—Monterey Bay, Calif. Shallow water; not common. Dredged from soft bottom in fourteen fathoms off McAbee's Beach, Monterey Bay, Calif., by C. B. Wilson, 1899.

### Nemertopsis Bürger

Fauna and Flora des Golfes von Neapel, Monogr. 22, p. 548, 1895.

Representatives of this genus are characterized by extremely long thread-like bodies of firm consistency. They resemble *Emplectonema* in form, habits and general internal anatomy, but differ in having only four ocelli, which are symmetrically placed on the head, in armature of proboscis, and in other anatomical details.

The worms are quite as slender as those of the genus *Cephalothrix*, but they do not coil the body in a spiral.

Proboscis sheath very short, proboscis armed with well-developed central stylet and basis, and with two pouches of accessory stylets; cerebral sense organs small, situated well in front of brain. Cephalic glands usually well developed.

But two species of this genus have thus far been described, both of which have been found in the Mediterranean. A third form, described below, occurs on the Pacific coast of North America.

#### 4. NEMERTOPSIS GRACILIS sp. nov.

Pl. xv, fig. 1; pl. xx, figs. 10, 11.

This very slender species bears a close external resemblance in form and color to *N. peronea* (Quatr.) Bürger, but differs in several features of internal organization, especially in the structure of the proboscis armature and the extent of the intestinal cæcum.

Like *N. peronea* the body is extremely long and slender, probably more so than any other Nemertean found on the coast except species of *Cephalothrix*. The body is commonly 10 to 15 cm. or more in length, and usually less than 1 mm. in breadth. The head is slightly broader than the body, which is somewhat flattened dorso-ventrally, but of nearly equal width throughout its length. Mouth and proboscis have a common opening.

*Color.*—The color of the dorsal surface of the body is dull whitish with a tinge of brown, or sometimes decidedly brownish, with two narrow longitudinal bands of deep brown extending throughout the length of the body. Each of these brown bands is perhaps one-eighth as broad as the body. They lie near the median dorsal line, and are separated from each other by about twice the width of either band. On the head they lie just internal to the eyes, and do not extend quite to the tip of the snout (Pl. xv, fig. 1). They are sharply marked off from the much paler color between them, but show a tendency to shade off laterally into the general pale brownish color of the dorsal surface. Towards the lateral margins the brownish tinge becomes very inconspicuous and gradually shades off into the whitish or pale flesh color which covers the ventral surface.

*Ocelli.*—Four eyes of large size are arranged, as in *N. peronea*, to form the corners of a square (Pl. xv, fig. 1).

*Cephalic Glands.*—Enormously developed cephalic glands occupy the greater portion of the head and stretch far back into body, extending even as far back as the most anterior sexual pouches. In the esophageal region these glands often occupy more space than the proboscis sheath and esophagus together, and fill up the space usually taken by the body parenchyma, which is in this species very much more reduced than in *N. peronea*.

*Proboscis.*—The proboscis sheath is not much more than one-third as long as the body. The proboscis is provided with eight large nerves which reach back to the stylet apparatus; the muscular and epithelial layers are as in *Amphiporus*. Central stylet of proboscis slender, provided with an elongated, slender basis, measuring (in a single specimen) about 0.123 mm. in length by 0.02 mm. in average diameter.<sup>1</sup> The basis is peculiar in being of nearly the same diameter throughout (Pl. xx, figs. 10, 11), and not swollen posteriorly. The shape of the basis alone will readily serve to distinguish the present species from *N. peronea*, which has a short conical basis. The central stylet is rather slender, but my notes unfortunately do not indicate its dimensions, nor whether it is shorter or longer than the basis. Each of the two lateral pouches contains usually from four to six slender stylets. In the preserved specimens there is no evidence that the stylets have their heads lobed or five-parted as do those of *N. peronea*.

*Alimentary Canal.*—The intestinal cæcum, which lies in the median line directly beneath the esophagus, is very short indeed and is

<sup>1</sup>But a single basis was measured, so that these dimensions may not represent average measurements.

without branches. It is much shorter than in *N. peronea* and is separated from the brain by several times its length, while in *N. peronea* it is described by Bürger (*loc. cit.*, p. 549) as reaching nearly to the brain. In one series of sections of *N. gracilis* the cæcum itself extended through seventeen sections only, while there were about seventy-five sections between its anterior end and the brain.

*Nervous System and Sense Organs.*—Brain and nervous system present no important deviations from those of *N. peronea*. Cerebral sense organs small, much elongated, situated far in front of brain and connected with exterior as usual.

The sexual products ripen late in summer. The ovaries and spermaries lie directly above the lateral nerve cords, but when fully developed extend also internal to them.

*Habitat.*—Pacific Grove, Calif., among mussels and other growths on rocks at low water. Not common. Collected in same locality in 1899 by C. B. Wilson.

#### Paranemertes Coe

Proc. Wash. Acad. Sci., III, p. 32, 1901.

Three species (*P. carnea*, *P. peregrina*, *P. pallida*) of this genus have been described from Alaska (*loc. cit.*).<sup>1</sup> A fourth species was found abundantly at San Pedro and San Diego, California. This form agrees with those previously described in general anatomical features, but differs in regard to the number and arrangement of the ocelli, so that the part of the generic diagnosis which refers to the ocelli (p. 32) will have to be amended to read, "Ocelli minute, usually numerous, but sometimes consisting of but a single pair."

#### 5. PARANEMERTES CALIFORNICA sp. nov.

Pl. xv, fig. 2; Pl. xviii, figs. 1-5; Pl. xxi, figs. 1-9.

Body long, moderately slender, rounded or cylindrical in the short esophageal region, very much flattened farther back. Intestinal region much wrinkled when contracted, but smooth when body is well extended. Head small and acutely pointed in ordinary states of contraction. The snout, with the ocelli, can be retracted to a very considerable extent into the tissues of the head, very much as in some species of *Teniosoma*. Intestinal region flat and ribbon-like with thin margins which are sometimes bent towards the ventral surface. Posterior extremity rounded.

<sup>1</sup> Also previous article, identically paged. The peculiar fluted or braided appearance of the stylets (both central and accessory) of *P. peregrina* was not described in the previous article but is represented on Pl. xx, figs. 14, 15.



*Size.*—Length of largest specimen obtained 45 cm.; width 4–6 mm.; usual length 10–20 cm.

*Color.*—The colors are far less opaque than in most species, and are of such a nature as to give the tissues a remarkably translucent appearance. Anterior portion of body pale orange inclining to flesh color, sometimes more decidedly orange and sometimes pale flesh color. Head distinctly orange, but usually of a pale tint. Brain region a little more reddish in color. General color of intestinal region grayish flesh color, or very pale salmon, and somewhat translucent, but this ground color is so much obscured by the dark green color of the intestinal tract that in effect this region appears of a greenish tinge. Commonly the green color extends as a pair of broad, irregular longitudinal bands separated by a pale reddish median band (where the intestinal lobes do not show), and bordered on the lateral margins by pale, grayish salmon or occasionally by whitish.

The ventral surface is somewhat paler than the dorsal, and the median reddish band is replaced by the greenish color of the intestine.

On the dorsal surface near the anterior end of the body are two regions of slightly differentiated color, the one reaching back in the median line nearly to the brain, the other extending about as far posteriorly behind the brain as is this organ from the tip of the snout. These show simply as regions of more orange color, and the posterior region is separated from the flesh colored portion behind by a V-shaped, orange colored groove. The apex of the groove lies in the median line and points posteriorly, while its limbs extend obliquely antero-laterally to the ventral surface where they come nearly into contact in the median line. A similar, but very indistinct, V-shaped groove lies just posterior to the anterior orange colored region.

On the under side of the head is a pale area on the tip of the snout marked off posteriorly by an orange colored line from the still paler triangular area found on each lateral side of the head.

About 10–15 mm. back of the head (in an individual about 20 cm. long) darker areas appear on the sides of the body and increase in number back to the intestinal region. These indicate the pouches of the intestinal cæca which stretch forward far into the esophageal region, and which in the intestinal region are dark green in color. This color is very permanent and remains after preservation in formalin or in alcohol, and even after imbedding in paraffin. The green intestinal lobes nearly all fork distally, and each fork is again divided, but there is much irregularity in this respect.

The median dorsal band of pale reddish color is due to the color of



the fluid in the proboscis sheath. This is not very conspicuous in the esophageal region, where the proboscis fills most of the space in its sheath, but in the intestinal region the proboscis sheath is seen to be filled with a clear red fluid. The red color does not reside in the corpuscles, but exists in the fluid itself, while the corpuscles are nearly colorless. Occasionally an individual has the intestinal region grayish in color, and in such cases the proboscis sheath is very conspicuous as a wavy longitudinal, blood-red band about one-fourth the diameter of the body.

After preservation the esophageal region becomes almost colorless, but the intestinal tract gives a decidedly greenish color to the rest of the body.

*Proboscis*.—When extruded the proboscis appears of a reddish color due to the red rhynchocœl fluid within it, but when this fluid is pressed out the proboscis remains colorless. It is of fairly large size, and is provided with four or six pouches of accessory stylets in addition to the central stylet (pl. xviii, fig. 2; pl. xxi, fig. 3). The basis of the latter is rather long and slender, slightly narrower anteriorly, but of fairly even diameter throughout (pl. xviii, figs. 4, 5; pl. xxi, figs. 4-8). The stylet itself is moderately slender and about half as long as the basis, or sometimes a little more than half as long. There are usually two or three accessory stylets in each of the four or six pouches. All the stylets, both central and accessory, show a peculiar darker or more opaque portion about the head (pl. xxi, figs. 4-9). This darker portion extends perhaps one-sixth the length of the stylet. Measurements in a single specimen are: Basis of central stylet 0.36 mm. long, 0.1 in average width; stylets about 0.17-0.2 mm. in length.

In each of three specimens sectioned the proboscis was provided with ten large and distinct nerves. A fourth individual showed an abnormal condition in that there were twelve distinct nerves in a short region of the proboscis, although there was but the usual number (ten) both anteriorly and posteriorly to this region. A fifth specimen showed eleven nerves. The nerves are often one-half to three-fourths as great in diameter as the thickness of the longitudinal muscular layer. Muscular and epithelial layers as usual, but the basement layer beneath the internal epithelium is so very much thickened that it practically equals the circular muscular layer in thickness.

Proboscis sheath reaches fully one-half the entire length of the body, but does not extend into the posterior one-third of the animal. In this respect the present species agrees well with the other members of the genus from Alaska. Muscular layers of proboscis sheath enor-

mously developed as far posteriorly as the anterior portion of the intestinal region. In few other Hoplonemerteans is the proboscis sheath so powerful as in the present species (Pl. XVIII, fig. 1).

*Ocelli.*—The snout when well extended is sharply pointed, but can be withdrawn to a considerable extent into the tissues of the head. For this reason the two very small ocelli which are situated near the tip of the snout (Pl. XXI, fig. 1) are likely to be overlooked, and are difficult to see in the living worm. They lie deep in the tissues of the head and can usually be seen clearly only after the specimen has been cleared in cedar oil or some other suitable medium. Sometimes instead of two single ocelli, we find two groups each made up of two or more minute pigment spots (Pl. XXI, fig. 2).

*Cerebral Sense Organs.*—These are extremely small, measuring scarcely more than one-tenth the diameter of head in same region, lie some distance in front of brain, and connect with exterior on latero-ventral margin of head near tip of snout.

*Cephalic glands* are voluminous, composing the greater portion of the tissues of the head in front of brain. They are much interspersed with connective tissue and muscle fibers, and do not extend posteriorly to the brain in any considerable numbers. There are a few isolated *submuscular glands* in the esophageal region.

*Brain* small as compared with the diameter of head, but of the usual proportions.

*Muscular System.*—Just in front of brain, and in the region of the attachment of proboscis to its sheath, a longitudinal muscular layer arises quite independently and is distinct from the longitudinal muscles of the body walls. These muscles surround the brain, esophagus, and proboscis sheath. This secondary longitudinal muscular layer increases greatly in size back of brain, but remains separated from the musculature of the body walls by a thick layer of parenchyma. Back of the brain this muscular layer (*lm'*, Pl. XVIII, fig. 1) becomes thicker than the main longitudinal layer (*lm*) of the body walls, and its fibers are larger, more closely placed in their bundles and stain more deeply. It reaches a considerable distance into the esophageal region, but gradually the bundles comprising it become more and more separated from each other by parenchymatous tissue, and gradually they approach nearer the body walls. Some of the fibers attach themselves to the proboscis sheath just outside the circular muscular layer. Eventually they become arranged just internal to the longitudinal muscles of body walls and form a portion of this layer. Their fibers are much larger, however, and by an increase in number farther back give rise to the

main portion of the longitudinal muscles of body walls. In no other species, so far as I am aware, has any such condition been described, though an approach to it is met with in *A. nebulosus*,<sup>1</sup> where the submuscular glands develop to such an extent as to form a distinct layer which divides the longitudinal muscular layer into an outer and an inner portion.

An unusual amount of parenchyma surrounds the muscles, nerves, proboscis sheath, esophagus and other organs.

*Alimentary Canal.*—Especially remarkable is the short extent of esophagus, which separates from rhynchodæum just in front of brain, and enlarges posterior to this organ, as usual. Instead of extending far posteriorly, however, as in most related species, it is only about twice as long as the distance from tip of snout to brain. It then enters the dorsal wall of the intestine, the anterior portion of which in this case corresponds in position and histological structure to the intestinal cæcum of other forms, although it does not end blindly. An extremely short cæcum proper is, however, present and extends forward, with a few pairs of lateral lobes, for a very short distance anterior to the posterior opening of esophagus.

The portion of the canal posterior to the esophagus which corresponds to the cæcum of other forms extends backward for a long distance before merging into the intestine proper. This condition has evidently arisen from the disappearance of the long, slender pylorus of the typical Hoplonemertean, so that the esophagus opens very near the anterior end of the long cæcum, instead of far back, as in most other members of the order. I shall therefore refer to the cæcum all that portion of the alimentary canal which lies anterior to the intestine proper and exhibits lateral diverticula. This will include the short cæcum proper, together with the intestinal canal back as far as the intestine proper.

The character of the epithelial lining of esophagus agrees with that in related species. Where the esophagus enters dorsal wall of cæcum, however, a marked change in the character of its epithelium appears, as in other forms. Both the cæcum and the cæcum proper have the same anatomical and histological peculiarities. Both send off paired lateral diverticula, which are closely placed together, of rather small size (pl. xviii, fig. 3), and extend laterally somewhat above the lateral nerves.

The histological structure of the cæcum is as in related species,

<sup>1</sup>Coe, Proc. Wash. Acad. Sci., III, p. 49, pl. xi, fig. 1, 1901; also previous article, paged identically.

except that the cells in the lateral diverticula are provided with a peculiar granular pigment which gives them a deep green color. The same pigment occurs in the intestine proper, and is conspicuous in life, giving the body a large portion of its characteristic coloring. It is insoluble in alcohol, cedar oil, or the mounting media, and is far more conspicuous in preserved specimens after they have been placed in clearing oil. In the cæcum the pigment is limited to the lateral diverticula, and is not found in the central canal.

Toward the posterior end of the cæcum the diverticula become longer and the canal gradually takes on the character of the intestine proper near the most anterior sexual glands. The intestinal diverticula are very closely placed, and for the most part fork once or twice into two or four similar branches. These are very conspicuous in life or after clearing in oil, because of their deep green pigment, as stated above. Other than in the presence of this peculiar pigment the histological structure of intestine is as in related forms.

*Blood and Nephridial Systems.*—In the head, as well as posterior to the brain, the blood vessels branch out into very numerous branches, which ramify through the parenchyma, including both that which lies internal to the inner longitudinal muscles and that between the two longitudinal muscular layers which are described above. The vessels are all of small size, and extend on all sides above proboscis sheath and beneath esophagus, as well as laterally. Back toward the intestinal region they form the usual pair of lateral vessels. The proboscis sheath vessel is as in related species.

In regard to the nephridia, it is necessary to state that no well-developed nephridial tubules were found, although several series of sections were examined carefully back as far as the anterior sexual glands. A number of very fine tubules in the esophageal region may possibly represent the nephridial system, although they were scarcely to be distinguished from blood vessels. There were some indications that these tubules were connected with several very minute efferent ducts opening to the surface laterally, but this could not be demonstrated with certainty in any case.

*Reproductive Organs.*—Sexual products had evidently been recently discharged from individuals collected near the end of July. The ducts, which still remained open, connected with the dorso-lateral surfaces of the body.

*Habitat.*—Individuals of this species are rather common in sand at low water in San Diego Harbor. They were also obtained from sandy locations on Dead Mans Island, San Pedro. A single specimen

was collected on a pile of wharf in San Diego Harbor. When handled the worms exude an abundance of a milky mucus.

### **Carcinonemertes Coe**

American Naturalist, xxxvi, p. 440, 1902.

Parasitic Nemerteans living on various species of Crustacea. Body small, slender, often filiform, rounded, and of about the same diameter throughout; head without distinct lateral grooves, not demarcated from body. Body not usually coiled or much twisted, but often folded sharply, so that anterior portion of body lies parallel and in contact with posterior portion. Mouth and proboscis open together; esophagus extremely short, opening broadly into intestine through a large muscular chamber situated immediately behind brain; intestine broad, with short lateral pouches which are but little developed in posterior portion of body.

*Proboscis*.—Proboscis sheath without muscular walls, consisting merely of a thin membrane closely applied to the small proboscis. Proboscis but little developed, very small in size, and extremely short, without lateral pouches of reserve stylets, but armed with central stylet and basis only. Central stylet minute, basis small and slender. Stylet region of proboscis can be withdrawn but little behind brain; consequently anterior chamber is very short, without distinct muscular layers, without distinct nerves, and without a thickened glandular epithelium such as occurs in almost all other Nemerteans. Chamber immediately behind stylet small but muscular, and with a lining of flattened epithelium, while posterior proboscis cavity is very short, often almost spherical, highly glandular, connected closely with the rudiments of the proboscis sheath and embedded in the connective tissue which lies internal to the body musculature.

*Ocelli* two. *Cerebral sense organs* probably wanting.

*Cephalic glands* massively developed; a remarkable development of submuscular glands extends throughout whole length of body, usually forming a distinct layer internal to the muscular walls of body, and often thicker than all other layers of body wall combined.

*Body musculature* consists of a thin, oblique or circular muscular layer and a somewhat thicker, but yet weak, longitudinal layer internal to the former.

Usually oviparous, though fertilization often takes place internally, and sometimes a portion of the ova of an individual may be retained in the body until after the development of free-swimming embryos. Development without complicated metamorphosis.

## 6. CARCINONEMERTES EPIALTI Coe.

Pl. XIX, figs. 1-9.

American Naturalist, xxxvi, p. 442, 1902.

Body small, rounded, slender, of same diameter throughout; sexually mature individuals about 4-6 mm. in length and less than 0.5 mm. in diameter; head not demarcated from body; lateral grooves and cerebral sense organs very inconspicuous or wanting.

*Color.*—Bright orange, sometimes inclining more to reddish and sometimes to yellowish. Head a little paler, for the color is largely due to the intestinal lobes which extend forward to brain.

*Ocelli.*—A pair of ocelli of irregular outline, but sometimes crescent-shaped, lie about half way between tip of snout and brain. Sometimes the ocelli are irregularly fragmented, and the pigment is arranged in four irregular masses.

*Proboscis.*—Proboscis sheath greatly reduced, extending but little posteriorly to brain, where it becomes united with posterior chamber of proboscis (Pl. XIX, fig. 2). The sheath consists merely of few fibers of connective tissue supporting a very thin flattened epithelium, and can be seen only in favorable preparations.

Proboscis very minute and short, extending scarcely more than its own diameter posteriorly to brain (Pl. XIX, fig. 5). Rhynchodæum (fig. 5, *r*) slender; esophagus separates from proboscis cavity just in front of brain (fig. 5). Anterior chamber of proboscis (figs. 2, 3, *ac*) very small, not as long as the diameter of a brain lobe, lined with thin, scarcely glandular epithelium. Stylet region swollen (figs. 2-4) and provided with large and abundant gland cells (*g*) which open both into anterior chamber and into the narrow canal connecting this with cavity behind stylet region.

Basis of central stylet slender, about three to five times as long as broad (figs. 3-5), measuring about .027-.033 mm. in length and .005-.008 mm. in diameter. Basis slightly larger posteriorly than near attachment of the very minute stylet (figs. 2, 6). There is no trace of accessory stylets.

The usual small oval middle chamber lies directly behind stylet region and connects with anterior chamber by a canal (figs. 3, 4) which passes close beside the basis of the central stylet and which, though narrow, is broader than in many other Hoplonemerteans. Middle chamber, behind the stylet, is highly muscular, lined with flattened epithelium, and is often filled with fluid containing an abundance of granules resembling hardened secretions (fig. 3). These apparently originate in the posterior chamber, as described below.

The proboscis now bends sharply on itself in ordinary states of contraction and ends in an oval chamber with small lumen and very massive glandular walls (figs. 2-5, *pc*). The cells lining this chamber are highly columnar, irregularly arranged in several layers, and are thickly packed with secretions which have great affinity for ordinary stains. Posterior chamber closely imbedded in the surrounding connective tissue (figs. 4, 5), and this appears to be connected with the muscular walls of esophagus. Its movements are doubtless to a great extent dependent on the contractions of esophagus, which, as described below, is converted into a sort of muscular pharynx.

*Body Walls.*—Outer epithelium as in other genera, and richly provided with glands.

Muscular layers of body wall consist of a thin, external circular or oblique layer of muscles and an internal longitudinal layer (figs. 7, 8), somewhat thicker than the former, but yet thinner than in most related genera. Lateral nerves occupy the usual places internal to longitudinal muscular layer. In this species, however, they lie internal also to the thick layer of submuscular glands (figs. 4, 7, 8), and therefore nearer center of body than in other genera where these glands are not so highly developed.

There is very little body parenchyma, the intestine filling most of the space internal to the glandular layer, except at the time when genital products are developing.

*Cephalic Glands.*—Throughout the head the tissues are crowded with cephalic glands. Those situated more anteriorly open mainly on tip of snout (text-fig. 18; pl. XIX, fig. 5, *cg*), but farther back they open directly outward on all sides of body.

Back of brain they pass gradually into *submuscular glands* which extend as a distinct layer throughout entire body. The glandular cells composing this layer open directly outward to the surface (figs. 4, 7, 8, *sg*) and are situated on the whole circumference of body immediately internal to the longitudinal muscular layer. The glandular layer is in most regions so massively developed that it exceeds in thickness all other layers of body wall combined. The secretions of these glands furnish the sticky mucus by means of which the worms cling so tenaciously to the crab or to other objects.

*Alimentary Canal.*—The esophagus, which leaves the rhyndæum just in front of brain (pl. XIX, fig. 5), passes beneath the ventral commissure as a narrow tube lined with rather flat cells, as in other genera. Just back of brain, however, it becomes enormously enlarged with high, columnar, ciliated epithelium, richly provided with gland



cells. This portion of esophagus is highly muscular and somewhat barrel-shaped (fig. 5, *e*), projecting a little way backward into the broad intestine which immediately follows posteriorly. Its posterior portion is therefore surrounded by the intestine, indicating rudiments of the intestinal cæca found in other genera. Intestinal canal broad, with short lateral pouches which become very much reduced toward posterior end of body.

*Nervous System.*—

The nervous system shows few deviations from that in related genera. Brain fairly well developed. From dorsal lobes a pair of large nerves pass anteriorly to eyes and anterior portions of head. These are easily seen in living worms. No indications of cerebral sense organs were found either when the specimens were stained *in toto* or when examined in sections.

*Reproductive Organs.*— The pouches of genital products become enormously developed and encroach greatly

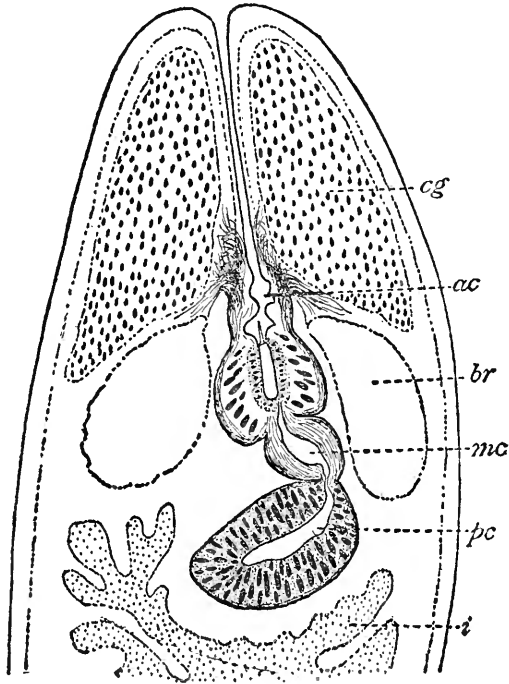


FIG. 18. *C. epialti*. Horizontal section through anterior portion of body; somewhat diagrammatic; *cg*, cephalic glands, *ac*, *mc*, *pc*, anterior, middle and posterior chambers of proboscis.  $\times 125$ .

upon the intestinal canal at time of sexual maturity (Pl. XIX, figs. 7, 8). Genital pouches extend farther forward than in almost any other Nemertean, reaching very nearly to brain. Ovaries (fig. 7, *ov*) regularly paired, with a single large pouch containing usually from twelve to thirty ova between each pair of intestinal lobes. Spermaries, on the other hand, far more numerous, surrounding intestinal canal on all sides. As many as fifteen or more separate spermaries (fig. 8, *s*) are sometimes found in a single transverse section of the body. As in most parasitic animals the abundance of sexual products is greatly in excess of that in related nonparasitic forms.

*Habitat.*—This is a much smaller and less slender species than *C. carcinophila* (Kölliker) Coe when sexually mature, and differs from it in regard to size of posterior chamber of proboscis, in the stylet apparatus, and in many other anatomical details, although the differences are not very considerable.

In general appearance, in color, arrangement of ocelli, esophagus, intestine, and brain the two species are very similar. *C. carcinophila* lives on the gills and among the egg masses of various species of crabs on the Atlantic coast of North America and on the coasts of Europe. *C. epialti* also lives when sexually mature among the egg masses of a crab—in this case *Epialtus productus*, the common kelp crab of the California coast.

Upwards of one hundred of these little worms were found among the eggs of a single crab at Monterey, Calif., September 3, 1901. In practically all, the sexual products were nearly mature, but no eggs were laid in confinement. The worm lived only a few days in a dish of sea water and appeared less hardy than the species on the Atlantic coast. I was unable to determine whether the worms pass their early life on the gills of the crab, as does *C. carcinophila*, but suspect that this may be the case.

## 7. AMPHIPORUS CRUENTATUS Verrill

pl. xx, figs. 1-6.

Proc. U. S. Nat. Mus., II, p. 184, 1879.

Trans. Connecticut Acad., VIII, p. 399, pl. xxxiii, figs. 7, 8; pl. xxxv, fig. 3, 1892.

This species, which has previously been found only in New England, is fairly common among various growths on the rocks of the break-water at San Pedro, Calif. A number of specimens were also obtained from piles at Monterey, Calif.

Body small, soft, rather slender, usually 10-25 mm. in length, of a pale yellow, bright yellow, or sometimes flesh color, and having very conspicuous vessels with deep red blood, the color of which resides in the large, discoid corpuscles.

Head slender, with inconspicuous oblique furrows placed far back from tip.

*Ocelli* usually five to ten on each lateral margin of head (pl. xx, fig. 6; text fig. 19), usually well separated, irregular in size and position; anterior ocellus on each side distinctly the largest and situated more superficially.

*Proboscis* very long and large, of a pale, slightly pinkish color.

Central stylet slender and acutely pointed, having a very slender basis of about the same length as stylet. Basis peculiar in that it is no wider, and is often narrower, posteriorly than at attachment of stylet. It is often irregular in shape (pl. xx, figs. 1-5) and about five or six times as long as its average width. Measurements vary from 0.07 to 0.1 mm. in length and 0.013 to 0.017 mm. in width. Two pouches of accessory stylets contain from two to four slender stylets each. Proboscis sheath reaches very nearly to posterior end of body. Retractor muscle of proboscis composed of about six strong fibers, attached in two groups to wall of sheath.

*Blood system* as in related species. In every individual of a large number of specimens the dorsal, or proboscis sheath vessel originated anteriorly from the right lateral vessel (text fig. 19).

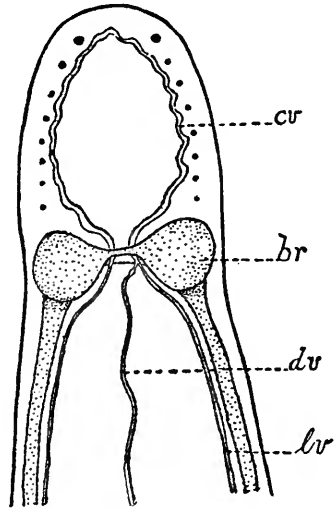


FIG. 19. *A. cruentatus*. Diagram of anterior portion of body, showing ocelli; *br*, brain; *cv*, *dv*, *lv*, cephalic, dorsal and lateral blood vessels.  $\times 30$ .

## 8. AMPHIPORUS PAULINUS Punnett<sup>1</sup>

Proc. Zool. Soc. London, p. 92, 1901.

Punnett describes this new species from several specimens collected by Professor D'Arcy Thompson in the Pribilof Islands. This is described as being a slender form, 50-90 mm. in length and up to 4 mm. in greatest diameter. Color in life unknown, but after preservation the worms assume a pale yellowish brown color dorsally, and are almost white ventrally. Submuscular glands well developed, reaching back to intestinal region. Intestinal cæca do not reach nearly to the brain. Proboscis sheath extends only about six sevenths the length of the body; the proboscis is about three fourths as long as body and contains fifteen nerves. Its armature consists of central stylet and two pouches with four reserve stylets each. Basis is same length as central stylet. A single efferent nephridial duct lies on each side. Cerebral sense organs small, situated immediately in front of brain. There are numerous ocelli.

<sup>1</sup>For the sake of completeness this species is included here, although it has not been studied by the writer.

## 9. TETRASTEMMA SIGNIFER sp. nov.

pl. XIV, figs. 9-11; XXI, figs. 10-12.

Body of moderate proportions or somewhat elongated for the genus, rounded throughout; not very changeable in shape. Head of moderate size, somewhat narrower than body, marked off from parts immediately following by rather conspicuous oblique lateral grooves; a second pair of similar oblique grooves lies farther forward on head, as shown in pl. XIV, fig. 11.

*Color.*—General color of body deep reddish brown or purplish throughout esophageal and intestinal regions. In the intestinal region the color is rather more opaque than it is farther forward. Ventral surface of the same general color as dorsal, but of a duller tone, and often much paler in the median line. This paler median band is sometimes quite distinct in the anterior esophageal region. A little back of the posterior pair of oblique lateral furrows the reddish color of body suddenly ceases, and the whole head is white, or colorless, except for a characteristic large dorsal marking. This marking is of a deeper brown and less reddish color, and is usually situated just anterior to the posterior pair of ocelli, although the relative position of these parts is largely dependent on the state of contraction of the head.

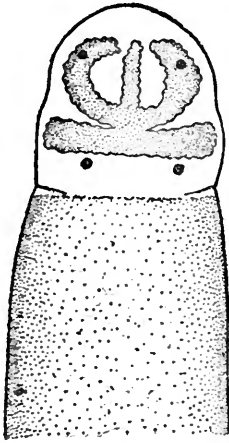


FIG. 20. *T. signifera*. Outline of anterior portion of body, showing shape of cephalic marking and arrangement of ocelli.  $\times 35$ .

In shape the marking resembles a wreath in heraldry (pl. XIV, figs. 9-11; text fig. 20), having a transverse, posterior or basal portion from which two semicircular branches pass anteriorly, but do not usually join. A fourth portion of the figure passes forward in the median line from the basal portion to the anterior ends of the semicircular lateral bands, but does not usually join them. All these parts of the marking have irregular edges so that the wreath-like effect is made still more striking. The general effect is often that of an open wreath with vertical crossbar and substantial base, the whole figure appearing upon a white field. The wreath is not always open, for one or both of its anterior ends may join the anterior end of the median longitudinal bar. The whole figure is surrounded by white, and is separated from the reddish brown of the esophageal region by a fairly wide band of the same

color. This white color also covers the whole ventral side of the head, as is shown in pl. XIV, fig. 10.

After preservation, and even after imbedding in paraffin, the dark brown color of body and the white anterior portions with the peculiar cephalic marking remain almost as distinct as in life.

Blood vessels are distinguished easily because of their reddish color. This color is resident in the oval or rounded discoid corpuscles, as in several other species of the genus. The corpuscles are very flat, with several small pigment bodies in each.

*Ocelli.*—The four ocelli are of rather large size, and arranged nearly in the form of a square (text fig. 20). They lie deep in the tissues of the head, and occupy a variable position as regards the marking on the head, but in ordinary states of contraction the posterior pair lies just behind the basal portion of the marking, while the anterior pair is situated beneath the antero-lateral portions of the wreath, as indicated in pl. XIV, figs. 9–11. As seen in sections, the eyes lie deep in the midst of the cephalic tissues.

*Size.*—Length about 15–25 mm.; width commonly less than 1 mm.

*Proboscis.*—Of moderate size; whitish or pale flesh color. Muscular and other layers as in related species. There are ten proboscicial nerves. Central stylet slender, acutely pointed; basis conical, opaque and granular in posterior third (pl. XXI, figs. 10–12).

*Body Walls.*—Composed of the usual layers. The pigment which gives the body its color is found in a thin, but very dense, layer between the integument and the basement layer, and to a less degree among the bases of the epithelial cells of the integument. It is even more dense in the cephalic marking than elsewhere. Nearly the whole space enclosed by the body walls is occupied by the internal organs, so that there is but very little body parenchyma.

*Submuscular glands* are almost entirely wanting. Cephalic glands are but little developed. Practically the only glands, therefore, which open at the surface of the body are the integumental glands. It was noticed in life that the worms of this species were remarkably free from mucus. There are numerous forms in which an abundance of mucus is associated with an unusual development of the submuscular glands (in *Carcinonemertes epialti*, for example), so that it seems probable that these glands furnish a supply of mucus accessory to that of the integument.

*Alimentary Canal.*—A pair of very slender intestinal cæca extend forward to abut against the posterior faces of the dorsal brain lobes. For a considerable distance behind their anterior ends these cæca are

less than half as great in diameter as are the lateral nerves, close beside which they lie. Quite anteriorly they are situated above the nerves, then gradually assume positions immediately internal to them, and farther back, and after increasing somewhat in size, come to lie beneath, as well as internal to, the nerves. At a point about one-fourth the distance from the brain to the most anterior sexual glands the cæca of the two sides join to form a single broad chamber beneath the esophagus. This is provided with a few broad lateral pockets, which are but slightly differentiated from the main chamber. At about two-thirds the distance from the brain to the most anterior sexual glands the narrow esophagus empties through the dorsal wall of the broad intestinal chamber, which shows but slightly developed lateral pouches in front of the anterior sexual glands, although they are well developed farther back.

The anterior portion of the esophagus is lined with highly columnar ciliated cells, closely packed together with massive gland cells. These latter gradually disappear more posteriorly until there is only a single layer of short cells filled with a clear cytoplasm and provided with long cilia, which line the narrow posterior portion of the esophagus — or the 'pylorus' as it is called by Bürger.

*Nephridial and Blood Systems.* — The nephridia are remarkably limited in extent, but consist of unusually large tubules. They are situated above the lateral nerves, beside the esophagus, and immediately behind the brain. Two large canals often occur on each side, one of which lies above and the other below the slender intestinal cæcum. After a very short extent, they unite to form a remarkably large efferent duct on each side, which passes above the lateral nerves to open on, or immediately below, the lateral margin of the body as usual. In no other species of Nemertean have the efferent ducts been found to be of such great volume as compared with the size of the body.

The blood vessels show no remarkable deviations from those in related species. Many of the larger vessels are filled with large, oval corpuscles, with very distinct nuclei.

*Sense Organs.* — The cerebral sense organs are voluminous and highly specialized. They are situated immediately in front of the brain. The large duct with which each communicates with the exterior passes anteriorly to the ventro-lateral margin of the head as usual. The brain shows a correspondingly high degree of development, being remarkably large for the size of the body.

*Reproductive Organs.* — Sexual products are mature in August.

*Habitat.* — San Pedro Harbor, Calif., on piles of wharf; off San Pedro, in 3–6 fms. on hold-fasts of kelp; not very common.

## 10. TETRASTEMMA NIGRIFRONS sp. nov.

Pl. xv, fig. 7; Pl. xvi, figs. 6-9; Pl. xvii, fig. 1; Pl. xx, fig. 16;  
Pl. xxi, figs. 15-23.

Body of moderate proportions, or rather slender for genus, rounded throughout. Blood corpuscles red in color. Head more variable in size and shape than in many related species; provided with two pairs of lateral, oblique furrows of more than ordinary distinctness. In Pl. xv, fig. 7 and Pl. xvi, fig. 6, the head is represented as being well extended, while in Pl. xvi, fig. 8, and Pl. xvii, fig. 1, it is considerably contracted. The anterior pair of furrows lies between the anterior and posterior pairs of ocelli; each furrow extends on dorsal surface from lateral border obliquely backward toward the median line, but fades out gradually before meeting its fellow; on the ventral side the furrows extend obliquely forward and join in the median line not far behind the rhynchodæum opening (Pl. xvi, fig. 7). The posterior pair of furrows is situated just behind the posterior pair of ocelli, and serves to mark off the head from the body. Conspicuous lateral constrictions at this point often accentuate the position of these furrows. They, too, pass obliquely backward on dorsal surface, but are not very distinctly marked in most cases.

*Color.* — In peculiarities of color and markings this species presents more variations than any other Nemertean described in this paper. A superficial examination led me to believe that no less than three species were represented by individuals which on more extended study were found to present all degrees of intergradation. They all agree in internal organization, and are all similar in having a whitish or pale yellowish head provided with a dark, dorsal marking of variable size and shape. The under side of head is whitish or very pale in all varieties. All agree, moreover, in having a deep red color in the blood corpuscles. The three more distinct color varieties suggest the varietal designations *purpureum*, *bicolor* and *pallidum*.

Variety *purpureum* (Pl. xvii, fig. 1). — Head opaque white, with large, shield-like dorsal marking of very dark brown color. This marking is rounded in front, and deeply bilobed in the median line; it is somewhat wider posteriorly and commonly shows two conspicuous indentations near its posterior end; posterior border of marking usually straight. The white color of head extends a short distance back of the marking, or as far as the posterior oblique furrows, where it abruptly changes to a deep rich purple, which color extends to posterior end of body. The individual shown in Pl. xvii, fig. 1, is represented as somewhat contracted, and the white color behind the marking



is consequently narrower than where the head is more fully extended. The line separating the white color of head from the purple of body is as sharp as possible. Ventral surface of same general color as the back, but somewhat paler and with a more reddish tinge; often with a much paler median band anteriorly. Color of ventral side of head whitish, separated abruptly from body color on a line corresponding to a similar line of demarcation on dorsal surface. Some of the purple individuals become reddish brown in intestinal region.

Variety *bicolor* (pl. xvi, figs. 8, 9). Head whitish with tinge of brown, with broad, triangular dorsal marking of dark brown. This marking is widest behind, with its obtuse apex in the median line anteriorly. Behind the head the color of body abruptly changes to deep rich brown, with a narrow median band of white. The brown color is deepest along the borders of the median white band, and is much paler laterally; toward the lateral margins of body it becomes pale brownish, and this color continues to the ventral surface, becoming gradually paler toward the median line. The ventral surface is therefore pale brownish, and this color continues on the ventral side of the head.

The third variety, *pallidum* (pl. xv, fig. 7), is much less deeply colored than those above described, and has a much narrower marking on the head. The marking is of the same deep brown color as in the other varieties, but is often less than one third as wide as the head. It is commonly acutely triangular with its pointed apex in the median line anteriorly. In this variety the ocelli are situated about half-way between the narrow marking and the margins of the head. The general color of head is whitish with a faint tinge of brownish. The whole body back of the head is of a pale brownish or buff color, or it is occasionally whitish with a faint tinge of brown. Oftentimes a paler, or whitish, line extends longitudinally on the dorsal surface, sometimes reaching posterior end of body. Ventral surface in this variety is pale buff throughout. The red blood vessels are naturally more conspicuous than in the darker varieties.

A variety which occurs on piles at San Pedro is deep flesh color with tinge of orange dorsally, and with dark brown cephalic marking. Ventral surface is grayish.

Another variety, common on the piles at Monterey, is shown in pl. xvi, figs. 6, 7. In this the head is opaque white with a moderately large wedge-shaped dorsal marking of dark brown color on head. Back of head and throughout body the color is reddish brown, thickly sprinkled with minute dots of darker color. Ventral surface



of head white, and this white color extends as a narrow band backward along ventral median line as far as the intestinal region (pl. xvi, fig. 7).

In some individuals of the other varieties mentioned a much paler band extends backward along the middle of the ventral surface in the esophageal region, and this band is often directly continuous with the pale color of the ventral surface of the head. In most cases this ventral band is not sharply demarcated, but shades off gradually into the darker color toward the sides of the body.

Other specimens are pale brick red in esophageal region, and chestnut brown posteriorly, with ventral surface grayish or pale reddish. In fact, there are all possible gradations between the most extreme color varieties.

Pigment to which color of body is due resides among the basal portions of the cells in the integument. The pigment of the cephalic marking, on the other hand, is situated among the cephalic tissues internal to the circular muscles. When the worms are kept for some time in stale sea water these outer tissues, including the pigment, are sloughed off, but the worms, which are very hardy, remain alive and crawl about for several hours more in this condition. Such worms are pale pinkish or flesh color with the ocelli and red blood vessels showing very conspicuously.

The general brownish color on the dorsal surface of the worms is retained after long preservation, and the cephalic marking is perfectly distinct even after imbedding in paraffin.

*Ocelli.*—The four medium-sized ocelli lie deep in the tissues of the head and occupy a variable position as regards the cephalic marking. Their position also varies greatly according to the state of contraction of anterior portion of body. When head is somewhat contracted the ocelli form a square (pl. xvi, fig. 8), but when well extended (pl. xv, fig. 7 and pl. xvi, fig. 6) the distance between anterior and posterior pairs of ocelli is considerably greater than between the two ocelli of the same pair. In an occasional specimen one or more of the ocelli are double, owing, no doubt, to fragmentation of the normal ocellus.

*Size.*—Largest specimens found were about 70 mm. long, and about 2 mm. in diameter, while the majority of sexually mature individuals were not more than 20–30 mm. long and 1 mm. wide. Many immature individuals were of much smaller size.

*Proboscis.*—Proboscis sheath extends to posterior end of body. Proboscis pale, often slightly pinkish. It is provided with ten conspicuous nerves. Basis of central stylet of the ordinary conical form,

with swollen, rounded posterior end. As shown in pl. XXI, figs. 16-23, there is considerable variation in size and shape of basis. Figs. 22 and 23 were drawn from two specimens of the same color variety collected at the same time, and yet the difference in size and shape of basis is greater than commonly occurs between two related species. The central stylet is of moderate proportions, not particularly sharp, and is usually a little more than half as long as basis. There are commonly three stylets in each of the two lateral pouches, although there are sometimes four, or occasionally only two in one or both of the pouches. Measurements of several specimens show the following variations :

Length of Basis.	Diameter of Basis at Widest Part.	Length of Stylet.
.17 mm.	.10 mm.	.08 mm.
.15	.08	.09
.14	.07	.08
.14	.06	.07
.12	.05	.08
.11	.05	.07
.11	.05	.06

The length of the longest basis measured is therefore more than half as long again as the shortest, while the diameter of largest is just twice that of smallest. The length of stylet, on the other hand, is much less variable, the longest being only half as long again as the shortest.

The posterior portion of basis is dark and granular (pl. XXI, figs. 16, 17), but gradually assumes the usual translucence in the anterior half.

*Body Walls.*—Integument and musculature as in related species. Pigment of dorsal surface situated among the basal portions of the integument. Basement layer of body walls thicker than in most species of the genus, and the species is also peculiar in having a rather large amount of body parenchyma separating the organs of the body. This parenchyma extends forward into the head in front of the brain.

*Cephalic glands* are fairly well developed and surround the rhynchodæum on all sides, but they do not extend back as far as the brain. Submuscular glands are wanting.

*Alimentary Canal.*—The rhynchocœl separates from the esophageal opening well in front of the brain, so that the rhynchodæum is unusually short. When the proboscis is partially extruded, the esophageal opening (mouth) appears almost like a separate aperture. A pair of slender diverticula of the intestinal cæcum reach forward to the dorsal brain lobes. They extend backward above the lateral nerves for some

distance, and then unite with the main cæcum, situated beneath the esophagus, as usual. Other pairs of slender diverticula are given off at intervals from the main cæcum, and these also pass forward to the dorsal side of the lateral nerves and end blindly at their anterior ends. The posterior portion of the esophagus is not very slender, and it unites with the intestine in front of the most anterior sexual glands.

*Blood System.*—The blood vessels are often very conspicuous in life, especially on the ventral surface of the body, because of their deep red color (pl. xvi, fig. 9). The coloring matter resides in the corpuscles themselves, which are oval and discoid. The union of the three longitudinal vessels at the posterior end of body is especially conspicuous, and corpuscles are seen to pass freely, but without regularity, in either direction in the same vessel. Their movement, either backward or forward, seems wholly dependent on the contraction of particular parts of the body, and is not controlled by any direct contraction of the walls of the vessels.

The blood vessels are also conspicuous in sections because of their content of large corpuscles with deeply staining nuclei. In many cases the vessels are so closely packed with these corpuscles that they are more conspicuous in the stained sections than most of the other organs of the body. The dorsal vessel lies within the rhynchocœl in the anterior portion of its course. The general relations of the vessels are as in related species, and the presence of the corpuscles allows the course of even the smaller vessels easily to be followed. Similar corpuscles are found abundantly in the rhynchocœl.

*Nephridia.*—The nephridial tubules extend from the brain region well back toward the end of the esophageal region. The tubules are largest anteriorly, where they ramify in the body parenchyma both above and below the lateral nerves, as well as beside, and a little in front of, the brain. There is a single pair of large efferent ducts, and usually one or more pairs of smaller ones. The large ducts are situated about on a level with the posterior ends of the dorsal ganglia, and pass obliquely downwards to open somewhat below the lateral margins of the head. Sometimes a second, smaller efferent duct lies near the larger one. Well back in the esophageal region a pair of smaller efferent ducts pass above the lateral nerves to open a little below the lateral margins of the body as usual. These smaller accessory ducts are not found in all individuals.

*Cerebral Sense Organs.*—These sense organs are situated some little distance—about their own diameter—in front of the brain, and somewhat nearer the ventral surface. The large ducts which com-

municate with the exterior pass anteriorly and ventrally to open on the latero-ventral aspects of the head, as usual.

*Reproductive Organs.*—Sexual products were found to be nearly mature early in September, but none of the eggs could be made to develop at this time by artificial fertilization. They are probably usually discharged late in September or in October. The sexual glands do not extend forward as far as the opening of the esophagus into the intestine, as they do in many related species. They are surrounded by a considerable amount of parenchyma, except when fully mature. The genital ducts were preformed as far as the basement layer of the body walls during the latter part of August. These ducts all open on the dorsal surface of the body, although in the male some of the spermaries are situated ventral to the lateral nerves. In such cases a long duct from each spermary passes internally to the nerve to open through the body walls above the lateral margin, as in the case of the glands situated dorsally.

*Habitat.*—Among algæ between tides, Pacific Grove; common. On piles of wharf, Monterey; abundant. In similar situations, San Pedro Harbor; not common. Collections of bryozoa and small algæ from piles at Monterey always furnished many specimens of this conspicuous, but variously colored species when left standing a short time in sea water. As noted above, these worms are very hardy, moving about actively for several hours after the pigmented integument has been sloughed off. When placed in formalin they do not break up spontaneously, but usually die intact and well extended.

#### 11. TETRASTEMMA BILINEATUM sp. nov.

pl. xiv, fig. 6; pl. xxi, figs. 13, 14; pl. xxii, fig. 4.

A minute species, measuring when sexually mature only 5 to 10 mm. in length, and less than a millimeter in diameter. Body rounded throughout, of moderate proportions, but rather shorter and stouter than in many related species. Head of moderate size, provided with two pairs of faintly-marked oblique grooves, but not distinctly separated from the parts following.

*Color.*—General color of body flesh color, creamy, or grayish, with two very conspicuous deep brown stripes extending along the dorsal surface nearly the whole length of the body. The longitudinal stripes are sometimes reddish brown and sometimes deep chocolate. The ventral surface is mainly grayish. Anteriorly the stripes terminate somewhat in front of the ocelli, but sometimes reach the very tip of the snout. Posteriorly they extend nearly, though not quite, to

the posterior extremity of the body, and are sharp and conspicuous throughout. The diameter of each stripe is perhaps one-sixth the diameter of body, and the two are separated about twice the diameter of each. In ordinary states of contraction the stripes are not quite as widely separated as are the ocelli, so that they pass medially to the latter. In preserved specimens the stripes retain their rich brown color even after imbedding in paraffin.

*Ocelli*.—The four ocelli are of moderate size, and, as in many related species, usually occupy the corners of a square (Pl. XIV, fig. 6). They are situated deep in the tissues of the head. There is no trace of pigment between the two ocelli of the same side.

*Proboscis*.—Presents few deviations from the normal type, and, as usual, is provided with ten nerves. Basis is of very small size, rather slender, and but slightly enlarged posteriorly. Its average length is only about .05–.07 mm. and its width .02–.025 mm. The central stylet is rather slender (Pl. XXI, figs. 13, 14); each of the two lateral pouches contains two or three accessory stylets. Proboscis is attached a little in front of brain; proboscis sheath does not extend quite to posterior end of body.

*Body Walls*.—The pigment which gives the brown color to the longitudinal dorsal bands (Pl. XXII, fig. 4, *pig*) is conspicuous in every transverse section of the body. It is not situated in the integument, but occupies the inner portion of the longitudinal muscular layer. Throughout the whole body, except in the head and most anterior esophageal region, the anastomosing pigment cells largely obscure the muscular fibers in the region where they are situated. This causes the longitudinal muscular layer to appear interrupted by an elongated dark mass on each side of the proboscis sheath. Just back of the brain, where the muscular layer is thickest, the pigment masses lie on the internal border of this layer, but farther back they occupy its whole thickness (Pl. XXII, fig. 4).

*Submuscular glands* appear only in anterior esophageal region, and are but little developed.

*Alimentary Canal*.—A broad intestinal cæcum extends forward through about half the length of esophageal region. It lies beneath and beside the esophagus, which opens through its dorsal wall posteriorly.

*Nephridia*.—Situated in the middle portion of the esophageal region. A single pair of efferent ducts passes immediately above the lateral nerves to open on the surface of the body just beneath the lateral margins. The efferent ducts are situated only a few sections posterior to the anterior end of the intestinal cæcum.

*Nerves and Sense Organs.*—Brain is of large size, with remarkably large ventral commissure. Cerebral sense organs remarkably voluminous, situated immediately in front of brain, and extending somewhat beside and beneath the ventral ganglion. Canal to exterior is of large size, and extends well forward toward tip of head, to open below lateral margin in a shallow oblique furrow.

*Reproductive Organs.*—Sexual products are mature in August. The most anterior reproductive pouches in the males are situated well forward in the esophageal region, or, in other words, well in front of the opening of the esophagus into the intestine. The anterior spermaries lie beneath the lateral nerves, but in the intestinal region, where several spermaries appear in each transverse section of body, they are found in smaller numbers above the nerves. The ovaries occupy similar positions in the female. The eggs when mature are very large in proportion to size of body, being fully one-third its diameter.

*Habitat.*—Common among bryozoa and tunicates (*Cione*) on piles of wharf in the harbor of San Diego, Calif.

## 12. TETRASTEMMA QUADRILINEATUM sp. nov.

pl. xiv, fig. 5; pl. xx, figs. 12, 13.

Body short, broad and stout; somewhat flattened, but with rounded edges. Head usually narrower than body; provided with the usual pair of lateral oblique grooves, which appear as slight constrictions opposite the posterior pair of ocelli. Intestinal region broad and somewhat flattened. Intestinal cæca not much branched; reaching nearly to brain region.

*Color.*—General color of body whitish, with four longitudinal deep brown stripes. Two of these stripes lie near lateral margins of body, while the other two are situated symmetrically on the dorsal surface. The two dorsal stripes are much the wider, and are each about equal in width to the white median stripe which lies between them. They are narrower on the head, and terminate anteriorly a little in front of the anterior pair of ocelli. Posteriorly they extend to the end of the body where they likewise become much narrower. These broad dorsal stripes are smooth in outline, but the lateral stripes, which are very much narrower, usually present a much broken and ragged appearance. In some individuals the lateral stripes are fully three-fourths as wide as the dorsal, but ordinarily they are less than half as wide. The two lateral stripes are strictly marginal, and ordinarily do not show from dorsal surface unless the animal is somewhat compressed. They each terminate anteriorly in the vicinity of the lateral

grooves on the head, or a little behind them. The white space separating the lateral from dorsal stripes is nearly equal to the width of one of the dorsal stripes. While the color of the stripes is always a deep rich brown (pl. xiv, fig. 5), the whitish ground color is subject to considerable variation in different individuals and in different states of development of the sexual products.

The head is usually pure white except for the brown stripes; esophageal region commonly pure opaque white, although several mature male specimens were pale yellowish or flesh-colored in this region. Intestinal region commonly has a tinge of yellow or of pale salmon, due to the color of the intestinal lobes which show through the other tissues. When filled with mature ova, the intestinal region often has a yellowish or very pale greenish tinge, while the males may be pale flesh colored.

The ventral is of practically the same color as the dorsal surface, but the effect of intestinal lobes and sexual products is here more marked, so that in the intestinal region there is often a tinge of salmon (from the intestinal lobes), of flesh color, or of greenish yellow (from the sexual products). The color is also affected by the dorsal brown stripes which show through the other tissues to some extent.

Proboscis whitish; brain pale yellow in color.

The four dark brown stripes are quite as conspicuous after preservation, and even after imbedding in paraffin, as they are in life.

*Ocelli.*—The four medium-sized ocelli are arranged nearly in the form of a square in ordinary states of contraction of the head. Their relative position to the brown dorsal stripes is very variable, because they lie so deep in the tissues of the head as to be unaffected by the contraction of the superficial tissues in which the pigment of the stripes resides. Commonly, however, they lie in or just lateral to the brown stripes—the anterior pair lying near the anterior ends of the stripes, and the posterior pair about on a level with the lateral oblique grooves, as these appear on the margins of the head (pl. xiv, fig. 5).

*Size.*—A small species, averaging only about 8–12 mm. long, and less than 1 mm. in width, when sexually mature.

*Proboscis.*—Proboscis sheath extends to posterior end of body. Basis of central stylet bell-shaped, short, much enlarged and rather abruptly truncated posteriorly (pl. xx, figs. 12, 13). Central stylet about three-fourths as long as basis, rather small, but of typical proportions. Each of the two lateral pouches usually contains two accessory stylets, in size and shape like the central stylet. Basis measures about .06–.07

mm. in length, and .04-.05 mm. in diameter near base; central stylet .045-.055 mm. long.

Retractor muscle of proboscis attached to the dorsal wall of the sheath at about two-thirds the distance from head to posterior extremity of body. Proboscis of large size, provided with ten large and conspicuous nerves.

*Body Walls.*—The pigment of the four dark longitudinal lines appears perfectly black in mounted sections, and is always very conspicuous. It is situated in the basal portions of the integument.

*Cephalic glands* are well developed, and fill up a considerable portion of the tissues of the head in front of the brain.

*Alimentary Canal.*—A pair of broad diverticula of the intestinal cæcum extends forward above, and a little in front of the dorsal brain lobes. Shortly behind the brain the two diverticula join the broad unpaired cæcum which lies beneath the esophagus. This latter portion of the alimentary canal swells out into a large chamber immediately behind the brain, while its slender posterior portion (pylorus) does not empty into the dorsal wall of the intestine until well behind the most anterior sexual glands. The broad intestinal cæcum sends off a few pairs of large diverticula. The most posterior of these extend between the anterior sexual glands, while the most anterior pair terminates above the dorsal ganglia, as mentioned above.

*Nephridia.*—The nephridial system is remarkable for its short extent and for the fact that the efferent ducts open on the head immediately beside the dorsal ganglia. The nephridial tubules lie above the anterior portions of the lateral nerves, but do not extend more than a very short distance behind the brain. A few branches also ramify beside and a little in front of the dorsal ganglia. The efferent ducts are rather large, and open on the sides of the head about on a level with the middle portions of the dorsal ganglia.

*Cerebral Sense Organs.*—These are of moderately large proportions. They lie a little in front of the brain and somewhat nearer the ventral surface. The ducts communicating with the exterior pass anteriorly to open on the ventro-lateral aspects of the head as usual.

The *lateral nerves* unite above the posterior end of the alimentary canal.

*Reproductive Organs.*—The sexual products were found to be nearly mature in August. As in most species of the genus, the sexual glands are very voluminous, and occupy the greater portion of the body in the intestinal region. As stated above, the most anterior sexual pouches lie some distance in front of the opening of the esophagus into



the intestine. The distance from the tip of the snout to the anterior sexual pouches is therefore very short.

*Habitat.*—Among ascidians and other growths on piles of wharf in San Pedro Harbor, Calif.; fairly common. Sexually mature in August. Ova large, opaque; pale greenish in color.

This new species resembles both *T. vittatum* (Hubrecht) Bürger<sup>1</sup> and *T. quadristriatum* Langerhans<sup>2</sup> in general appearance, and in having four longitudinal brown lines on dorsal surface. In the former species, however, the four lines usually become confluent behind the head in two quadrangular patches which send two fine lines between the posterior pair of ocelli; in the latter species the two median lines extend to the tip of the head before uniting, while the lateral are interrupted between the ocelli and do not unite on tip of head. In *T. quadrilineatum*, as described above, the median lines reach nearly to tip of snout, but do not join each other, while the lateral lines usually end behind the ocelli.

13. TETRASTEMMA (ÆRSTEDIA) DORSALE (Abildgaard)  
McIntosh

*Planaria dorsalis* ABILDGAARD, Zool. Danic., IV, p. 25, 1806.

*Tetrasemma dorsalis* MCINTOSH, British Annelids, pt. 1, Nemerteans, Ray Soc., p. 172, 1873.

*Oerstedtia dorsalis* Bürger, Fauna und Flora des Golfes von Neapel, Monogr. 22, p. 592, 1895.

This small, widely distributed species was collected by Mr. J. F. Abbott in about 20 fms. in Monterey Bay, Calif.

The species may be recognized by its firm, slender, cylindrical body, usually only 8–15 mm. in length, somewhat narrower toward both extremities; flesh color or pale yellowish, mottled on dorsal surface with brownish blotches and dots of various shades and with considerable variation in distribution, often being mainly collected into a series of transverse bands with a few scattered blotches between.

<sup>1</sup>Hubrecht, A. A. W., Genera of European Nemerteans critically revised. Notes from Leyden Museum, p. 229, 1879.

Hubrecht placed this species in the genus *Ærstedtia*, but Bürger refers it to *Tetrasemma*. The specific name *vittatum* is preoccupied in *Tetrasemma*, however, by Verrill, who described and figured a widely different species under this name in 1874 (American Journal of Science, VII, p. 45). If Hubrecht's species actually belongs to *Tetrasemma*, it is obvious that it must receive a new specific name.

<sup>2</sup>Langerhans, P., Die Wurmfauna von Madeira, Zeits. f. wiss. Zool., xxxiv, p. 136–140, 1880.

The head is continuous with body and provided with four ocelli. Proboscis armature as in other species of *Tetrastemma*.

*Habitat.*—On piles of wharves, on rocks, among algæ, bryozoa, ascidians and other growths. Widely distributed in Northern Hemisphere, occurring on the northern coasts of Europe, in the Mediterranean and on both the east and west coasts of North America.

14. TETRASTEMMA (ÆRSTEDIA) RETICULATUM  
sp. nov.

pl. xiv, figs. 7, 8; pl. xx, fig. 7-9.

A minute species measuring but 8-15 mm. in length when sexually mature, and less than 0.5 mm. in diameter. Body short, thick, rounded; much resembling *Oerstedtia* in form and movements, as well as in firmness of body and in general appearance. The peculiarities of the species are not sufficiently pronounced, however, to warrant its separation from the genus *Tetrastemma*. Head usually somewhat narrower than body, from which it is usually distinctly marked off by a pair of oblique lateral grooves. These lie opposite the posterior pair of ocelli (pl. xiv, fig. 8), as in related species.

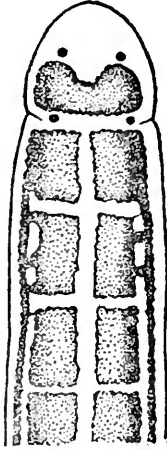


FIG. 21. *T. reticulatum*. Outline of anterior portion of body, showing position of ocelli and shape and arrangement of markings.  $\times 40$ .

*Color.*—General color of body white, with rectangular and longitudinal brown markings which obscure most of the white color of dorsal surface. Two varieties, presenting widely different arrangement of the dorsal markings, were met with, and these in extreme cases would suggest two different species. In both varieties the head, which is white or colorless, is provided with a very similar transverse deep brown marking between the anterior and posterior pairs of ocelli. This marking consists of a transverse band of color extending laterally somewhat beyond the ocelli, and having a rounded and deeply bilobed anterior margin (text fig. 21). It is often shaped like a dumb-bell, except that the contour is straight, and not indented, posteriorly.

In the most common variety (pl. xiv, fig. 7) there are about sixteen pairs of rectangular brown markings situated on the dorsal surface and extending from the head to the posterior end of the body. These occupy the greater portion of the dorsal surface, leaving but little space

between and beside the rectangular marks for the white ground color. They are often decidedly irregular in shape, but in ordinary states of contraction of body average about one and a half times as long as broad, and are separated medially by a space about half as great as their transverse diameters. In addition to the sixteen pairs of rectangular marks, a pair of slender, irregular, brown lines are situated near the lateral margins along the whole length of the body behind the head. Anteriorly these slender brown lines join the more anterior rectangular markings, but at about the third pair of rectangular markings become separated, to join again at about the fourteenth pair. When the animal is slightly compressed, a narrow white margin appears outside these lateral brown lines. The fusion between the first pair of rectangular markings and the lateral lines is usually complete, while the second pair is often joined by only narrow bridges of the brown color (text fig. 21). Sometimes other pairs of markings are connected with the lines by similar bridges of color, and toward the end of body this is usually the case. At about the fourteenth pair of markings there is often a complete fusion of brown color, both of the lateral lines and of the rectangular markings of the same pair, and very commonly only a narrow, transverse band of white serves to indicate the division between the fourteenth and fifteenth, and between the fifteenth and sixteenth, or last, markings. Often even this narrow transverse white band does not extend more than half way to the margins of the body. This fusion of all the brown markings is commonly limited to the three or four posterior pairs of markings, but in some individuals involves the greater portion of the dorsal surface. When carried to the extreme condition all the markings on the body back of the head are united, and this fusion gives rise to the second and less common variety.

In this second variety (pl. xiv, fig. 8) the whole dorsal surface back of the head is of a deep brown color interrupted by about fifteen irregular, transverse, whitish bands reaching laterally toward margins of body. These fifteen whitish bands indicate the spaces between the sixteen pairs of rectangular markings described for the first variety. The lateral lines have become fused and lost in the rectangular markings, and both markings of the same pair have completely lost their individuality. Occasionally, however, a paler median line is indicated. Laterally, too, the adjacent pairs of markings have fused completely. Often the transverse whitish bands do not extend more than half way to the lateral margins, as was mentioned in regard to the caudal region of the first variety. They often become indistinct, and gradually shade

into the brown color laterally. Sometimes, moreover, the fusion is so complete that only a portion of the full number of transverse whitish bands can be found.

The brown color of body varies from a rather light brown to deep, chocolate brown or sometimes deep reddish brown. The whitish intermediate spaces are caused by absence of brown color, and are not due to any special pigment.

The ventral surface is commonly dull grayish with a tinge of yellowish in median line, but there are often numerous fine granules of brownish pigment scattered over the surface. The colors of the dorsal surface show through to some extent, and in the second variety the brown color often encroaches on the ventral surface and shades off gradually toward the median line. When full of ripe ova, the ventral surface of the intestinal region shows a broad lateral band of dull greenish tint due to the olive green color of the ova.

*Ocelli.*—The four ocelli are of medium size and, as usual, are arranged nearly in the form of a square (text fig. 21), although in ordinary states of contraction of head there is rather more space between the two ocelli of the same side than between those of either the anterior or posterior pair (Pl. XIV, figs. 7, 8). Moreover, the ocelli of the posterior pair often seem to be slightly farther apart than those of the anterior pair.

*Proboscis.*—Proboscis sheath reaches end of body as in related species. Proboscis pale flesh color, of large size as compared to body of worm. Basis of central stylet about two and one-half times as long as broad, somewhat elliptical, of nearly equal diameter throughout, and only a little wider posteriorly than near the attachment of stylet (Pl. XX, figs. 7-9). Posterior half of basis appears granular and dark, but becomes gradually lighter anteriorly until the anterior third is as translucent as in other species. Central stylet slender, about two-thirds as long as the basis. Each of the two pouches usually contains two accessory stylets. Measurements average about .05 mm. for the length of the central and largest accessory stylets, while the basis is about .07 mm. long and .025 mm. in average diameter. The proboscis is usually provided with nine nerves, although in a single specimen there was an indication of a tenth nerve.

*Internal Organization.*—The dark pigment of the dorsal surface of the body is situated among the epithelial cells of the integument, and extends upward among the cells well toward the surface.

Voluminous *cephalic glands* situated both above and beneath the rhynchodæum reach back nearly to the brain.

*Alimentary Canal.*—A pair of rather large diverticula of the intestinal cæcum reach forward to the brain, and pass to the dorsal side of the dorsal ganglia. They join the broad unpaired cæcum shortly behind the mouth. The cæcum extends backward beneath the esophagus, sending off a few broad diverticula. The narrow posterior portion of the esophagus does not join the intestine until after the appearance of several pairs of sexual glands. In this, and a number of other features, the species very closely resembles *T. quadrilineatum*.

*Nephridia.*—The nephridial system is limited to the region near the brain. Its tubules extend beside, as well as a very short distance behind, the brain. The single pair of efferent ducts open laterally just opposite, or a trifle behind, the posterior ends of the dorsal ganglia.

*Cerebral Sense Organs* are remarkably large. They are situated beside and beneath the ventral ganglia, and project somewhat in front of them. Large ducts pass antero-ventrally to the surface of the head, as usual.

*Nervous System.*—The brain is unusually voluminous; otherwise the nervous system agrees with that of related species.

*Reproductive Organs.*—Sexual products are mature in September. The ova are very large (about .18 mm. in diameter), pale olive green in color, arranged in a single row along each side of intestinal region. The spermatocysts are correspondingly voluminous in the males. As stated above, the anterior sexual glands extend well in front of the posterior end of the esophagus (pylorus), so that but a comparatively short distance intervenes between them and the brain.

*Habitat.*—On piles of wharf in San Pedro Harbor, Calif., common.

#### 15. TÆNIOSOMA PUNNETTI<sup>1</sup> sp. nov.

Pl. XVI, figs. 1-3; Pl. XVIII, fig. 6.

Body large, soft, flabby, extremely contractile, rounded in esophageal region, and much flattened posteriorly when extended; much like *T. princeps*<sup>2</sup> in shape, and, like that species, becoming very short and subcylindrical when strongly contracted.

Head and anterior portions of body extremely contractile; smooth and somewhat flattened when moderately extended, but abruptly truncated, cylindrical, and thrown into deep circular wrinkles when con-

<sup>1</sup>The species is named in honor of Mr. R. C. Punnett, of St. Andrews, Scotland, well known for his recent work on this group of worms.

<sup>2</sup>Coe, Proc. Wash. Acad. Sci., III, Pl. II figs. 3, 4, p. 62, 1901; also preceding article, paged identically.



tracted. Snout small, rounded or emarginate in front, flattened considerably (pl. xvi, figs. 1, 2), but may be almost completely withdrawn into the swollen succeeding portions of head, as shown in fig. 3. Oblique cephalic furrows lie on the ventro-lateral margins. As seen from in front when strongly contracted, the snout presents an elliptical outline, separated by a deep groove from the tissues of the succeeding regions, which have been moved forward to surround the retracted head (pl. xvi, fig. 3). This groove passes through the cephalic furrows, and is continuous with them. The anterior portion of the esophageal region also is deeply wrinkled with circular grooves. Proboscis pore subterminal; proboscis rather small, whitish in color. Mouth extremely variable in size, according to state of contraction of anterior portions of body. When head is well extended the mouth is situated well back from snout and represents a large, much elongated opening (pl. xvi, fig. 2), but when head is strongly contracted the mouth assumes the proportions of a small, rounded pore (pl. xvi, fig. 3) on the ventral surface a little posterior to the retracted snout.

Esophageal region is often greatly swollen just behind the widely opened mouth when body is well extended, very much as in *Cerebratulus*. There are many indications that in this species of *Tænio-soma* the esophagus is often filled with water, which is ejected at intervals, and thus serves to some extent as a respiratory organ, as has often been considered the case in *Cerebratulus*. The greater portion of esophageal region is subcylindrical, becoming more flattened posteriorly.

Intestinal region often very flat and ribbon-like (pl. xvi, fig. 1), usually much wrinkled and showing a tendency to roll up into an irregular spiral, as has been noted in other species. This region may contract to but a small fraction of its usual length, becoming at the same time nearly as thick as broad. Posterior extremity not very slender.

*Color.*—General color of body usually deep brownish red, or dark red with only a tinge of brown; sometimes of a deep mahogany color. The body color often appears as if covered with a delicate whitish bloom. Anterior portion of head is much deeper brown or almost black, sharply marked off from a narrow white border which occupies the terminal and lateral margins of snout. The dark brown or blackish color is limited to the dorsal surface of snout, and usually consists of a rather narrow transverse marking which shades off gradually into the general body color posteriorly. It is bordered laterally by the white margin mentioned.

Ventral side of snout pure white, continuous with the white of the margins of dorsal surface, but this color does not commonly extend posteriorly to the snout. Occasionally, however, the white area extends back on the ventral side of the head proper, and may include the mouth region also. Back of snout the ventral color usually becomes gradually reddish, so that a pale red area generally surrounds the mouth (Pl. XVI, fig. 2).

Ventral surface of esophageal region of a brownish red color similar to that of dorsal surface, but of a much paler and more grayish shade. A much paler grayish median band is often found throughout the whole ventral surface. In intestinal region there is a similar pale brownish red color much influenced by the grayish color of the median intestinal canal and its lateral diverticula. These latter are conspicuous when the body is well extended, and add largely to the grayish effect of the ventral side of the whole intestinal region. Sometimes ventral surface is of the same brownish red color on the lateral margins as occurs on the upper side of body, but toward the middle line becomes much grayer and paler, while a median line of pure gray extends through the intestinal region.

The tissues of body in intestinal region show a general salmon or orange color when cut.

*Size.*—A large species, individuals often measuring 40–60 cm. in length and 8–10 mm. in width when extended. One of the preserved specimens still measures 20 cm. in length, and 5–7 mm. in width in intestinal region, and 12 mm. just behind mouth. When strongly contracted the body of a large individual may become but 6–8 cm. long, but is several times as thick as when extended.

*Ocelli.*—On each antero-lateral border of head is an irregular cluster of numerous minute ocelli. When cleared in cedar oil these appear distinctly as an irregular longitudinal row of forty to sixty or more small pigment spots just ventral to the dark head shield (Pl. XVIII, fig. 6).

*Proboscis.*—Proboscis sheath possesses an unusual length, extending backward throughout the greater portion of the intestinal region. Proboscis of large size, with two well-developed muscular layers—internal longitudinal and external circular—as usual.

*Body Walls.*—The three muscular layers are massively developed throughout the body.

*Cephalic glands* are enormously developed, as in most related species, and extend backward into the esophageal region. In front of the brain they encroach largely upon the muscular and connective

tissues surrounding the rhynchodæum and blood lacunæ, but are separated from the more superficial glands of the cutis by the rather thick layer of fibrous tissue which constitutes its inner portion. This line of separation is more marked on the dorsal than on the ventral side of the head. In the brain region the cephalic glands occupy a large portion of the longitudinal muscular layer on all sides of the body. In the region of the mouth they become more scattered, and lie mainly on the right and left sides, although they extend inward to the inner portion of the outer longitudinal muscular layer. Posterior to the mouth they are limited to the middle portions of the outer longitudinal muscular layer ventral to the lateral nerves, and occur only sparingly. They cease entirely a short distance behind the mouth.

The *cutis* is thick and, as in related species, consists of two conspicuous layers — an outer, glandular layer with closely packed, deeply staining gland cells, and an inner, fibrous layer consisting largely of interlaced connective tissue fibers. The cutis is several times as thick as the integument, and between the two lies a rather conspicuous layer of muscular and connective tissue fibers forming a basement layer for the integument.

*Alimentary Canal.*—As stated above, the mouth is remarkably distensible, appearing when contracted as a small round pore, but when distended is a large and long slit with thickened lips. The posterior end of the esophagus becomes much widened before it joins the intestine, and is peculiar in that it does not pass smoothly into the latter. The anterior end of the intestine proper is narrow, and opens into the widened esophagus immediately beneath the proboscis sheath, while the esophagus continues backward as a broad blind sac for some little distance, surrounding the lateral and ventral walls of the intestine. A section through this region, therefore, shows a rather small intestinal canal, surrounded, except dorsally, by the thick glandular walls of the broad, cæcal portion of the esophagus.

*Blood and Nephridial Systems.*—Cephalic blood lacunæ, lateral vessels and esophageal lacunæ as usual. Proboscis sheath vessel continues within the rhynchocœl nearly the whole length of the esophageal region. Nephridia remarkably extensive, originating a short distance posterior to the mouth and extending nearly the whole length of the esophageal region. The efferent ducts are numerous, but of small size. They are scattered at irregular intervals along the whole length of the esophageal region, and, as usual, pass to the exterior immediately above the lateral nerves. In the single specimen sectioned there were eight to twelve of these ducts on each side.



*Nervous System and Sense Organs.*—Brain and lateral cords as in related species. Cephalic and buccal nerves large.

Cerebral sense organs highly specialized, and of rather large size. They are much elongated, and their anterior ends are situated laterally in the angle between the dorsal and ventral ganglia. After extending back nearly to the posterior end of the dorsal ganglion, each sense organ enlarges until it is nearly equal in diameter to the dorsal ganglion, and eventually fuses completely with the posterior surface of the latter. At the narrow, anterior end of each sense organ a ciliated canal leads outward to open into the rather conspicuous oblique cephalic furrows.

*Reproductive Organs.*—Sexual products were found to be mature in the specimens dredged off San Pedro in August, but those examined at Monterey in September had neither ripe eggs nor sperm, and had evidently recently discharged their sexual products. The mature eggs are large and opaque, and when brought into sea water surround themselves with a jelly-like coating.

*Habitat.*—Dredged among red algæ, of color closely approximating that of the worms, in 50 fms., between San Pedro and Santa Catalina Island, Calif. This is a common species in that locality, and the individuals are remarkably hardy, living for a day or more among damp seaweeds. A number of large living specimens were obtained from Chinese fishermen, who caught them on their hooks in rather deep water (perhaps 10–20 fms.) in Monterey Bay, Calif. Just how the worms come to be caught on these hooks, which are set for ‘rock-cod,’ is difficult to imagine, unless they crawl about among the seaweeds on the bottom, and, as the hooks drag through, are caught in their bodies. It is possible that the worms actually find the bait and cling to it. The fact that the body is often entirely without injury points to this conclusion. The fishermen offered no conclusive evidence in the matter. The species must be abundant, or it would be more rarely caught on hooks.

Individuals live for a long time in captivity, and do not break up when roughly handled. They may be easily preserved without rupture, or without excessive contraction if killed slowly. Natural colors are well retained in formalin, but fade in alcohol.

16. ZYGEUPOLIA LITTORALIS C. B. Thompson

Zool. Anz., XXIII, p. 151, 1900.

Proc. Acad. Nat. Sci. Philadelphia, 1901, p. 657–739, Pl. XL–XLIV, 1902.

This very interesting species which has been so carefully studied and fully described by Miss Thompson (1902) occurs rather commonly

on the flats laid bare by the lowest tides in San Pedro Harbor. It has previously been recorded only from the vicinity of Woods Hole, Mass. The worms are found in sandy, and not in muddy locations.

The species may be recognized by the following characters: Body rather slender, usually 5-8 cm. in length, rather translucent. Head slender, when extended tapering to a fine point, without cephalic furrows; pure white in color. Esophageal region rounded; white, very

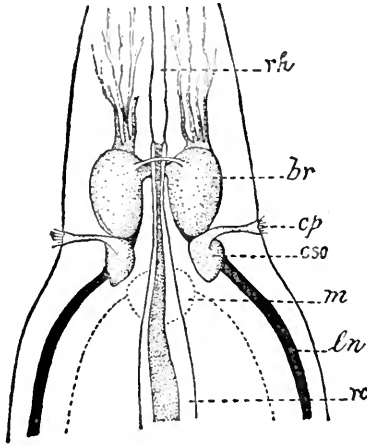


FIG. 22. *Z. littoralis*. Diagram of anterior portion of body, showing relation of cerebral sense organ (cso) to ciliated pit (cp) on side of head; rh, rhynchodæum; br, brain; ln, lateral nerve.

FIG. 23. *Z. littoralis*. Diagram of caudal cirrus and posterior end of body; ln, lateral nerve, extending into caudal cirrus (ln'); in, intestine; a, anus. Both figures after C. B. Thompson.

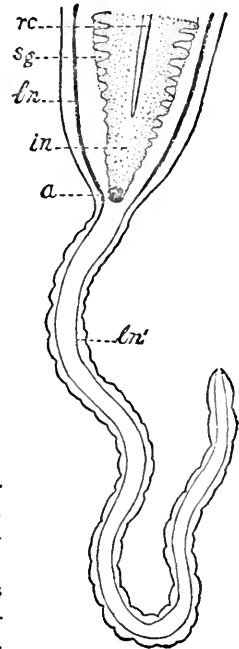


FIG. 23.

pale yellowish or flesh color. Intestinal region flattened in life, but rounded after preservation; color varies from rose to pale yellow, light brown or chocolate brown, being largely dependent on the amount and character of the contents of alimentary canal. Posterior extremity provided with a conspicuous, although slender, caudal cirrus, white in color (text fig. 23), with large central blood space.

In internal organization, the presence of an internal circular muscle at the beginning of intestinal region, the division of the anterior portion of alimentary canal into esophagus proper and stomach, the opening of the ciliated canals leading from cerebral sense organs into shallow lateral pits (text fig. 22, cp) in place of cephalic furrows, the absence

of any retractor muscle of proboscis, and the absence of the inner longitudinal muscle of proboscis, are among the more important peculiarities of the species.

In the paper referred to will be found detailed histological descriptions and figures of all the principal organs of the body.

17. *LINEUS RUBESCENS* sp. nov.

Pl. xiv, fig. 1; Pl. xv, figs. 3, 4; Pl. xxii, fig. 1.

Body very slender, rounded anteriorly, flattened in intestinal region; posterior extremity slender; head long, rather broad; cephalic furrows correspondingly long, reaching posteriorly as far as the anterior end of the mouth, which is situated well back from tip of snout.

*Size*.—A small species, the specimens obtained measuring only 10–15 mm. long, and less than 1 mm. in diameter.

*Color*.—Anterior portions of body, except tip of head, beautiful pink, or rosy flesh color, occasionally bright pinkish red, sometimes with tinge of blue. Tip of head, both above and below, whitish, almost colorless, sharply marked off from pink color behind. Intestinal region deep flesh color or pale, purplish brown, or occasionally buff, anteriorly, shading off to very pale pinkish towards posterior end of body; very pale posteriorly. Ventral surface paler, but of similar color, pinkish in front, pinkish buff or pale flesh color posteriorly; often with still paler median line. Intestinal lobes flesh color or buff; occasionally brownish or purplish. Head can be so much contracted that white tip will disappear. Brain appears pale flesh color. Space between ocelli is grayish. A most striking peculiarity of the color in the esophageal region is that it becomes purplish or, sometimes, bright blue in formalin. I know of no other species of Nemertean where the color changes from pinkish to bluish on preservation. The bluish color is not permanent, however, and after remaining a few weeks in formalin will have practically disappeared. But when such specimens are cleared in cedar oil, a delicate bluish or bluish green color reappears in the esophageal region, while the intestinal region remains colorless, except the intestinal lobes, which are slightly brownish. The nature and situation of the pigment are noted below.

*Ocelli*.—Situated in whitish area on tip of head is a row of two to four (or, rarely, as many as six or eight) ocelli on each side (Pl. xiv, fig. 1; Pl. xv, figs. 3, 4). These are irregular in shape, very dark reddish or almost black in color, and closely placed in a single row. The anterior ocellus on each side is usually the largest, but the ocelli

are often irregularly joined together, so that the individual ocelli cannot be distinguished, appearing rather as a row of scattered pigment masses on each side. In microscopic sections the eyes appear deep blue in color.

In internal organization the species shows many deviations from most other members of the genus although it is evidently closely related to *L. flavescens*. It presents a number of interesting anatomical peculiarities, which are noted below.

*Body Walls.*—At the point where the posterior esophageal cavity enters intestine, the circular muscular layer abruptly becomes less than half as thick as it is farther forward, and allows the outline of the body to become much wider and more flattened. In the esophageal region a cross section is but little wider horizontally than vertically, but in the intestinal region it is nearly twice as wide. This is due to the reduction of the circular muscular layer.

Extensive cephalic glands (pl. xxii, fig. 1, *cg'l*) reach inward almost to the blood lacunæ in the anterior portions of the head, but do not extend behind the brain except on the ventral side, where they reach as far as the posterior ends of the cerebral sense organs. Beneath the rhynchodæum is a conspicuous canal (*a*) which passes forward and joins the rhynchodæum immediately where this opens on the ventral side of the tip of the snout. This canal is apparently the common duct of the cephalic glands which lie beneath the brain, for it originates posteriorly in a large cluster of these glands. Yet in no other species of Nemertean has such a well-developed duct been observed. Unfortunately the character of its lining is obscured by the secretions which it carries, so that its precise nature is not absolutely certain.

The glands of the cutis (pl. xxii, fig. 1, *cug'l*) are extremely abundant in the head. They extend inward to the circular muscular layer throughout the whole intestinal region. Back of the mouth they sink gradually through the cutis and deeper into the external longitudinal muscular layer. In the region of the nephridiopores they have passed completely through this layer in a narrow area on the dorsal and on the ventral side, and have come in contact with the outer border of the circular muscular layer. Farther back the region in which the glands reach inward as far as the circular muscle becomes increased, until at the beginning of the intestinal region it extends along the whole circumference except in the vicinity of the lateral nerves. Throughout the length of the intestinal region these glands continue to border the whole surface of the circular muscles, except in the immediate position of the lateral nerves. Perhaps in no other member of the family

Lineidæ have these glands been found to be so extensive as in the present species.

*Pigment.*—The peculiar bluish color which appears after the worms have been preserved, and have consequently lost their original pink or reddish color, is due to a vast number of minute granules situated in the nervous plexus which lies immediately external to the circular muscular layer. The granules are present only in that portion of the plexus which lies dorsal to the lateral nerves.

*Proboscis.*—The proboscis sheath is remarkably long for the genus, extending very nearly to the posterior extremity of the body. The proboscis is of moderate proportions. In its musculature it exhibits an interesting departure from the type characteristic of the genus. The circular and outer longitudinal muscular layers are of the usual proportions, while the internal longitudinal musculature is represented by two bands placed symmetrically on opposite sides of the proboscis. These longitudinal bands occupy about one-sixth to one-eighth of the circumference of the internal epithelial layer, which elsewhere borders the inner face of the circular musculature. In thickness the two muscular bands, which represent the inner longitudinal musculature found in most related species, often equal that of the outer longitudinal layer in their middle portions, but are much thinner toward their borders. Back toward the middle portions of the proboscis they become gradually thinner, and more posteriorly eventually disappear, allowing the internal epithelium to border the circular muscles without interruption except from the nervous layer. Where the two longitudinal bands are present the proboscis nerves are well developed as a single pair of flattened cords which lie immediately external to those bands, but after the bands disappear, the nerves spread out as a plexus lying between the circular muscles and basement layer of the internal epithelium, as in related species. This peculiar arrangement of the musculature presents a condition intermediate between those members of the family Lineidæ in which the three layers are well developed, and those (such as *Lineus flavescens*, for example) in which the internal longitudinal layer is completely wanting. In the posterior portions of the proboscis only longitudinal fibers occur, and these are bounded externally by a thin fibrous layer, and internally by a thin epithelium lining the proboscis cavity.

*Alimentary Canal.*—Esophagus divided into two well-marked portions, separated by a constriction, and distinguished by differences in the epithelial lining similar to those which Miss Thompson has recently described for *Zygeupolia* (1902).<sup>1</sup> The mouth, situated as

<sup>1</sup> Proc. Acad. Nat. Sci. Philadelphia, 1901, p. 709.

usual, opens into the typical, broad esophagus with greatly convoluted walls lined with highly columnar ciliated epithelium and provided with an abundance of glands. Exactly in the region of the nephridiopores, however, or at about one-fifth the distance to the intestinal region, a marked change occurs. The esophageal lumen becomes narrow and situated immediately beneath the proboscis sheath, while beneath and beside it appears a second broad canal—posterior esophageal chamber or stomach, as it may be called. This is likewise devoid of lateral diverticula. A few sections back of the anterior end of this posterior chamber, the narrow, terminal portion of the esophagus proper, or anterior esophageal chamber, opens. The epithelial lining the posterior chamber differs conspicuously from that of the anterior chamber. In the latter the ciliated cells are situated superficially and their nuclei are not far removed from the surface, while the glandular cells lie mainly at a lower level and have their nuclei farther from the surface. In the posterior esophageal chamber, on the other hand, a comparatively small proportion of the cells are ciliated, and the nuclei of all are far removed from the surface. The cells are all very slender, and are thickly packed with small granules of secretions. The free surfaces of the cells appear to be irregular, and are covered with the secretion which partially fills the lumen of the esophagus, so that it is often difficult to determine exactly where the cells terminate. In this respect they differ greatly from those in the anterior chamber, where the ciliated cells always show a sharp and distinct free border.

The posterior chamber is fully four times as long as the anterior, and at its posterior extremity enters the broad cavity of the intestine proper, which is provided with the usual lateral diverticula, and exhibits the usual histological features. The transition from the posterior esophageal chamber to the intestine is very abrupt in both its anatomical and histological features. The circular muscular layer of the body walls becomes much thinner at this point, and the body is flatter and wider, as described above. The intestine at its anterior end becomes correspondingly wide and flat, with broad lateral diverticula. The lumen, on the other hand, becomes much narrower, and the epithelial lining several times as thick as in the posterior esophageal chamber. As in other species, the cells are large, without distinct outlines, and packed with peculiar spherical masses of deep-staining secretions. The nuclei are pushed deep into the bases of the cells. The general appearance, therefore, of these two portions of the alimentary canal is vastly different, although not so sharply marked as in other forms where the esophagus exhibits less specialized portions.

The posterior esophageal cavity — ‘stomach,’ or gastric portion of esophagus, as it may be called—is by no means a structure peculiar to the species at hand, for indications of a specialized posterior portion have often been described for the esophagus of other species. Yet in no other Heteronemertean has this chamber been found to be so highly differentiated. The transition is usually far more gradual, especially between the stomach and the intestine, as is the case in *Zygeupolia*. The general nature of the cavity resembles the intestinal cæcum of the Hoplonemerteans far more than it does the so-called ‘stomach’ (Magendarm) of these forms.

*Blood and Nephridial Systems.* — Cephalic blood lacunæ, lateral vessels, and anastomosing blood spaces about esophagus as in related species. Rhynchocœl vessel short, leaving the cavity of the proboscis sheath in the immediate vicinity of the nephridiopores, or at about one-fifth the distance from mouth to intestinal region.

Nephridial system remarkably short, but with rather large branches. It commences anteriorly a short distance behind the mouth and is limited to the anterior fifth of the esophageal region. The main longitudinal canal on each side is situated as usual in the angle between the proboscis sheath and the esophagus, and the branches ramify about the esophageal blood spaces. After an extent of less than one-fifth the length of the esophageal region, each of the two longitudinal canals swells out into a comparatively large chamber from which the rather large efferent duct passes above the lateral nerve to the nephridiopores, situated as usual on the dorso-lateral surface of the body. The nephridial canals do not extend farther posteriorly than the position of the nephridiopores, which are strictly paired.

*Nervous System and Sense Organs.* — These structures present no noteworthy peculiarities. Terminal, or frontal, sense organs apparently wanting. Cerebral sense organs well developed and closely united with posterior surfaces of dorsal ganglia. The canal by which each of the sense organs communicates with the posterior end of the corresponding cephalic furrow is broad and short.

*Reproductive Organs.* — No sexual products are present in specimens collected in August and September.

*Habitat.* — A few specimens of this beautifully colored species were found on piles in San Pedro Harbor, Calif. A single specimen was found by Mrs. Cockerell on a kelp ‘hold-fast’ outside the same harbor. The species also occurs sparingly on the piles at Monterey, Calif.

## 18. LINEUS FLAVESCENS sp. nov.

Pl. xvii, figs. 3, 4.

Body of moderate proportions for the genus; head long and rather slender, usually a little narrower than body, often pointed, and often slightly emarginate in front; cephalic slits longer than in most related species; esophageal region rounded; intestinal region only moderately flattened; posterior extremity rather slender, without caudal cirrus; proboscis sheath extends nearly to posterior end of body; proboscis rather slender.

*Color.*—General color of body yellowish, but of a great variety of shades in different portions of the body, and in different individuals. A number of specimens from crevices of rocks at San Pedro Harbor were pale yellow, sometimes with a tinge of orange, in esophageal region, and deep ochre throughout the remainder of the body except the head, which was ochre with a decided tinge of orange. Margins of head are paler. The pale yellow of esophageal region changes abruptly to the ochre of the intestinal region; posterior extremity and whole ventral surface of body of a duller, paler color.

Esophageal region often shows two distinct regions of different color, due to the two divisions of the esophagus described below. The anterior pear-shaped region lying next the mouth is more deeply colored, corresponding with the thicker esophageal walls, while the remainder of the region is usually paler (Pl. xvii, fig. 4).

Several specimens from among annelid tubes on San Pedro break-water were deep ochre anteriorly, with a sharp, median, dorsal, longitudinal white line which extended through the anterior half of the esophageal region. The remaining portion of esophageal region was greenish ochre, while the whole intestinal region was dull orange (due largely to the color of the intestinal canal), covered superficially by the pale yellowish of the body walls. Ventrally the color was dull whitish on head and in anterior esophageal region, then greenish ochre back as far as the intestinal region, which was of the same orange color as dorsal surface, but somewhat duller. Lateral and anterior margins of head colorless; cephalic slits long, sharply separating the ochre or yellowish orange of dorsal surface from whitish of ventral surface of head. Smaller specimens were commonly much paler in color. Some individuals were of duller colors, with dark buff intestinal regions.

Numerous large individuals taken in from 50–100 fathoms between San Pedro and Santa Catalina Island were of a rich golden brown anteriorly, with a tinge of yellowish orange on the head. Intestinal



region varied from ochre through deep buff to olive brown, sometimes showing a median dorsal longitudinal stripe of darker, more brownish color. These were filled with mature sexual products.

In all these varieties the brain region was indicated by its more rosy color, and this was sometimes quite conspicuous. The lateral and anterior margins of head were always very pale or colorless. The esophageal region showed clearly the two divisions of the esophageal walls, as seen through the somewhat translucent body walls. The ventral surface of head is much paler than dorsal surface, while throughout remainder of body the ventral differs from the dorsal surface in color mainly in having a duller and more whitish tinge. A paler median dorsal line in intestinal region, indicating the position of the proboscis sheath, is often present.

Proboscis straw color or slightly yellowish.

*Size.*—Small, pale-colored individuals were 8–15 mm. long; others 20–40 mm., while those from deeper water were often 80–120 mm. in length, with a diameter of 2–3 mm.

*Ocelli.*—On each side of tip of head is a transverse row of irregular pigment masses (pl. xvii, figs. 3, 4). These are very variable in shape, in size, and in number, and vary in color from blood red to purple or black. There are commonly three to seven irregular groups of pigment granules on each side, and of these the more anterior are the larger. Those of the two sides are separated by a fairly wide pale area above the proboscis pore, and extend as a single row along each antero-lateral margin of the head. Commonly the ocellus lying most anteriorly is much larger than any of the others, while the three or four most posterior ones are represented by minute dots only. The number of ocelli may not be the same on the two sides, and perhaps in the majority of cases it is impossible to determine the exact number because the pigment granules are so much scattered. Often there is an irregular row of scattered pigment masses, grouped irregularly, but not arranged into definite ocelli. These appear to have arisen from a fragmentation of ocelli which have previously existed.

Whether the ocelli should be blood red, wine color, purple or black, seemed to be an individual peculiarity, and was not always correlated with the color of the body or the environment under which the animal lived. It is to be noted, however, that most of the individuals dredged among the red seaweeds had wine-colored or purple ocelli.

As seen in sections, only the anterior pair of ocelli usually possess a well-developed visual apparatus, with distinct, cup-shaped retina having long, spindle-shaped sensory cells. They lie very deep in the



tissues of the head on either side of the anterior end of the rhynchodæum. The retina faces ventrally. The remaining ocelli are much simpler in structure.

In internal organization this species shows a close resemblance to *L. rubescens*, and hence a considerable departure from the typical species of the genus in many details of structure. The close similarity in many anatomical features between these two species and *Zygeupolia*, as described by Miss Thompson (1902),<sup>1</sup> is very striking, and serves to unite this genus more closely to the other members of the Lincidæ.

*Proboscis*.—Proboscis sheath does not extend to end of body. Proboscis attached to dorsal wall of sheath at the posterior end of the esophageal region, and only a few sections in front of the intestine, by a powerful retractor muscle. In this same region the circular muscles of proboscis sheath extend ventrally to surround the esophagus with a rather thick layer of circular muscles. The fibers are connected to some extent with the main circular muscular layer of the body walls by a crossing of fibers immediately above the proboscis sheath. This recalls the great thickness of the inner circular muscles found in this same region in *Carinoma*. A similar condition has been described for *Micrura alaskensis* (Coe, 1901),<sup>2</sup> and Miss Thompson (1902)<sup>3</sup> has recently described for *Zygeupolia littoralis* and *Micrura cæca* a well-defined inner circular layer in this region, and has shown its apparent homology with the inner circular muscular layer of *Carinella*, *Carinoma* and other Paleonemerteans.

This localized inner muscular layer doubtless serves the double purpose of holding the proboscis sheath, with its attached proboscis, firmly in place among the other tissues, and of providing a strong annular constriction between the esophagus and intestine. By the action of this sphincter, food materials, having entered the intestine, may be prevented from returning to the esophagus. Furthermore, the esophagus may under some circumstances act as a respiratory organ, as described by Wilson (1900)<sup>4</sup> for *Cerebratulus lacteus*, and as I have observed in other species, and in this case the muscular constriction will prevent the water from passing back into the intestine.

The muscular walls of the proboscis consist of the outer longitudinal and inner circular layers only. The inner longitudinal layer, which is

<sup>1</sup> Proc. Acad. Nat. Sci. Philadelphia, 1901, pp. 657-732.

<sup>2</sup> Preceding article, p. 72.

<sup>3</sup> *Loc. cit.*, p. 667.

<sup>4</sup> Quart. Journ. Micr. Sci., XLIII, p. 109.

represented in *L. rubescens* merely by two bands of longitudinal fibers (as described on p. 181), is here wanting completely. The two proboscis nerves are conspicuous in the anterior portions, but farther back spread out into a plexus as usual. The basement layer of the proboscis epithelium is therefore separated from the circular muscular layer only by the nerves or nervous plexus, as described on p. 181 for *L. rubescens*. A precisely similar condition has recently been described for *Zygeupolia* by Miss Thompson (1902),<sup>1</sup> and is known in other species of the Lineidæ.

*Cephalic glands* are well developed, but extend backward only to the anterior portion of the brain region.

*Cutis Glands*.—In the esophageal region the cutis glands form a thick and distinct layer in the midst of the outer longitudinal muscles. Anteriorly they lie well toward the periphery of this muscular layer, but sink gradually deeper until in the nephridial region they lie in contact with the circular muscles dorsally and ventrally. This condition is retained in the intestinal region, as was described for *L. rubescens*.

*Cephalic Furrows*.—These are deep, and broaden out dorso-ventrally on their internal faces near their posterior ends. The canal leading to the cerebral sense organ on each side joins the posterior, broadened end of the corresponding cephalic furrow through a broad papilla.

*Alimentary Canal*.—Mouth large, elongated, situated opposite posterior ends of cephalic slits. As stated above, the esophagus is seen in the living worm to be divided into two distinct regions. These consist of an anterior, pear-shaped cavity (Pl. XVII, fig. 4) immediately behind the mouth and a posterior tube, or posterior esophageal chamber, connecting with the intestine. The anterior cavity is distinguished by its much thicker, convoluted walls and deeper color. At its posterior end this chamber is widened considerably, and is then abruptly constricted as it opens into the posterior esophageal chamber, or stomach. This latter portion has thinner walls and paler color, and likewise exhibits a constriction just before it opens into the intestine. There are very marked histological differences between these two portions of the alimentary canal, but the conditions are here so very similar to those described for *L. rubescens* that the detailed descriptions given on p. 182 apply equally well for the species at hand. Perfectly similar conditions have recently been described for *Zygeupolia* and other forms.

The remarkable development of circular muscles about the posterior

<sup>1</sup> *Loc. cit.*, p. 693.

end of the esophagus forms a strong sphincter between the posterior esophageal chamber (stomach) and the intestine, as described above.

*Blood and Nephridial Systems.*—Cephalic and esophageal lacunæ as in related species. Proboscis sheath vessel passes outside rhynchocœl in the nephridial region, or at about the point where the anterior esophageal cavity opens into the stomach.

The main nephridial canals are of large size, but of limited extent. They are situated beside the posterior fourth of the anterior esophageal chamber, and the anterior third of the posterior esophageal chamber, or stomach. In one small specimen sectioned there was but a single pair of large efferent ducts, while in a larger individual there were two pairs. In the former case the ducts were exactly paired, while in the latter both the ducts on one side were in front of the more anterior of those on the other.

*Nervous System.*—Brain and nervous system show no marked deviations from the condition typical of the genus. The frontal sense organ appears to be represented by a crescent-shaped groove above the subterminal proboscis pore.

*Habitat.*—In crevices of rocks between tides, Dead Man's Island, San Pedro Harbor; among annelid tubes, breakwater, San Pedro, Calif.; not very abundant; one specimen from a floating kelp 'hold-fast' off San Pedro Harbor (Mrs. Cockerell); common among red algæ in 50 fms. between San Pedro and Santa Catalina Island.

The worms belonging to this species are remarkably hardy and will live for more than a day in damp seaweed at a temperature of 70–80° F., and may be kept for a long time in confinement in a small quantity of sea water. Sexual products appeared to be fully mature in August, but in some individuals had been previously discharged.

#### 19. LINEUS PICTIFRONS sp. nov.

pl. xvii, figs. 5, 6.

Body of large size, remarkably soft and flabby, very changeable in shape, but usually somewhat flattened throughout. Body often snarled and tied in knots; much fluted longitudinally, and constricted transversely when contracted. Head narrower than body, elongated, often emarginate in front, narrower at posterior end of cephalic slits than in its middle portion. Cephalic slits unusually long, rosy in color posteriorly, sometimes bordered by a narrow line of white. When contracted, body is thick, and not flattened, except near anterior end. Posterior extremity rather slender, rounded, not flattened.

*Color.*—General color of body, both above and below, deep brown,

chestnut, or slaty, with a tinge of green in reflected light, or of plumbago or bluish when seen in shadow. Sometimes a reddish tinge is given to the brown, and there is usually a soft, velvety sheen. Head has a rosy or chestnut tinge beneath the brown. Tip of tail very pale in color.

Throughout the whole body is usually found a series of transverse and longitudinal yellowish markings on dorsal surface. The transverse markings are the more conspicuous and consist of a series of lemon yellow rings. The more anterior of these commonly encircle the whole body, while farther back they appear on dorsal surface only. They are all much widened in the median line, and in some specimens appear to consist only of a series of diamond-shaped median markings. More commonly, however, each marking continues laterally as a fine line which completely encircles the body, although many are interrupted on the ventral surface. In the posterior half of the intestinal region these markings do not usually appear on the ventral surface. In some specimens the markings are very much obscured and occasionally are almost completely wanting. The first transverse marking occurs at the posterior end of the cephalic furrows, and this is usually much larger and more conspicuous than any of the others (Pl. XVII, fig. 5) although it does not extend to the ventral surface. On a worm of 10-20 cm. in length there are usually sixty to one hundred or more of these transverse rings.

The dorsal surface is corrugated with longitudinal flutings, except when the animal is fully extended. These flutings are accentuated by very fine, hair-like longitudinal lines of ochre or orange color which extend throughout most of the dorsal surface. They are not only very fine, but are much interrupted and irregular, usually wavy, and often consist of rows of elongated dots of color. On the head the lines are much interrupted and consist mainly of rows of very minute dots. On the ventral surface they are entirely wanting throughout the body. On the dorsal surface there are commonly about seven to fifteen or more of the fine lines, of which the one in the median dorsal line is more distinct than the others, and connects the transverse, diamond-shaped, pale yellow markings described above. On each side of the median line the lines are sometimes arranged rather symmetrically, but are sometimes almost entirely lacking. This is often the case in the posterior half of the body. In many specimens the lines are seen only when very carefully examined, and in some others appear to be entirely lacking. Sometimes they are wanting anteriorly to the third or fourth transverse yellow marking. The transverse markings are of a much paler yellow than are the longitudinal lines.

Especially characteristic is the peculiar coloring on the tip of the head, and this has suggested the specific name. On the dorsal surface near tip of snout is a narrow terminal border of white, and situated within this white border are two oval, orange-colored spots imbedded in an area of lemon yellow (pl. xvii, figs. 5, 6). Sometimes a few isolated dark brown dots are scattered in the yellow color. In some specimens the orange-colored spots are very conspicuous, while in others they are very small and indistinct. Sometimes the yellow color surrounding them is wanting, but the white terminal border is always present on the tip of the snout, both above and below.

After preservation in formalin the head becomes much contracted and wrinkled, the cephalic slits become short, and the body assumes a dull black or slaty color, without indications of the characteristic yellow markings seen in life.

Mouth large, with pale lips, reaching forward to the posterior ends of the cephalic slits.

Proboscis salmon or flesh-colored, very long and slender.

*Size.*—Usually about 15 cm. in length and 3-4 mm. in width, although individuals were found as small as 15 mm. long, while a single specimen measured nearly 50 cm.

*Proboscis.*—Provided with two muscular layers only, the internal longitudinal muscles being wanting. There is a well-marked crossing of fibers between the circular muscles and the outer fibrous layer, as in many related species.

*Body Walls.*—Structure of body walls as in other representatives of genus. The pigment which gives the dark color to the body is situated as a very dense layer of minute pigment granules immediately beneath the epithelium throughout the whole length of the body. It is even present as a less distinct layer beneath the epithelium of the cephalic furrows, and is lacking only in a narrow area immediately surrounding the proboscis pore. This area corresponds to the white zone seen in life at the tip of the snout. So dense is the pigment layer that if ocelli were situated in it they would be very difficult to distinguish. They are probably not present, however, for they do not appear in any of the sections.

A rather thin layer of connective tissue is found beneath the cutis glands, which indicates an approach to the condition of a true cutis. The cutis glands are massed in a distinct layer just beneath the pigment layer, and do not extend among the fibers of the outer longitudinal muscles even in the intestinal region. They are usually distinctly, though not widely, separated from these muscles by the thin fibrous layer.

*Cephalic glands* form a voluminous and well-marked mass of deeply staining glands which extends back both dorsally and ventrally nearly to the brain. Their secretions are discharged anteriorly at the tip of the snout as in the Tæniosomidæ.

*Alimentary Canal.*—The esophageal region is remarkably short in comparison with the total length of the body. There is a very short esophagus lined with the characteristic glandular and ciliated cells. At the posterior end of this is a decided constriction, or sphincter, which opens into a widened posterior chamber without lateral pouches, but having a lining of epithelium not widely different from that of the intestine. This posterior cavity is even shorter than the esophagus proper, and gradually passes into the true intestine with its paired lateral pouches. The esophagus proper is sometimes only as long as the transverse diameter of the body, and hence, much shorter than in most related species. The cavity behind this evidently corresponds to the 'stomach,' as described by Miss Thompson (1902)<sup>1</sup> for *Zygeupolia*, and is doubtless homologous with the posterior esophageal cavity of *Lineus rubescens* and *L. flavescens*, as described above. In these latter species, however, the epithelial lining of this cavity is markedly different from that of either the esophagus or intestine, while in *L. pictifrons*, as in *Zygeupolia*, it resembles the intestinal epithelium very closely.

Although the change from esophagus to 'stomach' is very abrupt both anatomically and histologically, yet it is quite impossible to determine exactly where the stomach ends and the intestine proper begins. The anterior intestinal pouches are but slightly indicated and pass gradually into the wavy outlines of the stomach, and the histological features show a similar gradation. The cells of the axial cavity of the intestine retain the appearance of the stomach cells for some distance posteriorly as in *Zygeupolia*.

An internal circular muscular layer, such as is described above for *L. rubescens* and *L. flavescens* just anterior to the intestine, is not found in the present species.

*Blood and Nephridial Systems.*—There is the usual arrangement of cephalic blood lacunæ, lateral lacunæ, rhynchocœl vessel, etc. Branches of the lateral lacunæ surround the esophagus, and are gathered into a single pair of vessels in the region of the stomach. In this region there are five large vessels in a transverse section of the body—the rhynchocœl vessel, the pair of lateral lacunæ situated in the angle between stomach and proboscis sheath, and the pair of ventral vessels

<sup>1</sup> Proc. Acad. Nat. Sci. Philadelphia, 1901, p. 709.

situated latero-ventrally beneath the stomach. At the beginning of the intestinal region the lateral lacunæ pass ventrally to join the ventral vessels, which continue to posterior end of body. The rhynchocœl vessel passes beneath the proboscis sheath at the beginning of the intestinal region.

The nephridia are limited to about the middle half of the very short region of the esophagus proper, and are consequently much less extensive than usual. The main longitudinal canal on each side lies on the lateral wall of the lateral blood lacuna and sends branches among the esophageal lacunæ. A single pair of efferent ducts pass to the exterior above the lateral nerves as usual. In one individual, one of the efferent ducts was peculiar in that it branched just outside the circular muscular layer. Only one of its branches passed to the exterior while the other penetrated only about two-fifths the distance through the outer longitudinal muscular layer.

*Nervous System and Sense Organs.*—The species is remarkable in having many of the smaller nerves far more conspicuous than in most other species. The cephalic nerves, for instance, are unusually large and numerous. Esophageal nerves are also large, with a distinct commissure near their point of origin from the ventral brain lobes. These nerves join in a distinct plexus beneath the esophagus a short distance behind the mouth. The dorso-median nerve is clearly marked and of remarkably large size. The internal dorso-median nerve, found in many species directly beneath the former and internal to the circular muscular layer, is likewise well developed in this species.

The brain is massive. The cerebral sense organs are correspondingly voluminous, and as usual are bathed posteriorly in the large lateral blood lacunæ. The cephalic furrows are of moderate depth, and their lining of regularly arranged epithelial cells with long cilia furnishes strong evidence of their sensory functions.

*Reproductive Organs.*—Sexual products are fully mature in August.

*Habitat.*—One specimen measuring nearly half a meter in length was found by Miss Robertson, of the University of California, in the crevices of a rock at Dead Man's Island, San Pedro, Calif. Other specimens of much smaller size were found among worm tubes and under stones in the same locality. The species is rather common in mud among tunicates growing on the piles of wharves in San Pedro Harbor, where the worms are usually from 15 mm. to 15 cm. in length. Dredged in several localities off San Pedro in 2 to 20 fms.



## 20. LINEUS ALBOLINEATUS sp. nov.

pl. xvii, fig. 2.

Body of moderate proportions for genus, rounded in esophageal region and flattened posteriorly. Esophageal region longer in proportion to length of body than in related species. Head short, broad, commonly a little wider than neck, but not distinctly demarcated, often slightly emarginate in front, flattened moderately. Cephalic furrows deep, of moderate length, and, in most states of contraction of head, well separated anteriorly; when strongly contracted, however, reaching nearly to proboscis pore as usual. Mouth small, situated about as far back as posterior ends of cephalic furrows. Proboscis small, with peculiarities as described below.

*Color.* — General color of body deep chocolate brown or olive brown, with very conspicuous, clearly marked, white or pale lemon yellow stripe extending whole length of body in the median dorsal line. On the head this median stripe widens out to form a broad, pear-shaped white marking (pl. xvii, fig. 2) which is often two-thirds to three-fourths as wide as head. It is broadest, and often slightly emarginate, very near the tip of the snout, gradually becoming narrower through about half the length of the head, where it is lost in the dorsal stripe which continues throughout the body. The narrow terminal border lying in front of the white marking on head is paler brown and more reddish than the general color of body. In some individuals a faint reddish line extends from each cephalic furrow backward along the lateral margin of the body. Occasionally this line becomes quite distinct.

Ventral of same color as dorsal surface. A more rosy coloring marks the position of the brain. Cephalic furrows often marked by a slightly paler, rosy color. Intestinal region inclining toward an olive brown shade. White dorsal stripe very sharply marked, without gradation into adjacent color. It averages about one eighth as wide as body, but is rather more irregular and less conspicuous posteriorly.

Ventral side of head reddish brown; tip of snout ventrally more distinctly reddish; mouth reddish inside, lips paler.

In formalin, and even after imbedding in paraffin, the worms retain their dark brown color with the strongly marked dorsal stripe and cephalic marking as in life. In addition, a pair of narrow lines of light color appear on the lateral margins, corresponding to the faint, reddish lines seen in life. They are continuous with the cephalic furrows, and lie exactly on the lateral margins throughout the body.

*Size.* — Length 100–150 mm. in extension; width 2 mm. or more.

*Ocelli.* — Apparently wanting, although some irregular masses of reddish brown pigment on the sides of the head may perhaps be concerned with light perception.

*Proboscis.* — The pair of proboscis nerves lying internal to the circular muscular layer are remarkably conspicuous. Inner longitudinal muscular layer almost completely wanting; consequently the pair of nerves appear to lie directly beneath the inner epithelial layer. Fibrous crosses between the internal and external muscular layers are very inconspicuous, although they are sometimes indicated. In many respects, therefore, the structure of proboscis approaches the condition found in *Taniosoma*. Proboscis is attached posteriorly at the boundary of esophageal and intestinal regions by a broad and powerful muscle to the dorsal wall of the proboscis sheath. Posteriorly to this point the cavity of the sheath is very small, and does not extend very far back into the intestinal region.

*Vascular System.* — A very large and extensive unpaired blood lacuna is situated in the head in front of the brain, and completely surrounds the walls of the rhynchodæum, except on the ventral side. Just in front of the brain the lacuna becomes broken up into smaller spaces, which unite about the cerebral sense organs into a single extensive lacuna on each side. These two large spaces are separated only by a thin strand of tissue. Back of the mouth each sends off a series of large anastomosing blood spaces around the lateral and ventral walls of the esophagus. These esophageal lacunæ extend back nearly two-fifths of the length of the esophageal region, where they unite again with the lateral vessels, which have continued in the angle between the proboscis sheath and esophagus.

*Nephridia.* — The nephridial system is very short and is limited to the second fifth of esophageal region. It is remarkable for the small number and comparatively large size of its branches. The anterior branches lie on the outer walls of the esophageal blood lacunæ, while the main longitudinal canal on each side lies above the esophagus and ventral to the large lateral blood lacuna. After extending backward for a distance of about 0.3 mm. (in an individual 100 mm. long) the branches in the esophageal lacunæ join the main nephridial trunk which passes to the dorsal wall of the lateral blood lacuna. The blood vessels around esophagus extend posteriorly only as far as the most posterior of these branches. The main nephridial trunk on each side then becomes situated in the connective tissue just above the lacuna and extends backward in this position, and without branching, for a dis-

tance fully equal to that occupied by its branches, or about 0.35 mm. The efferent nephridial duct passes directly outward from the posterior end of the longitudinal canal and opens externally a little dorsally to the lateral margin of body.

*Cephalic glands* remarkably voluminous, reaching deep into tissues of head—fully three-fourths the distance from exterior to rhynchodæum—and extending posteriorly almost to the anterior end of the brain region, where they cease abruptly and completely.

*Body Walls.*—The dark pigment which gives the deep color to the body, and which is not soluble in alcohol, cedar oil or xylol, is situated among the cutis glands in the outer longitudinal muscular layer in small amount, but its chief position is in a conspicuous layer just outside the circular muscles. In the head it is scattered through the deeper muscles and connective tissues. It is especially abundant between the cephalic furrows and the rhynchodæum.

In the anterior esophageal region the cutis glands reach inward entirely through the outer longitudinal muscular layer, except in the vicinity of the lateral margins.

*Frontal sense organs* not developed as special sensory pits.

*Nervous system* presents no marked peculiarities. Dorsal nerve is fairly conspicuous immediately behind brain, but is very little developed farther back.

*Reproductive Organs.*—From specimens collected in August, the genital products had evidently been recently discharged.

*Habitat.*—Dredged in 30 fms. off Point Fermin, near San Pedro, Calif. But few specimens were found, and these inhabited strong, parchment-like tubes among broken shells. Found also in 20 fms. in Monterey Bay, Calif. (J. F. Abbott.)

The species somewhat resembles the variety of *Lineus bilineatus* figured by Bürger in his Naples Monograph (Pl. v, fig. 15) in regard to the markings on the anterior portions of the body, but is much less slender, and shows many anatomical differences.

## 21. LINEUS WILSONI sp. nov.

Pl. xvi, figs. 10, 11.

Body only moderately slender, rounded anteriorly, flattened in intestinal region, but with rounded lateral margins. Body is sometimes wider in the intestinal region than the figure indicates. Head long and slender, not marked off from body, but somewhat narrower just back of brain; cephalic furrows correspondingly long. Intestinal

region commonly much wrinkled and with numerous constrictions. Posterior extremity not very slender.

Body fragile, often constricted at the white rings described below, and it is through these rings that the rupture usually takes place. Several individuals broke spontaneously at the third ring, while the rings in front and behind remained intact. This third ring seemed to be the usual position of the first rupture.

Mouth large, situated immediately behind brain.

Proboscis pore subterminal, near ventral margin of terminal white border. Proboscis slender, color very pale, with a tinge of yellow. Proboscis sheath extends very nearly to the posterior extremity of the body. *Ocelli* wanting.

*Color.* — General color of dorsal surface deep chestnut brown, slaty brown, purplish brown, or occasionally dark drab, the shade varying considerably in different parts of body. Some individuals are chocolate brown in esophageal region and are much paler brown posteriorly. The under side of the body is sometimes dark brown like the dorsal surface, but is usually paler, with a tinge of gray, and is occasionally light drab. Those individuals which have the less deep coloring on the dorsal surface have a correspondingly lighter tone on the under side of the body. When the intestinal lobes show through they appear to be still lighter in color.

Head bordered anteriorly by a narrow terminal band of white which also extends back along the borders of the cephalic slits. The white color extends back a little farther in the median line than elsewhere, except on the margins. Sometimes the white color extends backward to the posterior ends of the slits, both above and below, so that when the slits are open they appear white in color (pl. xvi, fig. 10). White terminal border is a little less broad on ventral than on dorsal surface and is less conspicuous owing to the paler color of the ventral surface. Head is often paler brown in front of brain, much deeper brown anteriorly next the white terminal border, and is brighter red in the brain region (both above and below), where the rosy coloring of this organ shows through the superficial darker brown color.

A series of very fine white rings encircles the body at intervals throughout most of its length. These rings occasionally show slight thickenings in the dorsal median line, but this is not usually the case. The first of these very narrow rings appears nearly as far behind the brain as is this organ from the tip of snout. The succeeding rings are commonly separated from each other by about the diameter of the body in ordinary states of contraction.

Anteriorly the rings usually encircle the whole body, but farther back they are merely indicated on ventral surface by very fine grayish lines of much less distinctness than on dorsal surface. In intestinal region they are sometimes separated by more than twice the diameter of body when moderately extended.

In some individuals the white rings are very indistinct, in others they are merely indicated on dorsal surface and are not present at all below, while they are wanting entirely in the posterior portions of the body. The fact that fission usually takes place through these white rings indicates that there must be some peculiarity of the body walls in these regions other than a lack or differentiation of pigment. This is true of other species of the genus and of other genera, notably *Carinella*. Body is often constricted at these points previous to rupture.

After preservation the delicate white rings disappear, and the body assumes a slaty black appearance, sometimes more grayish below, and with the distinct terminal white border.

*Size.* — Length commonly 7–15 cm.; width about 2–6 mm.

*Body Walls.* — Cephalic glands not well developed. Cutis glands limited to a rather thin but dense layer external to the outer longitudinal muscles. They do not encroach on this muscular layer to any great extent even in the intestinal region, nor do they sink in among the muscular fibers. The pigment to which the color of the body is due resides in the connective tissue among the cutis glands.

*Nephridial and Blood Systems.* — The nephridia are well developed, and extend through more than half the esophageal region. They reach anteriorly well toward the mouth, and send large branches among the esophageal lacunæ. In each of two specimens sectioned there was a single pair of large efferent ducts a little in front of the middle of the esophageal region. In another specimen a single accessory duct was found on one side, situated a considerable distance behind the normal pair and toward the posterior end of the nephridia. The single pair of efferent ducts is usually situated somewhat anterior to the middle of the nephridial region.

Cephalic and esophageal blood lacunæ large; numerous large blood lacunæ also surround the mouth. Proboscis sheath vessel leaves the rhynchocœl a little in front of the intestinal region.

*Nervous system and sense organs* show few deviations from those of related species. There is a large commissure of the esophageal nerves just in front of the mouth. The cephalic furrows are very deep and long. Frontal sense organs are present and well developed. They are situated in three well marked pits, of which one is situated above the

proboscis pore and one on each side, as in many related species, but are well separated from the proboscis pore.

*Reproductive Organs.*—Sexual products had evidently been recently discharged from specimens collected in August.

*Habitat.*—Common at Monterey, Calif., among kelp 'hold-fasts' attached to stones on sandy or rocky bottom in 2 fms. Pacific Grove, in crevices of rocks and under stones at low water. Dredged in several localities off San Pedro in 2 to 20 fms.

The species is named in honor of Prof. C. B. Wilson, of Westfield, Mass., well known for his work on Nemertean development, to whom I am indebted for several specimens of this and of other Nemerteans, and for valuable notes on a number of the species described in this paper.

## 22. MICRURA NIGRIROSTRIS sp. nov.

pl. xvii, figs. 7, 8.

Body of small size, only moderately slender, rounded anteriorly, only slightly flattened in intestinal region; head commonly a little wider than parts immediately following; tip of snout rather narrow; cephalic slits of moderate length; mouth as usual, its anterior end situated opposite posterior ends of cephalic slits; proboscis long, flesh-colored. Caudal cirrus was not found in the few living individuals examined, but is probably present in uninjured individuals.

*Color.*—Dorsal surface of esophageal region bright blood-red; intestinal region of same color, but deeper, and sometimes with a tinge of purplish. Ventral surface of same color, but usually paler and duller in tone. Head of same blood-red color as esophageal region, with a narrow, but very sharp and conspicuous, transverse band of white near tip of snout. In ordinary states of contraction this white band is crescentic or V-shaped, its convex side pointing backward in the median line. It is a little wider laterally than in the middle, and is limited to the dorsal surface, only its ends showing from below. Immediately in front of this is a narrow, blood-red area bounded behind and laterally by the narrow white band, and in the middle of the red area, and situated on the exact tip of snout, is a small, rounded, dark brown or black spot. On this dark terminal spot are scattered a few minute whitish flecks. The brown or black spot is only slightly visible on ventral surface, as it lies a little more toward the dorsal than the ventral side of the exact tip of snout (pl. xvii, figs. 7, 8).

Color after preservation brownish, but the narrow white ring near tip of snout and the terminal black or dark brown spot are still retained.

*Ocelli.* — None.

*Size.* — Length of the few individuals found 40–80 mm.; diameter about 2–3 mm.

*Proboscis sheath* extends to the posterior end of the body, and is well developed throughout. The circular muscles of the proboscis sheath increase to a remarkable degree near the posterior end of the stomach region, but the fibers do not extend beneath the alimentary canal as in several species described above. After reaching a great thickness at the posterior end of the stomach region they suddenly decrease to a very thin layer at the commencement of the intestinal region. It will be observed that although the fibers do not surround the alimentary canal, yet the thickening of the circular layer occurs in exactly the same region as in *L. rubescens* and other species, and is probably homologous with the inner circular muscles of those species.

*Proboscis.* — There are only two muscular layers present, the inner longitudinal muscles being completely wanting. Both the dorsal and ventral fibrous crossings between the circular muscles and the outer fibrous layer are well developed. A rather thick basement layer is situated between the nervous plexus and the inner epithelium. Another peculiarity of the proboscis in the single specimen sectioned is that there is a marked differentiation of the epithelium on one side throughout its whole length. This narrow strip of differentiated cells is quite conspicuous in each cross section, from the fact that in it the epithelium is much higher than elsewhere and behaves very differently to stains than do the other cells. This specialized area is composed of very slender cells, strongly resembling the sensory cells found in various parts of the body, and having numerous small nuclei among their bases.

*Body Walls.* — The cutis glands form a compact layer beneath the integument, and do not sink inward among the fibers of the outer longitudinal muscles as they do in many related species. Pigment which gives the brownish color to the body after preservation is situated in the connective tissue among the cutis glands.

*Cephalic glands* are well developed, and extend posteriorly nearly to the brain. Cephalic furrows are narrow, and are not deep. Except at their posterior ends, they reach less than half the distance from surface to rhynchodæum or brain.

*Alimentary Canal.* — The two divisions of the esophagus described for *Lineus rubescens*, *L. flavescens* and other forms are also well marked in the present species. The change from esophagus proper to stomach is abrupt, and the two sections are separated by a conspicuous sphincter of connective tissue. The position of this sphincter is at

about two-fifths the distance from snout to intestinal region, and is in the immediate vicinity of the efferent nephridial ducts. The histological peculiarities of the various portions of the alimentary canal have been described on previous pages for the two species mentioned above. The change from stomach to intestine is gradual, and the true intestinal pouches do not begin until after the appearance of a number of shallow pouches in the walls of the stomach.

*Blood and Nephridial Systems.*—The nephridia are very limited in extent, being confined to the posterior half of the esophageal region proper. Large nephridial tubules ramify among the esophageal blood lacunæ, and are collected into a main canal on each side. At the posterior end of this canal a single efferent duct passes to the exterior above the lateral nerves as usual. The nephridiopores are thus situated in the region where the esophagus opens into the stomach. The proboscis sheath vessel leaves the rhynchocœl at the same place. Here, too, the esophageal lacunæ unite into a pair of ventro-lateral vessels which pass back through the stomach region, and into which the lateral vessels empty at the beginning of the intestinal region. In the single specimen sectioned a pair of conspicuous longitudinal folds appear in the stomach epithelium immediately internal to the ventro-lateral vessels, and in many places the vessels themselves are situated within these folds.

*Nervous System.*—Brain and principal nerves as in related species. The median dorsal nerve is remarkably conspicuous throughout the length of the body. The internal median nerve, which rests on the dorsal side of the proboscis sheath, is also conspicuous. It is best developed in the stomach region.

Cerebral sense organs present no peculiarities.

*Reproductive Organs.*—Sexual products were not developed in individuals collected in August, and had evidently been discharged some time previously.

*Habitat.*—Among 'hold-fasts' of kelp and other algæ, low water to 2 fms., Dead Man's Island, San Pedro, Calif., not common; on floating kelp 'hold-fasts' off San Pedro Harbor, one specimen.

### 23. CEREBRATULUS ALBIFRONS Coe

pl. xvii, fig. 9.

Proc. Wash. Acad. Sci., III, p. 82; Pl. IV, figs. 3, 4, 1901; also preceding article, which has identical paging.

Specimens collected in mud in San Pedro Harbor, California, measured upward of 30 cm. in length. Similar specimens were



dredged at several localities off San Pedro in 2 to 20 fms. In these individuals the coloring of the body, and the extent of the white terminal border on head were somewhat different from that described for the specimen from Alaska. The rather small mouth with its grayish lips was situated some little distance posterior to the white terminal border of head, and as far back as the posterior ends of the cephalic furrows.

*Color* of body was usually very dark, smoky brown, with a tinge of purple, but was sometimes almost black. A more reddish median line was indicated only when body was much extended. Lateral margins were not pale. Both dorsal and ventral surface of head pure white for about three-fourths the distance to posterior ends of cephalic furrows. Proboscis pinkish in color.

A single specimen belonging to this species was dredged in 50 fms. between San Pedro and Santa Catalina Island, Calif. This specimen was jet black in color except on the head, which had the characteristic white cephalic border exactly as here described.

The species has previously been recorded only from Sitka, Alaska (p. 85 of previous article), where a single specimen was found under a stone at low water. It is not uncommon in mud between tides in San Pedro Harbor, Calif.

## INDEX TO GENERA AND SPECIES, PART II.

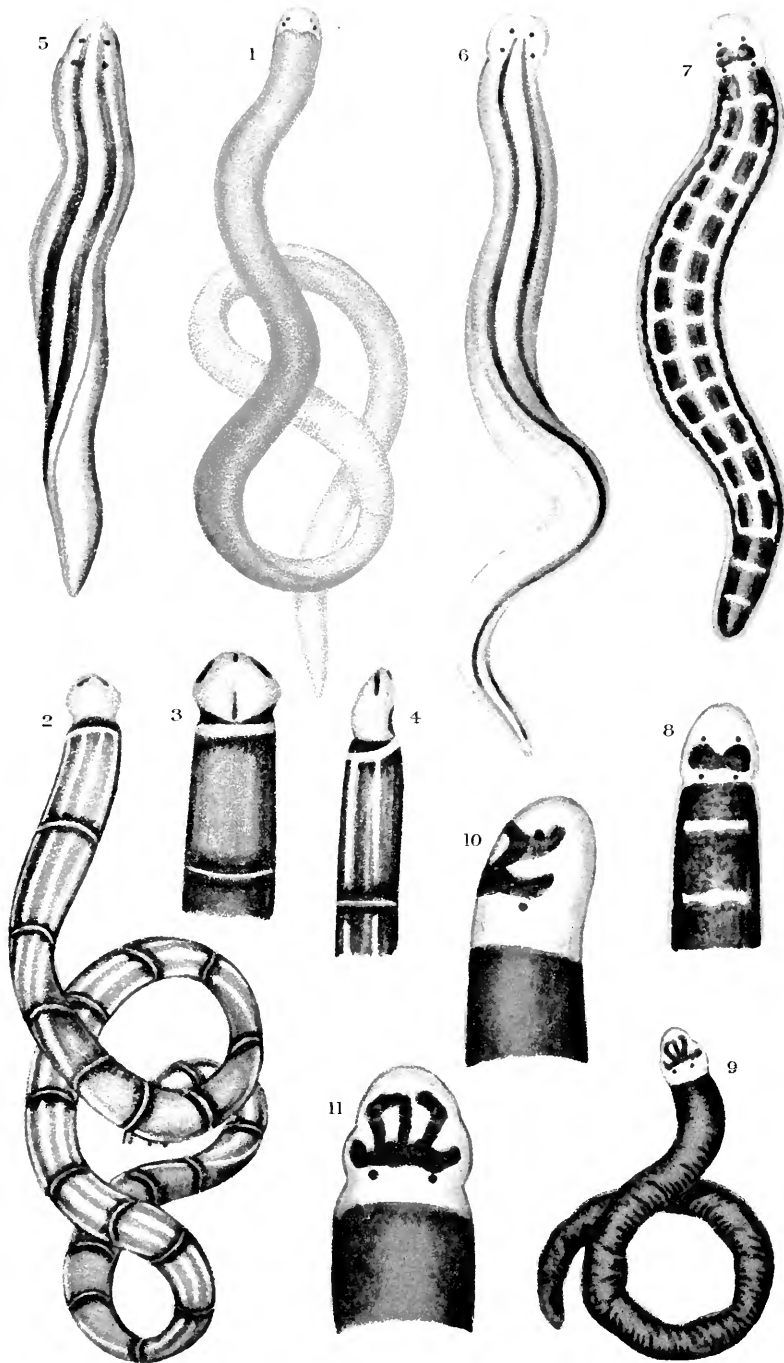
Synonyms are in *italics*; species new to science, and pages on which generic or specific descriptions occur, are in **black face type**.

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*albida* 121  
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## PLATE XIV

- FIG. 1. *Lincus rubescens* sp. nov. A large individual of the deep red variety. Pacific Grove, Calif. Enlarged five times. Compare figs. 3, 4, pl. xv.
2. *Carinella cingulata* sp. nov. Mature female, containing ripe ova. Monterey Bay, Calif. Twice natural size.
3. *C. cingulata*. Anterior portion of body from ventral surface. Enlarged three times.
4. *C. cingulata*. Lateral view of anterior portion of body. Enlarged three times.
5. *Tetrastemma quadrilineatum* sp. nov. San Pedro, Calif. Ten times natural size.
6. *Tetrastemma bilineatum* sp. nov. San Diego, Calif. Ten times natural size.
7. *Tetrastemma (Ærstedtia) reticulatum* sp. nov. San Pedro, Calif. Ten times natural size.
8. *T. reticulatum*. Anterior portion of body of individual of the variety with confluent markings. Twelve times natural size.
9. *Tetrastemma signifer* sp. nov. San Pedro, Calif. Three times natural size.
10. *T. signifer*. Side view of head, showing position and extent of characteristic cephalic marking. Enlarged ten times.
11. *T. signifer*. Dorsal view of head, showing typical form of cephalic marking. Enlarged ten times.



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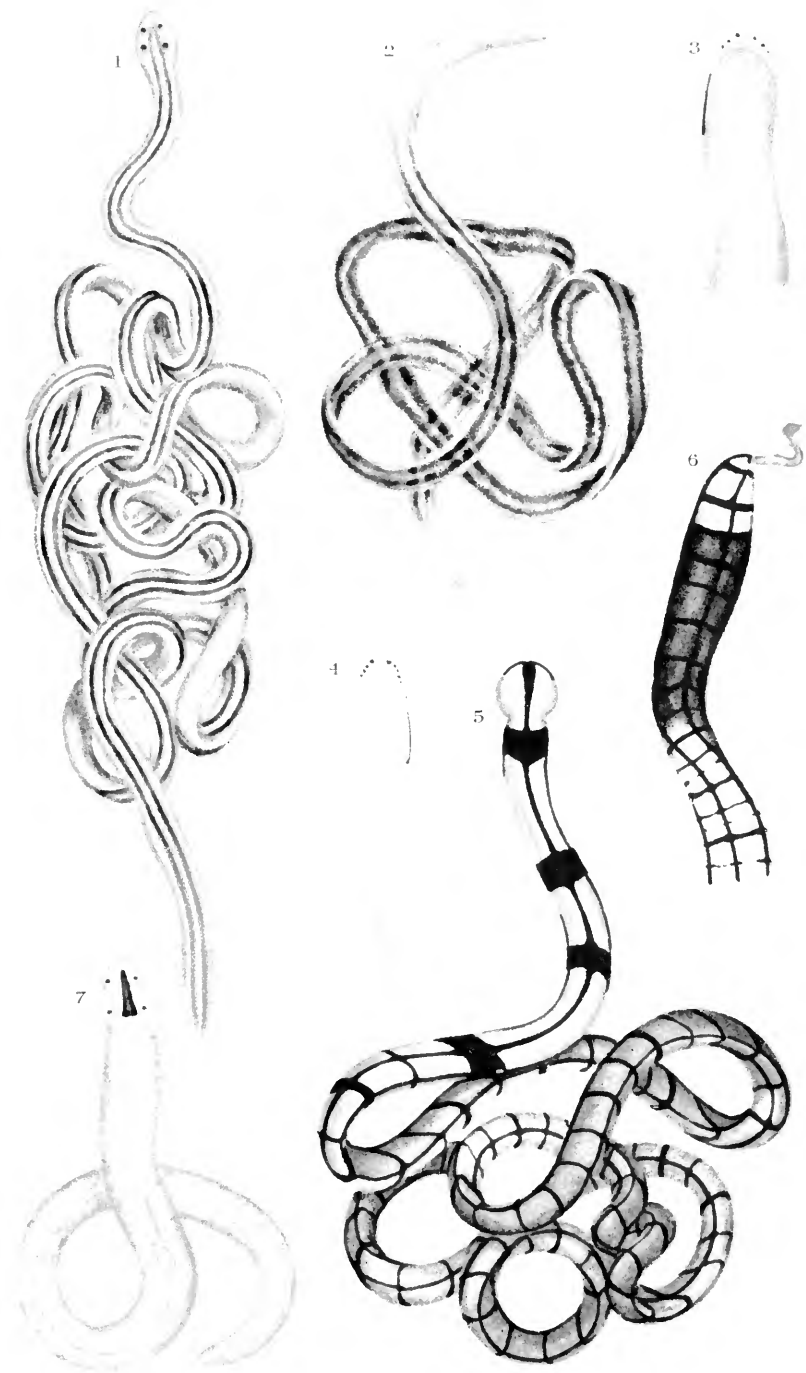




## PLATE XV

- FIG. 1. *Nemertopsis gracilis* sp. nov. Pacific Grove, Calif. Enlarged three and one-half times.
2. *Paranemertes californica* sp. nov. San Diego, Calif. Natural size.
3. *Lineus rubescens* sp. nov. Head of bright red variety with few ocelli. Monterey, Calif. Enlarged ten times. Compare fig. 1, pl. xiv.
4. *L. rubescens*. Head of pale, pinkish variety, with regularly arranged ocelli. San Pedro, Calif. Enlarged eight times.
5. *Carinella frenata* sp. nov. Mature female. The rosy color of dorsal surface in intestinal region is largely due to color of ova. San Pedro, Calif. Natural size.
6. *C. frenata*. Anterior portion of body after preservation in formalin. The body is strongly contracted, and shows the dark color which appears on body back of the third black ring after preservation. San Pedro, Calif. Twice enlarged.
7. *Tetrastemma nigrifrons* sp. nov. Variety *pallidum*. Monterey, Calif. Enlarged five times. Compare figs. 6-9, pl. xvi, and fig. 1, pl. xvii.



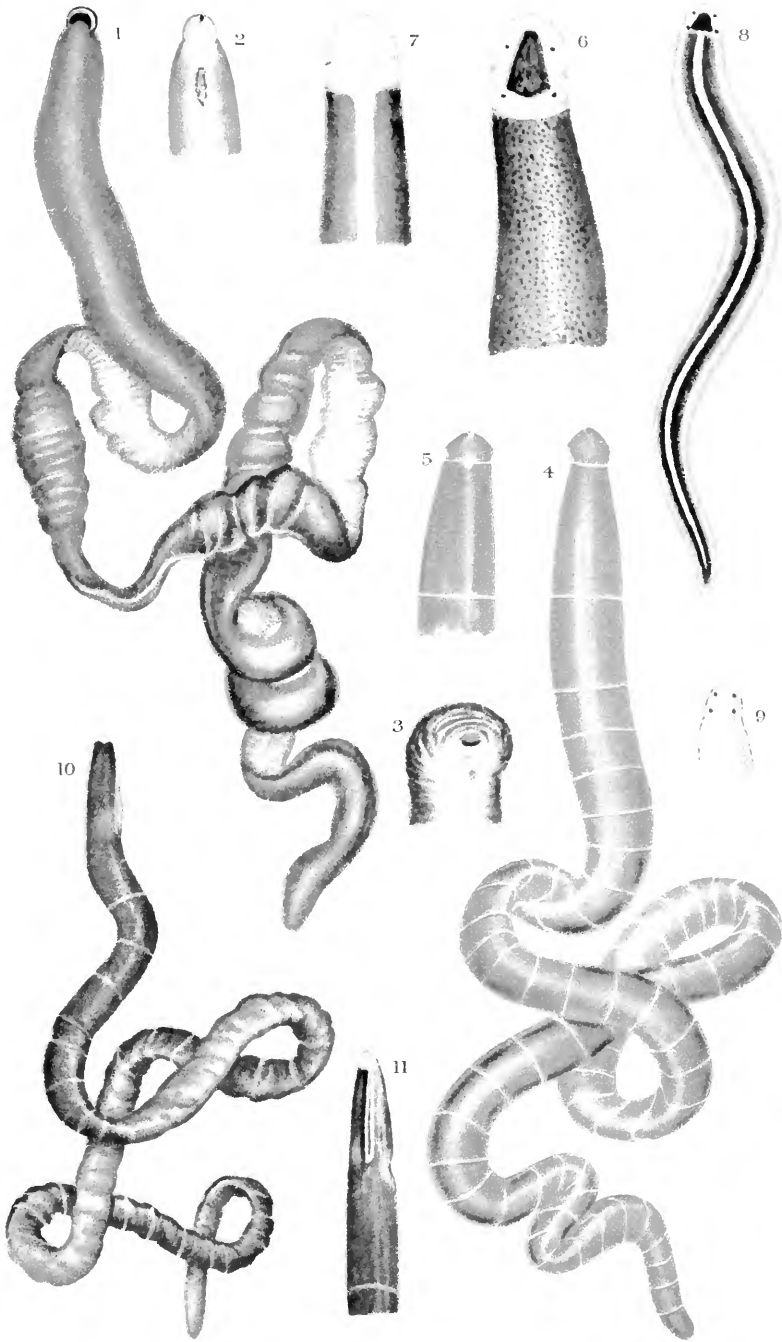






## PLATE XVI

- FIG. 1. *Tæniosoma punnetti* sp. nov. Caught on fishing-line by Chinamen, Monterey Bay, Calif. Somewhat less than natural size.
2. *T. punnetti*. Ventral side of head. Natural size.
3. *T. punnetti*. Ventral side of head when strongly contracted. Twice natural size.
4. *Carinella albocincta* sp. nov. Body somewhat contracted. Dredged between San Pedro and Santa Catalina Island, Calif., in 50-100 fathoms. Nearly twice natural size.
5. *C. albocincta*. Ventral side of head. Twice natural size.
6. *Tetrastemma nigrifrons* sp. nov. Anterior portion of body of the reddish variety. Monterey, Calif. Enlarged seven times. Compare fig. 7, pl. XIV, fig. 1, pl. XVII.
7. *T. nigrifrons*. Ventral side of head. Enlarged seven times.
8. *T. nigrifrons*. Variety *bicolor*. Monterey, Calif. Enlarged four times. Compare fig. 7, pl. XIV, fig. 1, pl. XVII.
9. *T. nigrifrons*. Variety *bicolor*. Ventral side of head.
10. *Lineus wilsoni* sp. nov. Pacific Grove, Calif. Slightly enlarged. In the process of reproduction this drawing has made the body of the worm to appear much too uneven and irregular both in outline and color.
11. *L. wilsoni*. Side view of head. Twice natural size.



NEMERTEANS

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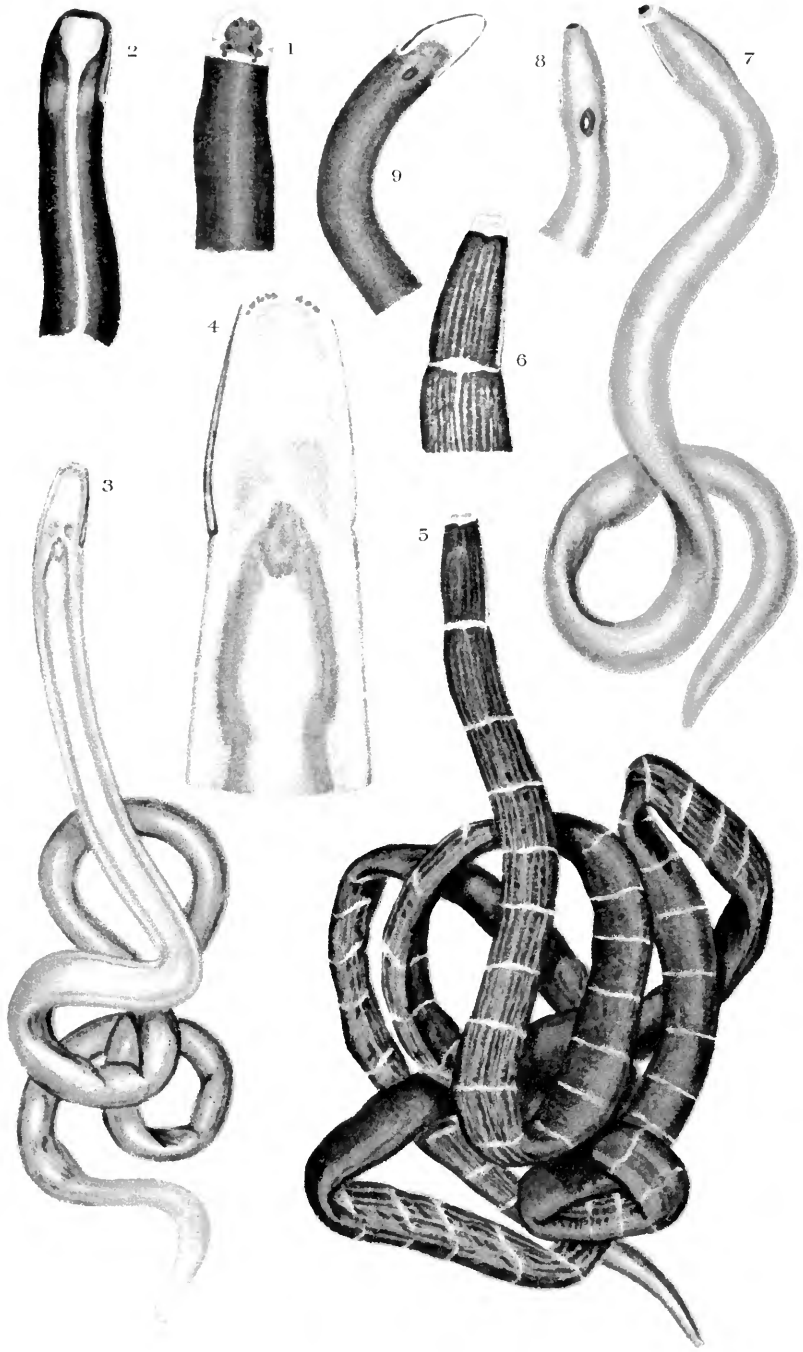




## PLATE XVII

- FIG. 1. *Tetrastemma nigrifrons* sp. nov. Variety *furfureum*. Dorsal side of anterior portion of body; head much contracted. Monterey, Calif. Enlarged five times. Compare fig. 7, pl. xiv, figs. 6-9, pl. xvi.
2. *Lincus alboineatus* sp. nov. Dorsal side of anterior portion of body. Dredged in thirty fathoms off Point Fermin, near San Pedro, Calif. Enlarged four times.
3. *Lincus flavescens* sp. nov. Dredged in fifty fathoms between San Pedro and Santa Catalina Island, Calif. Enlarged three times.
4. *L. flavescens*. Dorsal view of anterior portion of body showing arrangement of ocelli, position of ganglia, and the two portions of esophageal region. Enlarged ten times.
5. *Lincus pictifrons* sp. nov. Large individual. San Pedro, Calif. Enlarged one and one-half times. The longitudinal yellow lines are extremely delicate (and sometimes entirely wanting) in life, and appear much too distinct in this figure.
6. *L. pictifrons*. Dorsal surface of head. Enlarged three times.
7. *Micrura nigrirostris* sp. nov. San Pedro, Calif. Enlarged five times.
8. *M. nigrirostris*. Ventral side of anterior portion of body. Enlarged five times.
9. *Cerebratulus albifrons* Coe. Ventral side of anterior portion of body. San Pedro Harbor, Calif. Natural size.





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## PLATE XVIII

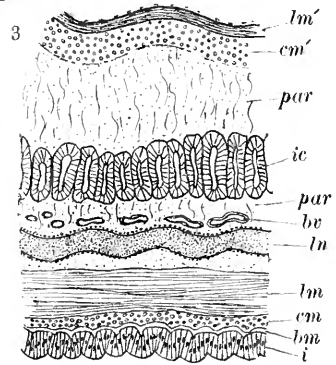
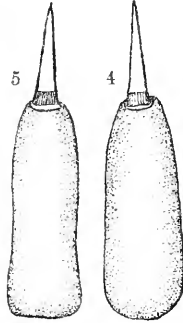
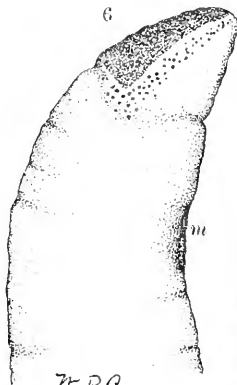
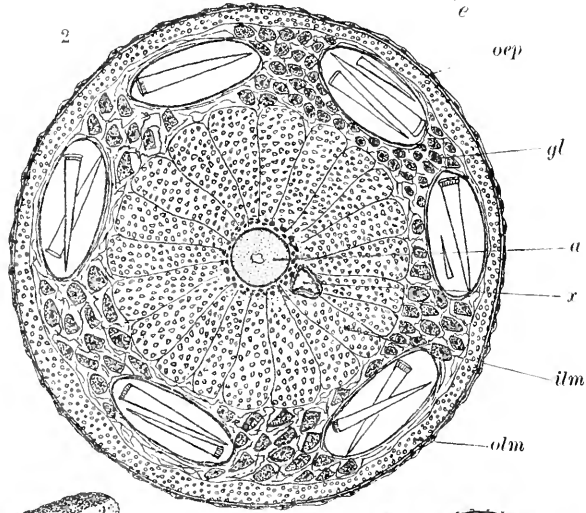
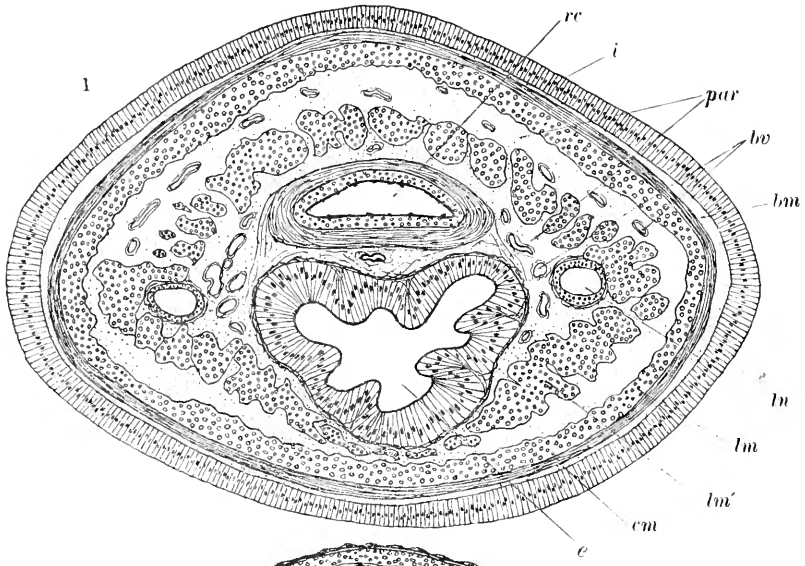
FIG. 1. *Paranemertes californica* Coe. Transverse section of body a short distance behind brain, showing the two distinct layers of longitudinal muscles (*lm* and *lm'*) of body walls separated by a thick layer of parenchyma (*par*). Numerous anastomosing blood vessels (*bv*) are imbedded in this layer of parenchyma, as well as in that lying internal to the inner longitudinal muscular layer; *bm*, basement layer; *ln*, lateral nerve; *e*, esophagus; *i*, integument; *rc*, rhynchocœl.  $\times 30$ .

FIG. 2. *P. californica*. Transverse section of proboscis through basis of central stylet. The section shows the six pouches of accessory stylets symmetrically arranged between the outer and inner longitudinal muscular layers (*olm* and *ilm*). The space between the stylet pouches is closely packed with large gland cells (*gl*) filled with deeply staining secretion. In the center of the proboscis, surrounded by the radially disposed bundles of the inner longitudinal muscles, is a section of the basis of the central stylet (*a*), and to the right of this a section of the duct (*x*) leading from the middle to the anterior chamber of the proboscis; *ocp*, outer epithelium of proboscis.  $\times 90$ .

FIG. 3. *P. californica*. Longitudinal, and nearly horizontal, section of body walls in the region of the intestinal cœcum, the lateral diverticula of which (*ic*) are arranged with great regularity in the parenchyma immediately internal to the lateral nerve (*ln*). A thick layer of parenchyma (*par*) lies between the diverticula of the intestinal cœcum and the muscular walls (*lm'* and *cm'*) of the proboscis sheath; *bv*, blood vessels; *ln*, lateral nerve; *lm*, longitudinal muscles; *cm*, circular muscles; *bm*, basement layer; *i*, integument.  $\times 30$ .

FIGS. 4, 5. *P. californica*. Central stylets and bases (see pl. XXI, figs. 3-9).  $\times 90$ .

FIG. 6. *Tæniosoma punnetti* Coe. Lateral view of anterior portion of body after clearing in cedar oil, showing distribution of the numerous small ocelli immediately ventral to dark marking on snout, which is marked off from succeeding portion of head by an annular constriction. The mouth (*m*) is indicated.  $\times 8$ .



F.R.C.





## PLATE XIX

FIG. 1. *Carcinonemertes cpialli* Coe. Diagram of body, showing ocelli, brain lobes, alimentary canal (in dotted lines) and genital glands.  $\times 15$ .

FIG. 2. *C. cpialli*. Optical section of proboscis removed from the worm; *ac*, *mc*, *pc*, anterior, posterior, and middle chambers respectively; *g*, gland cells; *c*, canal connecting anterior and middle chambers; *ps*, remnants of proboscis sheath attached to posterior chamber; *ct*, connective tissue in which posterior chamber is imbedded; *b*, basis of central stylet.  $\times 225$ .

FIG. 3. *C. cpialli*. Horizontal section of proboscis lying between the brain lobes (*br*) in its natural position, and showing the posterior chamber lying at right angles to the general axis of the proboscis. Reference letters as in fig. 2.  $\times 225$ .

FIG. 4. *C. cpialli*. Transverse section of body immediately back of brain. The posterior chamber of the proboscis (*pc*) is firmly imbedded in the surrounding connective tissue. Three lobes of the very short intestinal caecum (*ic*) are seen; *e*, esophagus lined with cilia; *cm*, *lm*, circular and longitudinal layers of muscles; *sg*, submuscular glands; *ln*, lateral nerve; *i*, integument.  $\times 150$ .

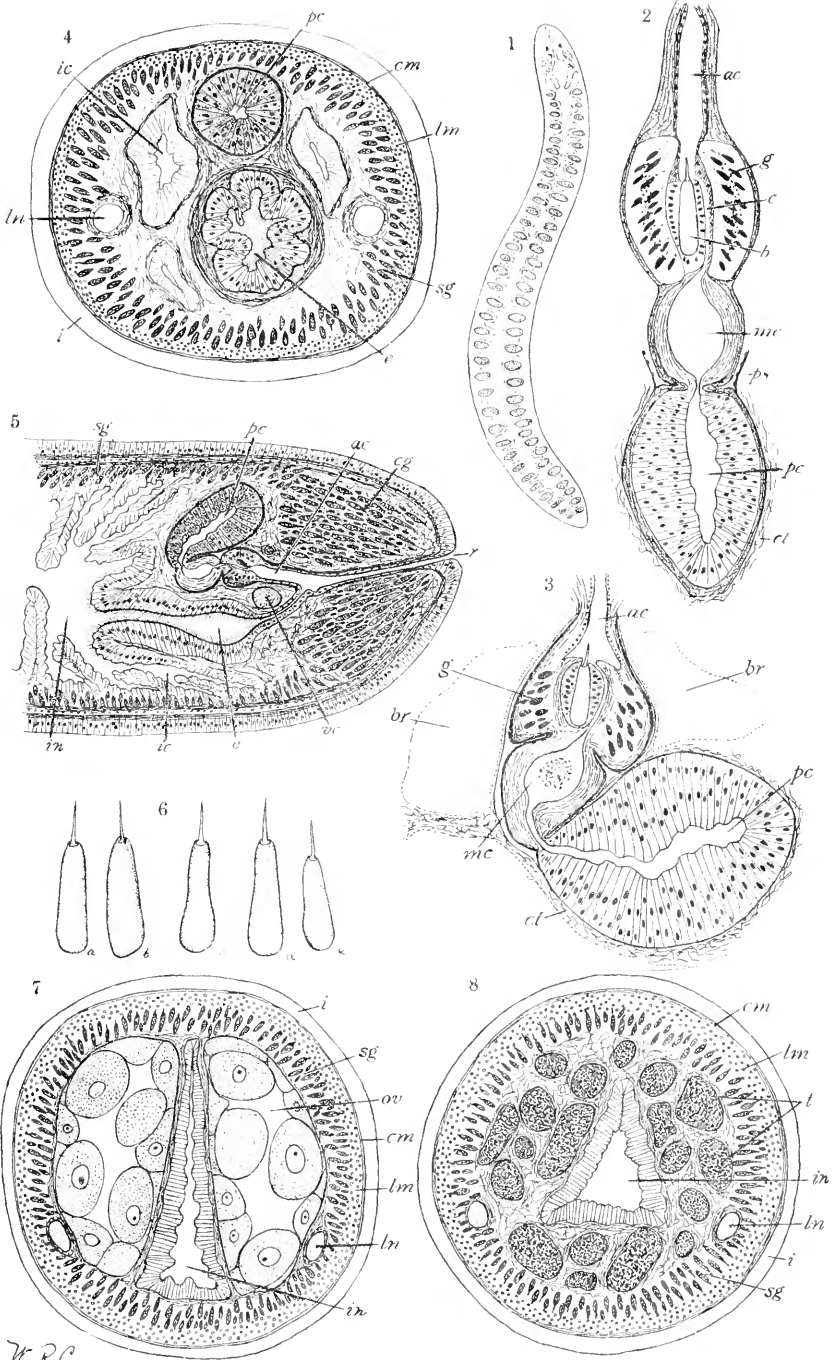
FIG. 5. *C. cpialli*. Oblique section through anterior portion of body; *r*, opening of rhynchodaeum; *cg*, cephalic glands; *ac*, *pc*, anterior and posterior proboscis chambers; *sg*, submuscular glands; *vc*, ventral commissure of brain; *e*, esophagus; *ic*, rudimentary intestinal caecum; *in*, intestine.  $\times 125$ .

FIG. 6. *C. cpialli*. Several stylets with their bases, showing variations in form and size.  $\times 400$ .

FIG. 7. Transverse section of body of *C. cpialli*, showing the thick layer of submuscular glands (*sg*) and the ovaries (*ov*) with large ova. The intestine (*in*) is reduced to a narrow canal. Other reference letters as in fig. 4.  $\times 150$ .

FIG. 8. *C. cpialli*. Transverse section of body, showing the large number of spermaries (*s*) and their distribution through the body parenchyma. Reference letters as in fig. 4.  $\times 150$ .





WRC

COE, DEL.

HELIOTYPE CO.





## PLATE XX

FIG. 1. *Amphiporus cruentatus* Verrill. Optical section of stylet apparatus of proboscis after extrusion. To the right of the basis is seen duct leading forward from middle to anterior proboscis chamber.  $\times 220$ .

FIGS. 2-5. *A. cruentatus*. Outlines of central stylets and bases, showing variation in size and form in different individuals.  $\times 220$ .

FIG. 6. *A. cruentatus*. Outline of head, showing comparative size and position of ocelli.  $\times 30$ .

FIG. 7. *Tetrastemma reticulatum* Coe. Optical section of stylet apparatus of proboscis.  $\times 220$ .

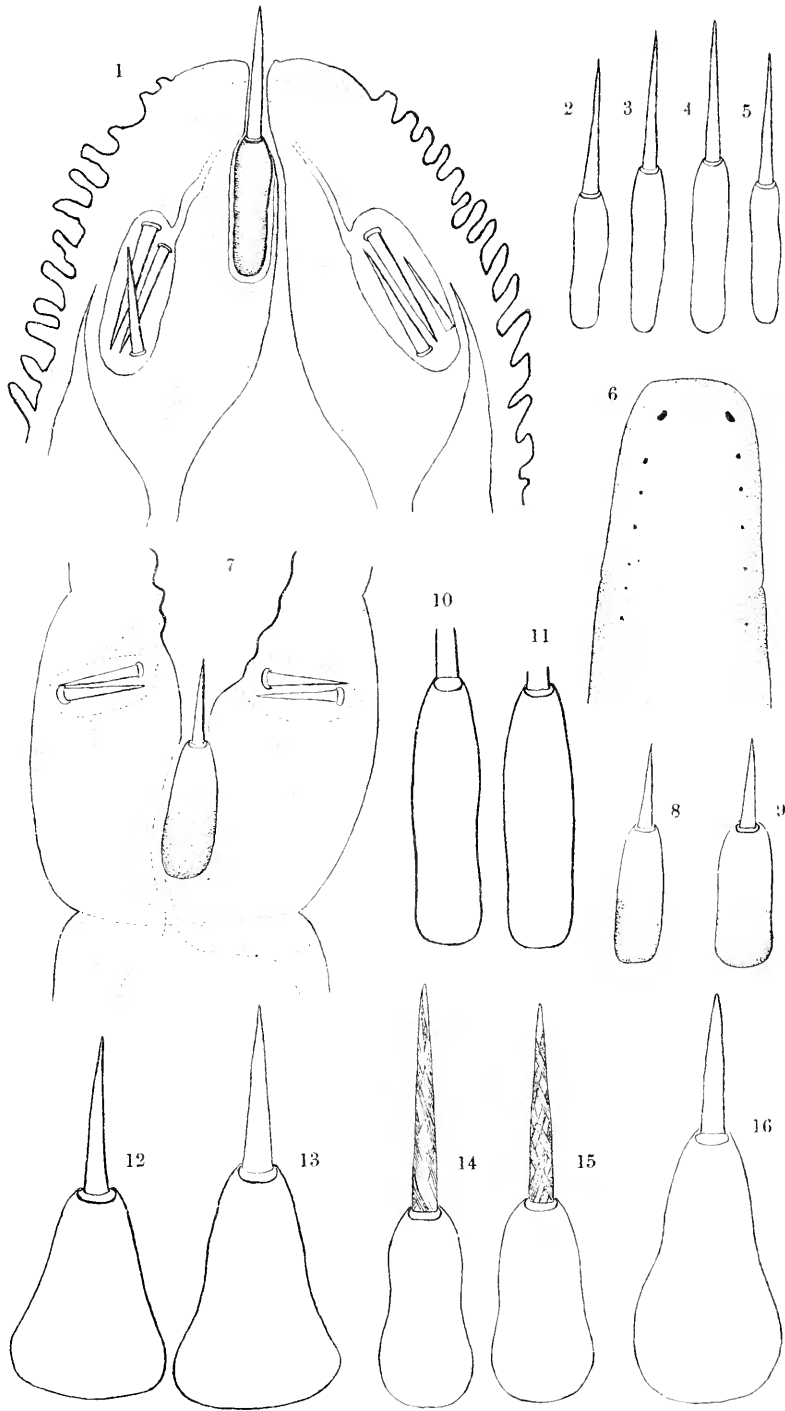
FIGS. 8, 9. *T. reticulatum*. Outlines of central stylets and bases in two individuals.  $\times 220$ .

FIGS. 10, 11. *Nemertopsis gracilis* Coe. Outlines of bases of central stylets in two individuals.  $\times 300$ .

FIGS. 12, 13. *Tetrastemma quadrilineatum* Coe. Outlines of central stylets and bases in two individuals.  $\times 430$ .

FIGS. 14, 15. *Parancmerites peregrina* Coe. Outlines of central stylets and bases, showing the peculiar braided appearance of stylet. Both central and accessory stylets present this peculiarity. The braided appearance is probably due to a deep spiral fluting, the translucence of the stylets allowing the flutings of both upper and lower surfaces to appear as if actually crossing.  $\times 300$ .

FIG. 16. *Tetrastemma nigrifrons* Coe. Outline of central stylet and basis (see pl. XXI, figs. 15-23).  $\times 220$ .



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## PLATE XXI

FIG. 1. *Parancmertes californica* Coe. Dorsal view of anterior portion of body, showing position of the two small ocelli on tip of snout. Position of cephalic furrows indicated by dotted lines; *br*, brain; *ln*, lateral nerve.  $\times 12$ .

FIG. 2. *P. californica*. Dorsal view of tip of snout, showing the two fragmented ocelli.  $\times 12$ .

FIG. 3. *P. californica*. Stylet apparatus of proboscis, showing central stylet and basis and four pouches of accessory stylets.  $\times 45$ .

FIGS. 4-8. *P. californica*. Central stylets and bases from five individuals, showing variations in size and shape.  $\times 90$ .

FIG. 9. *P. californica*. Accessory stylets more highly magnified, showing the peculiarly striated basal portion of each. The central stylets in figs. 4-8 are perfectly similar to these.  $\times 220$ .

FIGS. 10-12. *Tetrastemma signifer* Coe. Central stylets and bases from three individuals.  $\times 220$ .

FIGS. 13-14. *T. bilineatum* Coe. Outlines of bases of central stylets.  $\times 350$ .

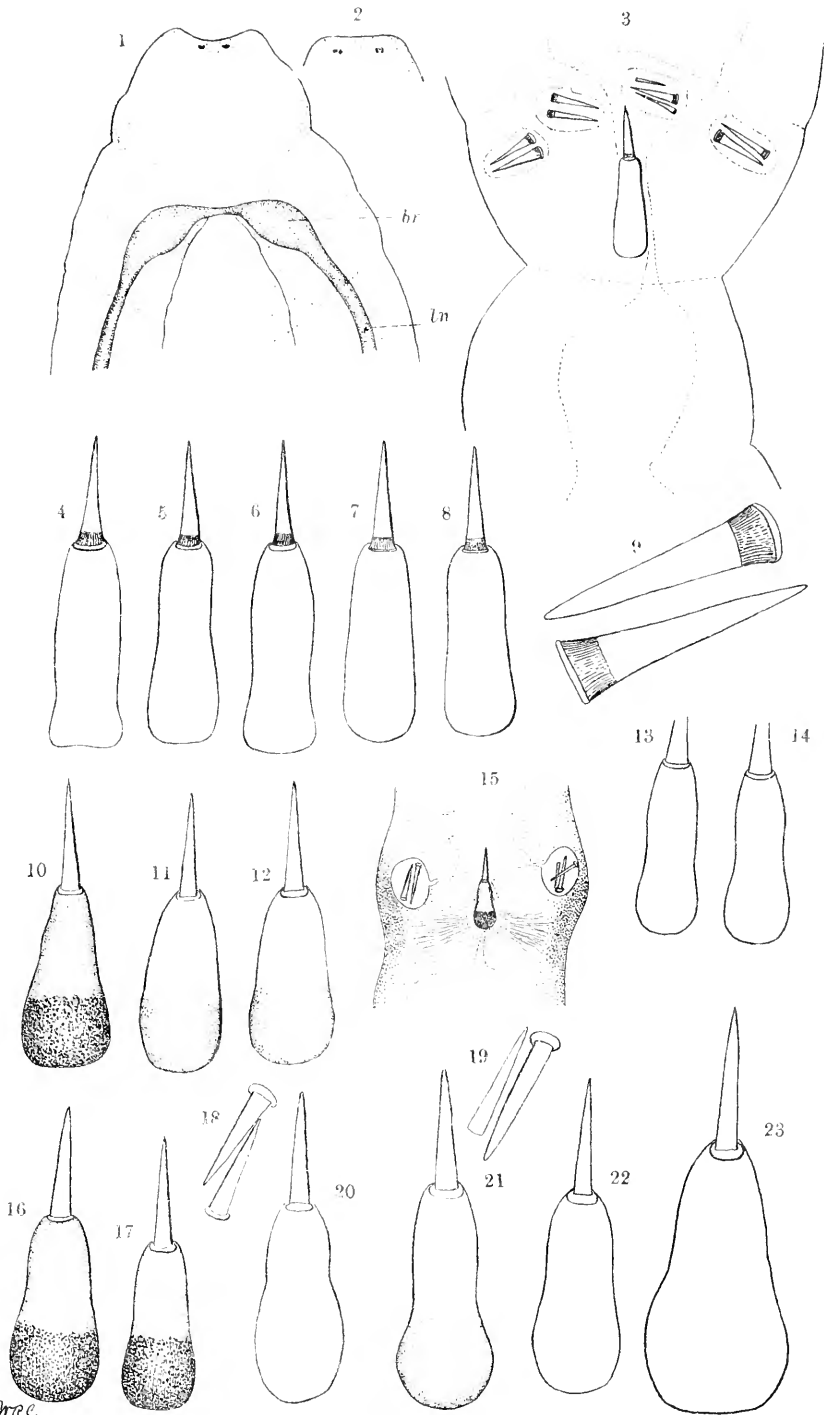
FIG. 15. *T. nigrifrons* Coe. Stylet apparatus of proboscis.  $\times 50$ .

FIGS. 16-17. *T. nigrifrons* Coe. Central stylets and bases, showing more opaque posterior portions.  $\times 180$ .

FIGS. 18-19. *T. nigrifrons*. Outlines of accessory stylets.  $\times 220$ .

FIGS. 20-23. *T. nigrifrons*. Outlines of central stylets and bases, showing variation in form and size. Figs. 20-22 from very small individuals; fig. 23 from the largest specimen collected.  $\times 220$ .





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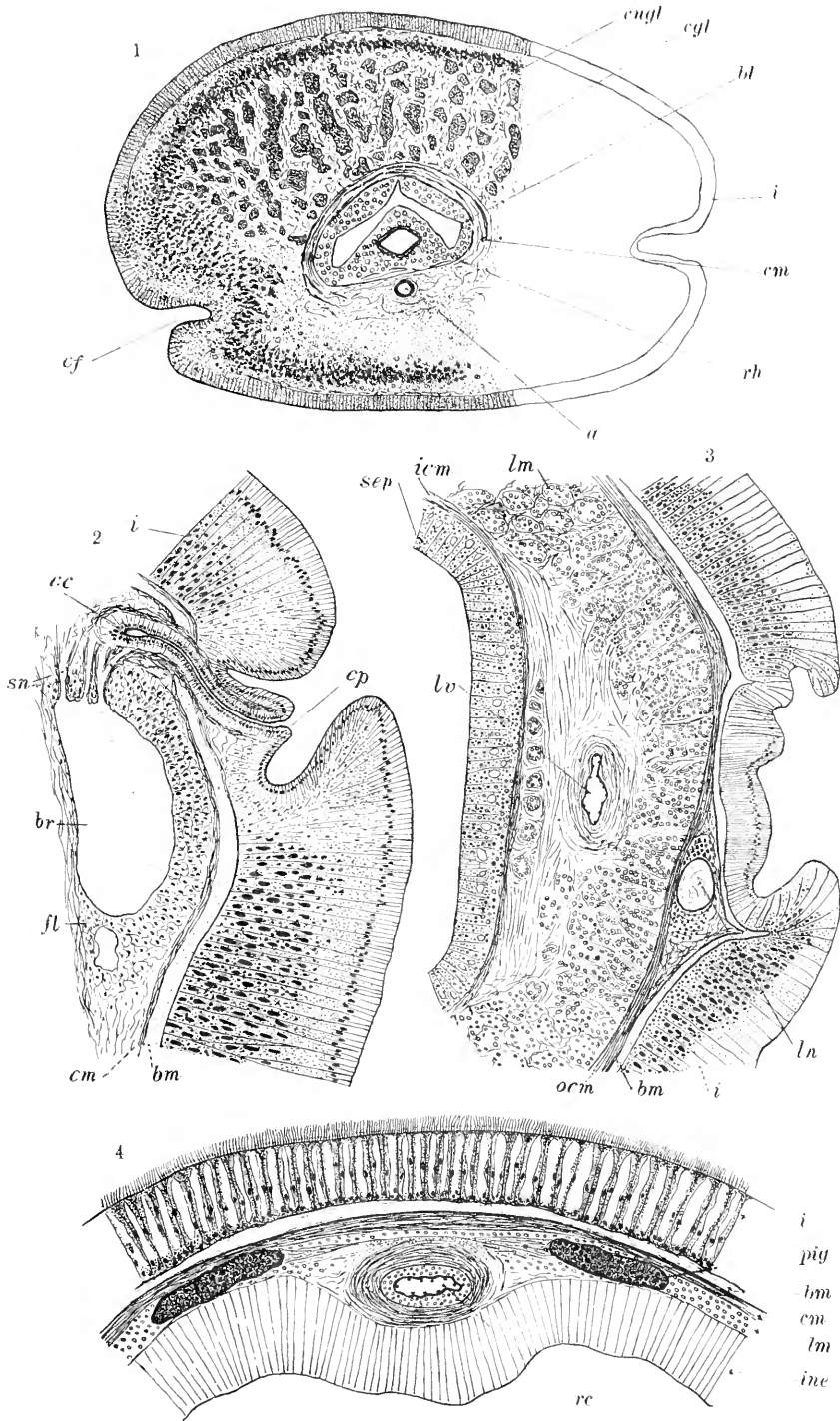
## PLATE XXII

FIG. 1. *Lineus rubescens* Coe. Transverse section of head in front of brain, showing distribution of cutis glands (*cugt*), the highly developed cephalic glands (*cgl*), and the duct (*a*) leading forward beneath the rhynchodæum (*rh*). This duct is probably the common efferent canal for the secretions of the more posterior cephalic glands; *cf*, cephalic furrow; *bl*, blood lacuna; *cm*, circular muscles.  $\times 50$ .

FIG. 2. *Carinella frenata* Coe. Portion of transverse section of head, showing the deep ciliated pit (*cp*) from which a ciliated sensory canal (*cc*) leads inward to the brain region, where it becomes surrounded with sensory nerves (*sn*) from the dorsal side of brain to form a highly specialized sense organ; *i*, integument; *f*, layer of fibrous connective tissue surrounding brain; *cm*, circular muscles; *br*, fibrous core of brain, surrounded except internally by a thick layer of nerve cells; *bm*, basement membrane.  $\times 60$ .

FIG. 3. *Carinella frenata*. Portion of transverse section of body through lateral sense organ; *i*, integument, sharply contrasted with the layer of specialized sensory cells lining the sensory pit; *ln*, lateral nerve; *lv*, lateral blood vessel; *sep*, epithelium of stomach; *icm* and *ocm*, inner and outer circular muscular layers; *lm*, longitudinal muscles.  $\times 60$ .

FIG. 4. *Tetrastemma bilineatum* Coe. Portion of transverse section of body. The two pigment bands (*pig*) which give the body its characteristic markings are situated in the midst of the longitudinal muscles (*lm*), on either side of the proboscis sheath (*rc*); *inc*, intestinal epithelium; other reference letters as in fig. 2.  $\times 230$ .



NEMERTEANS



*Nemertea*  
*Wesley R. Coe*

AMERICAN MUSEUM OF NATURAL HISTORY

HARRIMAN ALASKA EXPEDITION  
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*Wesley R. Coe*  
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# THE NEMERTEANS OF THE EXPEDITION



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