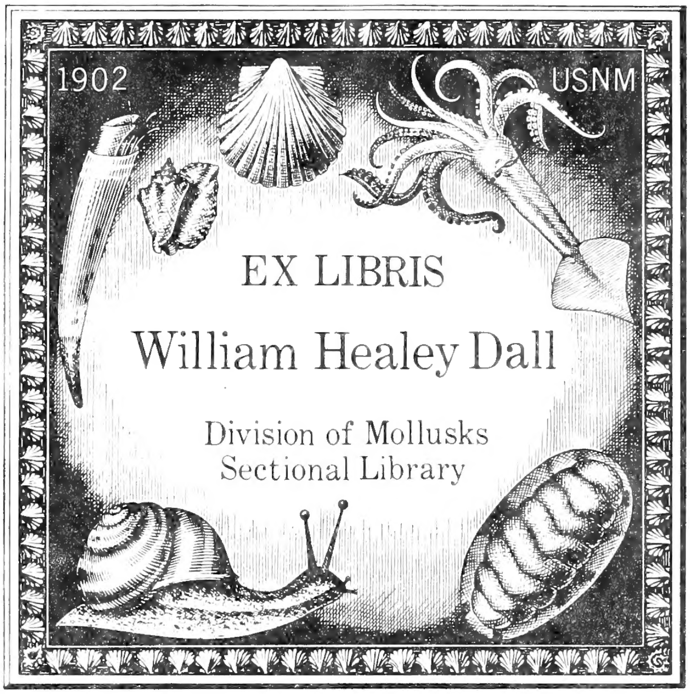
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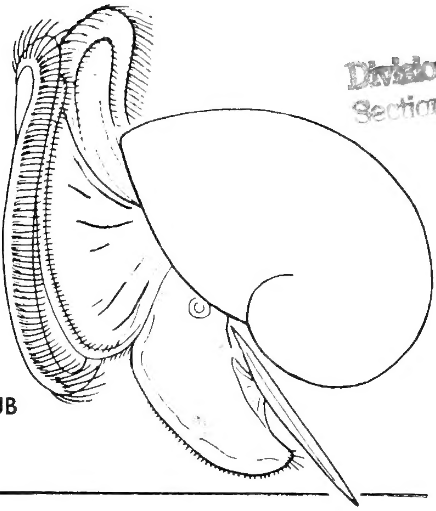

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Part One

Opisthobranch Mollusks from California

by

ERNST MARCUS

Foreword & Introduction

In accordance with Professor Marcus' wishes expressed because of the uncertainties of mailing manuscripts back and forth between Brazil and California, we have made minor changes, corrections and additions in the text of his paper without detailed consultation with the author. Corrections in matters of English style and usage are largely the responsibility of Joel W. Hedgpeth. Anatomical terminology has been made as consistent as possible by the editor in partial consultation with Miss Joan E. Steinberg. The custom of Professor Marcus not to offer explanations of new specific names (except dedicatory ones) and such explanations being required by the editorial policy of "The Veliger," we have endeavored to supply them after correspondence with Professor Marcus. Several of the new names given by Professor Marcus in the following pages are, according to a letter to Dr. Joel W. Hedgpeth, derived from folklore names for seals, including Aleut, Eskimo and Siberian sources.

The 29 plates as submitted by Professor Marcus have been rearranged and renumbered to agree with the format adopted for "The Veliger." For greater ease of reproduction, some of the figures had to be redrawn. All the artistic work that has gone into this part of the supplement was contributed by the skilled hands of Mrs. Emily Reid. We are indebted to Mr. Edmund H. Smith, recently returned from a stay in Professor Marcus' laboratory, for information relating to the staining techniques employed which consist for the most part of H & E (Haematoxylin and Eosin).

Emendations and additions are indicated in the text by the following conventions { }, while [ ] enclose reference numbers to anatomical parts shown in the illustrations.

Again, because of the time involved and the uncertainties of mailing, no proofs of the typescript have been submitted to Professor Marcus. We must, therefore, assume full responsibility for any typographical errors that have remained. Responsibility for the factual content and for the conclusions rests, however, with the author except for the portions clearly marked as indicated above.

A second part of this supplement to volume 3 of "The Veliger," containing keys to the known species of West North American opisthobranch mollusks, a glossary to the terminology used, and an index to the entire supplement as well as a stiff paper cover, will be mailed to owners of this part whose addresses are on record with us, without additional charge, as soon as completed.

R. Stohler, Editor.

Opisthobranch Mollusks from California

by

ERNST MARCUS

Department of Zoology, University of São Paulo, Brazil, P. O. B. 6994.

(With 10 Plates)

This paper is based principally on a collection of opisthobranch mollusks made by our friend, Dr. Diva Diniz Corrêa while on a John Simon Guggenheim Memorial Foundation Fellowship in the United States. She worked during the spring and summer of 1958 at Pacific Marine Station, Dillon Beach, Marin County, California, where she was helped by the Director, Dr. Joel W. Hedgpeth, Mr. Edmund H. Smith, and others. In September she took part in excursions in the San Diego area led by Dr. E. W. Fager of Scripps Institution of Oceanography. Dr. Hedgpeth and Mr. Smith sent us additional specimens after Dr. Corrêa's return to Brazil. From Dr. George M. Moore, University of New Hampshire, Durham, we received a number of fine, well expanded specimens of Onchidoris bilamellata (Linnaeus, 1767) from New Hampshire.

Smith and Gordon's list (1948), the bibliography in Ricketts and Calvin (1952) and Steinberg's chapter in Light's Manual (1954) show that the Californian opisthobranchs are rather well known, especially the nudibranchs. This is mainly due to Frank Mace MacFarland, whose publications (1905 to 1929) are among the best ever written about these animals.

The systematic arrangement followed here is that of Odhner (1939). The characters of the taxonomic categories higher than species are too lengthy to be given here. For their diagnosis Odhner's survey in Grassé's "Traité de Zoologie" must be awaited. Thiele's "Handbuch der systematischen Weichtierkunde" (1931) is out of date for the order Notaspidea and the suborders Dendronotacea, Arminacea, and Eolidacea; Hoffmann's excellent "Bronn" (1932 to 1940) was not completed and does not include the classification.

We must apologize for unavoidable deficiencies regarding the extensive faunistic literature of the California coast; for supplying needed systematic papers we are indebted to Dr. Diva Diniz Corrêa (during her stay in California); to Drs. Nellie B. Eales, Reading (England); Cadet Hand, Berkeley; and to Harald A. Rehder, Washington, who sent photocopies.

To our friend, Dr. Joel W. Hedgpeth, we are grateful for the correction of the language and to Miss Joan E. Steinberg for the reading of the proofs.

The material is deposited in the Department of Zoology of the Faculty of Philosophy, Sciences and Letters, University of São Paulo, Brazil, P. O. B. 6994.

The present paper deals with the following species:

ONCHIDIACEA

ONCHIDELLIDAE

1. *Onchidella borealis* DALL, 1871

CEPHALASPIDEA

Bullacea

BULLIDAE

2. *Bulla gouldiana* PILSBRY, 1893

Scaphandracea

ATYIDAE

3. *Haminoea virescens* (SOWERBY, 1833)

Philinacea

AGLAJIDAE

4. *Aglaja diomedea* (BERGH, 1893)
5. *Navanax inermis* (COOPER, 1862)
6. *Chelidonura phocae* MARCUS, spec. nov.

Note: The various taxa above genus are indicated by the use of different type styles, as shown by the following examples.
ORDER, Suborder, **DIVISION**, **Subdivision**, SECTION, FAMILY, Subfamily.

ANASPIDEA

Aplysiidae

Aplysiinae

7. *Aplysia californica* Cooper, 1863

Dolabriferinae

8. *Phyllaplysia zostericola* McCauley, 1960

ASCOGLOSSA

Hermaeidae

Hermaeinae

9. *Hermaeina smithi* Marcus, spec. nov.

Elysiacea

Elysiidae

10. *Elysia hedgpethi* Marcus, spec. nov.

NUDIBRANCHIA

Doridacea

EUDORIDACEA

Cryptobranchia

Dorididae

Glossodoridinae

11. *Cadlina flavomaculata* MacFarland, 1905

12. *Cadlina sparsa* (Odhner, 1921)

Thorunninae

13. *Rostanga pulchra* MacFarland, 1905

14. *Aldisa sanguinea* (Cooper, 1862)

Archidoridinae

15. *Archidoris montereyensis* (Cooper, 1862)

Discodoridinae

16. *Anisodoris nobilis* (MacFarland, 1905)

17. *Diaulula sandiegensis* (Cooper, 1862)

18. *Discodoris heathi* MacFarland, 1905

Phanerobranchia

NONSUCTORIA

Notodorididae

19. *Aegires albopunctatus* MacFarland, 1905

Polyceridae

20. *Laila cockerelli* MacFarland, 1905

Triophidae

21. *Triopha carpenteri* (Stearns, 1873)

22. *Triopha maculata* MacFarland, 1905

23. *Crimora coneja* Marcus, spec. nov.

SUCTORIA

Onchidorididae

24. *Acanthodoris rhodoceras* Cockerell & Eliot, 1905

25. *Onchidoris bilamellata* (Linnaeus, 1767)

26. *Onchidoris hystricina* (Bergh, 1878)

Goniodoridae

27. *Ancula pacifica* MacFarland, 1905

28. *Hopkinsia rosacea* MacFarland, 1905

POROSTOMATA

Dendrodorididae

29. *Dendrodoris fulva* MacFarland, 1905

Dendronotacea

Tritoniidae

30. *Tritonia festiva* (Stearns, 1873)

31. *Tritonia exsulans* Bergh, 1894

Hancockiidae

32. *Hancockia californica* MacFarland, 1923

Dendronotidae

33. *Dendronotus frondosus* (Ascanius, 1774)

Dotonidae

34. *Doto columbiana* O'Donoghue, 1921

35. *Doto amyra* Marcus, spec. nov.

36. *Doto ganda* Marcus, spec. nov.

37. *Doto kya* Marcus, spec. nov.

38. *Doto wara* Marcus, spec. nov.

Arminacea

EUARMINACEA

Arminidae

39. *Armina californica* (Cooper, 1862)

40. *Armina columbiana* O'Donoghue, 1924

PACHYGNATHA

Dironidae

41. *Dirona picta* Cockerell & Eliot, 1905

42. *Dirona albolineata* Cockerell & Eliot, 1905

Eolidacea

PLEUROPROCTA

Coryphellidae

43. *Coryphella piunca* Marcus, spec. nov.

ACLEIOPROCTA

Eubranchidae

44. *Capellinia rustya* Marcus, spec. nov.

Fionidae

45. *Fiona pinnata* Eschscholtz, 1831

46. *Precuthona divae* Marcus, spec. nov.

Cuthonidae

47. *Catriona ronga* Marcus, spec. nov.

CLEIOPROCTA

Facelinidae

48. *Hermissenda crassicornis* (Eschscholtz, 1831)

Aeolidiidae

49. *Aeolidia papillosa* (Linnaeus, 1761)

50. *Spurilla chromosoma* (Cockerell & Eliot, 1905)

List of Localities

OREGON

Southwest side of Sunset Bay, Charleston, Coos County, July, 1958; collector G. Robinson; received from Joel W. Hedgpeth. Species: No. 1

CALIFORNIA

Vicinity of Dillon Beach. Species: Nos. 1, 4, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 21, 22, 24, 25, 26, 30, 31, 33, 34, 36, 38, 39, 40, 41, 42, 43, 45, 46, 48, 49.

Shell Beach, Sonoma County, about 13 miles (24 km.) north of Pacific Marine Station, just below the mouth of the Russian River.

Bodega Harbor, Sonoma County.

Near Pacific Marine Station, Marin County, generally under stones (this is Dillon Beach strictly speaking).

Outer coast of Tomales Point, Marin County.

Inner coast of Tomales Point, Marin County.

Tomales Bay, Marin County.

Monterey-Pacific Grove area, Monterey County. Species: Nos. 11, 13, 18, 19, 20, 22, 27, 28, 29, 32, 33, 35, 36, 37, 38, 41, 43, 44, 47, 48. All collected by Edmund H. Smith.

Monterey Bay, boat harbor, on Obelia 8. VII. 1959.

Point Pinos, Pacific Grove, in protected tide-pool, among algae; 22. VII. 1959.

Carmel Point, under algae; 23. VI. 1959.

San Diego area, San Diego County. Species: Nos. 2, 3, 5, 11, 12, 13, 15, 17, 19, 22, 23, 24, 28, 29, 50.

Sea-water cooling galleries of the gas and electric company; 3. IX. 1958.

Point Loma reef near the Lighthouse; 12. IX. 1958.

La Jolla; 23. IX. 1958.

1. *Onchidella borealis* Dall, 1871

(Plate 1, Figures 1 and 2)

PRINCIPAL REFERENCES: Dall 1871, p. 135 (external characters); Binney 1876, pp. 184-185 (pl. 6: E. appearance, BB. jaw, EE. radula); Semper 1882, p. 282 (penis); Plate 1893, pp. 206-207 (lung, kidney); Watson, 1925, pp. 290-291 (Arctonchis Dall, 1905, suppressed); Hoffmann 1928, p. 95 (range, literature); Abbott 1954, p. 275.

OCCURRENCE: Sunset Bay, Oregon; Shell Beach in tubes of polychaetes and on boulders with algae; Dillon Beach; outer coast of Tomales Point, March, June and July 1958; a total of 29 specimens.

Further distribution: Oregon; Vancouver Island; Alaska; Aleutian Islands.

Alive the animals may attain a length of 12 mm. The preserved specimens (pl. 1, fig. 1) are three to ten mm. long, up to 5.5 mm. broad and 3.5 mm. high. They are highest and broadest a little behind the middle. The sole of the foot is 3.5 mm., the hyponotum 1 mm. broad or, especially behind the middle, still broader. The anterior end is somewhat truncated, the posterior end slightly pointed. Head and sensory lobes are big, the tentacles short.

The mantle is strewn with warts containing glands of various sizes; the 20 to 28 conical ones at the margin are the largest. Between them lie variable numbers of smaller papillae. Small papillae cover the outer side of the hyponotum which is smooth from the distinct hyponotal line downwards.

The color is black, brownish black or dark grey, sometimes with light yellowish white dots, streaks or meshes between the warts. The top of the marginal papillae is white, and also the notal papillae have light tips of varying size. The pigment of the eyes is black, but in preserved specimens under a layer of white tissue they appear blue as described by Dall (1871). The head is grey; in Plate's specimens it was dark with a light front. The dark color of the back extends to the hyponotal line, farther posteriorly the hyponotum is not pigmented. The sole, the tentacles, and the sensory lobes are ivory white.

The opening of the mantle cavity, formerly called anus, is covered by the tip of the foot. The respiratory opening (pneumostome) is free; its distance from the posterior border is about half the breadth of the hyponotum. The distance between pallial and respiratory opening is one third to one half the hyponotal breadth.

The female aperture lies to the right of the pallial opening in a fold. This fold is continuous with the ciliated groove which passes along the right side of the body near the junction of foot and body wall to the pedal mucus gland. The male aperture is situated beside the right tentacle.

The peritoneum is pigmented more or less intensely greyish. In the oral cavity the cuticle is thickened to form a transverse ridge, the so-called jaw. The radulae of the examined animals have 50 to 52 rows of 45-53. 1. 45-53 teeth, but the literature indicates 61 rows and 88 teeth. The innermost pleural teeth are smaller than the following ones, which decrease in size again farther outwards. The median cusp of the rachidian tooth is a little longer than the lateral ones. As in other species of the genus the intestine corresponds to Plate's type IV (1893, pl. 8, fig. 32). The algae in the stomach resemble Prasiola (Ricketts and Calvin 1952, p. 385, a). The finger-shaped tubules of the digestive gland form clusters; their tips appear on the periphery. The left anterior hepatic lobe is bigger than the right; the posterior lobe is quite small.

According to Plate (l. c.) the vessels of the lung do not project over the surface of the wall, and in the right half of the kidney there are no lamellae. The so-called seminal vesicle, a diverticulum (caecum: Fretter 1943, p. 699) of the hermaphrodite duct, is quite small, tubular (Plate 1893, p. 207).

From near the female genital aperture the vas deferens courses forwards in the dermis along the right side of the body. Under the right tentacle it goes into the body cavity and forms a number of silky coils (pl. 1, fig. 2 [66]), different from one another in the four dissected specimens. Together with the retractor muscle [73], which originates on the ventral body wall at the level of the pericardium, the vas deferens enters the penial pouch. Both continue through the muscular penis papilla [70], the retractor disappearing gradually. The ciliated vas deferens opens on the tip of the papilla, not as Semper (1882, p. 283) said, at its base. The middle part of the papilla is free from the wall, as if passing through a sheath; farther forward the sheath is coalesced with the broad tip of the papilla. In the outer half of the papilla the epithelium of the vas deferens forms many pouches secreting calcareous crystals. These pass, at least in part, into the vagina during copulation (Joyeux-Laffuie 1882, p. 329) which fact Plate (1893, p. 145) contested. In the bursa copulatrix of the Chilean Onchidella marginata (Gould, 1852) we found such calcareous concretions (Marcus 1959, p. 18).

Discussion of

Onchidella borealis Dall, 1871

Hoffmann (1928) indicated California for Onchidella borealis according to Binney (1876), but that was incorrect at that time. On the other hand O. carpenteri (Binney, 1860), a mainly southern species, occurs as far North as Puget Sound (Abbott 1954, p. 274), so that the two species seem to overlap from Central California northwards. The male copulatory organ with an external caecum and a retractor originating near the hind end separates O. carpenteri from O. borealis. Superficially O. carpenteri is recognizable by the dark, yellowish green back, yellowish brown hyponotum, small head, and short sensory lobes. O. binneyi Stearns (called O. carpenteri in 1879, O. binneyi in 1893, p. 342) from the Gulf of California, the original figures of which are reproduced in Keen (1958, p. 512, fig. 1037), cannot be separated from O. carpenteri, as long as it is not studied anatomically (Hoffmann 1928, p. 94).

Hoffmannola lesliei (Stearns, 1892) is also recorded from the Gulf of California (Steinbeck and Ricketts 1941, p. 545). This species is easily distinguished from the other Onchidiacea of the Pacific coast of North America by its male genital aperture in the middle of the forehead.

2. *Bulla gouldiana* Pilsbry, 1893

(Plate 1, Figures 3 and 4)

PRINCIPAL REFERENCES: Pilsbry 1893, p. 340 (older literature), pl. 36, figs. 22 to 24 (shells); Bergh 1901, p. 214, pl. 22, figs. 24 to 29 (anatomy); Kelsey 1907, p. 34 (as B. nebulosa; on mud flats, at low tide; Grant and Gale 1931, p 457 (literature); Steinbeck and Ricketts 1941, p. 547 (literature); MacGinitie 1949, fig. 202, 12 (shell), fig. 227 (living snail); Ricketts and Calvin 1952, p. 261, pl. 40, fig. 4 (photograph); Abbott 1954, p. 278; Keen 1958, p. 496.

OCCURRENCE: Point Loma, three snails.

Further distribution: From Ecuador to Santa Barbara, Southern California. Intertidal, on mud-flats, feeding on detritus (MacGinitie, l. c., p. 365) and swallowing bivalves and smaller snails (Ricketts and Calvin, l. c.).

Like Bulla striata Bruguière (Si, 1931, p. 29), B. gouldiana shuns light (Abbott, l. c.). It lives about one year (MacGinitie, p. 374); the egg masses resemble tangled yellow yarn (p.

379). The grapsoid crab Opisthopus transversus Rathbun, 1893, is commensal in the mantle cavity (MacGinitie, p. 313).

The largest of the present shells is 22 mm. long, 15 mm. broad, the smallest 16 mm. long and 10 mm. broad. {In the collection of the Department of Zoology at the University of California in Berkeley are several large specimens, the largest being 59 mm. long and 43 mm. wide, collected in the Flood Control Channel in San Diego. - Editor.} The shell is thin, oval, with a sunken spire. The outer lip rises above the deeply umbilicated apex, which is spirally striated in the present shells. The reflection of the columella is continued into a crescentic callus. The color is pinkish fawn, dappled with greyish black spots. These are bordered with cream on the inner, and shading into the ground color on the outer side. The surface is smooth, with growth lines.

The jaws are almost semicircular and built up by closely packed columns, which are composed of layers and arise from hexagonal bases. The radula (pl. 1, fig. 3) comprises 24 rows of 1.2.1.2.1 teeth. The rachidian tooth has a small central denticle and 4 to 5 different-sized denticles on either side. The first lateral tooth has about 7 cusps with the middle one largest. The five or six cusps of the second lateral tooth decrease in size outwards. The marginal tooth is smooth. The gizzard plates drawn by Pilsbry (l. c.) and by Bergh (l. c.) appear four-leaved seen from the front, dumbbell-shaped from the side. The gut contains soft algae and corallines; Bergh (l. c.) also mentioned algae.

The male apparatus (pl. 1, fig. 4) consists of a muscular acrembolic tube enclosed in a strongly muscular sheath. The seminal groove leads the sperm into the short atrium, whence it enters the penial canal. In the distal part of the latter the epithelium is folded, farther inwards the canal forms some loops, and in the innermost widened bulb it is very intensely coiled, so that in one section of the bulb the canal was cut 36 times. Its width is greater in the beginning of the bulb than near the base. A short caecum, the blind end of the canal, stands out over the muscular wall of the bulb. Our description corresponds to Bergh's figure 29, except that the latter does not show any terminal bulb.

3. *Haminoea virescens* (Sowerby, 1833)

(Plate 1, Figures 5 to 9)

PRINCIPAL REFERENCES: Pilsbry 1893, pp. 360-361 (older literature), pl. 40, fig. 5, pl. 43, fig. 19 (shells); MacGinitie 1949, p. 370 (eggs); Abbott 1954, p. 279.

OCCURRENCE: Point Loma, 7 snails.

Further distribution: From the West coast of Mexico, Mazatlan, north to Puget Sound; a littoral species of the open coast (Abbott, l. c.).

The shells (pl. 1, figs. 5, 6, 7) of the present animals are up to 16 mm. high and 11 mm. broad. The shell is delicate, much contracted above, globularly expanded below, forming one and a half whorls. The apex is truncate, with a sunken spire. The sharp outer lip overtops the apex, is slightly concave above the middle, and widely rounded below. The open columella is deeply concave; its narrowly reflected white margin is continued into a callus which covers the inner lip. The color is white with a yellowish green hue. The structure consists of growth lines parallel to the curve of the border. The periostracum is thin and caducous; the inner surface is shiny.

The Hancock's organ has 18 leaflets on either side and reaches nearly to the end of the head shield, hence it is much longer than in Haminoea elegans (Gray, 1825) [Marcus 1958a, p. 36]. The common genital aperture lies far in front, almost under the hind end of the right Hancock's organ, whence the deep seminal groove leads forward along the ventral border of this organ. The wide male pore is situated at the beginning of the Hancock's organ.

The semicircular jaws consist of stratified rodlets with blunt, broad ends. The radula (pl. 1, fig. 8) comprises 34 rows of 64.1.64 teeth. All lateral teeth are smooth. The cusps of the innermost teeth are short, broad, and pointed; to the sides the cusps are longer and narrower, in the outer half of the rows they are blunt. The teeth decrease in size towards the margins. Not only the rachidian teeth (Haminoea elegans, Marcus 1957, p. 396), but also the lateral ones have rough, almost hairy bases. The brownish black gizzard plates have about 18 ridges each.

The male copulatory apparatus (pl. 1, fig. 9) extends from the male aperture [76] backwards and transversely to the left, ventrally to the heart. The retractor [73] originates on the left body wall. Fibres of this muscle insert on the prostate [67], on the fundus of the atrium [75], and on an ovoid muscular mass [69] pierced eccentrically by the prostatic duct. On this mass the retractor inserts in two bundles, one opposite the other at the same level.

The seminal groove [66] runs along the male atrium to its base. The richly muscular atrial wall is folded longitudinally, and contains some blue-staining glands. From the bottom of the atrium arises the thin, about 2.5 mm. long penis. Its inner portion, 1.5 mm. in length, is enclosed in a muscular sheath. Proximally this covering is tightly apposed to the wall of the penis; in its outermost 0.1 mm. it forms a free collar. The muscular penis contains a central canal, whose epithelium has groups of cyanophilous glands along its course. A blood space runs beside this canal, but is not continuous along the whole penis. At the penial tip, the central canal opens, at the base it is continued into the prostatic duct. A communication between the seminal groove and the canal could not be found. Hence it appears that the canal carries the prostatic secretion only, while the sperms flow along the outer wall of the penis.

The muscles of the penial sheath, together with those of the atrial wall, accompany the prostatic duct inwards and thicken massively, constituting an olive-shaped organ [69] which possibly pumps the secretion of the prostate from this gland into the penial canal and out of it. The epithelium of the coiled prostatic duct projects into the lumen in four rib-like glandular folds. The spherical prostate, 1.7 mm. in diameter, produces a blue-staining secretion in its cells near the duct, red-staining granules in its inner tubules. The high epithelium that lines the central cavity of the prostate is thrown into deep folds. A strand of connective tissue and muscle fibres runs from the periphery of the prostate to the male opening.

The eggs are laid in white ribbons attached by one edge in a circle or a loose coil.

Discussion of *Haminoea virescens* (Sowerby, 1833)

The present material belongs to the typical Haminoea virescens, not to H. virescens var. rosacea Spicer, 1933, reported from Ballast Point, San Diego. After Pilsbry (1933, p. 141), followed by Abbott (1954, p. 279), we have excluded Pitcairn Island (see Nautilus, vol. 47, no. 1, p. 37) from the geographic range. Grant and Gale (1931, p. 458) and Keen (1958, p. 496) apply the name H. cymbiformis Carpenter, 1856, based on a single, probably immature shell from Mazatlan (Pilsbry 1893, p. 360). In the opinion of the Californian authorities Grant (in a letter to Pilsbry 1933, l. c.) and Keen (l. c.) H. strongi Baker and Hanna, 1927 (p. 130) is specifically distinct from H. virescens.

4. *Aglaja diomedea* (Bergh, 1893)

(Plate 1, Figures 10 to 13)

REFERENCES: Bergh 1893, p. 133 (preliminary); 1894, pp. 211 - 212, pl. 11, fig. 1 (shell); Pilsbry 1895, pp. 52 - 53, pl. 15, fig. 95, not pl. 1, fig. 14; Ricketts and Calvin 1952, p. 456 (Dillon Beach).

OCCURRENCE: Tomales Bay on mud flats in tide-pools, often dug in, 20. VI. 1958; 66 animals and some egg masses.

Further distribution: Monterey Bay, Elkhorn Slough; Dillon Beach; Charleston, Oregon; Puget Sound; Peninsula of Alaska, Kodiak (St. Paul) and Shumagin Islands; in 11 to 36.5 m. Spawning occurs in June, July, and August at Dillon Beach; the egg masses are pear shaped.

Preserved animals measuring 10 mm. long by 6 mm. wide by 5 mm. high are reported; the largest specimen in this collection is 8 mm. long. The living animals (pl. 1, fig. 10) were uniformly black, the preserved ones are black on the outer surfaces and light in the folds. The borders between the surfaces and folds are speckled. In the original material there were more whitish or yellowish flecks on the outer surface. The head shield is narrowed and rounded in front and nearly as long as the mantle shield.

Between head shield and foot a small fold occurs on either side of the mouth. The posterior mantle lobes are short and broad.

The relatively big shell (pl. 1, fig. 11) is longer than broad; its outer lip extends into the right mantle lobe. In the present material the shell is delicate and light brown; the larval shell projects behind. The columella, Bergh's large process directed forward and downward, is distinct.

There are neither jaws nor radula. The pharynx is small, about one sixth of the body length; the gut contains many large, more or less digested nematodes, muscles of crustaceans, and sand grains. The small ctenidium is yellowish.

The male copulatory organ (pl. 1, fig. 12) lies transversely under the pharynx; its retractor [73] originates on the left body wall. At the base of the 3mm. long atrium [75] the seminal groove enters into the penis [70] piercing it as a closed ejaculatory duct. The tip of the penis is cuticularized (pl. 1, fig. 13). As Bergh (1894, p. 212) noted, there are two prostatic glands [67] connected with the root of the penis, one

3.5 mm. long, lies alongside the atrium and the other in its prolongation, its duct accompanying the retractor.

Discussion of *Aglaja diomedea* (Bergh, 1893)

As Bergh (1894, p. 212) said, the species is readily recognizable by its coloring and the shell. He called the tip of the penis nearly colorless, and we found it cuticularized. The shell of Aglaja adellae (Dall, 1894), a species geographically intermediate between the original Alaska localities of A. diomedea and California, differs too much from that of the latter for being considered as a variety. A. purpurea (Bergh 1893, p. 133; 1894, p. 209) from Southern California has the outer part of the male atrium ("penis sac" of Bergh's terminology) black and contrasting with the white inner fourth and the prostate. A. ocelligera (Bergh 1894, p. 212) from Alaska has a flagellum, and the end of the prostate is forked.

To these four species from the Pacific coast of North America MacFarland added (1924, p. 391) Aglaja bakeri from the Gulf of California.

The minute black tectibranch mentioned as Philine (sp. nov. ?) by MacGinitie (1935, p. 736) and cited by Ricketts and Calvin (1952, p. 250) is evidently Aglaja diomedea.

As the use of the correct names Aglaia, Aglaiidae (O'Donoghue 1929a, p. 11) is not obligatory (White 1945, p. 91), we prefer the vernacular forms which do not involve possible misprints of the family name.

5. *Navanax inermis* (Cooper, 1862)

(Plate 1, Figures 14 to 16)

REFERENCES: Cooper 1862, pp. 202 - 203; Bergh 1894, pp. 214 - 217 (anatomy), pl. 10, fig. 13, pl. 11, figs. 2-5; Pilsbry 1895, p. 58, pl. 15, figs. 89-93 (Bergh's figures); MacGinitie 1935, p. 737 (range); 1949, pp. 371, 380 (food, reproduction, age), fig. 226 (dorsal view); Ricketts and Calvin 1952, p. 250, 267 (eel grass beds, mud flats), pl. 41, fig. 2 (ventral view).

OCCURRENCE: La Jolla; 2 specimens by courtesy of Mr. Sam D. Hinton, Senior Museum Zoologist at Scripps Institution of Oceanography.

Further distribution: From Lower California and Southern California northwards to Monterey Bay, Elkhorn Slough.

The animals are up to 180 mm. long alive, preserved ones 45 mm. long. Our material measures 25 mm. in length, 13 to 15 mm. in breadth. The parapodia envelop the longish cylindrical body leaving the rectangular head and the bifid tail free. The foot is nearly as long as the body. The two posterior mantle lobes, the posterior wings of Bergh's terminology, are short and broad appendages of equal size with pointed ends.

The ground color is brown or purplish black with yellow more or less elongated dots on back, sides, sole, and outer side of the parapodia whose inner side is flesh - colored. The outer edges of the parapodia are bordered with an orange line accompanied by a row of alternate yellow and blue spots. The black eyes are surrounded by light haloes.

In life the outer corners of the head shield are produced and there are two more projections medial to them. In the preserved specimens (pl. 1, fig. 14) these four prominences are rolled in as outer [7] and inner [8] dorsoventral folds on either side of the mouth [29] between the borders of the head shield and the foot [23]. Under the antero - lateral border of the head shield lie the weakly developed perpendicular folds of the Hancock's organ [20].

The skin is smooth. The brownish calcareous shell is broader than high, its right side has a deep sinus and ends with a point. The posterior border is covered by a white porcellaneous callus (pl. 1, fig. 15).

The pharynx with neither jaws nor radula attains one third of the body length or even much more in preserved animals, as this muscular organ contracts less than the body. The intestine passes through the digestive gland; its anal opening is near the hind border of the mantle. The whitish ctenidium extends to the left beyond the anus.

The larger of our two specimens was sectioned; the flat prostate indicates that it was not quite mature. The broad, 3 mm. long male atrium (pl. 1, fig. 16 [75]) is pigmented. On either side of its inner surface projects a longitudinal black fold flanked by deep pouches. From the base of the atrium a white penial papilla [70], 1.6 mm. long arises. The penis is somewhat folded but smooth. The seminal groove [66] enters the male aperture [76] which lies under the right outer fold[7], courses along the inside of the atrium and the side of the penis. At the hind end of the atrium the retractor [73] inserts and the whitish prostate [67] is attached. It is bent forwards and fastened to the body wall by a strand. The 2.6 mm. long prostate of irregular breadth consists of two tubular glands of different structure, intimately apposed to one another. The ducts of these glands run separately through the muscular tissue of the penis and open into the seminal groove near its tip.

G. E. and Nettie MacGinitie observed the following biological facts: The animals feed on Bulla, Haminoea and also swallow small members of their own species. The shells pass unbroken through the body. Individuals may reach an age of eight month or one year. When handled the animal gives off a yellow fluid. The egg string contains nearly 800'000 eggs and resembles a skein of white thread. On the outer surface and on the gill of this species a parasitic copepod, Pseudomolgus navanacis Wilson, 1935, occurs, and between the parapodia the grapsoid crab Opisthopus transversus Rathbun, 1893, is found as a commensal.

Discussion of *Navanax inermis* (Cooper, 1862)

Bergh (1905a, p. 42) united the genus Navanax Pilsbry, 1895, which he called by one of its invalidated names, with Chelidonura. Thiele (1931, p. 395) maintains Navanax with the diagnosis "head shield produced into short rhinophores at the anterior corners". But the "ear like fold of the skin at each corner" which makes the head "resembling a cat's head seen from above" (Cooper 1862, p. 202) is no rhinophore, though Bergh (1894, p. 213) called it so. Rhinophores are tentacles on the dorsal side of the head, which are absent in all Cephalaspidea (Hoffmann 1933, p. 203). The folds under the head shield, less conspicuous in N. inermis (Bergh 1994, p. 216) than in N. aenigmaticus (p. 218), occur also in Chelidonura (Marcus 1955, pl. 1, fig. 8).

Nevertheless the genus Navanax should be preserved. It differs from Chelidonura by the smooth penis ("glans") which is absent or warty in Chelidonura.

6. *Chelidonura phocae* Marcus, spec. nov.

(Plate 1, Figures 18 to 24)

OCCURRENCE: Tomales Bay, on mud flats in tide pools (type locality: 38°14' North; 122°58' West), and from dredgings in White Gulch (in 6 m.); on 19. III., 20. and 30. VI. and 2. VII. 1958; a total of 14 specimens.

The preserved animals are 5 to 13 mm. long, the largest is 8 mm. broad and 7 mm. high. The head shield [6] is anteriorly truncate with produced corners. In the living animal (pl. 1, fig. 18) it is longer than the mantle shield, in preserved ones shorter, because the shell prevents the mantle shield [9] from contracting as strongly as the head shield. The foot corners [23] are finger shaped. The sole of the foot is almost as long as the body; the triangular posterior mantle lobes are of equal or of different size, sometimes the left bears a filiform prolongation. Between head shield and foot and head shield and parapodium an inner [8] and an outer [7] fold lie on either side of the mouth [29]. The outer folds are inconspicuous.

The color of the living snails was indicated as dark red or as olive, with small white dots. The anterior border of head shield and foot and the borders of the mantle flaps were yellowish white. The preserved animals are dark grey with groups of fine red dots which in some specimens are surrounded by white haloes. These red dots occur on the entire surface including the sole of the foot.

The strongly calcified shell (pl. 1, figs. 20, 21) is almost circular in outline. The outer lip extends into the right mantle lobe. The columella is shallow and covered by a strong callus which forms a free projection.

There are neither jaws nor radula. The pharynx is nearly half the length of the body. In the protruded state the right and the left anterior pharyngeal borders form sharp grasping lips. The wide portion of the oesophagus contains coagulated juice and sand grains.

The reproductive organs (pl. 1, figs. 22, 23, 24) are similar to those of Aglaja depicta (Guiart 1901, fig. 89) and Chelidonura evelinae (Marcus 1955, fig. 18). From the compact hermaphrodite gland [59], composed of small follicles, the hermaphrodite duct [60] widens to form a coiling ampulla [62] continued into a narrow spermoviduct [63]. This duct receives the canal of the pear-shaped spermatocyst [88], loops around the albumen gland [93] with which it communicates, and opens into the muscular common atrium [78]. The tubular mucus gland [92] is attached to the albumen gland. A spherical spermatheca [86] is connected with the atrium by a long canal. The seminal groove [66] attains the outer fold of the head shield, enters the wide male atrium, passes to the root of the penial papilla, and runs along the penis to its tip. The innermost coils of the prostate [67] are free, while its black outer windings are contained in a sac [68] attached to the base of the atrium. The broad base of the penis bears a number of cuticularized conical warts; the narrower outer part of the penis is slightly annulate and ends with a point.

The holotype is 13 mm. long.

The name of this species is derived from the genus name, Phoca, of the typical seals.

Discussion of
Chelidonura phocae Marcus, spec. nov.

The pleurembolic penis with basal cuticular warts and the sac which encloses the outer part of the prostate are the most striking characters of this new species. The type of Chelidonura A. Adams, 1850, Ch. hirundinina (Quoy & Gaimard, 1833), has an acrembolic copulatory organ, i. e. the everted male atrium, penis sac or praeputium in Bergh's terminology, functions as penis. When the atrium is inverted, the base is thrown into high folds, but a true penis or penial papilla which Bergh called "glans" does not occur. These features were described by Bergh (1900b, p. 220) for Ch. hirundinina and repeated in 1905a (p. 45) in the description of Ch. velutina which (except pl. 3, fig. 6) is Ch. hirundinina (Pruvot-Fol in Risbec, 1951, p. 124). Ch. plebeia Bergh (1900a, p. 181) has the same type of male organ as Ch. hirundinina, and this applies also to Ch. evelinae Marcus (1955, p. 95). Figure 17 shows the male organ of the latter species for comparison with Ch. phocae (fig. 23).

We know of a single indication of a 7 mm. long penis in a Chelidonura which refers to Ch. varians Eliot (1903, pp. 335 to 336). Most descriptions of species of Chelidonura do not record the anatomy of the male copulatory organ.

The Chelidonura velutina of plate three, figure six in Bergh (1905a) is an Aglaja. If Risbec's synonymy (1951, p. 124) is correct, it must be called Aglaja cylindrica (Cheeseman, 1881), not A. splendida Risbec, 1951.

Chelidonura fulvipunctata Baba (1938a, p. 3) from the coast of the Kii Peninsula is similar to the present species. As only shape and color were described, its comparison with Ch. phocae remains incomplete. Ch. fulvipunctata has a light mark on the hind end of the head shield, absent in Ch. phocae; the sole of its foot is purplish black without spots; the light band of the head shield runs at a distance from the anterior border in Ch. fulvipunctata, and its parapodia are margined with yellow, not with black. The right caudal lobe of Ch. fulvipunctata ends rounded, not pointed. Ch. tsurugensis Baba and Abe (1959, p. 279) from Middle Japan is a black glossy purplish without different color of the parabodial border.

7. *Aplysia californica* Cooper, 1863
(Plate 2, Figures 25 and 26)

REFERENCES: Cooper 1863, pp. 57-58, fig. 1 (shell); Pilsbry 1895, pp. 89-91 (Tethys), pl. 56, figs. 13, 16 (animal, shell); Cockerell 1901c pp. 90-91 (Tethys ritteri); Kelsey 1907, p. 34; MacGinitie 1934, pp. 300 - 303 (egg laying); 1935, pp. 737-739 (size, reproduction), fig. 20 (living animal); 1949, figs. 217, 235 (photographs of animal and egg mass); Steinbeck and Ricketts 1941, p. 541 (range); Ricketts and Calvin 1952, pp. 76-77 (secretion deep purple), 267 (rocky shore, low tide horizon and mud flats), fig. 35 (whole animal); Eales 1957, p. 247 (ritteri as synonym); Winkler 1958a, b, c; 1959a (color depending on food and preservation; range; larval and adult shell).

OCCURRENCE: Inner side of Tomales Point, 4. VII. 1958, J. W. Hedgpeth coll. one specimen.

Further distribution: From the Gulf of California to Bodega Bay, north of Dillon Beach (Hanna 1939).

The northern specimens may be 480 mm. long, 260 mm. high and 170 mm. broad while crawling, and attain a weight of nearly 7 kg. The southern form is smaller. These sea hares live to be two years old, spawning in the second year. They eat seaweed, especially Codium and Zostera. A single egg mass may contain 86 million eggs; the southern form can produce 478 million eggs in less than 5 months (MacGinitie).

The specimen examined is not quite adult; it was 150 mm. long alive, preserved it is 55 mm. long, 35 mm. high and 30 mm. broad. The color consists of a dark net over an olive grey ground with round black spots of up to 2 mm. in diameter. Head and sole of foot are dark and strongly contracted. The inner margin of the parapodia bears alternating dark and light areas. Farther below the inner surface of the parapodia is lighter than the outer side. The roof of the mantle is dark with light spots; its pore is minute. The gill is rather light with a small amount of uniformly distributed pigment.

The parapodia are joined low posteriorly. The contracted siphon is blackish. The opaline gland is composed and uniporous.

The flat shell is 24 mm. long, 13 mm. broad with a 12 mm. long sinus. Its posterior end is spatulate, without a spire, but with an accessory plate, which led Cooper (1863) to introduce the subgeneric name Neaplysia.

The radula (pl. 2, fig. 25) comprises 40 rows of 5. 24. 1. 24. 5 chestnut brown teeth. The outermost 5 or less marginal teeth have no cusp; the long cusp of the lateral teeth is flanked by many sharp denticles, one of which on the inner side is bigger and one on the outer side still broader. These two in their turn bear secondary denticles.

The straight digestive caecum (pl. 2, fig. 26 [43]) courses from the anterior left to the posterior right; it appears on the ventral surface of the first intestinal loop.

The tapering penis is smooth and white. On the ventral side of the penial sheath two black lines accompany the seminal groove which continues along the right side of the penis.

Discussion of *Aplysia californica* Cooper, 1863

The name of the genus has been accepted as a "nomen conservandum" (see Abbott 1954, p. 285). Aplysia californica and A. nettiae Winkler (1959b, pp. 8-10), the latter with a 3 mm. wide mantle pore and parapodia separated posteriorly, are the true Aplysia from the coast of California. A. parvula Mörch, 1863, was collected in the Gulf of California (MacFarland 1924, p. 398). A. cedroensis Bartsch & Rehder (1939, p. 2) and A. vaccaria Winkler, 1955, belong to the subgenus Tullia Pruvot-Fol, 1933, (Engel and Eales 1957).

8. *Phyllaplysia zostericola* McCauley, 1960

(Plate 2, Figures 27 to 32)

REFERENCES: MacGinitie 1930, p. 68; 1935, p. 739 (eggs); 1949, p. 377 (as food of Conus), fig. 236 (photographs); Smith and Gordon 1948, p. 179; Ricketts and Calvin 1952, p250 (occurrence); Steinberg in Light et al. 1954, p. 264. All these under the specific name P. taylori Dall, 1900. McCauley 1960, pp. 549-576, figs. 1 - 6 (full description and new name).

OCCURRENCE: Tomales Bay, on the blades of the broad-blade eelgrass, Zostera marina Linnaeus, partly in 6 m. depth, 19. III. to 25. VII. 1958, 4 animals.

Further distribution: Southern, Central and Northern California, Humboldt Bay; Washington, San Juan Archipelago and Puget Sound. Not yet collected on the Oregon coast.

The preserved and curved animals are 25, 20, 6 and 2 mm. long respectively; straightened out the first three measure 48, 32 and 9 mm. The breadth of the two biggest animals is 15 and 9 mm., that of the contracted sole 7 and 6 mm. The biggest animal is 10 mm. high in the middle and lower in the anterior half. Its parapodial slit is 12 mm. long, begins 24 mm. behind the fore end and terminates 12 mm. in front of the hind end.

The color of the 32 mm. long specimen is preserved best and consists of a light olive ground with several pairs of black lines whose interspaces are light. Fine transverse black lines run from pair to pair (pl. 2, fig. 27). Our four specimens show these "india-ink lines of stippling" (Ricketts and Calvin, l. c.).

The tentacles [2] are longitudinally or transversely striped, pointed, broad and flat leaves with a grooved outer border. The light rhinophores[5] are short and rolled in. Oral lobules flank the mouth. The skin is quite smooth, the tail tapers gradually. The right parapodium overlaps the left.

There is neither a shell nor a shell chamber with a mantle pore. The parapodial cavity [12] extends far to the left over the digestive gland [42]. The gland-cells of Blochmann [13] which correspond to the purple gland in Aplysia open in a compact area on the underside of the mantle shelf. The border of the shelf is recessed, and in this indentation the anal papilla [45] is located. The ctenidium is a strongly developed organ, 11 mm. long. The osphradium [14] is situated in front of the gill, near the entrance of the mantle cavity. Beneath the entire floor of the latter and extending even farther forward under the pericardium lie numerous unicellular opaline glands. The common genital atrium [78] opens [77] outside the parapodial slit, in front of the entrance of the pallial cavity, and here the seminal groove [66] begins. This position is the same as in Phyllaplysia engeli (Marcus 1957b, p. 54), while the genital aperture lies just inside the mantle cavity in Ph.

lafonti and Ph. plana (Engel 1936, p. 200; Eales 1944, p. 11).

The central nervous system was described by MacCauley (1960, pp. 563-569, fig. 5).

The brownish yellow jaws form a narrow ring of curved and pointed hooks, open only dorsally. The palatal teeth, whose shape is rather irregular, extend over long and narrow areas. The pharyngeal bulb [33] of the biggest specimen is about four mm. long. Its radula comprises 43 rows of 50-53. 1. 50-53 teeth (pl. 2, fig. 31). The rachidian tooth has five cusps, the lateral teeth have three, the median of which is broadest. The outermost cusp is sometimes wanting, especially in the marginal teeth, about 10 of which are small and bifid. The oesophagus (pl. 2, fig. 29 [36]) dilates behind the nerve ring [47]. The thick-walled anterior gizzard [38] contains about 12 masticatory teeth, the thin-walled posterior gizzard [39] has two transverse rows of small papillae, each with a spine. A wide diverticulum of the left anterior wall of the stomach [41] receives the hepatic ducts at its hind end; just anterior to this there is a minute caecum [43] which appears on the under surface of the digestive gland [42]. The intestine [44] leaves the hind end of the stomach, courses through the digestive gland to the left side and on its surface forwards, then it bends backwards, still adherent to the digestive gland, and runs free to the right to the anal papilla [45]. The digestive gland [42] is a slender spongy sac without lobes and projects backwards into the hind end.

The hermaphrodite gland (pl. 2, fig. 32 [59]) is composed of about four subdivided lobes. The hermaphrodite duct [60] passes into a long convolute ampulla [62], the little hermaphrodite duct of Eales (1921). The following narrow spermoviduct [63], Eales' loop of the little hermaphrodite duct, opens into the fertilization chamber [90]. From this chamber a narrow canal leads to the female gland mass [91] with the winding gland [64]. The female canal is connected with the duct of the spermatocyst or receptaculum seminis [88] where the gland mass passes into the large hermaphrodite duct [61]. A spermatheca or bursa copulatrix [86] is annexed to the distal third of the large hermaphrodite duct, whose terminal dilated portion, the common genital atrium [78], bears a gland [79].

The penial sheath, male atrium or collar (pl. 2, fig. 30) opens [76] under the right tentacle, is about 8 mm. long and is fastened behind to the body wall by a strong retractor [73]. The seminal groove spirals to the inner end of the atrium. The middle of the collar is surrounded by a sphincter. The penis [70] is also spiral and is pointed at the end. On one of its sides it bears a row of about 12 cuticular spines inserted on papillae which become smaller anteriorly and are unarmed. The base of the atrium contains two rows of six to eight large papillae with spines and between the high folds of the wall a number of small spinous papillae. Distally to the sphincter the wall is thin, not pigmented. About four low papillae, each with a small spine, form a transverse row in this part.

The firm short egg ribbons and the animals are hardly recognizable on the blades of Zostera (MacGinitie 1949, p. 380; McCauley 1960, pp. 552, 574), which they resemble in color and markings.

Discussion of *Phyllaplysia zostericola* McCauley, 1960

The preceding description refers only to the material at hand from Tomales Bay, since McCauley (1960) has given a detailed morphology based on abundant material. Slight numerical differences in the teeth of the radula and those of the anterior gizzard between McCauley's and our material lie within the range of variation. Independently from McCauley we had separated the species from Phyllaplysia taylori Dall, 1900 (pp. 91-92), which has an internal shell (Bergh 1902, p. 369), and whose color, only known from preserved specimens, is pale lemon-yellow without marks or spots. Dall's species was transferred to the genus Petalifera Gray, 1847 (Aplysiella P. Fischer, 1872) by Engel and Hummelinck (1936, pp. 44, 54). The latter authors consider taylori as a subspecies of Petalifera petalifera (Rang, 1828), but actually it seems to deserve specific rank.

Eales' differential diagnoses of Petalifera and Phyllaplysia (1944, p. 17) need some comments. The shape of the body may be broad and flat, Phyllaplysia-like, in Petalifera (Si 1931, pl. 5, fig. 1; Engel and Hummelinck 1936, pp. 48-49), and elongate and rather convex in Phyllaplysia, as Ph. viridis (Bergh 1905a, pl. 3, fig. 3) and Ph. zostericola show. The position of the genital opening cannot be used for the separation of the genera (E. and E. Marcus 1957, p. 54). A secondary shell without nucleus may exist on the mantle roof of Phyllaplysia, while the free margin of the shell chamber has disappeared (l. c., p. 56). A smooth penis does not seem to occur in Phyllaplysia. The intestine is shorter in Petalifera, though in Phyllaplysia zostericola it is not as long as in Ph. engeli. The hermaphrodite gland is compact in Petalifera, follicular (Ph. engeli) or lobate (Ph. zostericola) in Phyllaplysia.

9. *Hermaeina smithi* Marcus, spec. nov.

(Plate 2, Figures 33 to 37)

OCCURRENCE: Tomales Bay (type locality: 38° 14' North, 122° 58' West) on Zostera, 22. V. 1958, E. H. Smith coll., one animal.

The preserved specimen is five mm. long, 1.5 mm. broad and 1.5 mm. high at the highest point, the reno-pericardial eminence. The color of the preserved specimen corresponds to that of the living animal noted by Dr. Diva Diniz Corrêa, as is the rule with black pigmented sea slugs. The body is black with exception of the area around the mouth, the lips, a mask-like drawing on the anterior part of the foot (pl. 2, fig. 33), the inner side of the rhinophores, and the tips of the cerata. These places are white. The sole of the foot and the bases of the cerata are dark grey. The color is epidermal and only with high power magnification are the openings of cutaneous glands visible.

The mouth lies on the ventral side of a projecting lobule, which is too small to be called a veil. The lips are thickened. The rhinophores bear a broad flap at their base, and their borders are symmetrically rolled in in the middle. The tips of the rhinophores are narrower than the middle, and round. Light eye - spots which surround the black eyes are located behind the rhinophores and in front of the first cerata. The anterior border of the foot is set off from the lips and slightly notched. On the sides the foot is separated from the body by a fold; it ends pointed.

The cerata (pl. 2, figs. 34, 35) are fusiform, broad-oval in transverse section, and set in 2 to 3 rows; the most ventral cerata are smallest. The digestive diverticula in the cerata are branched into numerous short and straight tubes as figured by Trinchese (1877-1879, pl. 22, figs. 3, 5). The albumen gland does not enter the cerata.

The anus lies dorsally on the right side, near the second ceras, the renal pore farther in front, close to the first ceras. The two genital apertures are ventral to the cerata and appear as light spots in a furrow behind the right lip, under the right rhinophore.

The radula (pl. 2, fig. 36) consists of six teeth in the ascending and 31 in the descending limb which terminates with a spiral in the ascus. The smallest tooth is 6 μ long, the second 11 μ; the largest functioning tooth is 190 μ long. Of the last measurement the base occupies only 42 μ. The underside of the cusp bears two serrate laminae flanking a groove. The denticles of the saw are up to 3 μ high and pointed; about ten denticles occupy an extent of 30 μ on the lamina; they diminish in size towards the broadly rounded tip of the tooth. A keel on the upper side of the next tooth fits into the concavity between the denticulated blades. The structure of the teeth contrasts with that in Elysia, whose median lamina of the underside fits into a groove on the upper side of the following tooth.

A crop or an oesophageal pouch evidently does not exist.

The species is diaulic; the penis (pl. 2, fig. 37) is unarmed, formed like a bricklayer's hammer whose short end is pierced by the vas deferens.

The species is named for Mr. Edmund Hobart Smith, Woodland Hills, California.

Discussion of *Hermaeina smithi* Marcus, spec. nov.

Pruvot-Fol (1951, p. 69; 1954, pp. 189-190) substituted Aplysiopsis elegans Deshayes, 1834 to 1858, for Hermaeina maculata Trinchese, 1874, because she found the peculiar straight color lines on the cerata (Trinchese 1877-1879, pls. 21, 22) in a figure of Deshayes' Traité élémentaire de Conchyliologie. We are not inclined to introduce one genus more with an uncertain type into the classification of the difficult Hermaeidae (Stiligeridae). These lines occur in H. maculata and in H. formosa (Pruvot-Fol, 1953, p. 47), not in H. smithi. H. orientalis Baba (1949, pp. 32, 130) and H. nigra Baba (1949, pp. 33, 130) differ by color, rhinophores and shape of the cerata from H. smithi. Baba's very accurate figures (figs. 21 B and 23 B in the text) show the same structures on the upper and under side of the radular cusp as are described in the preceding diagnosis. H. sinusmensalis Macnae (1954a, p. 62) is fawn and brown in color. Two species of the genus were reported from the West coast of America: A) H. enteromorphae (Cockerell and Eliot, 1905, p. 52) from San

Pedro, Southern California, with flat, leaf-like cerata and therefore allocated to a separate genus, Phyllobranchopsis. B) H. brattströmi Marcus (1959, p. 21) from North Chile, with distally broadened, truncate rhinophores, and a small amount of black pigment on lips, back, especially tail, and outer side of the cerata. The latter are elliptical in cross - section.

10. *Elysia hedgpethi* Marcus, spec. nov.

(Plate 2, Figures 38 to 40)

OCCURRENCE: Tomales Bay, mud flats at Tomales Bay Oyster Co. (type locality: 38° 06' 56" North, 122° 51' 37" West) in pools on muddy bottom at low tide, 6. VII. 1959, J. W. Hedgpeth et al. coll., 3 specimens.

{Since these collections were made, we have been able to obtain some hydrographic data for Tomales Bay. The region in which Elysia hedgpethi occurs is hydrographically quite different from the cold ocean at Dillon Beach. During the month of July, 1960, the average water temperature at the mouth of Tomales Bay near Dillon Beach was 11.5° C, while near the oyster beds it was 18.6° C; in such a region further "warm water testimonials" may be found. — J. W. Hedgpeth.}

The preserved, well extended animals are respectively 23, 25 and 29 mm. long; 15, 19, and 20 mm. broad with extended parapodia. The height (measured in microscope sections) is 1.2 mm. Alive they were Ulva-green with flecks of pale blue, and resembling scraps of Ulva. A pale green color is preserved in formalin, more intense on the under than on the upper side, where the green branches of the digestive gland are superimposed by hermaphrodite gland, albumen gland, and vessels. At the posterior border of the pericardial eminence the kidney shines white through the skin. The rim of the lips is finely stippled with black; the edge of the rhinophores and a deep transverse furrow of the sole of the foot behind the head are white. The parapodial borders are intensely green. The white male copulatory organ stands out under the right rhinophore of the largest specimen.

The rhinophores [5] are rolled up and about as broad as long. The eyes [58] behind them lie under small pits. The parapodia begin separated from one another to the sides of the heart, are broadest in front, and meet at the tip of the pointed tail. The sole of the foot is not set off from the body. The skin is smooth, without warts or papillae. About four or five principal vessels, which are transparent, ramify and anastomose in either parapodium. The short kidney lacks a salient, posteriorly directed renal thickening. The fine diverticula of the digestive gland differ in diameter and course.

The anus [45] between the female apertures [82, 80] lies in the white fold that runs between the insertion of the right parapodium [10] and the transverse pedal furrow [22]. The renal pore [25] is situated to the right of the pericardial eminence [27].

The nerve ring [47] surrounds the oesophagus [36] behind the pharynx [33]. The sub-intestinal ganglion is bigger than in Elysia viridis (Pelseneer 1894, fig. 167; Russel 1929, p. 205, pl. 3, g. sb. int.), though smaller than the supra - intestinal ganglion.

Two groups of cells [30] to the sides of the beginning of the oral cavity are pigmented. The oral cavity is slightly cuticularized at its passage to the pharynx. The radula (pl. 2, fig. 39) contains 8 teeth in the dorsal, 12 in the ventral limb, and about 25 concentrated in the ascus. Their nearly vertical position is brought about by their peculiar shape. Their bases are short, measuring $\frac{1}{4}$ to $\frac{1}{3}$ of the total length which attains 170 μ. The cusp is sharply pointed; the serrulation of its inner edge consists of minute, 1.2 μ broad denticles which were seen only with high power magnification.

The salivary glands are racemose and voluminous. The pharynx is small, about 0.9 mm. in diameter. The hind end of a globular, muscular, and dorsal pouch (pl. 2, fig. 40 [35]) (Marcus 1957, p. 413) is connected with the oesophagus [36], a long organ which enters the posterior end of the stomach [40]. The epithelium of the slender stomach has longitudinal folds and is continued into the short intestine [44].

As the mucus gland is brittle in the sections (Lloyd 1952, p. 3), swells, and makes it difficult to flatten them, the reproductive organs were only partially analyzed. The hermaphrodite gland, as in other species of the genus, is dorsal to the digestive gland, ventral to albumen and prostatic tubes and blood vessels. The follicles of the hermaphrodite gland contain the male germ cells in their dorsal, the female ones in the ventral half. The ampulla of the hermaphrodite duct was seen by transparence. The mucus gland opens [80] ventrally to the anus [45], the vagina [82] dorsally. The latter leads to a spermatheca lying to the left and dorsally. Its communication with the oviduct was not seen. The male duct arises from the mucus gland which conceals the bifurcation of the spermoviduct, and enters the penial papilla [70] under the right rhinophore [5] near the male pore [76]. The retracted penis is directed backwards in its folded pouch, the male atrium. The penis is 1.08 mm. long, slender and pointed.

The species is named for Dr. Joel W. Hedgpeth, Director of the Pacific Marine Station.

The holotype is the 29 mm. long specimen.

Discussion of *Elysia hedgpethi* Marcus, spec. nov.

Besides Tridachiella diomedea (Bergh 1894, p. 194) from the Gulf of California and the Bay of Panama no elysiids have been reported from the Pacific coast of the Americas. Elsewhere, these ascoglossans which feed on various (chiefly green) algae belong to the most common opisthobranchs. The Californian species was first compared with the Japanese (Baba 1957b) and West Atlantic species of Elysia (Marcus 1957, pp. 414 - 416; ibid. Bull. Mar. Sci. Gulf and Carrib., in press). North Japan has present relations with the littoral of California; New England and the West Indies have ancestral ones, because a Caribbean-Pacific sea connection existed in Tertiary times (Ekman, 1935, p. 48 ff.; Hedgpeth, 1953, p. 122 ff.). Furthermore, the place where the new species was found suggests the possibility of introduction together with oysters from Japan or from the East coast of North America (Ricketts and Calvin 1952, p. 399 ff.).

The only species we found somewhat similar to Elysia hedgpethi is E. hirasei Baba, 1955 (pp. 11, 41 to 42) from Sagami Bay, first described as viridis (Baba 1949, pp. 34, 131). This very small species, four to six mm. long in life, differs by black bands on the head from Elysia hedgpethi. Baba's earlier E. viridis from the Okinawa Islands (1936, p. 20) is now E. babai Pruvot-Fol, 1946 (p. 38); it is quite unlike E. hedgpethi.

Elysia viridis (Montagu, 1804), whose range of color variation includes the coloring of E. hedgpethi (Pruvot-Fol 1954, pp. 200-201), differs from E. hedgpethi by a shorter and broader penial papilla (Pelseneer 1894, fig. 180) and a smaller subintestinal ganglion.

11. *Cadlina flavomaculata* MacFarland, 1905

(Plate 3, Figures 41 and 42)

REFERENCES: MacFarland 1905, p. 43; 1906, pp. 126 - 128, pl. 19, figs. 32 - 37; pl. 21, fig. 110 (full description, colored figure: pl. 25, fig. 9); Kelsey 1907, p. 35; O'Donoghue 1922a, pp. 154 - 155; 1926, p. 210 (literature); 1927a, p. 85; Abbott 1954, p. 302.

OCCURRENCE: Shell Beach, Sonoma County, under stone, 16. VII. 1958; 1 specimen. Point Pinos-Pacific Grove, 7 specimens. Point Loma one specimen.

Further distribution: San Diego to Vancouver Island, region.

The live animal from Shell Beach (pl. 3, fig. 41) was 25 mm. long; preserved its length is 20 mm., the breadth 10 mm., the height 6 mm. and the width of the foot 5 mm.; the specimens from Pacific Grove and from Point Loma are smaller. The color is cream with six to ten or more yellow knobs on either side. The rhinophores are blackish brown or brownish yellow, the gills are white. The foot is more yellow than the notum in our individuals, but white in life.

The outer margin of the blunt flattened tentacles is grooved. The rhinophores have 10 to 12 leaflets on either side; the border of the rhinophorial pit is slightly tuberculate. The anterior border of the foot is bilabiate, the upper lip entire or notched; the tail is pointed. The densely spiculate notum bears low rounded bosses which are smaller and closer together towards the margins. The 10 to 12 gills are unipinnate, occasionally bipinnate in part; the rim of the branchial pit is smooth.

The labial disc is set with bifid pegs about 24μ high. The radula (pl. 3, fig. 42) comprises 68 to 77 rows with the formula 22-27.1.22-27. The rachidian tooth has four to six denticles of equal size. The first lateral tooth has two to three inner and four to five or up to 7 outer denticles. The number of these outer denticles increases to 12 to 15 in the following teeth, where their series occupies about half the length of the tooth. The outermost three to four teeth are a little smaller than the others.

The reproductive organs were described by MacFarland 1906, p. 127.

12. *Cadlina sparsa* (Odhner, 1921)

(Plate 3, Figures 43 to 45)

REFERENCES: Odhner 1921, pp. 225-226, fig. 3, pl. 8, figs. 13, 14; 1926b, pp. 56-57 (genus Juanella suppressed); Marcus 1959, p. 27, figs. 39 - 44 (reproductive organs).

OCCURRENCE: San Diego, cooling galleries of Power and Light Company; one specimen.

Further distribution: Chile, northern coast of Chiloé, in 2 to 5 m.; Juan Fernandez, Mas-a-Tierra, in 20 to 40 m.

The preserved animal (pl. 3, fig. 43) is 18 mm. long, 10 mm. broad and 7 mm. high. In life the animal was light yellow and had black spots with yellow centers. This color is on the whole maintained in the preserved state. The spots are dark glands shining through the skin, the yellow centers are their outlets. The dorsal papillae (pl. 3, fig. 44) which contain a strand of spicules are independent from these glands, and bigger in the middle of the back and smaller on the sides. Their form varies from conical to hemispherical, villous or scale-like.

The tentacles are grooved on their outer side; the rhinophores have 12 leaflets on either side. The foot is bilabiate, not notched, but this last character is not constant. The margin of the pit lodging the 12 unipinnate gills bears small papillae.

The labial armature consists of bicuspidate hooklets. The radula of the present specimen (pl. 3, fig. 45) contains 84 rows of teeth, hence more than the Chilean animals with 56 to 69. The formula is 28. 1. 1. 1. 28. The rachidian tooth has four denticles; the intermediate (first lateral) tooth, a middle cusp, three inner and six outer denticles. The following lateral teeth have denticles only on the outside; their number increases outwards up to 19. The outermost lateral teeth are reduced.

The proximal course of the male duct is glandular but without prostate; the penial portion bears hooks.

Discussion of *Cadlina sparsa* (Odhner, 1921)

This light yellow species was first assumed to be Cadlina marginata MacFarland, 1905 (1906, pp. 125-126) reported from San Diego (Kelsey 1907, p. 35) and also known from other localities in Southern California (Cockerell and Eliot 1905, p. 35; O'Donoghue 1927a, p. 86). All descriptions of C. marginata, including those that refer to specimens from the Vancouver Island region (O'Donoghue 1921, p. 161; 1924, p. 29), are rather uniform with regard to color and radula and do not agree with the characters of the present specimen from San Diego. In C. sparsa the dark glands extend farther to the middle than in the Chilean material, and the greyish violet dots in the middle of the back described for the original specimens are absent.

13. *Rostanga pulchra* MacFarland, 1905

(Plate 3, Figures 46 to 49)

REFERENCES: MacFarland 1905, p. 40; 1906, pp. 119-122, pl. 18, figs. 18-21, pl. 21, fig. 109 (full description; colored figure pl. 24, fig. 8); O'Donoghue 1922a, pp. 152 to 154; 1926, p. 208 (literature); 1927a, p. 83; Costello 1938, pl. 1 (egg ribbon), pl. 2 (deposition of eggs); Ricketts and Calvin 1952, pp. 34 to 35, 72, pl. 5, fig. 6 (photograph on red sponges); Abbott 1954, p. 300 (colored figure: pl. 16, g); Marcus 1959, p. 35, figs. 65 to 68.

OCCURRENCE: Shell Beach, Sonoma County; Dillon Beach: inner and outer Tomales Point, Marin County; 11. III. to 16. VII. 1958. A total of 8 specimens. Point Pinos, 2 specimens. Point Loma, one specimen.

Further distribution: Chile, northern coast of Chiloé, intertidal zone; San Diego to Vancouver Island region.

The present animals (pl. 3, figs. 46 and 47) are four to nine mm. long; specimens 18 mm. long from Monterey Bay and about 20 mm. long from Chile (15 mm. long preserved) are recorded. These big specimens may be 9 mm. broad by 5.5 mm. high. Young animals may be transparent white; adult ones are most frequently bright red, but also yellow, pinkish, orange, or deep scarlet, often with brown or black spots in the notum under the papillae.

The rhinophores have 10 to 12 nearly vertical leaflets on each side; the shaft is prolonged above the club as a blunt process. The tentacles are long and slender alive, finger-shaped or conical in the preserved state. The anterior border of the foot is bilabiate with a notch in the upper lip. The 8 to 12 unipinnate gills are completely retractile into their pit, the border of which is spiculate. The dorsal papillae (pl. 3, fig. 48) are closely set, up to 0.42 mm.

high and 80μ in diameter. They are true caryophyllidia (Hoffmann 1935, pp. 592-596; Marcus 1955, p. 153), hence glandular and sensory epidermal outgrowths strengthened by vertical spicules with basal muscles.

The labial cuticle bears two small areas with five to six rows of pegs. The radula (pl. 3, fig. 49) contains 80 rows of 75-90.0.75-90 teeth. The innermost lateral hook bears 5 to 8 denticles in the present material; the specific range of variation is 4 to 11. The following about 35 teeth are hooks without denticles. From the twelfth outwards they increase in length, from the 30th their cusps become long and thin, and from the 35th, denticulate on their outer side. These denticles increase in size and number outwards; at first there is one short denticle, then up to 6 secondary cusps, only little narrower than the principal cusp. Up to one third of the length of the outer teeth is split up into denticles.

The reproductive organs were described by MacFarland (l. c.) and ourselves (Marcus 1959, fig. 68). Penis and vagina open into a common atrium, the nidamental duct farther behind. The seminal receptacles, that is spermatheca and spermatocyst, are arranged after Odhner's serial type (1926b, p. 51).

Discussion of
Rostanga pulchra MacFarland, 1905

The indication of the geographic range does not include Japanese and other Pacific localities referring to Rostanga arbutus (Angas, 1864), because we do not consider R. pulchra to be identical with that species (Marcus 1958b, p. 25; 1959, pp. 36 - 37).

14. *Aldisa sanguinea* (Cooper, 1862)
(Plate 3, Figures 50 to 53)

REFERENCES: Cooper 1862, p. 204; 1863, p. 58; MacFarland 1906, pp. 123-125, pl. 18, figs. 25 - 26; pl. 21, figs. 112, 114 (full description; colored figure: pl. 24, fig. 7); Kelsey 1907, p. 39; O'Donoghue 1926, p. 209 (literature); Baba 1940, pp. 103-104, figs. 1, 2; 1949, pp. 62, 150 (colored figure: pl. 24, fig. 86); Abbott 1954, p. 301; Baba 1957a, p. 9; Baba, Hamatani and Hisai 1956, p. 211, pl. 24, fig. 6 (egg ribbon).

OCCURRENCE: Bodega Harbor (jetty), 1 specimen.

Further distribution: Dan Diego to Monterey Bay, in rocky tide-pools; Japan, Kyushu to Hokkaido, shallow water.

The preserved animal (pl. 3, fig. 50) is 11 mm. long and 7 mm. broad. MacFarland indicated for living animals up to 17 mm., breadth eight and height six mm.; the Japanese slugs are still bigger, 25 mm. long. The foot of our specimen (pl. 3, fig. 51) is 8 mm. long, 4.5 mm. broad, its anterior border is bilabiate, the upper lip undivided. The breadth of the hyponotum, that is the underside of the mantle, is 1.5 mm. The color in life is red of different shades which disappears in the preservatives. There are generally one to two, sometimes 4 black spots on the back, behind the rhinophores and in front of the gills. In the present animal These spots are completely absent.

The short tentacles are grooved longitudinally on their outer side and connected with one another by the broadened head. The mouth is a transverse slit. There are 12 to 15 leaflets on either side of each rhinophore. The dorsal warts are smaller around the rhinophorial pits. The sculpture (pl. 3, fig. 52) consists of flat warts of different sizes containing spicules. The eight mainly unipinnate gills are arranged in the present specimen so that one in front and one behind stands in the mid line. The border of the branchial pit is beset with the common notal warts.

The tiny labial rodlets are only seen in sections. The radula has 60 to 70 rows of 80 to 100 teeth on either side of the naked rachis. The innermost teeth are 700μ, the outermost 30μ high; their denticulation is drawn in plate 3, fig. 53. The breadth of all teeth is about 9μ, and their bases are short. The male duct is dilated into a thick-walled prostate, as such also occurs in the type species of the genus (Odhner 1939, fig. 14, pr.), and is distally lined with minute hooks.

15. *Archidoris montereyensis* (Cooper, 1862)
(Plate 3, Figures 54 and 55)

REFERENCES: Cooper 1862, p. 204; 1863, p. 58; Bergh 1878, pp. 624-625; 1879b, p. 107, pl. 16, figs. 10, 11 (radula); Cockerell and Eliot 1905, p. 34; MacFarland 1906, pp. 114-116, pl. 18, figs. 1-5 (full description; colored figure; pl. 23, fig. 4); O'Donoghue 1921, pp. 154-156 1926, pp. 206-207 (literature); 1927a, p. 80; Costello 1938, pl. 1, fig. 5 (large egg ribbon), pl. 2 (copulating pair, deposition of eggs); Ricketts and Calvin 1952, fig. 37; McGowan and

Pratt 1954, pp. 261-276 (reproductive organs, eggs, veliger); Abbott 1954, p. 299 (colored figure: pl. 16, h).

OCCURRENCE: Shell Beach, Sonoma County; Dillon Beach; outer Tomales Point, in rocky areas; 19. VI. to 17. VII. 1958. A total of ten specimens. San Diego, cooling galleries of the Light and Power Company; two specimens.

Further distribution: San Diego to Alaska, from tide-pools to 55 m. depth.

The present animals are up to 35 mm. long, 18 mm. broad, and 8 mm. high. For living animals the corresponding maxima are 75, 25 and 12 or more (Cooper 1863, p. 58). The color is highly variable, dusky yellow with dark gills and brownish black patches of different size, only in part maintained in the preserved state. In our slugs the contents of glands (pl. 3, fig. 54 [16]) in the center of the notal papillae are the only dark elements.

The body is slender, the back more or less arched with rounded anterior and posterior end. The free border of the mantle is thick, about 4 mm. broad, hence narrower than in Discodoris heathi. The consistency of the notum is firmer than in that species, though the spicules are less numerous.

The tentacles are short and grooved. The perfoliation of the rhinophores consists of 20 to 30 leaflets on either side; the rim of the rhinophorial pits is papillose. The anterior border of the foot is bilabiate, the upper lip is very slightly notched. The foot is big, 33 mm. long and 15 mm. broad in our largest specimen; its upper side is smooth (in contrast to Discodoris heathi). The notal papillae are of irregular size. The maximum, a diameter of 0.6 to 0.8 mm. and nearly equal height, applies to large and small animals, though in the latter there are fewer big and more small papillae. These are blunt pegs stiffened by parallel spicules which leave the central gland [16] free. The spicules between the papillae are less numerous than in D. heathi; they are also smaller, up to 0.5 mm. long, 50 µ thick and have a rough surface. There are seven tri- to quadripinnate gills.

The labial cuticle is smooth; the radula has 33 rows of 42 to 65 hooks on either side of the naked rachis. The stomach stands out from the digestive gland; the caecum is free and long.

The reproductive organs (pl. 3, fig. 55) extend far backwards but occupy only the right half of the body cavity. The hermaphrodite gland [59] passes with a quite short hermaphrodite duct into a narrow winding ampulla [62]. The outlet of the latter is the point where male and female duct originate. The first [66] runs to the male atrium [75] as a curled vas deferens lined with gland cells. Scattered spicules lie in the connective tissue around the vas deferens and the spermatheca [86].

The vagina [82] begins close to the male atrium and courses to the left. It forms a loop whose wall is thickly muscular, possibly a pump, and enters the spherical spermatheca [86]. From this entrance the duct [89] that leads to the spermatocyst [88] goes out. If the spermatheca is more distended by its contents, the entrance of the vagina and the outlet of the insemination duct will be separated as they are in McGowan and Pratt's figure (1954, pl. 1, fig. 1). The pyriform spermatocyst may be smaller or bigger than the spermatheca.

As in other species spawning extends through several months (Costello 1938, p. 326), e. g., from April to early June (Vancouver), November to March (Monterey), December to May (Corona del Mar). At the end of the egg-laying season the animals died at the last mentioned locality (MacGinitie 1949, p. 379). The average number of eggs is 220'000 (Ch. and E. O'Donoghue 1922, p. 137).

16. *Anisodoris nobilis* (MacFarland, 1905)

(Plate 3, Figures 56 to 58)

REFERENCES: MacFarland 1905, p.38; 1906, pp. 116-118, pl. 18, figs. 6-11 (full description; colored figures: pl. 22, figs. 1-2); O'Donoghue 1921, pp. 156-158; 1922c, p. 126 (sometimes pure white); 1926, p. 207 (literature); 1927a, p. 81; MacGinitie 1949, p. 377 (eggs eaten by Megathura crenulata); Ricketts and Calvin 1952, pp. 175-176 (size, odor, eggs in November: Monterey); Abbott 1954, p. 300 (colored figure: pl. 16, e).

OCCURRENCE: Shell Beach, Sonoma County, 3. VI. and 16. VII. 1958; Dillon Beach, 8. III. and 5. V. 1958. A total of 9 specimens and one egg ribbon.

Further distribution: Laguna Beach to Vancouver Island region.

Three of the present specimens are 10 to 35 mm. long, six are 40 to 77. Living animals of this species may attain 200 mm. in length, 60 mm. in width, and 30 mm. in height. The color is light to orange yellow mottled with irregular dark brown or black blotches of variable number between the notal tubercles. The gills have pink bases and white plumes; the rhinophores are yellow.

The outline of the body is uniformly ovate, the back more or less arched, according to contraction. The tentacles are digitiform. The rhinophores bear 24 to 25 leaflets, and the rim of their pits is densely papillose. The upper lip of the bilabiate anterior pedal border is entire or slightly notched. The posterior border of the foot is rounded. The free margin of the notum is broad, 10 to 12 mm. in the larger of the present individuals. The diameter of the low, peg-shaped papillae (pl. 3, fig. 56), which are free from pigment, increases with the size of the body, in contrast to Archidoris montereyensis. They are, in millimeters: 0.2 (body length 10), 0.5 (15), 0.6 to 0.8 (35 to 40), and 0.8 to 1.2 (60 to 77). The lateral papillae are smaller. The papillae are supported by more or less parallel bundles of long and thin spicules. Also in the connective tissue of the notum these form a network. They are simple bicuspidate needles, up to 0.7 mm. long and 25 μ in diameter. Some of them have a rough surface. Six to seven tri- to quadripinnate gills encircle the anus. Their pit has a lobate rim.

The labial cuticle is smooth. There are 23 to 27 radular rows with 55 to 62 teeth on either side of the naked rachis. The inner teeth are small, the following ones increase gradually in size attaining definitive height at about the 25th. The four to five outermost teeth decrease in size.

The hermaphrodite gland lies around the digestive gland. The hermaphrodite duct (pl. 3, fig. 57 [60]) runs forward. The ampulla which is empty in the dissected specimen is a flat W-shaped organ firmly attached to the spermatheca [86]. The male and the female duct originate at the outlet of the ampulla. The male duct dilates immediately into a bulky round prostate [67] which is a little constricted in its middle. From this furrow the vas deferens [66] emerges; it forms several loops. A muscular sheath [71] surrounds the short terminal portion of the duct loosely. Part of the latter (pl. 3, fig. 58 [70]) is evaginated into the male atrium [75] in the examined specimen.

The oviduct (pl. 3, fig. 57 [65]) enters the gland mass [91] whose nidamental opening [95] lies close behind the apertures [80, 76] of vagina and male atrium. The vagina [82] runs to the left, bends in a sharp angle and enters the spermatheca [86], a thin-walled organ with a folded epithelium. As the entrance into and the outlet from the spermatheca is established by a single duct, the seminal receptacles are arranged semiserially. The insemination duct [89] leaves the angled communication between the two receptacles, or seminal vesicles in Bergh's terminology, distally to the spermatocyst [86] which constitutes the innermost caecum of the vaginal way.

The orange egg ribbon contains an average of two million eggs (O'Donoghue 1924, pp. 22 to 23).

17. *Diaulula sandiegensis* (Cooper, 1862)

(Plate 3, Figures 59 to 61)

REFERENCES: Cooper 1862, pp. 204-205; 1863, pp. 58-59; Bergh 1880, pp. 41-46 (full description), pl. 5, figs. 3 to 9; 1894, p. 173 (feeding on dead fishes); MacFarland 1906, pp. 122-123, pl. 18, figs. 22-24 (colored figure: pl. 23, fig. 5); Kelsey 1907, p. 39; O'Donoghue 1921, pp. 159-161; 1924, p. 23 (color variation); 1926, p. 209 (literature); 1927a, p. 83; Baba 1935a, p. 346 and 1935b, p. 119 (as Peltodoris mauritiana, see Baba 1957a, p. 13, fig. 6); Costello 1938, pl. 1 (egg ribbon), pl. 2 (copulating pairs); MacGinitie 1949, fig. 212 (photograph); Ricketts and Calvin 1952, p. 35, pl. 6, fig. 2 (photograph); Abbott 1954, p. 301 (colored figure: pl. 16, d).

OCCURRENCE: Dillon Beach, on leaves of eel grass; Inner side of Tomales Point; Tomales Bay, among oysters of Oyster Company, 20. IV. to 1. VIII. 1958. A total of eight specimens. San Diego, cooling galleries of Power and Light Company. Eleven specimens.

Further distribution: San Diego to the Aleutian Islands, Unalaska; Japan, North Honshu and Hokkaido.

The present animals are 11 to 70 mm. long, measured over the back. Alive the species may attain 87 mm. The breadth is up to 30 mm. and the height up to 20 mm. The color of body and rhinophores varies from pale yellow to chocolate brown. A row of three to six dark rings (biggest diameter 8 mm.) occurs on either side. They may be replaced by irregular spots (pl. 3, fig. 59). The gills are white.

The body is longish with parallel sides, rounded in front and behind. The free mantle border is crenulate. The tentacles are finger-shaped; the rhinophores bear 20 to 30 leaflets on either side. The prominent rims of rhinophorial and branchial pits are crenulate. The anterior border of the foot is bilabiate with a notch in the upper lip, the hind end rounded. The notum is velvety due to numerous caryophyllidian papillae (pl. 3, fig. 60) whose maximum diameter is 60 μ in small, 100 μ in middle-sized and 200 μ in big animals. The six to seven gills are tripinnate; the conical anal papilla is high.

The labial cuticle is smooth. There are 19 to 23 rows of radular teeth, 25 to 34 on either side of the naked rachis. The teeth are smooth hooks with the exception of the outermost which are straight. About nine inner teeth increase, the five outer ones decrease in size. Those in between are of equal height. The oesophagus forms a long loop before it enters the stomach from the anterior side. The digestive gland conceals the stomach completely. A 2.5 mm. long caecum shows to the left of the pylorus. Sometimes the gut contains bits of Keratosa.

The hermaphrodite gland covers the digestive gland. The hermaphrodite duct is short, the ampulla [62] a coiled tube whose outlet divides immediately into male and female duct. The male duct begins with a compact prostate [67] extending ventrally from right to left and dilated into a ball. From the right side of it emerges the vas deferens [66] which forms a few coils and enters with a long muscular penis [70] into the atrium [75]. The tip of the penis is bent inwards in the two dissected specimens.

The vagina [82] begins in the same atrium and runs from right to left where it opens into the spermatheca [86]. The insemination duct [89] originates beside the entrance of the vagina. It is rather long and communicates with the short duct of the spermatocyst near its middle. In the female gland mass [91] the insemination duct meets the strongly ciliated inner oviduct [65]. The outer oviduct or nidamental duct [95] opens close to the vagina.

In the Monterey region the white egg ribbons are deposited almost throughout the entire year (Ricketts and Calvin, l. c.). The 16 mm. broad ribbon may attain a length of one meter and contain up to 16 million eggs (Costello 1938, p. 329 to 330).

Discussion of *Diaulula sandiegensis* (Cooper, 1862)

According to Eliot (1907, p. 355) and Odhner (1926b, p. 89) Diaulula sandiegensis var. pallida Bergh, 1894 (p. 172) from the Patagonian coast is identical with D. vestita (Abraham, 1877, p. 252).

18. *Discodoris heathi* MacFarland, 1905
(Plate 3, Figures 62 to 64)

REFERENCES: MacFarland 1905, p. 39; 1906, pp. 118-119, pl. 18, figs. 12-17 (colored figure: pl. 23, fig. 6); O'Donoghue 1922a, pp. 151-152; 1927a, p. 82; Costello 1938, pl. 1, figs. 9, 23 (egg ribbon), pl. 2, fig. 29 (copulating pair); Abbott 1954, p. 300 (colored figure: pl. 16, i).

OCCURRENCE: Outer coast of Tomales Point, in rocky areas, 17. VII. 1958; 3 specimens. Point Pinos, Pacific Grove, 2 specimens.

Further distribution: Laguna Beach; Monterey Bay, rather rare in rocky tide pools; Vancouver Island region.

The present animals are up to 35 mm. long, 20 mm. broad and 9 mm. high. The color has faded out; in life it is light yellow with dark dots, or the middle of the notum is darker. The shape is longish, rather narrow, rounded in front and behind. The notum is thin, the free border six mm. broad, undulate and fragile. In spite of the numerous spicules its consistency is soft.

The spiculated tentacles are flat and pointed, not grooved. The rhinophores bear 10 to 15 leaflets on either side. The anterior pedal border is bilabiate; a notch in the upper lip is inconstant. As in Archidoris montereyensis the foot is rounded in front and behind and stands out posteriorly in the creeping animal, but in Discodoris heathi its upper side is papillose, not smooth. These papillae, as well as those of the notum (pl. 3, fig. 62) are rather low. The diameter of the latter is up to 0.4 to 0.5 mm.; some occur also around the rhinophorial pits. The spicules are densely arranged and diverge in the papillae; between these they form a network. Their length attains 1.2 mm., the diameter at most is 50 μ. Notum glands [16] are situated between the papillae. There are 8 to 10 tri- to quadripinnate gills.

The labial cuticle has two fields of rodlets. There are 20 to 22 radular rows. On either side of the naked rachis our specimens have 31 lateral and 9 to 10 marginal teeth (pl. 3, fig. 63), while the literature indicates 20 to 25 and 12 to 17 respectively. The innermost tooth has a short cusp and a big, wing-like process; outwards the cusp becomes longer, the process shorter and more basal. From about the 25th tooth outwards the cusp decreases again. The marginal teeth have no cusp; they are thin, curved leaves closely apposed to one another, and diminish towards the margin. Sigma-needles of siliceous sponges were found in the anterior gut. The stomach is hidden by the intestinal gland; the globular caecum is free.

The complex of the reproductive organs (pl. 3, fig. 64) is broader than long and extends to the left body wall. The ampulla [62], a long tube, winds ventrally forwards and divides into male and female duct. The male duct begins with a bulky prostate [67] whose inner part is soft, the outer dense and hard. The coiled vas deferens [66] runs to the right on the anterior margin of the genital complex and enters a big, muscular, unarmed penis [70].

Vaginal and nidamental [95] opening lie behind the male atrium [75]. The vagina [82] is accompanied by an angled thin-walled gland [85] which opens beside the vagina with a long duct. Also the bean-shaped spermatheca [86] is conspicuous; the pyriform spermatocyst [88] is smaller. These two seminal receptacles are arranged serially as those of Discodoris evelinae and D. pusae Marcus (1955, pp. 143, 147), that is the insemination duct [89] leaves the spermatheca independent from the vagina.

Discussion of
Discodoris heathi MACFARLAND, 1905

Discodoris fulva O'Donoghue (1924, pp. 27 to 28) from the Vancouver Island region is probably a young specimen of D. heathi. It was only 5.25 mm. long alive. Neither the relative positions of gills and rhinophores nor the small, unfigured difference in the shape of the radular teeth need be specific.

19. *Aegires albopunctatus* MACFARLAND, 1905
(Plate 4, Figures 65 and 66)

REFERENCES: MacFarland 1905, p. 45; 1906, p. 133, pl. 19, figs. 41 - 44; O'Donoghue 1926, p. 213 (literature); 1927a, p. 95; 1927b, p. 7; Ricketts and Calvin 1952, p. 72 (on white sponges).

OCCURRENCE: Point Pinos, Pacific Grove, 2 specimens. San Diego, cooling galleries of Power and Light Company.

Further distribution: Laguna Beach; Santa Catalina Island; San Pedro; Santa Barbara; Monterey Bay, especially upon sponges in a tunnel-like grotto formed by the waves; Vancouver Island region.

These specimens are 7 to 18 mm. long preserved (pl. 4, fig. 65), hence larger than the previous record of 17 mm. alive. The three larger ones are greyish white with scattered black spots, as they were in life. The two 7 mm. specimens are white; in life their rhinophores were light grey. In the literature a pale yellow color was also indicated with dark brown spots and golden yellow rhinophores.

Blunt tubercles occur on the veil, on more or less regular ridges along the back, and between these. The club of the rhinophores is smooth, the sheath bears 4 to 7 claviform papillae around its margin except on the lower inner side. Small tentacles flank the mouth. The anterior border of the foot is slightly notched, not grooved, the edge of the foot is free from tubercles, the tail is somewhat pointed. Each of the 3 tripinnate gills is protected by a lobed appendage with tuberculate outer surface. The skin is hardened by numerous spicules, small stellate needles crowded in the tubercles, and bigger straight or curved ones underneath.

The anal papilla lies in the center of the gills, the renal pore at its anterior right base, the genital aperture [77] under the notal ridge in the anterior third of the body.

The cuticle of the labial disc is strengthened to a grasping ring formed by rods on the sides of the inner mouth. Dorsally lies a thick, unpaired, shield-shaped jaw plate. The radula is composed of up to 22 rows. There are 22.0.22 teeth in the largest specimen, while the literature indicates only up to 20. All are simple hooks.

The central nervous system has completely united cerebro-pleural ganglia with apposed rhinophorial ganglia and sessile eyes. An abdominal ganglion is not developed. The visceral loop is short and rostral to the pedal and parapedal commissures. The gastro-oesophageal ganglia contain one large and about six smaller cells. This detail is the only difference from the central nervous system of Aegires punctilucens (Bergh 1881, p. 653, pl. 12, fig. 2). The peritoneum has some black pigment. The cardiac and pyloric parts of the stomach are free from the digestive gland.

The hermaphrodite gland covers the digestive gland; it communicates by a narrow duct [60] with the wide pear-shaped ampulla [62]. The exit of the ampulla bifurcates near the anterior border of the gland mass [91]. The female branch [65] enters the latter together with the insemination duct [89].

The male branch emerges from the ampulla as a thick prostatic portion [67], followed first by a very narrow, soft part and then by a cuticularized part [66]. The latter has a muscular sheath, wherein it runs free in its proximal course, while the sheath is apposed to the wall of the vas deferens farther distally. Here it is lined with minute spines; and the penial termination [70] projects as a blunt, nearly cylindrical papilla into the spherical male atrium [75].

The female gland mass [91] is voluminous and flat. It opens by a nidamental duct [95] which has a common outlet [77] with the vagina [82]. The latter begins wide and narrows inwards to a muscular canal lined with a cuticle. This canal is connected through a conical valve [83] with the spermatheca [86], a spherical organ which lies on the upper side of the gland mass to the left. Together with the entrance of the vagina the insemination (uterine) duct leaves the spermatheca. Curving forwards under the vagina this duct receives the pear-shaped spermatocyst [88] which hangs backwards. The spermatocyst is ventral to the vagina, dorsal to the gland mass, and contains oriented sperms.

Discussion of
19. *Aegires albopunctatus* MacFarland, 1905

The species with a projecting lateral rim of the mantle were united in the subgenus Anaegires Odhner (1934, p. 242). Therefore the present species, which agrees with the type species Aegires punctilucens (d'Orbigny, 1837), by its series of papillae on the mantle border, must be allocated to the subgenus Aegires. A. (A.) albopunctatus shows negative phototaxis.

20. *Laila cockerelli* MacFarland, 1905
(Plate 4, Figures 67 to 70)

REFERENCES: MacFarland 1905, p. 47; 1906, pp. 134-135, pl. 19, figs. 45-50 (full description; colored figure: pl. 27, fig. 15); Kelsey 1907, p. 41; O'Donoghue 1921, pp. 163-165; O'Donoghue and O'Donoghue 1922, pp. 138-139, pl. 4, fig. 8 (egg string); O'Donoghue 1926, p. 216 (literature); 1927a, p. 99; Smith and Gordon 1948, p. 180; Abbott 1954, p. 304 (colored figure: pl. 16, j).

OCCURRENCE: Carmel Point, under algae, 23. VI. 1959. Two specimens.

Further distribution: San Diego to Vancouver Island region.

The present specimens (pl. 4, fig. 67) are 15 mm. long, 6 to 7 mm. broad and 4 mm. high; alive the species may attain 20 mm. The color of living animals is yellowish or pure white with orange or red rhinophore clubs, tips of marginal processes and of tail. Sometimes orange flecks occur on the gills and the tubercles in the middle of the notum. The connective tissue of the notum contains two layers of spicules. In each of them the spicules are parallel but form an angle of 90° with the other layer. They are about one mm. long and 70 µ thick. Above these there are numerous hexactines, 40 µ to 60 µ in diameter.

The margins of head and back are set with club-shaped papillae, up to 6 mm. high, arranged in 3 to 4 rows. The length of the papillae increases from the outer ones inwards; those on the head are smaller. Each papilla is stiffened by a vertical bundle of spicules. On either side of the head a flattened ridge, about 2 mm. long, extends from the level of the tentacles to that of the genital openings. The digitiform short tentacles are grooved dorsally. The retractile rhinophores bear 12 to 14 leaflets; the rim of their sheaths is smooth. The mouth is large with fleshy folded lips.

The foot has a truncate bilabiate anterior border with rounded corners and protrudes behind in the living animal; it is abruptly pointed. Scattered low tubercles of varying size are on the back of the notum. Five tripinnate gills surround the anal papilla; the renal pore lies near its base and to the right.

The central nervous system (pl. 4, fig. 68) is rather flat. The cerebral ganglia [47] are separated from each other by a dorsal furrow, as are the pleural ganglia [48]. However, the cerebral ganglia are contiguous with the pleural ganglia. The pedal ganglia [49] lie to the sides. The ventral view (pl. 4, fig. 68) shows the subcerebral commissure, the pedal and parapedal commissures united in a sheath of connective tissue [54]. The visceral loop [53] is short. At its left root it contains a ganglion [52] which gives off a visceral nerve and farther to the middle two nerve cells.

The labial cuticle is thin and smooth; jaws are absent. The radula (pl. 4, fig. 69) comprises 74 to 88 rows with 10-14.2.1.2.10-14 teeth.

The spurious rachidian tooth is an oblong plate. The thin inner lateral teeth are vertically set hooks. They are so frail that they are completely worn in the 26 oldest of the 88 rows of the examined radula. The outer lateral hook is stouter and longer, has an oblique, irregularly shaped base with an outer ridge and a cusp with three claw-like hooks. The four innermost of the pavement-like marginal teeth bear two small points on a broad cusp which is reduced and finally disappears in the outer teeth.

The hermaphrodite duct [60] dilates into a curved and long ampulla [62]. The male duct is narrow at its beginning and continues as a wide coiled prostate [67]. This passes through a very small vesicle into an outer penial portion [70] sheathed with a muscle layer and lined with tiny cuticular hooks. The inner oviduct [65] passes into a gland mass. The vagina begins with a pyriform, sperm containing sac, similar to the dilation at the vaginal entrance in Polycerella conyna Marcus (1957, fig. 109, ve). This sac is connected with the spermatheca [86] by a tubular vaginal portion [82], from the middle part of which the insemination duct arises. The latter joins the canal of the spermatocyst [88] in an enlargement from which the duct continues into the gland mass.

Spawning was observed from late in May to early in July in the Vancouver Island region. The pale pink egg string, a close spiral, contains only 6500 eggs.

21. *Triopha carpenteri* (Stearns, 1873)

(Plate 4, Figure 71)

REFERENCES: Stearns 1873, p. 78, fig. 2; MacFarland 1906, pp. 135-137; pl. 19, figs. 51 to 55; pl. 21, figs. 108, 113 (colored figures: pl. 27, figs. 16, 17); O'Donoghue 1926, p. 214 (literature); 1927a, p. 96; Costello 1938, pl. 1, 2 (egg ribbon, copulation, deposition of eggs); Ricketts and Calvin 1952, p. 35 (behavior), pl. 6, fig. 1 (photograph); Abbott 1954, p. 304 (colored figure: pl. 16, k); Baba 1957a, p. 11, fig. 1.

OCCURRENCE: Bodega Jetty on Aglaophenia, 7. V. 1958; outer and inner coast of Tomales Point, 1. and 17. VII. 1958. A total of eight specimens.

Further distribution: Laguna Beach; Monterey Bay region, and north to Dillon Beach; Japan, NE Honshu and Hakodate.

Creeping, wholly extended animals may attain (as the collector recorded) 120 mm. in length; our preserved specimens are 8 to 40 mm. long. In life the color is white, slightly yellowish above, often sprinkled with minute white spots borne on tiny knobs. Appendages of the head and back, clubs of rhinophores, tips of gills, scattered dorsal warts and numerous irregular blotches on the sides are orange. These spots are particularly numerous around the tip of the tail.

The veil of the head bears a total of 10 to 12 irregularly lobed papillae. The veil is continuous with an inconspicuous notal ridge which has 4 to 8 similar appendages on either side. Simple or compound tubercles, sometimes as big as the lateral processes, are irregularly scattered on the back or may form a median series, especially on the head. Two or three tubercles occur in front of the rhinophores and a similar median or several scattered eminences occur behind the gills.

The retractile rhinophores have clubs with 20 to 30 leaves and sheaths with smooth or slightly wavy margins. The short stout tentacles are ear-like, often cup-shaped in preserved material. The rounded anterior margin of the foot is grooved, the tail bluntly pointed.

There are five tripinnate gills with separate bases; one is antero-median and two pairs are lateral. The anal cone lies in their center, the renal pore near the base of the cone. The genital aperture is located on the right side in a line with the second dorso-lateral appendage.

The central nervous system (pl. 4, fig. 71) is similar to but not identical with that of Triopha modesta Bergh (1880, pl. 15, fig. 1). The cerebral ganglia [47] together with their rhinophorial ganglia [46] are smaller than the pleural ganglia [48] and distinctly separated from them. An abdominal ganglion [50] is apposed to the right pleural ganglion as in Plocamopherus (Bergh 1883, pl. 9, fig. 7). Farther distant from the left pleural ganglion the visceral loop contains a ganglion which consists of several small cells. It corresponds to a still smaller ganglion in Polycera (Pelseneer 1894, fig. 118, X), and a nerve, the left visceral nerve [57] of Alder and Hancock's figure (1854, fam. 1, pl. 17, fig. 12, nerve 16), originates here (see also Hoffmann 1936, p. 806). Gastro-oesophageal ganglia are not developed; they are also absent in T. modesta; Bergh did not find them again in a second specimen (1894, p. 185). The strong pedal commissure [54] probably comprises a parapedal commissure within the same sheath of connective tissue.

On the yellow cuticle of the labial disc two strengthened triangular areas, (jaws in MacFarland's terminology) consist of curved blunt rods. The radula comprises 29 to 33 rows. On either side of the mid-line two spurious teeth are developed, the inner quadrangular, the outer triangular. Then follow 9 to 18 strongly hooked lateral teeth and to the margin 9 to 20 quadrilateral plates (MacFarland's uncini) which decrease in size outwards. The stomach lies in a groove in the anterior end of the digestive gland. In the dissected specimen it is filled with anascous Bryozoa. The groove divides the digestive gland into a smaller anterior and a larger posterior lobe.

The reproductive organs differ from those of Triopha maculata (pl. 4, fig. 76) by a proportionally shorter hooked portion of the vas deferens, which measured about one fifth of the length of the duct. The hooks are up to 30μ long. The insemination duct enters the gland mass with a slight dilation, not observed in T. maculata. The egg ribbon is white (Costello 1938, p. 330).

Discussion of

Triopha carpenteri (Stearns, 1873)

Odhner (1941, p. 12) united the polyceridan genera with ramose or compound appendages in front or on the sides of the back as Triophidae. To these correspond the Caloplocaminae in Pruvot-Fol's system (1954, p. 323) which maintains the family Polyceridae for all Phanerobranchia Nonsuctoria.

O'Donoghue (1922b, p. 138) listed seven species of Triopha from the Pacific coast of North America. One of them, T. catalinae (Cooper 1863, p. 59), whose radula is unknown, ought to be collected again at the type locality or at Santa Cruz near the Monterey area (Smith and Gordon 1948, p. 180). The color of T. catalinae agrees with that of T. carpenteri and T. aurantiaca Cockerell, 1908 (p. 107), hence its name might have priority to one of these. In agreement with MacFarland (1906, p. 137) and O'Donoghue (1921, p. 167) we separate T. carpenteri from T. modesta Bergh (1880, p. 113; 1894, p. 184) and from T. aurantiaca, fully described as T. elioti (O'Donoghue, l. c.). Baba's material from northern Japan (1957a, p. 11) is T. carpenteri, not T. modesta, as would be expected from the distribution of T. modesta on the coast of Alaska and the Aleutian Islands. T. scrippsiana Cockerell, 1915 (p. 228) is an independent species although its colors are similar to the T. carpenteri-type. Adult animals may be distinguished by the radular characters shown in table 1.

Table 1: Radular Characters in Species of *Triopha*

Species of *Triopha*	Number of Rows	Lateral Hooks	Marginal Plates
T. carpenteri	25 to 33	9 to 18	9 to 20
T. modesta	28	4 to 7	10 to 13
T. maculata	13 to 17	3 to 5	7 to 10
T. grandis	18	8	8
T. aurantiaca	20 to 25	4 to 6	8
T. scrippsiana	58	22	16

22. *Triopha maculata* MacFarland, 1905

(Plate 4, Figures 72 to 76)

REFERENCES: MacFarland 1905, p. 49; 1906, pp. 137-139, pl. 19, figs. 55a to 59; pl. 21, figs. 106, 107 (full description; colored figure: pl. 28, fig. 18); O'Donoghue 1926, p. 214 (literature); 1927a, p. 98; Ricketts and Calvin 1952, p. 128, fig. 40; Abbott 1954, p. 304 (colored figure: pl. 16, f).

OCCURRENCE: Bodega Jetty; Dillon Beach; outer and inner coast of Tomales Point; April to July 1958: a total of 24 specimens. Point Pinos, Pacific Grove: 13 specimens. Point Loma: 6 specimens.

Further distribution: Laguna Beach; Monterey area.

Our preserved animals are from 4 to 20 mm. long; the largest on record measured alive 52 mm. Small individuals are orange with white spots; the larger ones are darker brown on back and sides, and the white spots appear bluish, bordered by orange-yellow lines. The sole of the foot is orange yellow. The appendages of head and back, the rhinophorial clubs, and the tips of the gills are bright orange, the stalks of the rhinophores are yellowish.

The head has 10 to 12 branched processes; the tentacles are ear-shaped; the perfoliate rhinophores are retractile into short sheaths with wavy margin. The anterior border of the foot is grooved.

The lateral borders of the notum each bear four to six ramified appendages. Sometimes there is a median row of about five larger eminences in front of the gills. The latter are five to seven tripinnate plumes. The anus lies in the center of the branchial circle, the renal pore at the base of the anal papilla, and the genital aperture level with the second right dorso-lateral appendage.

The colorless labial cuticle bears two yellow triangles densely beset with rodlets (pl. 4, fig. 72). The radula (pl. 4, figs. 73 to 75) consists of 13 to 17 rows. The rachis is covered with a pair of colorless quadrangular granular plates. The next outward element is a triangular plate of the same consistency. Then follow three to five lateral hooks and seven to ten rectangular marginal plates gradually decreasing in size towards the border.

The thin-walled stomach is free from the digestive gland, whose smaller anterior and larger posterior portion are separated by a furrow.

The hermaphrodite gland covers the upper surface of the digestive gland. The hermaphrodite duct [60] dilates into the convoluted ampulla [62], whose end is the point where male and female ducts separate. The former begins with a wide glandular prostatic portion [67] followed by a narrow muscular duct [66], which contains a massive, sausage-shaped seminal vesicle [87], approximately in the middle of its course. The wall of this organ is strongly muscular and continuous with the sheath of the distal portion of the vas deferens. The male duct ends in the cylindro-conical atrium [75]; its eversible terminal third is armed with small hooks. These are up to 25 μ long and about 5 μ thick with basal plates 10 μ in diameter.

The inner oviduct [65] enters the gland mass [91] which opens through the nidamental duct [95]. Between this and the aperture of the male atrium begins the vagina [82] which at first is wide, then narrow, and leads to a large spermatheca [86]. The insemination (uterine) duct [89] emerges from the spermatheca, well separated from the entrance of the vagina. The club-shaped spermatocyst [88] is connected with its middle by a short canal. The insemination duct enters the gland mass [91] near the entrance of the inner oviduct [65].

Discussion of

Triopha maculata MacFarland, 1905

The radulae of two specimens (one 12 mm., the other 20 mm. long) examined conform to the preceding description. They are 2.8 and 4.2 mm. long respectively and comprise 14 and 16 rows. A four mm. long slug had a 1.4 mm. long radula with 34 rows, a six mm. long specimen a 1.9 mm. long radula with 31 rows, and a seven mm. long animal a 1.75 mm. long radula with 19 rows. Hence it appears that the number of rows decreases with the individual's growth as in another nonsuctorian phanerobranch, Thecacera pennigera (Marcus 1957, p. 428). The size of the teeth increases, e. g. from 0.15 mm. long hooks in the six mm. long slug to 0.43 mm. in the biggest specimen 20 mm. in length. The innermost marginal plates grow from 0.075 to 0.2 mm.

The rachis of the six mm. animal (pl. 4, fig. 74) bears a single broadly quadrangular plate with an allusive median bipartition similar to Bergh's figure of Issena (1881, pl. 14, fig. 6). The next element on either side is a true triangular tooth with a short cusp. Then follow one lateral hook and ten rectangular marginal plates.

In the radula of the seven mm. long slug (pl. 4, fig. 75) the older rows are arranged as those of the six mm. specimen. The shape of the middle rows passes gradually to that of the newest rows, which show the adult type with three hooks. In the rachis of the transitory zone there are two plates, at first close together, and in newer rows separate. The neighboring triangular teeth lose their cusp and assume the granular, spurious consistency of the rachidian rectangles. The innermost marginal plates are gradually transformed into lateral hooks. Thus the number of hooks increases and that of the marginal plates diminishes. The oldest rows whose hooks are worn (pl. 4, fig. 75) will be eliminated with the continued growth of the animal as this particular specimen has four rows more than the large specimens.

This series of radulae establishes the origin of the spurious rachidian elements by retrograde development of true teeth, as Hoffmann (1938, p. 1024) had supposed.

23. *Crimora coneja* Marcus, spec. nov.
(Plate 5, Figures 77 to 83)

OCCURRENCE: Point Loma, reef near Lighthouse (type locality: 32°40' North, 117°40' West); 12. IX. 1958; five specimens.

The preserved animals (pl. 5, figs. 77, 78) are 5.5 to 7 mm. long, white with black tips on most of the peg-shaped appendages. According to the collector's notes the gliding animals were narrow with a long tail. In life the ground color was white, as were the gills. The rhinophores, the 25 or so appendages on either side of the edge of the notum, and those of the dorsomedian crest behind the gills were orange, with or without black cap or black granules, The same black pigment, caps or granules, occurs also in the remaining white papillae. These are about seven small ones around the frontal veil and many of different size on head and back in front of the gills. The varying shape of the appendages (observed on the living animal), round, pointed or bifid, shows that they are contractile. Some of those on the edge of the notum are ramified. The sides of the body are smooth, and in some slugs with a few black dots. The tail has no knobs. The few spicules are enormous, 400 μ long and 60 μ in diameter.

The longitudinal slit of the mouth is surrounded by an oral disc, continuous with blunt short labial tentacles. The perfoliation of the rhinophores consists of about 9 leaflets. The anterior border of the foot is bilabiate with a transverse groove. The sole of the foot is narrower than the body, tapers backwards and ends at the tip of the pointed tail. The three tripinnate gills stand in an arch around the anal opening. The branchial glands known from many Doridacea (Hoffmann 1940, p. 48) are numerous and conspicuous (pl. 5, fig. 83) Their secretion stains blue. The genital apertures lie in the anterior third of the body, ventrally to the right edge of the notum.

There is a labial cuticle around the entrance of the pharynx but no jaws. The radula (pl. 5, figs. 79, 80) comprises 53 rows with a "polymorphous multitude of teeth" (Odhner 1941, p. 12), with the formula 9.6.2.(1).2.6.9. A rectangular thickening of the rachis can be considered as a spurious tooth. The first lateral tooth is also little differentiated, a rounded triangle often hidden by the large second tooth. The latter is a strong polyceridan hook with a spur on its basal third. The three following teeth are broad rectangles with more or less projecting points on the inner side, one at the upper corner, and one near the basal angle. The upper point elongates gradually into a true cusp in the fourth to sixth lateral teeth; the sixth is scythe-shaped. The long and soft marginal teeth which arise from very narrow bases are minutely denticulate. The middle of the radula is worn more rapidly than the margins; from the 41rst row forward the inner teeth have disappeared, and only the older groups of marginal teeth are preserved to the 53rd row.

The oesophagus enters the digestive gland, whose ducts communicate with a slight gastric dilation. The longitudinally folded intestine leaves the digestive gland in its left upper part. At the root of the intestine a spacious caecum originates. It is directed forward accompanying the oesophagus but is surrounded by the digestive gland in its entire extension. The blood glands extend to the nerve ring.

The hermaphrodite gland [59] covers the digestive gland on all sides. The hermaphrodite duct [60] dilates into a long and thick ampulla [62]. The following spermoviduct [63] is much longer than could be drawn in figure 81 (pl. 5). It bifurcates, giving rise to the vas deferens [66] and the oviduct [65]. A short distance from its origin the vas deferens forms a prostate [67] with a tubular beginning, a large lumen and a folded wall. The prostate courses first forwards and to the right, then downwards and transversely to the left. Here it is very much widened and the gland cells of its high folds produce a pink-staining secretion. It continues as a thinner tube to the right to just under the shaft of the rhinophore, and here it becomes muscular and narrow. This tube forms some loops, and then is enclosed in a sheath [71] as a penis about one mm. long [70], which bears cuticular hooklets almost on its entire length. This penis is directed backwards where it opens with the male pore [76] on a papilla.

The female gland mass [91] is a lobate organ. Its opening, the nidamental aperture [95], is situated ventrally to and a little behind the papilla of the male pore. On this papilla the opening [80] of the vagina [82] is also located. This orifice is surrounded by some ciliated epidermal tubules. There is a strong sphincter [84] in the distal part of the vagina. The following duct is very long. At the level of the nervering the vagina bends to the left ventral side, opening into a voluminous spermatheca [86]. The uterine or insemination duct [89] begins in the downward portion of the vagina, bears a small diverticulum near its origin, and joins the duct of a longish spermatocyst [88], which extends forward to the region of the nerve ring. The insemination duct is tightly coiled from its origin at the vagina to its entrance into the gland mass. Here it meets with the oviduct [65]. A rather ample ciliated cavity in the gland mass evidently functions as a fertilization chamber.

The holotype is the seven mm. long slug.

{Editor's note: It is desirable that the meaning of names be given, especially when they are not derived from the classical Latin or Greek. We have endeavored to elicit such an explanation from Professor Marcus and we refer the reader to the explanation reproduced in the preface. However, the word coneja does not seem to fit into the general scheme since it is apparently derived from the Spanish and denotes "rabbit" which may have been chosen because of the remote resemblance of this species to a rabbit. However, there may have been other, much more obscure reasons that prompted the choice of this particular name. We do not believe that it is one of the folklore names of a seal!}

Discussion of *Crimora coneja* Marcus, spec. nov.

One slug among Zostera "in a few fathoms water" off Guernsey in the English Channel represents the type specimen of Crimora papillata Alder and Hancock, 1862 (p. 263), not found again since 1865 but sufficiently known through Eliot's description (1910, pp. 110, 152) and the publication of Hancock's drawings (pl. 2, figs. 1 to 5). These were recently reproduced by Pruvot-Fol (1954, p. 326, figs. 128 e, f). Size (20 mm.), the knobs on the sides of the body, the absence of black pigment, and the different formula of the radula distinguish C. papillata at once from C. coneja. Of the second species of Crimora, C. lutea Baba, 1949 (pp. 133, 139), two specimens were found in 15 to 17 m. in Sagami Bay. Crimora lutea is much more closely related to C. coneja than to C. papillata. It differs by chrome-yellow body color, pinkish gills, lesser size (3 mm.) and correspondingly fewer knobs on the edge of the notum, back and post-branchial crest. A spurious rachidian plate does not occur in C. lutea; the six teeth lateral to the hook are plainer and the external ones not elongate. The feathery marginal teeth are stiffer and shorter. It is impossible to decide whether C. lutea may grow as large as C. coneja and if its radula would become more similar to that of C. coneja.

24. *Acanthodoris rhodoceras* Cockerell & Eliot, 1905

(Plate 5, Figures 84 to 88)

REFERENCES: Cockerell and Eliot 1905, p. 38; MacFarland 1925-1926, pp. 7-12 (full description), pl. 2, figs. 3, 4 (labial armature, radula), pl. 3, fig. 4 (part of female organs).

OCCURRENCE: Dillon Beach, 30. VI. 1958; one specimen. Point Loma; three specimens.

Further distribution: San Diego; San Pedro; probably Monterey Area.

The preserved animals from Point Loma are 4, 7 and 13 mm. long, the latter is 8 mm. broad. The specimen from Dillon Beach, measuring 15 mm. in length and 10 mm. in width, is larger than the three previously known slugs which were up to 12 mm. long in the preserved condition. It has 20 to 25 rhinophorial leaflets and five gills, while the animals from Point Loma have four larger and two posterior smaller ones. Our material has up to nine conical processes tipped with black on the sheaths of the rhinophores. As in MacFarland's specimens (l. c., p. 8) no rim encircles the gills. The foot has a bilabiate anterior border; the upper lip bears small black dots.

The peritoneum of the animal from Dillon Beach contains some black pigment, so that it appears mottled with grey. The central nervous system corresponds to the figure of Acanthodoris pilosa (Hoffmann 1936, fig. 552). The two abdominal nerves, a 1 and a 2 of the cited figure, originate from a small abdominal ganglion, visible in ventral view and apposed to the right pleural ganglion. Also the short visceral loop, parallel to the pedal commissure, appears in this view. The fifth marginal tooth of the radula (pl. 5, figs. 87-88) is less refractive than the four preceding ones and therefore sometimes hidden, but always present. In the reproductive organs the peculiar vesicle (MacFarland 1925-1926, pl. 3, fig. 4, v), connecting the proximal and distal portions of the vagina (vagina and vaginal duct in MacFarland's terminology), and the smooth cuticle lining the penis were seen.

Discussion of

Acanthodoris rhodoceras COCKERELL & ELIOT, 1905

This species, easily recognizable by its color pattern, is evidently the "black and white dorid" of MacGinitie's figure 213 (1949, p. 363), whose locality was not indicated. MacGinitie characterized a slug from Elkhorn Slough in the same way (1935, p. 739), whence we infer the occurrence of Acanthodoris rhodoceras in the Monterey region.

Twelve species and varieties of Acanthodoris are known from the Pacific coast of North America (O'Donoghue 1927b, pp. 6-7). Probably all of them, with the exception of A. rhodoceras, have an armed penis. It is true that this character was not indicated for A. atrogriseata and A. armata (l. c., pp. 2 and 4), but is included in the diagnosis of the genus (p. 2) and considered in another species of O'Donoghue (1921, p. 173). One cannot separate the species with unarmed penis, e. g. A. rhodoceras and those from New Zealand and Tasmania (Bergh 1905 b, pp. 94-100), subgenerically because the armature is inconstant. Eliot and Cockerell found penial hooks in A. rhodoceras (1905, p. 39); A. falklandica Eliot, 1907 (p. 358) has scales lining the ejaculatory duct in the original material, but a smooth cuticle in specimens from the Chiloé area (Marcus 1959, p. 61, fig. 138, k).

25. *Onchidoris bilamellata* (LINNAEUS, 1767)

(Plate 5, Figures 92 to 96)

REFERENCES to North Pacific material: Abraham 1877, p. 198; Bergh 1880, pp. 62-67 (var. pacifica); 1894, p. 192 (feeding on dead fishes); 1905b, p. 101; O'Donoghue 1921, pp. 174-176 (var. pacifica suppressed); 1922c, pp. 126-129, pl. 2 (color variation); 1926, p. 220 (literature; name: Onchidorus fuscus); 1927b, pp. 9-10 (big, white specimens); Baba 1957a, p. 11, figs. 2B, 4.

OCCURRENCE: Bodega Jetty, under stones, 15. VII. 1958; two specimens.

Further distribution: North Pacific: Puget Sound to Aleutian Islands; E. and S. Hokkaido. Elsewhere: W. and E. Greenland; Atlantic Ocean from Massachusetts and the NW coast of France northwards.

Our specimens are six and seven mm. long; Alder and Hancock (1851, 1854, 1855) found living slugs up to 31 mm. long. Specimens of this size range were kindly sent us by Dr. M. Moore from Newcastle, New Hampshire, an island in the mouth of the Pisquataqua River. They are 25 mm. long, 16 mm. broad and 8 mm. high. Material from the North Pacific also attains this size (Bergh; O'Donoghue; Baba). The following measurements in millimeters refer to the largest preserved American specimens: Breadth 16, height 8 to 12, length of foot 18, width of foot 12, rhinophores 4, gills 5 and breadth of free notal border 3 to 4.

The color is light rust to deep chocolate brown with lighter papillae and somewhat denser brown pigment in two to three irregular longitudinal stripes and at the bases of rhinophores and gills. A light spot between the rhinophores is common; The underside is a dull white. The form is oval, a little broadened in front. The outer border of the head is connected with that of the foot. The anterior border of the foot is simple, the tail may project in crawling animals. The rhinophores have 15 to 20 leaflets on either side; the rim of the pit is smooth. The notal papillae (pl. 5, figs. 93, 94) are of different height and diameter. The spicules may stand out at their tops. The size of these papillae is almost the same in the small specimens from Bodega Harbor and the big ones from New Hampshire, but their number is much smaller in the former. The gills are unipinnate; their number varies widely, from 16 to 32 and more (animals from New Hampshire). Several notal warts and the little anal papilla lie in the reniform interbranchial area (Hoffmann 1940, fig. 34 C). A cluster of branchial glands is situated between every two neighboring gills.

A narrow girdle of minute rods forms the labial armature. The radula (pl. 5, fig. 95) contains up to 30, often less (24 to 28), rows. The formula is 1.1.1.1.1. The rachidian tooth is a long narrow plate without cusp. The intermediate tooth is a big thin plate with broad base and long smooth cusp, the lateral tooth, a small thin plate with short cusp. The crop, or buccal pump (Forrest 1953, fig. 5 d) is connected with the pharyngeal cavity by a slender duct ("pedicel" Forrest). The gut contains crustaceans. At the pylorus a small caecum projects on the right side of the gut.

The hermaphrodite gland [59] covers the digestive gland. The hermaphrodite duct [60] is continuous with a long and narrow ampulla [62] whose outlet, the spermoviduct [63], bifurcates shortly behind its origin. The male duct, a very long coiled tube, begins glandular [67] and continues muscular [66], for the most part enclosed in a loose sheath [71]. Spiral epithelial folds line the duct [70] within the sheath; only the outermost part of the duct is cuticularized, although not provided with hooks. The penis enters the tubular male atrium whose outer opening [76] is a pore lying far in front on the right side, almost at the level of the connection between head and foot.

The aperture [80] of the vagina [82] and that of the mucus gland [95] are close behind the male pore. The distal course of the vagina is narrow, its proximal continuation, the so-called vaginal duct, is wider. It leads to the spherical spermatheca [86] which is surrounded by the coils of the male duct. At the limit between the outer and inner portion of the vagina arises the insemination duct [89]. It is dilated into a spermatocyst [88], and farther inwards, where it meets the inner oviduct [65], into a fertilization chamber [90]. The narrow windings of the oviduct in the albumen gland portion are more ventral, the broad ones of the mucus gland [91] more dorsal. The spermatocyst has a proximal caecum.

Eggs were observed in February, May and June (Vancouver). The ribbon is 5.8 cm. long, 1.6 cm. broad (Ch. and E. O'Donoghue 1922, pl. 4, fig. 6). The average number of eggs is 60'000 (ibid., p. 139).

26. *Onchidoris hystricina* (Bergh, 1878)

(Plate 5, Figures 89 to 91)

REFERENCES: Bergh 1878, p. 614, pl. 68, figs. 17-23 (labial rods; radula); 1880, pp. 70-72 (same specimen).

OCCURRENCE: Dillon Beach, 20. IV. 1958; one specimen.

Further distribution: Kyska, one of the westernmost Aleutian Islands, in 18 m. depth.

The preserved animal (pl. 5, fig. 89) is broad oval, 6.5 mm. long, 4.5 mm. broad and 2 mm. high. The underside of the notum is 1.5 mm. broad; the foot is 4.2 mm. long and 3 mm. broad in front, narrowing backwards. The color of the living animal was white, the same as it is in the preserved condition. The specimen from Kyska was bluish while living and white after preservation.

The head is broad, veil-like, and connected with the foot at the sides; the mouth is a transverse slit. The anterior border of the foot is bilabiate and notched in the middle. The back is covered with claviform papillae (pl. 5, fig. 90) up to 0.3 mm. in diameter. The marginal papillae are smaller, and big ones stand within the circle of gills, almost hiding the anus. Spicules are abundant in the connective tissue of the notum and project from the truncate top of the papillae. The 9.5 mm. long animal of the first description had 12, the present one has 11 gills.

The cuticle that lines the buccal cavity forms a narrow belt of denticles on the labial disc. The radula (pl. 5, fig. 91) comprises 32 rows in our specimen, while the larger one from Kyska had 34 completely developed series. The formula is 1.1.1.1.1. The rachidian tooth is a longish, nearly rectangular plate, and the marginal tooth is a hook with a pointed cusp bent downwards. The lateral tooth, a strong plate with an almost straight cusp, is largest. Eight to 11 denticles, 6 to 8 in Bergh's specimen, stand in a row on the inner side of the cusp. This row ends well before the point, in contrast to Onchidoris varians Bergh, 1878, another whitish Aleutian species, whose series of 15 to 20 denticles of the lateral tooth almost attains the tip of the cusp (Bergh 1880, pl. 11, fig. 13).

27. *Ancula pacifica* MacFarland, 1905

(Plate 6, Figures 97 to 102)

REFERENCES: MacFarland 1905, p. 53; 1906, pp. 148-149, pl. 20, figs. 89-92; pl. 21, figs. 93-96 (full description; colored figure: pl. 30, fig. 23); Guernsey 1912, p. 75; O'Donoghue 1926, p. 221 (literature); Smith and Gordon 1948, p. 180 (rare); Abbott 1954, p. 307.

OCCURRENCE: Point Pinos, Pacific Grove, two specimens.

Further distribution: Laguna Beach; Monterey area.

The present animals (pl. 6, fig. 97) are 9 mm. long, 2 mm. broad and 4 mm. high. The maximum record of living animals is 16 mm. Their translucent yellowish white body has a median orange line which begins at the level of the rhinophores and runs along a low crest behind the gills to the tip of the tail. Two additional orange lines accompany the dorso-lateral margins and end shortly behind the last pair of extrabranchial appendages. The latter are tipped with orange and so are the main branches of the gills, the rhinophore clubs and the processes of the rhinophore shaft. The color is not retained in the preserved specimens.

The head is rounded, without a velum. The tentacles are thin, short and slightly flattened. The club of the large, non-retractile rhinophores is perfoliated with eight to nine yellowish leaflets. Two digitiform processes, nearly as long as the whole rhinophore, insert at the base of the rhinophorial shaft and are directed forward and outward. The narrow foot is abruptly rounded in front and tapers behind to the tip of the slender tail.

The three gills are bipinnate, in part tripinnate. Immediately behind their bases lies the anal papilla with the adjacent renal pore. On either side of the gills, on a common crest, are situated four, sometimes three, club-shaped appendages of different size.

The central nervous system (pl. 6, fig. 98) is composed of three pairs of globular ganglia of nearly equal size. In figure 98 the cerebral ganglia [47] seem to be smaller than the others, but they are higher than broad. The complete separation between cerebral and pleural [48] ganglia rather resembles primitive Nonsuctoria, viz. Gymnodorididae (Odhner 1941, p. 15), than Goniodoris and Okenia, members of the same family as Ancula. The right pleural ganglion is bigger than the left one, indicating that it comprises the abdominal ganglion. Different size of the pleural ganglia of Ancula cristata was not mentioned (Bergh 1881, pp. 632-633) nor drawn (pl. 11, fig. 3). The pedal commissure of A. pacifica is also more separated from the pedal ganglia [49] than in the Atlantic species.

The labial cuticle bears a dorsally open ring of imbricated platelets (pl. 6, fig. 99). True jaws are absent. There is a sessile pharyngeal crop. The radula (pl. 6, fig. 100) consists of 35 rows whose posterior teeth are twice the size of the anterior ones. A rachidian tooth in form of a longish plate appears only behind the first 8 to 10 rows; in Ancula fuegiensis Odhner (1926b, p. 45) it is absent. Each half-row comprises two broad triangular lateral teeth. The inner, larger tooth bears 11 to 18 sharp recurved denticles on its thickened inner margin and ends above in a strong hook. The outer tooth is smaller, without denticles, and also terminates in an apical hook.

The hermaphrodite gland covers the digestive gland. The hermaphrodite duct [60] opens into a curved ampulla situated between female gland mass [91] and prostate [67]. The spermoviduct is quite short. The male duct begins wide and folded, continues prostatic in a very long double loop and passes on to a thin and muscular portion [66] which ends with a small ciliated penis [70] bearing a collar of hooked spines (pl. 6, fig. 102). The male organs resemble those of the Atlantic species (Bergh 1881, pl. 11, fig. 11) very closely.

The inner oviduct [65] enters the female gland mass [91]. A closely folded and spacious nidamental duct [95] is connected with a broad vagina which begins with a loop and ends with two sperm-storing vesicles, spermatheca [86] and spermatocyst [88]. Their vaginal arrangement (Odhner 1926b, p. 51) and the impossibility of distinguishing between a diffuse (bursa copulatrix) and an orderly (receptaculum seminis) disposition of the sperms make the corresponding numbers in figure 101 somewhat arbitrary. It is however probable that the vesicle whose canal is nearer the insemination duct [89] is the seminal receptacle. A lobed gland [94] is attached to the distal region of the female organs; its exact point of insertion could not be ascertained.

28. *Hopkinsia rosacea* MacFarland, 1905
(Plate 6, Figures 103 to 106)

PRINCIPAL REFERENCES: MacFarland 1906, pp. 149-151, pl. 21, figs. 97-103 (full description, colored figures: pl. 31, figs. 24, 25); O'Donoghue 1926, p. 222 (literature); 1927 a, p. 100; MacGinitie 1949, p. 379 (pink egg ribbon); Ricketts and Calvin 1952, p. 128, fig. 41 (dorsal aspect at rest); Abbott 1954, p. 307 (colored figure: pl. 16, a).

OCCURRENCE: Point Pinos, Pacific Grove: six specimens. Point Loma, under stones in the intertidal zone: two specimens. {Specimens have frequently been observed and collected at Tomales Point (Marin County), Shell Beach and Salt Point (Sonoma County), Gualala (Mendocino County). — J. W. H. and Ed.}

Further distribution: San Diego (Kelsey 1907, p. 41); La Jolla; Laguna Beach (O'Donoghue 1927a, p. 100); San Pedro; Monterey Bay; Sonoma County; Mendocino County; under shelving stones in the intertidal zone.

The animals are deep rose pink when living, up to 29 mm. long, 16 mm. broad and 5 mm. high without cerata. The body is elongate elliptical when the animal is moving, but depressed and rounded at both ends. The animal is stiffened by numerous calcareous spicules everywhere in the connective tissue. The foot (pl. 6, fig. 106) is incised in front, the head broadened by a veil which replaces the tentacles; the mouth is a longitudinal slit. The rhinophores are perfoliated in three fourths of their length.

The dorsum (pl. 6, fig. 105) is thickly set with movable cerata up to 18 mm. long, which are sparse in the mid-dorsal portion. These appendages contain an axis of small spicules surrounded by annular muscle fibers and two blood sinus with subcutaneous ramifications. An arc of 7 to 14 mostly unipinnate, in part bipinnate gills encloses the anus and the renal pore, situated at the right and in front of the latter. The genital aperture [77] lies on the right side, level with the bases of the rhinophores.

As in the related genera Okenia and Goniodoris (Hoffmann 1936, fig. 553) the cerebral and pleural ganglia are fused without an external furrow.

The labial cuticle bears a ring of nodules or short rodlets. The pharynx (pl. 6, fig. 103) has a muscular sucking crop lined with a cuticle. The radula (pl. 6, fig. 104) originates in a projecting sac and comprises up to 16 rows of teeth (1.1.0.1.1). The inner tooth, up to one mm. long, has a triangular base and a flattened blade-like cusp which ends with a blunt hook often broken off in the teeth of the lower radular branch. The marginal tooth is about 90 µ long, and variable in form; its more or less pointed free edge is often divided into irregular denticles. The stomach is almost entirely enclosed in the digestive gland.

The digestive gland is overlain by the lobules of the hermaphrodite gland. The prostate is enormous. The penis is two mm. long and ends with a blunt cone. There are minute cuticular hooks on the terminal 0.24 mm. of the penis. The vagina and insemination (uterine) duct open side by side into the spermatheca. The nidamental outlet and vaginal entrance are shared in common.

The rose-colored narrow egg ribbon spirals counter-clockwise (Costello 1938, p. 340, pl. 1, fig. 20).

29. *Dendrodoris fulva* MacFarland, 1905

(Plate 6, Figures 107 and 108)

REFERENCES: MacFarland 1905, p. 45; 1906, pp. 130-131, pl. 19, figs. 38-40 (full description; colored figure: pl. 22, fig. 3); Guernsey 1912, p. 77; O'Donoghue 1926, p. 212 (literature); 1927a, p. 92; Costello 1938, pl. 1, fig. 3 (egg ribbon); Ricketts and Calvin 1952, fig. 39; Abbott 1954, p. 303.

OCCURRENCE: Point Pinos, Pacific Grove: 3 specimens; Point Loma: two specimens.

Further distribution: Laguna Beach to Monterey Bay, from tide-pools to 46 meters (Smith and Gordon 1948, p. 181).

The present preserved animals (pl. 6, fig. 107) are 8 to 21 mm. long; the largest is 11 mm. broad. Living specimens of this species may attain 65 mm. in length, 30 mm. in breadth, 12 to 13 in height and have an 8 mm. broad free notal border. The color of the preserved animals is greyish brown with white dots on the back; below they are lighter. In life the underside is lighter than the yellow back. The gills are white, the rhinophores darker. The white dots are openings of glands on and between the notal papillae. These dots are often ring-shaped with a ground-colored center.

The body is elongate, elliptical, with nearly straight, parallel sides and equally rounded in front and in back. The margin of the notum is smooth in the present individuals, crenulate in MacFarland's much bigger specimens. The rhinophores are perfoliated by 15 to 20 leaflets on either side; the tentacles are minute. The foot is rounded in front and in back; its anterior border is bilabiate with a deep notch in the upper lip. The foot shows behind in the crawling animal.

The smooth notum bears quite low tubercles, generally with a white glandular opening on their top (pl. 6, fig. 108). The connective tissue contains triradiate and quadriradiate spicules. Five tripinnate gills surround the anal papilla; the spreading margin of the branchial pit is smooth. The renal pore lies at the base and in front of the anal papilla. As in all Dendrodorididae there are no cuticular elements in the gut.

For the anatomy, see MacFarland (op. cit., p. 131).

The egg band is a closely coiled yellow ribbon, about seven mm. in width.

30. *Tritonia festiva* (Stearns, 1873)
(Plate 6, Figures 109 to 114)

REFERENCES: Stearns 1873, p. 77, fig. 1 (some external characters; name: Lateribranchiaea festiva); Costello 1938, p. 321 ff. (one specimen from the type locality, Point Pinos).

OCCURRENCE: Outer coast of Tomales Point 20. IV. 1958: two specimens.

Further distribution: Monterey Bay.

The preserved animals at hand are 9 mm. long, 3 mm. broad and 3 mm. high. They are translucent white with opaque white lines arranged as shown in pl. 6, fig. 109. The collector recorded an orange spot in the three to four white circles mid-dorsally on the living slugs.

The animals are broadest anteriorly. The back is wider than the foot: the sides are nearly straight, and the body tapers gradually from in front of the middle to the tail. The semicircular anterior border of the foot is grooved. The sides of the body and the back are smooth, although the glandular areas, as illustrated for Tritonia australis (Marcus, 1959, fig. 145), are visible with strong illumination.

The cephalic veil is entire, not bilobed, and bears a total of about ten simple papillae. The short contracted rhinophorial sheaths with smooth borders surround the pinnate plumes of the clubs. The longitudinal mouth slit is flanked by swollen lips (pl. 6, fig. 110). On the sides of these lips the nearly spoon-shaped tentacles are inserted. Each is deeply grooved along its ventral surface and ends in a line with the velar papillae.

The borders of the notum are distinct and bear about nine tufted gills on either side, which are at least bipinnate, but are much contracted in our specimens. Larger and smaller gills alternate, and the notal edge is somewhat incurved between succeeding gills. The genital aperture lies under the second right gill, the anus between the third and fourth gill approximately in the middle of the body. The renal pore lies in front of the anus and is more dorsal.

The pharynx is 3 mm. long, hence one third of the body length. The jaws are 2 mm. long, 0.75 mm. broad (pl. 6, fig. 113). The masticatory border is set with teeth (pl. 6, fig. 114). These are 5 μ long and disposed in nine rows anteriorly. The number of rows diminishes posteriorly, but the teeth become larger, up to 80 μ, and stand on hexagonal bases. The border of the masticatory process distal to the teeth is slightly undulate and smooth. It is curled inwards in the present jaws which were treated with potassium hydroxide. The radula (pl. 6, fig. 111) contains 37 series of teeth with the formula 33.1.1.1.33. The median tooth is tricuspidate. The intermediate tooth bears a tiny point near its posterior end as in Tritonia australis (Marcus 1959, fig. 151). The lateral teeth are simple hooks whose size decreases outwards.

The genital mass is small, probably because the animals are young. Nevertheless the curved ampulla is filled with sperm. The vas deferens [66] is lined with a glandular epithelium along its entire length and is of uniform caliber. The male atrium [75] encloses the blunt penial bulb whose distal margin forms a fold with a wavy border (pl. 6, fig. 112[70]). Vagina [82] and nidamental duct [95] open together. The vagina is broad at the beginning and continues as a narrow spermathecal canal of the same length as the spermathecal vesicle [86].

Discussion of
Tritonia festiva (Stearns, 1873)

Based on Odhner's studies of northern tritoniids (1926a, pp. 13-17; 1939, p. 42 ff) we assign the present species to the subgenus Tritonia because its vas deferens has no thickened prostatic portion set off from the rest, and the spermatheca has a long canal.

We do not know any description of Tritonia festiva besides the very cursory original one. Bergh (1884b, p. 704, note 3) assigned the species tentatively to the Dendronotacea, but O'Donoghue (1926, p. 218) still listed it with the Phanerobranchia under Stearn's generic name. Evidently MacFarland allocated it correctly to the Tritoniidae where it is included in modern papers concerned with the mollusks of Central California, e. g. Smith and Gordon (1948, p. 148) and Light's Manual (1954, p. 268).

Sphaerostoma undulata O'Donoghue (1924, p. 3), from the Vancouver Island region, is similar to Tritonia festiva but is probably not identical with it. As O'Donoghue's two specimens of S. undulata were considerably larger (48 and 36.5 mm. long alive) than the original (25 mm.) and the present specimens of T. festiva, the differences in the number of the radular rows and teeth can hardly be evaluated. The lateral cusps of the rachidian tooth of T. festiva are longer than in S. undulata. In T. festiva they project beyond the base of the tooth, while they do not even reach the edge of the base in S. undulata. Also the orange center of the dorsal white circles in T. festiva were not described for S. undulata. The reproductive organs of the latter are not known.

Besides Sphaerostoma undulata, O'Donoghue's list contains five other American Pacific tritoniids. Two of them, Tritonia diomedea and Tritonia exsulans, are discussed below; two others, Tritonia tetraquetra (Pallas, 1788) and Tritonia gigantea (Bergh, 1904) are identical (Odhner 1936, p. 1080). They belong to Tritoniopsis Eliot (1905, p. 22). This name does not need (Mattox 1955, p. 12) the alteration proposed by Pruvot-Fol (1933, p. 108). Mattox compared (p. 13, l.c.) his Tritoniopsis aurantia with the descriptions of Tritoniopsis tetraquetra (Bergh 1879b, p. 98; O'Donoghue 1922a, p. 147). He found some differences in the numbers of radular rows and teeth. But these lessen if the description of Tritoniopsis gigantea (Bergh 1904, pp. 26 - 28) is considered. The orange color of Tritoniopsis aurantia and the brick-red of Tritoniopsis tetraquetra described from the painting of a living animal do not differ essentially. Mattox furnished a good simplified drawing (l. c., fig. 5) of the reproductive organs of T. aurantia; but it is difficult to compare this with Bergh's detailed description without figures of these organs of T. tetraquetra. Possibly T. aurantia is identical with T. tetraquetra, especially in view of the wide range of the North Pacific tritoniids which in general, are not split into distinct geographic subspecies. Tritoniopsis tetraquetra has been dredged in Monterey Bay (Smith and Gordon 1948, p. 180).

The fifth species, Tritonia palmeri Cooper (1862, p. 207) from San Diego and San Pedro (Cockerell and Eliot 1905, p. 33), cannot be assigned to any of the subgenera at this time. The size and color of the living animals from the two localities differ widely. The specimen from San Pedro, which was white and 17 mm. long when living, must be compared with our slugs from Dillon Beach. It differs from T. festiva by its rugous back with small warts and by the shape of its rachidian tooth (l. c., pl. 7, fig. 1, a).

31. *Tritonia exsulans* Bergh, 1894
(Plate 6, Figures 115 to 118)

REFERENCES: Bergh 1894, pp. 150-152 (figures of jaw and radula); O'Donoghue 1921, pp. 152-154, pl. 7, figs. 4-6 (radula); Baba 1937, pp. 310-312, text fig. E (entire animal and parts); 1957a, p. 9 (Western Pacific localities).

OCCURRENCE: South of Hog Island in Tomales Bay, in 4.9 m. on fine black mud, 8. VII. 1959, J. W. Hedgpeth et al. leg. One specimen with eight mm. long pieces of a sea pen in the gut.

Further distribution: West Coast of Florida, Manatee Bay, in 5.5 m.; off Lower California (26° 14' N; 113° 13' W), in 88 m.; Monterey Bay; off Año Nuevo Point, in 79 m.; Vancouver Island region, in 42 m.; SE Hokkaido, in 311 m.; NE Honshu, in 274 m.; Sea of Japan, off Niigata (38° N); Sakhalin.

The preserved animal (pl. 6, fig. 115) is 40 mm. long, 24 mm. broad, and 20 mm. high. The living specimen was rather bright salmon to rose on the back (Dr. J. W. Hedgpeth) and is a little paler in formalin four months later. The sides are translucent white and the sole is opaque white. The body is widest in the middle; the anterior end is truncate, the tail pointed. The anterior border of the foot is grooved and contracted in the middle; the sole is 12 mm. broad. The back is nodulous with sub-epidermal glands. The sides are rather smooth.

The cephalic veil is longer laterally than in the middle and bears a slight notch anteriorly in the midline. It also bears about 22 simple papillae, larger on the sides than in the middle. The veil is flanked by conical tentacles, each with a slit along its outer side. The rhinophorial sheaths are 8 mm. apart. Their rims are slightly crenulate. In retracted condition the pinnate plumes surpass the shaft. The mouth appears as a longitudinal slit in a broad and prominent labial triangle.

The 28 mostly tripinnate gills are arranged alternately outwards and inwards on either side of the notum. They end in front of the tail, but the notal border is continued as a ridge. The ridges from both sides unite on the tip of the tail. The genital apertures lie at the end of the first third of the body length, about halfway up the side. The anus is situated more dorsally and in the middle of the body; the renal pore is located immediately over the anus. If all, even the smallest, gill tufts are considered, the genital aperture is located below the eleventh tuft, the anus below the 16th tuft.

The yellow jaws are 12 mm. long and 5 mm. broad. The masticatory border (pl. 6, fig. 116) bears rows of polygonal platelets, the largest of which are prolonged into cones. The present specimen has about six rows of cones and six or more rows of very small platelets. The radula (pl. 6, fig. 117) contains 36 rows of teeth with the formula 52.1.1.1.52. The rachidian tooth is tricuspidate, its median cusp being a little longer and broader than the lateral ones. The intermediate tooth has a very small cusp. The size of the hook-shaped lateral teeth increases from the innermost to the tenth. The ten outer teeth decrease in size.

The light orange hermaphrodite gland covers the digestive gland. The coiled ampulla (pl. 6, fig. 118 [62]) is followed by a short spermoviduct [63]. The vas deferens is short, thin [66] at its origin and dilated in its distal part [67]. This portion is prostatic. The penis [70], lodged in a muscular atrium [75], is a short, broad cone, topped with a thick knob. The origin of the oviduct [65] is a pore-like communication of the spermoviduct with the gland mass [91]; it is drawn a little longer in the diagram (pl. 6, fig. 118). The nidamental gland opening is located [95] close beside the vagina [82]. The latter is a wide sac connected with the pyriform spermatheca [86] by a thin and straight duct (stalk) which originates at the base of the vaginal vesicle.

Discussion of *Tritonia exsulans* Bergh, 1894

We allocate this species to the subgenus Tritonia by reason of the long-stalked spermatheca and the number of velar processes. The dilated prostatic portion of the vas deferens contrasts with a proximal prostate in Duvaucelia and a rather uniform duct of Tritonia. We had already doubted the systematic value of this character (Marcus 1959, p. 68). A sessile spermatheca in the subgenus Duvaucelia (Bergh 1884b, pl. 70, figs. 34, 41) differs clearly from the long-stalked one of the subgenus Tritonia (ibid., pl. 74, fig. 4). Whether T. diomedea Bergh (1894, p. 149) with a sac-shaped spermatheca may belong to Duvaucelia, cannot be decided; its size and the number of its velar papillae would indicate that it belongs to the subgenus Tritonia.

The color of the body, the number of teeth and rows of the radula, as well as the pigmentation of the oral cavity, buccal tube and esophagus, distinguish Tritonia diomedea from T. exsulans.

32. *Hancockia californica* MacFarland, 1923
(Plate 7, Figures 119 and 120)

REFERENCES: MacFarland 1923, pp. 66-90, pls. 1-6 (monograph); Smith and Gordon 1948, p. 181.

OCCURRENCE: Point Pinos, Pacific Grove; five specimens.

Further Distribution: Monterey area, near extreme low-tide level, clinging to brown algae.

Living animals may attain 21 mm. in length and a maximum diameter of 3 mm. Our preserved specimens are up to 8 mm. long, 2 mm. broad and 1.8 mm. high, not including the cerata which are 2.2 mm. high (pl. 7, fig. 120). In the living animal the color is reddish brown or tending to greenish and is uniform or with darker blotches of brown. The cerata, rhinophore shafts, and tubercles of rhinophore sheaths are white or sprinkled with white. Sometimes the dorso-lateral region of the body to the third cerata also shows larger white spots. Our preserved specimens are white with greyish violet rhinophores and cerata.

The head has, on either side, a broad palmate velar lobe with six to ten or more fingerlike subdivisions of unequal length. The rhinophores are retractile. Their clubs bear six to eight vertical leaflets on either side; six to nine nodulous ridges run along the funnel-shaped sheath. The ridges contain branches of the digestive gland. The nodules are cnidosacs. The foot is bluntly rounded anteriorly with a median notch; the posterior end is notched and is longitudinally grooved on the ventral side.

Either lateral margin of the notum has a series of four to seven cerata; the members of the first pair are situated opposite one another in front of the pericardial prominence. The remaining ones become progressively less directly paired, those of the right side being shifted posteriorly. The stout cerata are palmate, concave on the outer surface, and end with four to 16 digitiform processes arranged in a horseshoe-shape. Clusters of blue-staining glands open on the concave surface.

The central nervous system is highly concentrated. The cerebro-pleural ganglia are fused; the ovoid pedal ganglia are somewhat shorter. The cerebral commissure is only visible in transparent preparations or in sections. The thick pedal commissure is also very short, the parapedal one, longer.

The labial disc bears blunt rodlets of varying size. The jaws are elliptical and thin, except for the somewhat thickened portion near the hinge. The masticatory border is minutely serrulate. The radula comprises 50 to 62 rows of 1.1.1 teeth. The rachidian tooth is horseshoe-shaped and has a strong middle cusp with three to five smaller denticles on either side. The very variable lateral teeth are thin transparent plates with a lancet-shaped projection at the inner posterior angle and a bidentate projection at the inner anterior angle. The paired posterior glands of the oral tube extend into the rhinophores nearly to the tip of the club. A ventromedian gland, perhaps a reservoir of these glands, reaches backwards as a thin sac beneath the posterior duct of the digestive gland, extending over three fourths the total length of the animal. The salivary glands are tubular and ramify freely between pharynx and stomach. They open by slender ducts on either side of the exit of the oesophagus. The oesophagus is displaced to the left by the large anterior genital complex. A blind dorsal diverticulum, whose base is directed anteriorly, is given off by the oesophagus.

The ventral thin-walled stomach is roomy. From its left dorsal wall the anterior duct of the digestive gland is given off, at once dividing into right and left ducts which supply the rhinophore sheaths and the first cerata. Close behind the common origin of the anterior ducts the posterior duct arises and passes backward below the hermaphrodite gland. Behind the opening of the posterior digestive gland the stomach bends dorsally and becomes strongly muscular and cuticularized. The pylorus of this gizzard is provided with a sphincter, and a longitudinal ventral fold begins here. This is continued on into the intestine as a typhlosole. The intestine loops to the right and opens midway between the first and second right cerata.

Beneath the integument of the back lie the heart and its main veins and below them is situated the broad renal sac with its numerous diverticula. It extends nearly the full length of the body. The reno-pericardial communication is located to the right behind the passage of the aorta through the pericardium. Close to the opening of this communication into the renal organ a short canal is given off which opens immediately above the anal papilla.

The hermaphrodite gland fills the posterior half of the body with 36 or more mixed follicles. The hermaphrodite duct passes forward to the anterior genital complex where it dilates into the ampulla [62]. Nearly all of the coiled male duct is prostatic [67]. The penis [70] is irregularly folded. The male aperture [75] lies in front of the right first ceras. The female opening [80] is situated slightly posteriorly. The inner oviduct [65] leads to a vesicle [88] (which receives alien sperm) from an outer dilation [86], a spermatheca or bursa sopulatrix. Both sperm-storing vesicles communicate with the outer oviduct (nidamental duct) [95] through the gland mass [91].

The narrow, pale greenish egg ribbon is coiled in two to three turns and fastened to brown algae, e. g. Delesseria, growing in tide pools. Eggs were found from July to October.

33. *Dendronotus frondosus* (Ascanius, 1774)
(Plate 7, Figures 121 to 124)

REFERENCES: North Pacific references and synonyms: Bergh 1879b, pp. 89-94, pl.I, figs. 18-20, pl. III, figs. 7-12 (Dendronotus purpureus), p. 94, pl. I, fig. 21, pl. II, figs. 9-12, pl. III, figs. 2-6 (D. dalli); 1894, p. 137 (D. arborescens), p. 139, pl. 3, figs. 2-5 (D. dalli); 1904, p. 15 (D. purpureus), p. 18 (D. dalli); O'Donoghue 1921, p. 184, pl.4, fig. 45 (D. arborescens), p. 186, pl. 4, fig. 6, pl. 5, figs. 54-56 (D. dalli), p. 190, pl. 4, fig. 48 (D. rufus); 1926, pp. 223-224 (literature); Abbott 1954, p. 307 (colored figure: pl. 15, e); MacGinitie 1959, p. 144, pl. 3, fig. 2.

OCCURRENCE: Bodega Jetty, on Aglaophenia, 7. V. 1958; Dillon Beach, 4. and 19.VI. 1958. A total of ten specimens and one egg string (17. V. 1958). Monterey Bay, boat harbor; three specimens. Point Pinos, Pacific Grove: twelve specimens.

Further Distribution: Pacific North America: Vancouver Island region; Alaska; Bering Sea. Elsewhere: Arctic; North Atlantic including Western Baltic; southern limits: French coast, Arcachon (Cuénot 1927, p. 266); Cape Cod, Mass. (Dendronotus elegans Verrill, 1880, is a synonym). Monterey area (present collection); Hokkaido (Baba 1957a, p. 9); Sea of Japan, S. of Vladivostok, 42° 10' N, 130° 44' E (Bergh 1904, p. 15). Vertical range: 0 to 400 meters.

Living animals may attain 100 mm. in length, 7 mm. in breadth and 10 mm. in height. The cerata are up to ten mm. long. In the Arctic region and in deep water large specimens are frequent.

The color varies very much. Our animals (pl. 7, fig. 121) are brownish with white spots or whitish with large purple or red-brown flecks. Others are translucent grey with two brown stripes on either side between the insertions of the cerata, or white with orange-yellow points on the principal branches of the appendages.

According to the literature pure white predominates in deep water. The brown color is localized in ramified chromatophores which lie in the subepidermal connective tissue. Movement of the pigment granules has been observed by Meyer and Möbius (1865, p. 45).

The head has a narrow veil which bears three to four principal branched appendages on each side and smaller ones between them. Beneath the veil there are blunt papillae on the upper lip. The mouth is an elliptical transverse slit. The sheaths of the rhinophores bear four to five dendriform processes on their margin and a similar smaller one on the posterior side about half way down. The rhinophorial club is perfoliated with up to 25 leaves of different size.

The anterior border of the narrow foot is rounded and weakly grooved. The pointed tail is short and does not extend far beyond the last pair of cerata. The sides of the foot are thin and adapted for clasping.

There are five to eight arborescent cerata on either side of the back. Smaller ones may occur between them. The cerata generally have the same color as the body and contain large blood sinus which communicate with a net of lacunae in the subepidermal connective tissue.

The larger cerebral ganglia are separated from the smaller pleural ganglia by a furrow and are united by a subcerebral commissure which is independent of the pedal and parapedal commissures. The optic nerves are long; the small eyes lie on the sides of the central nervous system below the rhinophores in the integumentary connective tissue.

Labial glands are well developed. The labial cuticle bears two fields of hair-like processes. The yellow or brown jaws are longer or broader, have a rounded process on the hinge, and have triangular straight-sided or slightly curved posterior and anterior processes. The masticatory border of the latter process bears a single row of denticles. Length and breadth of these processes vary (Vayssière 1913b, figs. 8, 19). The radula (pl. 7, figs. 122, 123) generally consists of 40 rows; in the present specimens there are 60. The formula is 9-15.1.9-15 teeth, but 5 to 25 lateral teeth have been mentioned. The triangular rachidian tooth is serrulate or smooth on either side of the cusp. Up to 40 denticles have been indicated on either side. The lateral teeth, the innermost of which sometimes has a shorter cusp, are elongate and narrow or short and broad. They may be smooth or may have up to 14 denticles.

The salivary glands extend backwards to the posterior digestive gland. The sacculiform stomach has longitudinal folds covered, in the pyloric region, by a cuticle which lies near the opening to the oesophagus at the anterior side. The anterior right, the anterior left and the posterior digestive glands begin with separate ducts. Their extension varies individually. They end at the bases of the rhinophores and the cerata (Odhner 1936, fig. 3, p. 1105: material from the Swedish coast) or enter them as far as into the fine branches (British material, Alder and Hancock 1845, part II, fam. 3, pl. 2, fig. 2; and the sectioned specimen from Dillon Beach). The anterior digestive glands supply the rhinophores and the first cerata; the posterior digestive gland supplies the following pairs of cerata. The intestine is short and is bent in a semicircle. The anal papilla lies on the right side of the back between the first and second ceras, rarely outside the second ceras (Bergh 1904, p. 16). The renal pore is situated on the inner side of the base of the anal papilla.

The genital opening is located on the right side of the body on a line with the first ceras. The renopericardial swelling is located dorsally between the two first pairs of cerata. The pulsations of the heart can be seen inside it. The renopericardial communication is as long as the ventricle.

The hermaphrodite gland is a single mass, indistinctly subdivided, and lies on the posterior digestive gland. The ampulla is sausage-shaped. The male duct (pl. 7, fig. 124) begins with a prostatic part convoluted in one plane and forming a disc. It continues into a wide vas deferens and ends with a distal narrow part which is coiled within the unarmed penis. The latter is uniformly thin in young animals. In adult specimens it is swollen at the base and thinner towards the distal portion. The oviduct enters the gland mass close to its origin from the spermoviduct. The wide vagina bears a small spermatheca (bursa copulatrix) in its distal third and becomes narrower where it opens into the thin-walled seminal receptacle (spermatocyst). The alien spermatozoa reach the eggs through a short insemination duct which runs from the receptacle to the spermoviduct (Odhner 1936, fig. 39a, p. 1106).

The pale yellow or rosy egg string is about 19 cm. long, coiled and winds in a spiral of seven cm. diameter; it contains approximately 16'000 eggs.

Discussion of
Dendronotus frondosus (ASCANIUS, 1774)

The radulae of five specimens were examined. In two of these, measuring nine and twelve mm. respectively, much, if not all, of the radula of the recently metamorphosed animal is present. Also present are teeth which occur in later stages of development.

The animal measuring twelve mm. has 56 rows of teeth. Rows 1 to 8 (pl. 7, fig. 123) have no lateral teeth (formula 0.1.0). Rows 9 to 12 have one lateral tooth on each side (formula 1.1.1). In row 13 two lateral teeth appear and the number of lateral teeth increases posteriorly. The width of the first rachidian tooth is 10 μ. The width of this tooth increases posteriorly to 60 μ. Similarly, the number of lateral denticles increases posteriorly from two to about twelve.

According to Odhner (1926a, pp. 18-19; 1936, pp. 1105-1109) Dendronotus frondosus and D. iris Cooper, 1863 (pp. 59-60) are the only valid North American Pacific species of the genus. Dendronotus iris is known from Santa Barbara and from the regions of Vancouver Island and Monterey (Smith and Gordon 1948, p. 181), under the name of D. giganteus O'Donoghue 1921 (p. 187). {Specimens are occasionally taken in Tomales Bay; a large one (± 6") was collected in a trawl over eelgrass near Marshall, June 30, 1960. — J. W. H.} Dendronotus iris was figured by Agersborg (1922, figs. 1 to 4) and Odhner (1936, pl. 1, fig. 9). Only Odhner's figure shows one of the specific characters of D. iris, the thick, cylindrical, untapered penis which differs from the attenuated penis of D. frondosus. An elongated prostate, an opaque white line around the foot, and three to five small dendriform processes on a posterior crest of the rhinophore sheath are further features separating D. iris from D. frondosus

Lemche (1941, p. 24) regards Dendronotus frondosus as "propagatively cold - stenotherm and vegetatively eurytherm. The species propagates only at temperatures about or slightly above zero". It seems however that the vegetative eurythermy is accompanied by a certain degree of reproductive eurythermy in the southern regions of the distribution. On the coasts of England D. frondosus spawns in the spring months (Alder and Hancock 1845, fam. 3, pl. 3), and at Dillon Beach the average temperature in the beginning of May is about 11° C. {In Tomales Bay the temperature may be even higher. - J. W. H.} From the distribution it seems evident that D. frondosus can spawn successfully at higher temperatures. On the Norwegian south coast the animals mature in the second year (Larsen 1925, pp. 41-42).

The species feeds on hydroids (Graham 1938, p. 300; 1955, p. 153), possibly also on sponges (Lemche 1938, p. 15), and is eaten by fishes (Volodschenko 1955, p. 182).

34. *Doto columbiana* O'DONOGHUE, 1921
(Plate 7, Figures 125 to 129)

REFERENCES: O'Donoghue 1921, p. 204, pl. 9, fig. 33 (radula).

OCCURRENCE: Dillon Beach, on Hydrozoa, 4. and 19. VI. 1958; 25 specimens.

Further distribution: Vancouver Island region, in depths from 22 to 36.5 meters.

The preserved animals are two to seven mm. long, up to 1.8 mm. high without cerata, and 1.7 mm. broad. The maximum length of the cerata is two mm. Specimens of three mm. in length already have developed a female gland mass.

The color of the living animal was whitish with brown pigment on the head, back and sides, as well as between the tubercles of the cerata. In the preserved specimens the ground color is yellowish. The dark pigment is maintained on the sides and the back; however, the marks of the insertion of the cerata on either side are unpigmented. The veil is dark; the rhinophores [5] are light in color. The tubercles on the cerata are lighter than the skin between them, whose darker yellow tone corresponds to the contents of gland cells. Each tubercle is surrounded by a dense ring of pigment. Only about five specimens show this pigmentation completely. In the others it has partially or even entirely faded away. The body pigment is better preserved than that around the tubercles of the cerata. Some of the small specimens are entirely colorless. The black pigment of the eyes behind the rhinophores is not dissolved.

The collector's sketch of the living animal (pl. 7, fig. 125) justifies the original description of the body as "limaciform"(O'Donoghue 1921, p. 204). After preservation the cerata appear as disproportionately voluminous barrels (pl. 7, fig. 127). The cephalic veil is evenly rounded and projects laterally beyond the anterior border of the foot. This border is weakly grooved. The veil is smooth, without tubercles or ridges in front of the rhinophores. The rhinophorial sheaths are bordered by smooth rings. The clubs are contracted to knobs.

The cerata are generally in seven pairs, even in the smallest animals. The seventh pair is the smallest. Usually the fourth, but sometimes the sixth, is the largest pair. Each ceras is tipped by a blunt tubercle and has about four circlets of flat tubercles below it. On the outer side of the ceras a fifth half-ring may be formed by two smaller tubercles. On the inner side the second ring is already transformed to the gill [15]. Internally, at the level of the third and fourth ring, the ceras originates with a broad surface pierced by the digestive diverticulum [42] and the afferent and efferent blood sinus [28]. The five to seven tubercles of each circlet are perpendicular to those of the next. They contain the large glands present in the tubercles of most, but not all, species of Doto (Vayssière 1888, p. 104; Hecht 1895, p. 600; Marcus 1957, p. 458).

The jaws are very delicate. The radula comprises up to 83 teeth each with about four lateral denticles on either side of the small median cusp. The distances of the denticles from the cusp alternate in the succeeding teeth, as was described by O'Donoghue (1921, p. 205) and also in the species Doto uva (Marcus 1955, p. 167) and D. chica.

The genital aperture [77] lies ventrally to the first right ceras. The anus lies in front of the second right ceras. The duct of the digestive gland runs between the follicles of the hermaphrodite gland. Behind the gland this duct is quite ventral.

The follicles of the hermaphrodite gland are mixed, as in the species that we have examined previously (Doto uva, D. pita and D. divae). The ampulla [62] is longish (0.45 mm.) and is followed by a rather long spermoviduct [63]. A long stretch of the male duct [67] is prostatic from its beginning at the bifurcation of the spermoviduct as in D. uva. In D. pita and D. divae a narrow portion occurs between the origin of the male duct and its prostatic part. The distal muscular vas deferens [66] and the conical, pleurembolic and unarmed penis [70], enclosed in a deep male atrium [75] occur in D. columbiana as well as in the other species mentioned above. Only the dimensions differ. The carrot-shaped penis is 300 μ long and 84 μ thick. Hence the proportion of length to diameter is about 3.5 to 1. The ejaculatory duct winds through the penis.

In Doto columbiana, as in D. uva (Marcus 1959, fig. 160) and D. divae, the eggs reach the female gland mass through the vagina. The inner oviduct [65], functioning as a fertilization chamber, is connected with the seminal receptacle [88] where the spermatozoa lie fastened to the wall by their heads. The entrance of the inner oviduct into the receptacle is valve-like. The following duct serves both as vagina [82], and as oviduct, and opens near the nidamental outlets [95]. The so-called gland mass represents a coiled glandular oviduct. The fertilized eggs enter it and pass through its windings before they are laid. The outer opening of the vagina and the female aperture [80] are provided with sphincters.

The fundamental plan of the reproductive organs in Doto is triaulic, although the vagina of most species joins the nidamental duct just inside the opening of the latter.

Discussion of *Doto columbiana* O'Donoghue, 1921

Several characters of the original description were not mentioned in the preceding diagnosis in order to maintain the characteristics of the population from Dillon Beach as distinct from that from Vancouver Island region. The northern specimens were larger, 14 mm. when alive, but had fewer cerata: five pairs. The latter were clavate and attached by a slender stalk. The veil bore a few short papillae, but it may be noted that a tubercle in front of the rhinophorial sheath is insignificant systematically (Odhner 1934, p. 301). The greater number of radular teeth, 86 to 96, in O'Donoghue's animals corresponds to their greater body size.

The black "pencillings", the rings around the tubercles, and the shape of the tubercles were the crucial characters used for uniting the present slugs specifically with Doto columbiana. Dark subapical rings around the tubercles of the cerata are not frequent in Doto. In Odhner's synopsis (1936, pp. 1119-1121) only D. columbiana, D. annuligera Bergh (1905a, p. 221) from the Sulu Sea, and D. nigromaculata Eliot (1906, p. 153) from the Cape Verde Islands have this character. The tubercles of O'Donoghue's material, "short truncated cones" may contract to the flat tubercles of the present specimens. Although the radula cannot be used in the classification of most species of Doto (Odhner 1922, p. 36; 1934, p. 301)(with one exception: D. racemosa Risbec 1928, p. 269), that of O'Donoghue's figure (fig. 33) is, at least, not opposed to ours (pl. 7, fig. 126). From what is known of Doto in European waters, with seven certain and 13 uncertain species (Pruvot-Fol 1954, pp. 403-410) excessive splitting in this genus is risky.

35. *Doto amyra* Marcus, spec. nov.

(Plate 7, Figures 130 to 134)

OCCURRENCE: Monterey Bay, boat harbor, on Obelia, 28 specimens (type locality: 36° 36' 20" N; 121° 53' 04" W); Point Pinos, Pacific Grove, two specimens.

The preserved specimens attain 9 mm. in length, 2 mm. in breadth and 3 mm. in height without cerata. The cerata are up to 3 mm. long. The living animals were white with pink to orange cerata; the preserved material is ivory white.

The cephalic veil is smooth except for the ridges extending from the base of the rhinophores to the velar border. The rhinophore sheath is cup-shaped and irregularly expanded in front, sometimes forming a spout. The clubs of the rhinophores are completely retracted in several specimens. The anterior pedal border is slightly notched.

The anal papilla is remarkably high. The maximum number of cerata is seven pairs. The tubercles are elongate, but their length varies widely in different individuals. In general, the tubercles form four to six distinct circlets, sometimes three or seven. The uppermost ring contains four to six tubercles, the second six to eight. The latter ring is often interrupted on the inner side by the gill. The considerable variation in the length of the gill is illustrated by figs. 131 and 132 (pl. 7); the latter does not illustrate the shortest gill found on one of the larger cerata.

The jaws are very thin. The radula has about 70 teeth; the position of the lateral denticles shifts, as is the case in other species of Doto. True hepatic tissue is restricted to the diverticula within the cerata. The diverticula of the digestive gland enter the tubercles only if these are well expanded; the less prominent tubercles contain, exclusively, the subepidermal glands, reputed to be defensive, and which were mentioned in the description of D. columbiana.

In the hermaphrodite glands of three sectioned animals, the follicles are filled peripherally with female and centrally with male germ cells. The ampulla and the rather long spermoviduct [63] are without specific characters. Immediately after the bifurcation of the spermoviduct the male duct forms a wide prostate [67]. This is very long; it stains red and blue in different portions. Also the muscular vas deferens [66] is very long, longer than in any of the other species described here. It serpentines freely in its course as well as through the penis [70]. This organ is about 0.5 mm. long and 0.11 mm. in diameter (ratio: about 5 to 1).

A valve [83] lies at the beginning of the inner oviduct. The latter can barely be distinguished from the seminal receptacle [88], which is a slender, loculated organ with spermatozoa fastened to its wall. The vagina [82] is extremely long. Its winding course is closed by a sphincter [84] shortly before it joins the gland mass [91].

The holotype is the seven mm. long specimen, which is figured.

{The name is derived from that of a mythical figure in the song "Alpin" by Ossian as translated by Goethe and quoted in the second book of "Die Leiden des jungen Werther." To make the name more similar to a latinized one Dr. Marcus took certain liberties with the spelling (i. e. the name of the figure is Annira). For the general explanation of names chosen by Dr. Marcus see the introduction. — Ed.}

Discussion of *Doto amyra* Marcus, spec. nov.

The elongate tubercles of the cerata allocate this species to Odhner's group III (1936, p. 1120), whose species with at most seven circlets of ceratal tubercles and distinct gills must be compared with Doto amyra. In D. kabretiana (O'Donoghue 1929b, p. 829) the most well developed gills attain the uppermost circlet of tubercles (fig. 230, c). Doto apiculata Odhner (l. c., p. 1122, fig. 46, c; Bergh 1904, p. 13, especially pl. 1, fig. 37) has a much longer tip of the cerata. Doto rosacea Baba (1949, pp. 95, 172), described after the publication of Odhner's key, has no gills and no more than three circlets of tubercles on the largest cerata.

36. *Doto ganda* Marcus, spec. nov.
(Plate 7, Figures 135 to 138)

OCCURRENCE: Dillon Beach, on Hydrozoa, 19. VI. 1958 (type locality: 38° 15' N; 122° 58' W); three specimens. Monterey Bay, boat harbor, on Obelia, one specimen.

The preserved animals are up to four mm. long, 1.4 mm. high without cerata, and 1 mm. broad. The cerata are up to two mm. long. The color alive is white with orange cerata. The preserved specimens are nearly colorless. The rounded, projecting tubercles are white against the yellowish ground color of the cerata.

The cephalic veil is smooth, round and broad. The borders of the rhinophore sheaths are nearly round or somewhat projected in front forming a little spout. The anterior border of the foot has a shallow groove.

There are five to seven pairs of cerata, the third of which is the largest. The tubercles are set in five to six circlets with up to nine tubercles in each, arranged in spirals around the ceras or one above the other. The interspaces between the rings are about as broad as the diameter of the tubercles. These contain the large, so-called defensive glands. The gill is less branched than that of Doto columbiana and interrupts the circlets of tubercles from the third downwards. It is not developed on the sixth or seventh ceras.

Neither jaws nor radular teeth (pl. 7, fig. 137) differ considerably from those of Doto columbiana; the number of teeth is 69. The duct of the digestive gland runs between the follicles of the hermaphrodite gland which surrounds it on all sides.

Each follicle contains both male and female germ cells; the follicles are separate from one another. In the sectioned specimen the ampulla [62] is 0.6 mm. high, 0.5 mm. long and 0.2 mm. broad. The spermoviduct [63] leaves the ampulla in front and bifurcates after a course of moderate length.

The male duct becomes prostatic [67] immediately at its origin. The prostate is coiled and very long; it is wide proximally and narrows distally. Its cells are high and stain differently in the various portions. The muscular part of the vas deferens [66] is still thinner and is about twice as long as the penis [70]. The latter is a stout, turnip-shaped organ, 0.3 mm. long and 0.12 mm. in diameter, a ratio of about 2.5 to 1.

The ciliated inner oviduct [65] is rather long. It begins with a valve [83] and opens into the seminal receptacle [88]. The short vagina [82] bears a medium sized sphincter [84]. The eggs must pass through the vagina to enter the outer part of the oviduct [91], the mucus and albumen glands.

The holotype is an entire, four mm. long specimen.

The name is derived from a folklore name of a seal {see explanation in the introduction. Ed.}

Discussion of
Doto ganda Marcus, spec. nov.

The tubercles which are lighter than the cerata show that Doto ganda must be compared with the species of Odhner's group II (1936, p. 1120). It can be separated from all of them by its distinct gills, but this criterion is difficult to verify in some of the earlier species. In Odhner's subgroup II A, "colour uniform, without spots," a vertical ridge on the rhinophore sheath, an annulate rhinophore club, a translucent white body with eight pairs of cerata, and four circlets of tubercles are the distinguishing characters of the four species mentioned in the key. Doto pita Marcus (1955, p. 169) has indistinct gills, brownish spots on the back, and ceratal small tubercles which are irregularly scattered without forming rings.

37. *Doto kya* Marcus, spec. nov.
(Plate 8, Figures 139 to 142)

OCCURRENCE: Point Pinos, Pacific Grove (type locality: 36° 38' 15" N; 121° 56' W); one specimen.

The length of the preserved animal is six mm., the breadth 1.5 mm. and the height, without cerata, 2 mm. The cerata are 2 mm. high. The color of the living animal is preserved; it is white with black pigment situated in melanophores in the connective tissue. The anterior part of the back and sides and the bases of the cerata are the principal sites of pigmented cells. These cells are also scattered on the rhinophores and the cerata, but not on the ceratal tubercles. The spots at the insertions of the cerata lie on the inner side. Regenerating cerata are not pigmented.

The veil appears smooth, but as the epidermis is somewhat separated from the underlying tissue, the absence of tubercles or ridges between rhinophores and velar border cannot be determined with certainty. The upper borders of the rhinophore sheaths are scalloped and expanded a little in front. The anterior border of the foot is weakly notched.

Of the eight pairs of cerata, those in the middle are longest. They bear four to five circlets of ovoid tubercles whose integument contains the large glands common in Doto. The uppermost ring consists of four to five tubercles. The second ring has six to seven tubercles. The transparent gills extend up to this ring and are distinctly ramified. The radula is composed of 95 teeth.

The reproductive organs were dissected, not sectioned, and therefore not completely analyzed. The ampulla [62] is small. The spermoviduct [63] is rather long and dilated at its bifurcation. The male duct is prostatic [67] from its origin. The prostate is bulbar proximally but narrows distally. A rather long tubular portion of the duct is glandular, and only a short stretch [66] between it and the penis [70] is muscular. Its continuation, the ejaculatory duct, winds spirally within the 0.6 mm. long, 0.1 mm. thick penis (ratio of 6 to 1), whose tip is curved backwards within the male atrium [75].

The inner oviduct enters a slightly chambered seminal receptacle [88]. The alien spermcells are fastened to the walls of the chambers by their heads. The vagina [82] enters the outer portion of the gland mass [91] as in the other species described here.

The holotype is the unique specimen described here.

The name is derived from a folklore name of a seal {see explanation in the introduction. — Ed.}

Discussion of

Doto kya Marcus, spec. nov.

Doto rosea, D. cinerea and D. aurea Trinchese, 1881 (pp. 92-93) from the Mediterranean may be compared with D. kya. Pruvot-Fol (1954, p. 406) unites D. rosea and D. cinerea and considers D. aurea a questionable synonym of them. The absence of gills in the corresponding figures is not pertinent for comparison with D. kya, because gills were drawn in only one of Trinchese's eight species (pls. 54, 61). Doto aurea has five pairs of cerata without black spots at their bases. These spots do occur in D. rosea and D. cinerea, both with six pairs of cerata. In D. rosea the tubercles are very low, and in D. cinerea they are irregularly arranged. The radular teeth of D. cinerea (Vayssière 1888, pl. 7, fig. 136) have much smaller lateral denticles than D. kya.

The only other North American Pacific species with black pigment is Doto columbiana. Its characteristic dark rings around the tubercles may, it is true, fade, but spots at the bases of the cerata do not occur in our ample material. The quite short muscular portion of the vas deferens and the very long penis distinguish D. kya safely from D. columbiana.

38. *Doto wara* Marcus, spec. nov.

(Plate 8, Figures 143 to 146)

OCCURRENCE: Dillon Beach, on Hydrozoa, 19. VI. 1958 (type locality: 38° 15' N; 122° 58' W); two specimens; Monterey Bay, boat harbor, one specimen; Point Pinos, Pacific Grove, 11 specimens.

The length of the preserved animals is from 3.5 to 6 mm., the height 1.5 without cerata, the breadth 1.5 mm. The cerata are up to two mm. long. The body of the living animals was uniformly white with brown or pinkish cerata. The preserved specimens are colorless.

The cephalic veil bears a ridge between the base of each rhinophore and the anterior velar border. The latter is sometimes slightly contracted at the ends of these ridges. The sheaths of the rhinophores have an approximately pentagonal border and form a little spout in front. The furrow of the anterior border of the foot is distinct.

There are five to seven pairs of cerata. Some cerata are regenerating. The anterior pairs of cerata are generally largest. The last cerata, which are the smallest, bear two to three rings of tubercles, the lowest of which is only a half ring on the outer side of the ceras. The tip of the cerata is occupied by a rather strong tubercle; in the bigger cerata this tubercle is followed by four to five circlets of round tubercles which are quincuncial, large, with narrow interspaces between them. The first circlet comprises five to seven tubercles, the second eight, the third six, the fourth four to five, and the fifth two to three tubercles on the outer side only. The small but prominent gill interrupts the circlets on the inner side from the third downwards. Although first and second cerata are of equal size, the gills of the second pair are larger.

The jaws are thin. The radula is composed of 65 or more broad teeth, each with four to five lateral denticles in alternating position. The posterior duct of the digestive gland, which runs between the distinctly separated follicles of the hermaphrodite gland, is lined with flat cells. These cells continue in the branches of the duct which enter the cerata. Only the diverticula within the cerata contain true hepatic tissue.

Each follicle of the hermaphrodite gland is composed of male and female germ cells. The ampulla [62] is about 0.4 mm. long and broad, and 0.2 mm. high. The spermoviduct [63], drawn with an interruption (pl. 8, fig. 146), is long. It dilates near the origin of the male duct where a valve [83] is developed. The prostate [67] becomes thick immediately at the origin of the male duct. It is several times longer than its width of 50 to 120 µ; this is moderately long compared with other species of Doto. The staining of the prostatic cells differs in the successive portions. The distal portion of the prostate is narrow. The muscular vas deferens [66] is shorter than the straight penis [70]. The penis is 0.42 mm. long and 84 µ in diameter (a ratio of 5 to 1). Within the penis the course of the ejaculatory duct is straight.

The moderately long inner oviduct [65] opens by a valve [83] into the seminal receptacle [88], whose broad base is subdivided into several pouches formed by folds of its wall. The sperm-cells are fixed with their heads in these pouches. The narrow outlet of the receptacle consists of a curved vagina [82] provided with a strong sphincter [84]. The vagina opens into the nidamental duct [95] through which the eggs continue their way through the gland mass (the outer oviduct [91]).

The holotype is an entire specimen, 3.5 mm. in length.

The name is derived from a folklore name of a seal {see explanation in the introduction. — Ed.}

Discussion of

Doto wara Marcus, spec. nov.

Doto albida Baba (1955, pp. 25, 50) from the Sagami Bay is closely related to D. wara, but the radular teeth are different. It appears risky to disregard the radula so completely in the classification of the species of Doto as would be necessary if we were to unite the present specimens with D. albida, whose radula has one to two lateral denticles on either side of the median cusp. When Odhner (1922, p. 36) said that the radula of the Dotonidae does not offer characters for distinguishing the species, he was considering three European species, whose radulae, indeed, differ much less from one another than those of D. albida and D. wara.

Remarks on the classification of Doto

In the present state of knowledge, Odhner's key for 22 species (1936, pp. 1119 to 1121) is very helpful. The degree of contraction of the preserved animal must be considered in determining whether the tubercles were round or elongate and pointed in life. The gills also may be shortened by contraction. The contrast in color patterns, apical spots of tubercles paler than general color, or tubercles without apical spots and of the same uniform color as the body can be verified in preserved material only if the color is intense. The subapical dark rings around the tubercles in Doto columbiana have partly faded away in the course of ten months. A quite smooth and a somewhat uneven margin of the rhinophores may occur in one and the same species (D. caramella). The radulae were already mentioned as generally of little value.

The length of the prostate, of the efferent duct, and of the penial papilla, are systematically important. Also a straight or a spiral course of the vas deferens within the penis is a specific character. Among the female organs the length of the vagina is the principal taxonomic character. The inner oviduct communicates usually with the seminal receptacle. Only rarely does it communicate with the gland mass (Doto pita).

39. *Armina californica* (Cooper, 1862)

(Plate 8, Figures 147 to 150)

REFERENCES: Cooper 1862, p. 203; Bergh 1890a, pp. 3-8 (first detailed description with figures); 1894, pp. 154-157, pl. 3, figs. 13-14, pl. 4, figs. 7-12; O'Donoghue 1921, pp. 178-180, pl. 5, figs. 49-50; 1922c, p. 124; Smith and Gordon 1948, p. 181; MacGinitie 1949, p. 373 (food); Ricketts and Calvin 1952, p. 237, pl. 36, fig. 5 (photograph of living animal); Light et al. 1954, p. 269.

OCCURRENCE: White Gulch, Tomales Bay, muddy sand (shrimp trawl), August 1951, courtesy of Dr. Joel W. Hedgpeth; one specimen.

Further distribution: Gulf of Panama in 29 m.; Gulf of California, 24° and 26° N, in 48 and 88 m.; West coast of Lower California, Punta Banda, 31°40' N, intertidal zone; San Diego, intertidal zone; dredged off Monterey on sandy bottom; Vancouver Island region, 27 to 64 m. Lives on sand-flats, half buried in the sand and feeds, at least in part, on sea pansies (MacGinitie).

The measurements of the preserved animal (pl. 8, figs. 147, 149) are as follows: length of body 70 mm.; breadth of notum 30 mm.; height 20 mm.; length of foot 62 mm.; breadth of foot 20 mm. The specimen is white, probably because the original color has faded out. The more or less parallel ridges, about 22 in number and corresponding with light stripes of living animals, begin at the anterior border of the notum, which is so much contracted that they all originate quite near one another. The outer stripes diverge towards the notal border where they end, and in the caudal region a few new stripes emerge between the anterior ones. The notal border is smooth and is bordered with a white line.

The glandular sacs [18] on the notal border are numerous. Since recently emptied glands are not apparent, the glands seem to be irregularly distributed. Behind a short anterior part of the hyponotum there is a roundish area with about 24 branchial leaves [15]. The branchial lamellae are directed longitudinally, and there are many shorter ones between them. Three of these lamellae are continuous with the following lateral lamellae [17] which are distended by digestive diverticula. The lamellae do not diverge much from the notal border. Besides the 24 complete lamellae there are several incomplete ones, especially toward the posterior.

The semilunar cephalic veil [1] is as broad as the foot and ends with rounded flaps. In the present specimen it is tilted so that its upper margin is directed forwards. The nuchal area is smooth. In front of the rhinophores there are two inconspicuous swellings, the so-called caruncles (pl. 8, fig. 153 [4]). The rhinophores [5] have about 20 perpendicular leaves. The anterior border of the foot is slightly notched and grooved, and has somewhat prominent corners [23]. A shallow glandular furrow [24] runs ventro-medially on the pointed tail. A ridge passing dorsally over the muzzle unites the velar flaps. The anus [45] lies at the end of the second third of the body, the genital aperture [80] is under the posterior end of the branchial band and the minute renal pore [25] is between these two openings.

The flat central nervous system is small (Misuri 1917, p. 35) in proportion to the size of the animal. Cerebral and pleural ganglia are separated by a distinct furrow and together are larger than the pedal ganglia. Taken by themselves the pedal ganglia are the largest single ganglia.

The pharynx is 8.5 mm. long. Each jaw is 7.3 mm. long and 3.3 mm. broad. The radula (pl. 8, fig. 150), six mm. long and five mm. broad, has 41 rows. The formula is 60.1.1.1.60. The median tooth has five to seven lateral denticles on each side of the cusp, one of which can be confluent with the cusp. The intermediate tooth has an irregularly dentate cusp. The outermost lateral teeth, about six in number, decrease in size and are smooth. The denticle of the innermost lateral tooth, if present, is small. All the other teeth generally have a single strong denticle near the tip, almost parallel to the main cusp, the claw-like type of O'Donoghue (1921, p. 180). The denticle is sometimes bifid, rarely trifid.

The hermaphrodite gland lies on the digestive gland. The hermaphrodite duct enters the ampulla which is almost entirely embedded in the gland mass (pl. 8, fig. 148 [91]). The ampulla [62] is a tube of about 20 mm. length. Its distal end is the point where male and female branch separate. The rather thick vas deferens [66] begins with a glandular epithelium and becomes muscular farther distally, as is shown by its glossy surface. The convolutions of the duct, when unrolled, measure about 40 mm. This duct lies on the anterior side of the gland mass.

A bulbar, nearly spherical, three mm. long penis [70] projects beyond the body wall [26]; its opening lies on a little point directed backwards. Possibly the penis is shortened by contraction.

The oviduct [65] enters the gland mass. The voluminous mucus gland [91] lies anterior to the much smaller gelatinous albumen gland [93]. Immediately behind the penis the female opening [80] is located. A common swollen ring surrounds the genital openings. The nidamental pore receives a firm, consistent nidamental duct [95]. The vagina [82] begins with a wide folded, glandular and rigid portion and continues as a narrower, thin-walled canal shorter than the receptaculum seminis [88], which in the present specimen is flat and empty.

40. *Armina columbiana* O'Donoghue, 1924
(Plate 8, Figures 151 to 154)

REFERENCE: O'Donoghue 1924, pp. 11-14, pl. 2, figs. 13-17.

OCCURRENCE: White Gulch, Tomales Bay, muddy sand (shrimp trawl), August 1952, courtesy of Dr. Joel W. Hedgpeth; one specimen.

Further distribution: Oregon; Vancouver Island region, in 15 to 27 meters.

The preserved specimen is 60 mm. long by 25 mm. high and its notum is 37 mm. broad. The foot is 51 mm. long and 25 mm. wide. These measurements agree approximately with those given by O'Donoghue. The head-shield (pl. 8, fig. 153 [1]) is mottled, the back dark with white stripes of different breadth. Most of the stripes begin in front, and the narrower ones broaden in the anterior third of the notum where some of the lateral ones end on the border. In the hind part some new stripes appear; the total of 20 to 24 stripes is almost parallel. Due to the contraction of the notum the stripes stand out as white ridges separated by pigmented furrows. The stripes do not extend quite to the smooth white notal margin.

The glandular sacs are numerous. The hyponotum is smooth at the anterior; then there is a transverse band of branchial leaves [15]. These begin and end in a straight line and are parallel.. They alternate with lower and shorter ones (see pl. 8, fig. 151). The caudal ends of five leaves are continuous with five of the lateral lamellae [17]. Of these there are about thirty, which run obliquely backwards. Not all extend from the inner to the outer side; some end earlier, others begin later.

The cephalic veil [1] was preserved in the same position as on the specimen of Armina californica, with the upper, laterally expanded margin tilted forwards. The nuchal area bears small irregular tubercles, the so-called nuchal papillae, which stand out light against a dark ground color. The caruncles [4] are poorly developed. The rhinophores [5] are perfoliated with about 22 leaves. The foot and the furrow of the posterior pedal gland are similar to A. californica but the anterior pedal border is not grooved. The ridge between mouth and velar flaps, and the position of the intestinal, renal, and genital apertures are the same as in the preceding species.

The length of the pharynx is seven mm. The jaws are 6.5 mm. long and 2.7 mm. wide. The radula is 5.1 mm. long, 4.7 mm. broad, and has 41 rows with 65.1.1.1.65 teeth. The rachidian tooth has on each side four to six lateral denticles, one of which may stand on the median cusp. The intermediate tooth is broader and lower than in Armina californica, and its cusp is smooth. The outermost lateral teeth (about six) are smooth; as usual, their size decreases. The other lateral teeth as well as the innermost tooth, are highly variable. Many of them have up to six small denticles; however, the claw-like type with one long denticle and others with a bifid or more split denticle also occur. The short split denticles are intermediate between the claw type and the brush-like type with six small denticles.

The hermaphrodite gland covers the digestive gland on all sides, although not completely. The hermaphrodite duct (pl. 8, fig. 154 [60]) enters the anterior genital mass from behind, and dilates to an ampulla [62] about three mm. wide and 40 mm. long. The ampulla runs for the most part within the gland mass, where it forms about five bends. The male and female branches originate at the distal end of the ampulla. The male duct begins with a seminal vesicle [87] and becomes narrower and muscular in its short distal course [66]. From the genital opening protrudes a penis 15 mm. long [70]. This is a spirally twisted and tapering tube with a terminal pore.

The inner oviduct [65] enters the female gland mass, whose larger anterior part is the mucus gland [91], the smaller posterior one the albumen gland [93]. A dilation of the oviduct at its opening into the gland mass may be a fertilization chamber. The outer oviduct or nidamental duct [95] is soft and thin; it opens [80] behind the penis. The nidamental duct and the vagina [82] begin at the same place. The vagina has longitudinal folds in its outer portion. It courses over the gland mass and bends twice sharply; the curved part is thinner than the outer one. The voluminous seminal receptacle [88] contains sperm.

Discussion of
Armina californica (COOPER, 1862)
and
Armina columbiana O'DONOGHUE, 1924

The description of Armina californica given here refers to the present specimen only and does not include any indications of the literature, because the concept of A. californica is not yet settled. The original description, and, as Bergh (1890a, p. 3) remarked, the figures as well, are so primitive that it is only convenient but not safe to consider the specimens described by Bergh and O'Donoghue as identical with Cooper's species. The radula of our specimen agrees with Bergh's and O'Donoghue's diagnoses sufficiently to justify our determination. Besides many brush-like denticles the claw-like type occurs also in A. columbiana, but the brushes predominate. Therefore we consider the specimen dredged on the coast of Oregon (Bergh 1904, pp. 19-20, pl. 4, figs. 23-26) as A. columbiana, although Bergh called it A. californica. In the two individuals separated specifically here the measurements of pharynges and radulae differ.

The nuchal papillae of Armina columbiana, not mentioned previously, are a distinctive character. Ampulla, male duct, penis, and vagina differ widely in our two specimens. The short penis of our A. californica agrees with Bergh's, not with O'Donoghue's A. californica. The long spermoviduct and long and thin vagina of Bergh's material (Bergh 1890a, pl. 2) differ from our material. The male organ of A. columbiana is described as "bluntly conical"; we found it long and spirally twisted.

On the basis of the radula Armina vancouveriensis (Bergh, 1876b, p. 5) is probably the valid name for A. columbiana, but in view of the incomplete state of our knowledge of the Pacific North American species of Armina we postpone the question of the name.

Armina digueti Pruvot-Fol, 1955 (p. 464) from the Gulf of California has only a small "claw" on a few of the lateral teeth; most of them have no denticles at all. This radula differs distinctly from the A. vancouveriensis-columbiana type, but only by degree from that of A. californica from the same region (Bergh 1894).

A distinguishing character of Armina californica was stressed by O'Donoghue (1921, p. 179; 1924, p. 11). He describes the notal ridges as starting from the middle and passing outwards and backwards at an acute angle with the mid-dorsal line. In some figures in the literature, e. g. that of A. cuvieri (d'Orbigny 1837, p. 199; 1846, pl. 17, fig. 1) and of A. paucifolia Baba (1955, pl. 11, fig. 31), which illustrate animals with a specially broad anterior part of the notum, the anterior stripes begin near the mid-line and run obliquely outwards and backwards, but we could not find in any of the figured species of Armina a disposition of all lateral lines as described by O'Donoghue. Bergh did not mention it, and if it were indeed a distinguishing feature of A. californica neither the present specimen, nor that figured in "Between Pacific Tides" belongs to this species.

41. *Dirona picta* COCKERELL & ELIOT, 1905
(Plate 9, Figures 155 to 158)

REFERENCES: Cockerell and Eliot 1905, pp. 46-48, pl. 7, figs. 6-11; MacFarland 1912, p. 517 (colored figure: pl. 30, fig. 1); O'Donoghue 1927a, pp. 101-102; pl. 3, figs. 61-63.

OCCURRENCE: Dillon Beach, 8. III. to 17. VII. 1958; 36 specimens. Point Pinos, Pacific Grove, 5 specimens. Dr. Diva Diniz Corrêa described the animals as gregarious; when she found one, she was sure to find a second or more on the same stone.

Further distribution: Laguna Beach; San Pedro; Monterey Bay.

The three animals from Dillon Beach were small, six mm. long when living, 3 mm. when preserved. The largest of the specimens preserved was 16 mm. long, 6 mm. broad and 7.5 mm. high (pl. 9, fig. 155). The longest cerata are 5 mm. long and 2 mm. broad, hence almost one third of the body length. MacFarland's specimens attained 40 mm. in length alive and 7 mm. in breadth as well as in height. The color of the present small lot was white with dark viscera shining through the skin, white spots on the sides and orange cerata. The larger slugs were light yellow with reddish stippling on the cerata. Groups of silverish dots and some brown pigment occurred over the entire body. The animals from Point Pinos were green with greenish brown cerata. MacFarland described the color as "reddish yellow to brown, the dorsum sprinkled with fine yellowish-white, olive green, and pink spots". The preserved specimens have lost their brilliant colors but have retained some fine dark brown granules in the skin which form a pattern of rings on back and sides, and streaks on the cerata.

The body is stout, rounded in front, broadest at the posterior limit of the anterior third, whence it tapers to the pointed tail. The latter is about two mm. long behind the hindmost cerata. The foot is about as broad as the body and has undulating margins. Its thick anterior border is truncate and simple, neither furrowed nor notched, nor with produced angles. Notum and sides are smooth; on the margin between them the notum and the cerata are arranged in a broad band. The largest are near the mid line, and the smallest to the sides. They are often, but not always, separated in front and meet over the tail.

The head is expanded into a broad veil. The rhinophores have pigmented shafts and perfoliate clubs, whose leaves are slanting and irregular.

The cerata are flattened antero - posteriorly and are tuberculate, chiefly near the top of their shorter inner surface. The outer face is longer and smoother. In less contracted state they are more or less spindle-shaped and round in cross section. The digestive gland does not enter the cerata, whose bases are provided with two sphincters around the passages of the afferent and efferent blood sinus.

The anal opening is situated on a broad papilla in the right row of cerata near the hind end. The genital apertures lie close together under the right row of cerata at the end of the anterior third, the renal pore in the same position in the middle of the body.

The mouth cavity is lined with a high epithelium thrown into radiating folds, every cell of which is provided with a long cuticular cilium. The muscular pharyngeal bulb is located between the jaw plates. The bulb is about one third of the body length, viz., 4 mm. in a specimen 12 mm. long. The strong brownish jaw plates (pl. 9, fig. 156) are concave on their outer surface and on their convex inner side bear folded processes where muscles insert; the lower edges of these processes serve as masticatory processes. The radula (pl. 9, fig. 157) consists of up to 24 rows (up to 35 in MacFarland's material) of 2.1.2 teeth. The teeth are considerably larger than MacFarland indicated and measure in µ: length of median tooth 73 (MacFarland : 60), length of base 56(37), length of first {inner} lateral tooth 207 (168), base 140 (114) , cusp 67 (54), length of second {outer} lateral tooth 392 (334), base 224 (198), cusp 168 (126). The first lateral tooth bears a row of 5 to 8 (MacFarland: 4 to 7) small denticles (14µ) on its inner side. In the smallest animals these denticles are the same size, but the tooth is much smaller (70µ), so that they are proportionately much larger. The second lateral tooth resembles the first in shape, but it is larger and has no denticles.

The oesophagus turns to the left after passing through the nerve ring and dilates to a long stomach winding from left to right. The stomach receives the two ducts from the digestive gland and continues into the intestine which descends to the ventral side, runs backwards, rises again on the left side, passes dorsally over the hermaphrodite gland, and reaches the anal papilla on the right side. The digestive tract contained walls of several cheilostomatous Bryozoa, e.g., Celleporella (formerly Hippothoa) hyalina (Linnaeus). The digestive gland is composed of a number of smooth and roundish lobes: a left anterior lobe in the curve of the stomach, a right anterior lobe in the loop formed by pylorus and intestine, and a larger posterior, subdivided lobe on the dorsal, left and ventral side behind the stomach.

The nervous system was thoroughly studied by MacFarland (1912, pp. 528-530, pl. 32, fig. 24), to whom we refer.

The heart lies in the middle of the body. The auricle extends far over the left side, the ventricle is directed transversely. The renal organ is so delicate that it was seen only in the serial sections. It extends to the sides and around the digestive and hermaphrodite glands. A wide folded ciliated duct leads to the narrow renal pore. The renopericardial communication is a conspicuous folded canal in front of the level of the renal pore.

The band of gland cells described by MacFarland (1912, p. 521) lies immediately under the musculature of the body wall and extends from the genital apertures backwards around the anus and on the left side forwards to the middle of the body. Although this band runs near the bases of the cerata, it is neither functional as in Madrella (Odhner 1917, p. 65, fig. 18), nor a vestigial hepatic prolongation as in Charcotia (Vayssière 1906, p. 30). The only inner organs connected topographically with the band are occasional blood lacunae. In a young specimen, which was sectioned, the band was not developed.

In the most posterior and ventral part of the visceral cavity the slightly lobed hermaphrodite gland is the only organ. Farther in front, on the right side near the heart, it turns upwards.

The hermaphrodite duct leaves the hermaphrodite gland in front and forms a slender ampulla. The narrow emerging spermoviduct is short.

The vas deferens lies coiled on the right side in front. It begins with an inner wide, glandular stretch followed by a narrow, muscular middle one [66], which is silky in appearance. Its distal coils are lodged within a membranous sac [71], a sort of penial sheath. This sac is continuous with the thickly muscular outer male duct, lined with ciliated epithelium. The narrow portion of the middle part projects with a penial papilla [70] into the wide lumen of the outer duct. The latter opens into the male atrium [75], a strongly muscular organ, whose inner base is connected to the body wall by a retractor [73]. The male duct is fastened to the atrial bulb by muscle fibers which secure the duct shortly before its entrance into the membranous sac.

The oviduct widens shortly after its origin from the spermoviduct and forms a roomy tube lined with high epithelium thrown into dense folds. The oviduct [65] is coiled into several loops and is independent of the female gland mass [91]. The oviduct meets the female gland mass only in the atrium [81], whose female part is as strongly muscular as the male part. The atrial lumen receives three outlets: the inner one of the albumen and mucus gland [91], that of the oviduct in the middle, and outermost the vaginal opening [82]. The spermatheca [86] is small. Muscular valves separate these apertures, that between vagina and oviduct [83] is strongest.

Discussion of *Dirona picta* Cockerell & Eliot, 1905

Dirona picta has tuberculate cerata and a smooth penial papilla. The pink color identifies D. picta as far as material of Dirona from the North American Pacific coast is concerned. There are however two other pink Dirona in the Sea of Japan. One of them with tuberculate cerata classified as D. picta (Volodschenko 1955, pl. 48, fig. 11) seems to be a different species. It has a wreath of cerata around the rhinophores, and also its sides, not only the dorsum, are sprinkled with dots of color. The second pink Asiatic Dirona is mentioned in the discussion of the following species.

42. *Dirona albolineata* Cockerell & Eliot, 1905

(Plate 9, Figures 159 and 160)

REFERENCES: Cockerell and Eliot 1905, p. 46; MacFarland 1912, p. 518 (colored figure: pl. 30, fig. 2); O'Donoghue 1921, p. 181; 1926, p.224 (literature); 1927 a, pp. 102 - 103, pl. 3, figs. 64-67; MacGinitie 1949, fig. 215 (photograph).

OCCURRENCE: Outer coast of Tomales Point, tide-pool, 20. IV. 1958; one specimen.

Further distribution: Laguna Beach; Monterey Bay, in tide - pools; Vancouver Island region. From the intertidal zone to 35 meters.

Our preserved specimen is 8 mm. long, 3 mm. broad and 3.5 mm. high without the cerata which are up to 2 mm. long. MacFarland gives the following dimensions: length up to 42 mm., height 8, width 7 (1912, p. 519). O'Donoghue (1922a, p. 164) saw a living animal 165 mm. long by 36 mm. broad and 52 mm. high, including the cerata.

The color of the preserved specimen (pl. 9, fig. 159) is ivory with yellowish viscera shining through the integument. Alive the animals are translucent whitish grey with opaque white bands. These occur around the veil, the margins of the cerata, the median ridge of the tail, and pass from the inner side of the clavus of each rhinophore down the inner side of its stalk, uniting in a transverse line across the head. There is, in adult animals, a broad whitish glandular zone on the right side which runs immediately behind the reproductive openings to the posterior end of the dorsum (MacFarland l. c., p. 519). This glandular zone is not recognizable in our young animal. Sometimes the body and cerata of large specimens are flecked with minute spots of pure white; the inside of the large cerata may be amber colored.

The stout body has straight sides, is rounded in front and ends with a blunt point. It is highest in the middle. The squarish head passes into an undulating veil, which is wider than the foot. The leaves of the rhinophores are circular at the tip, longer and slanting towards the base. The mouth is a longitudinal slit with thick lips. The foot is broad and rounded in front where its border is thickened. The sides of the foot are slightly undulated. The short tail bears a low dorso - median crest.

The cerata are smooth, slightly flattened antero-posteriorly in adult animals and carrot-shaped in our immature specimen. They are inserted obliquely on each side of the convex back, and therefore the inner sides are shorter than the outer. In front the row of cerata extends beyond the rhinophores, but is interrupted in the mid line, although it is continuous above the tail. The inner cerata are generally the largest and may reach half the length of the animal.

Anus, genital and renal openings are arranged as in Dirona picta.

The mandibles are strong and massive, similar to those of Dirona picta; MacFarland (l. c., p. 519) said that the boundary between the upper and lower portions of the inner face of the wing is less strongly marked than in D. picta, but in the present young animal it is distinct. The present specimen has 22 rows of radular teeth (pl. 9, fig. 160), while up to 32 are indicated in the literature. Our measurements in μ (compared with MacFarland's in parentheses) are: total length of rachidian tooth 62 (72 to 80), its base 34 (48 to 50), total length of first lateral tooth 125 (198 to 216), its base 85 (138 to 198), total length of second lateral tooth 224 (342 to 396), its base 114 (210 to 228); the first lateral tooth bears 3 to 5 (2 to 4) denticles.

The average number of eggs is 350'000 (Ch. and E. O'Donoghue 1922, p. 134).

Discussion of *Dirona albolineata* Cockerell & Eliot, 1905

This species seems to be more eurythermic than Dirona picta. Although the southernmost findings are the same for both, only D. albolineata extends to the coast of British Columbia. A pink species with smooth cerata from the Pacific coast of Hokkaido, first classified as D. albolineata (Baba 1935b, p. 120), was later separated as a new species, D. akkeshiensis Baba (1957a, p. 13).

43. *Coryphella piunca* Marcus, spec. nov.
(Plate 9, Figures 161 to 167)

OCCURRENCE: Dillon Beach, on Hydrozoa, 11. III. to 4. VI. 1958 (type locality: 38° 15' N; 122° 58' W): 68 specimens. Monterey Bay, boat harbor: 6 specimens. Point Pinos, Pacific Grove: 6 specimens.

The preserved animals (pl. 9, fig. 161) are up to 10 mm. long, 2 to 3 mm. high without cerata, and 1.5 to 3 mm. broad. The cerata are 1 to 2 mm. long. The genital aperture [77] generally lies one sixth of the body length from the anterior end, the anus [45] one third. The renal pore is situated between genital and anal opening, much nearer the latter. The tail is short.

The living animals are yellow or pink with yellow or red tips of the cerata and brownish digestive diverticula. On either side and in the dorsal mid line runs a silvery stripe. The median stripe bifurcates on the head and continues along the back of the tentacles. The pigment of this stripe lies under the epidermis, over the muscle layer. Preserved animals are ivory or light brown, the stripes are often faded. White elements may occur in the rhinophores also, recognizable as granules in the sections.

In the living animals tentacles (pl. 9, fig. 162 [2]) and rhinophores [5] are of about the same length. In the preserved animals the rhinophores are well extended or nearly globose, smooth, wrinkled, annulate or perfoliate. All these types occur in the same population (pl. 9, fig. 163). The number of leaflets is 7 to 12; comparison of sectioned perfoliate rhinophores with those of Spurilla chromosoma (pl. 10, fig. 197 [5]) reveals no difference. The eyes lie behind the rhinophores. The foot is narrow and pointed behind, its anterior border is thick, bilabiate and notched. The antero-lateral corners are produced and pointed, but are shorter than the tentacles and rhinophores.

The cerata are densely set, decreasing in size laterally. The anterior digestive glands supply 10 to 13 cerata each; the posterior digestive gland enters about 30 on either side. In the preserved specimens the cerata are often contracted and curved. In life they are rather stubby, with roundish tips. Their digestive diverticula are smooth, the cnidosacs measure about one tenth of the length of the ceras, a useful specific character (Odhner 1927, fig. 1). In some preserved specimens the cerata begin in front of the rhinophores, but this may be due to strong contraction of the headregion.

The broadly oval jaws (pl. 9, fig. 164) have a thick masticatory process. This bears about ten rows of tubercles whose size increases outwards to conical denticles. In the outermost row these denticles are rough. The radula (pl. 9, figs. 165, 166) consists of 16 to 25 rows, about five of which belong to the descending limb. The strong cusp of the median tooth is flanked by four to seven, generally five to six, spines. Sometimes the innermost spines insert on the cusp and are small; more frequently they are implanted more basally and are nearly as long as the middle cusp, although they do not appear so. The outer spines are somewhat smaller. The base of the lateral teeth is concave; the inner side is straight and bears 6 to 12, mostly seven to nine, denticles which leave a long tip free; the outer side is convex and longer than the inner one. One specimen from Dillon Beach had 12 to 13 denticles on the lateral teeth, and the five to six distal ones were broken off in the older rows recalling the description of Coryphella longicaudata O'Donoghue (1922a, p. 157). As the number of spines on the median tooth varies within certain limits in one and the same species of Coryphella, it is not surprising that the denticles of the lateral teeth are also variable. The alimentary tract contains hydroids.

Male and female germ cells are mingled in the follicles of the hermaphrodite gland (pl. 9, fig. 167 [59]). A rather short vas deferens [66] begins distally to the long ampulla [62]. The vas deferens has a glandular epithelium, shorter than in the Atlantic species drawn by Odhner (1937, fig. 5; 1939, figs. 22, 26, 28). It opens into an external furrow of the broad muscular penis [70], a double fold of the base of the atrium, sometimes projecting from the genital aperture [77].

The oviduct [65] stores sperm and evidently functions as a fertilization chamber. It runs backwards forming a long loop and enters the external part of the gland mass [91]. The common atrium [78] receives the nidamental duct [95] near the genital aperture, and the short vagina [82] is located more proximally. The vagina leads to a small spherical spermatheca [86]. Though externally monaulic, the species is actually triaulic.

The name of this species is derived from a folklore name of a seal {see explanation in the introduction — Ed.}.

The holotype consists of a series of cross-sections (four slides) and the radula of the same animal.

Discussion of
Coryphella piunca Marcus, spec. nov.

The present species demonstrates that perfoliate rhinophores cannot prevent the allocation of a species to the genus Coryphella. O'Donoghue (1921, p. 198) and Risbec (1928, p. 266; 1953, p. 143) already included such species in Coryphella. Hence the genus Himatella Bergh (1890b, p. 36), now Himatina Thiele, 1931 (p. 453) cannot be maintained. It was based on a single specimen from Alaska (Bergh 1894, p. 134) which differs from Coryphella only by perfoliate rhinophores. Such occur in the present material from Dillon Beach together with annulate and wrinkled ones, while the animals from Monterey Bay (pl. 9, fig. 163) have smooth rhinophores as well as the other types. C. piunca must therefore be differentiated from the older North Pacific species, preferably by characters other than those of the rhinophores.

1) Coryphella athadona Bergh (1875, pl. 11, figs. 12, 13; 1876a, p. 635); Baba (1935a, p. 352; 1935b, p. 123; 1940, p. 107). Sea of Japan and Pacific coast of northern Japan. Very similar to C. piunca, but without lateral stripes and with rounded, not produced, anterior foot angles.

2) Coryphella californica Bergh (1904, p. 6). Gulf of California. Front angles of foot longer than tentacles and rhinophores. Median tooth with 13 to 21 denticles on each side.

3) Coryphella cooperi Cockerell (1901a, p. 85). San Pedro. Pellucid white with a decided pink tinge; a brilliant greenish blue patch between the first two tufts of cerata whose bases are greenish. Cerata set in six pairs of groups. Lateral teeth with ten denticles, five lower relatively large and five upper very small ones.

4) Coryphella fusca O'Donoghue (1921, p. 195). Vancouver Island region. Rhinophores with 32 to 38 leaves. Lateral teeth with three to five denticles. Similar to C. trilineata, but less numerous cerata, although the animal is larger.

5) Coryphella longicaudata O'Donoghue (1922a, p. 156). Vancouver Island region. Long, slender tail, even in preserved specimens, often projecting almost one third of body length beyond the cerata; rhinophores with 14 to 16 leaves; masticatory process with a single row of denticles.

6) Coryphella orientalis Volodschenko, 1940 (quoted from 1955, p. 184). Sea of Japan. Lateral teeth smooth.

7) Coryphella salmonacea (Couthouy, 1838). Arctic Alaska. Lateral teeth with 19 to 26 denticles.

8) Coryphella trilineata O'Donoghue (1921, p. 197). Vancouver Island region. One row of denticles on masticatory border (as in C. longicaudata); lateral teeth are right-angled triangles whose hypothenuse is denticulated. Genital aperture at the end of the first third of the body.

9) Coryphella trophina (Bergh 1894, p. 134). Alaska. Rhinophores with 35 rings or perfoliations; lateral teeth with four to five denticles.

10) Coryphella verrucosa (M. Sars, 1829) mentioned under the later name (Odhner 1939, p. 58) C. rufibranchialis (Johnston, 1832) by Volodschenko (1955, p. 183) from the Sea of Japan. Penis a stalked disc bearing marginal tubercles (Odhner 1929, p. 9).

As the radulae of Coryphella subrosacea (Eschscholtz, 1831) O'Donoghue (1922b, p. 135) from Sitka, Alaska, and of C. alderi Adams (1861, p. 140) from Tsugaru Strait, are unknown, their generic position remains uncertain.

44. *Capellinia rustya* Marcus, spec. nov.
(Plate 9, Figures 168 to 172)

OCCURRENCE: Monterey Bay, boat harbor; on Obelia (type locality: 36° 36' 20" N; 121° 53' 04" W); seven specimens.

The preserved animals (pl. 9, fig. 168) are five mm. long, 1.5 mm. broad and 1.4 mm. high without cerata. The tentacles are 0.6, the rhinophores 1.5 and the cerata 1.8 mm. long. The living animals were white to translucent with pink cerata. In preservative, they are white with small black eyes immediately behind the rhinophores.

Tentacles [2] and rhinophores [5] are smooth; the former are bent downwards and backwards, the latter obliquely upwards. The anterior border of the foot is somewhat thickened, transversely truncate with rounded antero-lateral corners. The edge of the foot is separated from the body by a slight constriction; the foot is pointed posteriorly.

The cerata are inflated and are pointed at the tip. They form four to five groups on either side and contain digestive diverticula arranged in two to three rings of tubercles. The first group of cerata is supplied by the anterior digestive gland. This group contains up to six cerata which form an arch. In each of the posterior groups there are only two cerata. The digestive gland (pl. 9, fig. 169) has many diverticula which enter the cerata; the cnidosacs are 0.12 mm. long. The wide genital aperture [77] is located under the first group of cerata. The anus [45] lies in the interhepatic space, a little to the right of the mid line.

The pale jaws (pl. 9, fig. 170) bear one row of about 20 denticles on their masticatory border. These denticles had a slight brush-like appearance as in Capellinia conicla Marcus (1958b, fig. 77). The radula (pl. 9, fig. 172) comprises up to 50 to 60 rows of 1.1.1 teeth. In the oldest rows the rachidian tooth is five μ broad, in the youngest 30 μ. It has four denticles on either side. The lateral teeth are thin, smooth plates with a triangular tooth whose appearance varies widely, according to the angle of viewing. The glands of the oral cavity [31] are long clusters of spherical cells and reach beyond the female gland mass, hence reach the middle of the body.

The hermaphrodite gland [59] (pl. 9, fig. 171) consists of two large follicles, one behind the other. The male cells occupy the centers, and the heads of the ripe sperm-cells are fastened to the ventral wall. Numerous female acini cover the dorsal surfaces. The two hermaphrodite ductules leave the dorsal sides of the follicles and run forwards uniting [60] at the level of the anal papilla. Farther anteriorly the hermaphrodite duct enters a tubular ampulla [62] composed of two sections. The proximal one is narrow and directed backwards. It opens into the large and muscular distal part, from which oviduct [65] and vas deferens [66] arise separately.

The vas deferens is simple, muscular and loops before it enters the penis [70]. The end of the ejaculatory duct joins the wide duct of the voluminous prostate [67]. The tip of the papilla bears a cuticular stylet about 50 μ long. The penis is 400 μ long, 120 μ thick; the prostate is 700 μ long, 400 μ in diameter and is connected with the body wall by a retractor [73].

The short and wide oviduct [65] opens into the female gland mass [91]. In the beginning there is a small fertilization chamber. At the end of the glandular part a long, wide ciliated nidamental duct [95] leads to the folded female atrium [81]. From a posterior fold of the latter a quite short vagina [82] goes to the spherical spermatheca [86].

The name of this species is derived from a folklore name of a seal {see explanation in the introduction. — Ed.}.

The holotype is a series of cross sections (one slide); the paratype is the radula of another animal.

Discussion of
Capellinia rustya Marcus, spec. nov.

Only one eubranchid is known from the North Pacific: Galvina olivacea O'Donoghue (1922a, p. 158). As its penis is not described, one can not tell whether it is a Capellinia with armed penis, or Eubranchus without stylet. The radula of G. olivacea, expressly characterized as "not tapering" shows that C. rustya is not the same species.

Vayssière's Mediterranean Galvina farrani (for literature see Marcus 1958b, p. 45) has a penial stylet (Vayssière 1903, p. 86, pl. 2, fig.

14). The description of the single specimen found by Vayssière is different only in color from Capellinia rustya. The Mediterranean C. doriae and C. capellinii Trinchese (1877-1879, pls. 24 to 27) have broader lateral radular plates than C. rustya; those of C. doriae were drawn by Vayssière (1888, pl. 7, fig. 125). C. conicla Marcus (1958b, p. 41) from Brazil and Florida has fewer denticles on the rachidian tooth and a longer vagina.

45. *Fiona pinnata* Eschscholtz, 1831
(Plate 10, Figures 173 to 179)

PRINCIPAL REFERENCES: Alder and Hancock 1855, vol. 7, fam. 3, pl. 38a; Bergh 1874, pp. 605-610 (literature), pl. 8, figs. 2-11, pl. 9, fig. 13; 1879b, pp. 85-88, pl. 1, figs. 7-8; 1884a, p. 9; 1892b, pp. 6-8, pl. 1, figs. 7-16; 1894, pp. 130-132, pl. 1, figs. 13-15; Casteel 1904, pp. 325-405, pls. 21-35 (development); O'Donoghue 1922b, pp. 145-147 (oldest name); 1926, p. 234 (valid name); Russell 1929, p. 210 ff., textfigs. 2, 3 (nervous system); Hoffmann 1939, fig. 789 E (inner organs); Baba 1949, pp. 101, 176 (colored figure: pl. 43, fig. 149); Pruvot-Fol 1954, pp. 438-439 (figures from various sources).

OCCURRENCE: Shell Beach, Sonoma County; animals and egg masses on a log washed ashore, 1. IV. 1958; Dillon Beach, with lepadids on a board found on the beach, 4. VI. 1958. A total of 37 specimens.

Further distribution: Pacific North America: Alaska, Sitka, on a piece of wood washed ashore; 800 km. off San Francisco, feeding on Velella; on driftwood bearing cirripede colonies in Monterey Bay (Smith and Gordon 1948, p. 181 - quoting from MacFarland); North Pacific Ocean (Bergh 1894). Elsewhere: pelagic and gregarious in warm and temperate seas, feeding on Chondrochorae (Velella, Porpita) and Lepadidae, also found on driftwood, algae (Sargassum, Macrocystis), pumice, and floating buoys.

The length of our preserved specimens is 17 mm., the height 7 to 8 and the breadth 5 mm.; the cerata are up to four mm. long (pl. 10, fig. 173). The living animals may attain a length of 25 mm. The color is yellowish or reddish with grey cerata which leave one third of the back free in the middle.

The head is long and narrower than the body, which is broadest in the middle. A four mm. long pointed tail bears no cerata. The male pore [76] is ventral to the interspace between right tentacle and rhinophore, and the female aperture [80] is slightly posterior. The anus lies approximately in the middle of the body, near the cerata of the right innermost row, and the renal pore a little anterior to it on a small papilla.

Tentacles and rhinophores are of nearly equal length, smooth, pointed, and have broad rounded bases. The anterior border of the foot is indistinctly notched in the middle, not grooved, and without produced angles. A small lobe on either side connects the foot with the lips. The lateral borders of the foot are undulated.

The cerata (pl. 10, fig. 174) cover uniform fields which end with a straight line to the sides. The smallest cerata are the outer, the largest the inner ones. They contain diverticula of the digestive gland [42] but no cnidosacs. Those of about four of the inner rows bear a branchial fold [15] in which runs the vessel that leads the blood to the auricle.

The small pharynx is longish. The yellowish jaws (pl. 10, figs. 175, 176) have a row of round rugged knobs on their masticatory process. The radula has 36 to 40 teeth which are smaller in the lower than in the upper limb (pl. 10, fig. 177). On each side of the large median cusp there are five to seven smaller denticles. The wall of the stomach is stippled with pigment. The duct of the posterior and the left anterior digestive glands open near together. On both sides the anterior and posterior portions of the digestive gland form continuous sausage-shaped unbranched tubes which give off a diverticulum to every ceras (Odhner in Hoffmann, l. c.). In the posterior end of the body the digestive gland tubes of both sides are confluent.

The hermaphrodite gland has separate male and female follicles; the latter are smaller and surround the bigger male follicles (Pelseneer 1894, fig. 144). The penis (pl. 10, fig. 178 [70]) is ten mm. long, 0.25 mm. in diameter, lying in a narrow tubular atrium [75] and projecting from the male aperture [76] with its thread-like tip.

46. *Precuthona divae* Marcus, spec. nov.
(Plate 10, Figures 180 to 184)

OCCURRENCE: Dillon Beach, 4. VI. 1958 (type locality: 38° 15'N; 122° 58'W): three specimens.

The preserved animals are five, seven, and eight mm. long, the cerata maximally 3 mm. high (pl. 10, figs. 180, 181). The collector's sketch of a living animal shows rhinophores a little longer than the tentacles; in the preserved condition both are about one mm. long. The rhinophores [5] are smooth or somewhat wrinkled by contraction, not perfoliated. The cerata are sausage-shaped and cylindrical with nearly blunt tips. The digestive diverticula within the cerata are knobby; the cnidosacs are about 0.2 mm. long. A dense layer of gland cells is located under the epidermis of the cerata and fills the space between epidermis and diverticulum. In the living state the dark digestive diverticula shine through the walls of the cerata; preserved the animals are ivory. Black eyes lie behind the rhinophores. There is no true veil which Pruvot-Fol (1954, p. 386) attributes to Cuthona and Precuthona, but a broad head, as is characteristic of Cuthona and present also in Precuthona peachii (Alder and Hancock 1854, fam. 3, pl. 10, fig. 1). The tentacles [2] are directed forwards beyond the round border of the head. The antero-lateral corners of the foot are slightly prominent, to the same extent as in C. distans Odhner (1922, fig. 11). The anterior border of the foot is weakly notched. The lateral pedal edges are thickened. The tail is short.

In the sketch of the living animal the cerata containing the dark digestive diverticula cover the back as a uniform pelt, leaving only the cardiac region free. The cerata form dense groups whose series can be recognized but are barely defined by the connecting branches of the digestive diverticula which are extremely narrow and pale. As in Precuthona peachii (Odhner 1939, p. 67) the number of rows increases towards the margins of the back by branching. The difference in size between the smaller outer and longer inner cerata is not pronounced. The number of the cerata belonging to the right digestive gland is 25 in a larger, 40 in a smaller specimen, hence obviously insignificant for the description. The bilabiate genital aperture [77] is located below the first group of cerata of the right digestive gland. The borders of the pore bulge.

The interhepatic space follows the fourth inner row of cerata which corresponds to the seventh row at the margin of the foot. On this level lies the ventricle [27] with the root of the aorta turned towards the right, farther to the side the renal pore [25], and close to the latter the anus [45]. In relation to the height of the animal the anus is situated a little over the middle. The adanal stem of the posterior digestive gland extends dorsally beyond the anus and ends in front of the latter without encompassing it. If this stem were counted as the first branch of the posterior digestive gland, the anus would be considered as lying between first and second branch of the posterior digestive gland, but actually it is interhepatic.

The jaws (pl. 10, fig. 183) are very weak and fragile. The masticatory border bears a single row of about 15 blunt denticles; the anterior ones are small, the hindmost rather large. Also the radular membrane is weak and the teeth lose their connection easily. The eight mm. specimen had 21 radular teeth with a strong middle cusp as in Cuthona and three to nine smaller denticles on either side. The base of the tooth is prolonged towards the sides and forms square wings of soft and colorless cuticle [34], which contrast with the yellowish middle part, but are not separated from it (pl. 10, fig. 182). This structure is somewhat similar to Bergh's drawing (1884a, pl. 12, fig. 11) of the base of the radular tooth of Cuthonella abyssicola.

The follicles of the hermaphrodite gland are separate, the female ones surround those with sperm. The rather short, glandular male duct [66] enters the penis (pl. 10, fig. 184 [70]). The base of the latter is spherical, its termination an unarmed, pointed cone. The base is continued into a carrot-shaped gland [72] which opens into the penis without a special duct and ends blindly in the body cavity.

The species is named for Dr. Diva Diniz Corrêa.

The holotype is the seven mm. long animal.

Discussion of
Precuthona divae Marcus, spec. nov.

In the acleioproct Eolidacea a uniseriate radula originates by reduction of the lateral plates of the Eubranchidae (Odhner 1940, p. 6). The present species indicates that similar vestigial lateral plates occur in a cuthonid. This character distinguishes it from the only other species of the genus, Precuthona peachii (Alder and Hancock, 1848). Also the single row of denticles on the mandibular masticatory process differs from the two to three rows of small, irregularly crowded tubercles in P. peachii (Odhner 1939, p. 71). Worn jaws have a smooth masticatory border, and on such the description (Odhner 1927, p. 18) cited in Thiele's handbook (1931, p. 455) was based. Aeolis (Cratena) nana from the Bering Sea (Krause 1885, p. 296) is Precuthona peachii (Odhner 1929, p. 16).

Pruvot-Fol (1954, p. 386) separates Precuthona merely as a subgenus from Cuthona. A penial gland fixed to the male atrium without a narrow duct occurs also, it is true, in some species of Cuthona (Odhner 1944, fig. 36). Other cuthonids have a narrow duct of this gland opening into the base of the penis or into the middle of the efferent duct, while still others have no penial gland. The classification of the family evidently cannot be based upon this organ. However, the digestive diverticula of Precuthona are peculiar. Some of the diverticula in front of and behind the anus supply double series of cerata. The postanal stem sends a short branch forwards, whose few cerata lie in front of the anus. This constitutes a precursor of the cleioproct condition and justifies the generic separation of Precuthona from Cuthona.

47. *Catriona ronga* Marcus, spec. nov.
(Plate 10, Figures 185 to 187)

OCCURRENCE: Point Pinos, Pacific Grove (type locality: 36° 38' 15" N; 121° 56' W); one specimen.

The animal is five mm. long and 1.5 mm. high without cerata. The lengths in millimeters are: tentacles 0.4; rhinophores 0.8; cerata 1.0; cnidosacs 0.2. Both, in the living and in the preserved state the animal is white with dark brown digestive diverticula in the cerata. The antero-lateral corners of the foot are rounded, not produced.

There are eight rows of cerata, three of which belong to the anterior digestive glands. The rows on the right side contain: 4, 6, 8; 6, 5, 4, 4, and 3 cerata; those on the left side: 4, 5, 6; 6, 5, 4, 3, and 2 cerata. These numbers have only an approximate value, because several smaller cerata may regenerate in the place where a larger one had fallen off.

The anus lies on the right side in front of the fourth row, the genital aperture under the second right row. A slender penis [70], about 0.3 mm. long and 0.1 mm. thick, projects from the genital opening. The tip of the penis bears a stylet 40 μ long.

Vaulted, oval, brown jaws surround the pharynx. Their masticatory process is bordered by a single row of 12 to 15 knobs. The 40 teeth of the radula are of equal size (pl. 10, fig. 187). In side view the middle cusp projects strongly, but seen from the front all denticles are of the same size, except for the outermost ones which decrease somewhat in size. The median cusp is flanked by four to five denticles.

The name of this species is derived from a folklore name of a seal {see explanation in the introduction. — Ed.}.

The holotype is the single specimen collected and described.

Discussion of
Catriona ronga Marcus, spec. nov.

The only species of Catriona known from the North American Pacific coast, C. columbiana (O'Donoghue 1922a, p. 160), differs from C. ronga by its tiny spines between the bigger cusps of the tooth.

From our recent list (Marcus 1958b, pp. 49 to 52) only the North Pacific species with three to four rows of cerata in the anterior digestive glands can be compared. Of these Catriona bicolor (Bergh 1904, p. 3) and C. ornata (Baba 1937, p. 331) have produced antero-lateral foot corners; C. venusta (Baba 1949, pp. 98, 174) and C. puellula (Baba 1955, pp. 28, 52), a maximum of four cerata in one row. Catriona anulata (Baba 1949, pp. 98, 175) has a series of constrictions, C. pinnifera (ibid., pp. 99, 175) pinnae on the rhinophores. Catriona nigricolora (Baba 1955, pp. 29, 52) is black.

48. *Hermissenda crassicornis* (Eschscholtz, 1831)
(Plate 10, Figures 188 to 192)

PRINCIPAL REFERENCES: Cooper 1862, p. 205; 1863, p. 60 (first Californian localities); Bergh 1879a, pp. 573-574 (genus); 1879b, pp. 81-85, pl. 1, fig. 9, pl. 2, figs. 1-6 (preserved material); Kelsey 1907, p. 33; O'Donoghue 1921 pp. 201-204, pl. 3, fig. 32 (living animals); 1922b, p. 133 (name); 1922c, pp. 125-126 (color variation); 1926, p. 233 (literature); 1927a, pp. 107-108, pl. 3, figs. 74-76; Costello 1938, p. 321 ff., pl. 1, fig. 19, pl. 2, figs. 33-35, 42-43 (eggs); MacGinitie 1949, p. 257 (copepod on surface); Ricketts and Calvin 1952, p. 144 (magnified photograph), p. 267.

OCCURRENCE: Dillon Beach, 4. VI. 1958; outer coast of Tomales Point, 20. IV. 1958; Tomales Bay, on mud flats with eel grass, numerous animals and egg strings, 21. V. to 20. VI. 1958; one animal in six meters depth (19. III. 1958). A total of 40 specimens was preserved, although many more were seen. Point Pinos, Pacific Grove: two specimens.

Further distribution: San Diego; La Jolla; Laguna Beach; San Pedro; Santa Barbara; Monterey Bay; Vancouver Island region; Alaska, Sitka. Mud-flats, on Ulva and other algae of rocky shores, and in depths to 30 meters.

The largest preserved specimens in this collection are 25 mm. long, 10 mm. broad and 9 mm. high without the cerata, which latter are up to seven mm. long. The maximum length of living animals is 55 mm. (O'Donoghue 1927a, p. 108).

The highly variable color of the living animals is generally transparent yellowish to bluish grey, yellow-green or grass-green. The cerata may be translucent like the body, reddish with light blue, green, orange or white specks, probably cutaneous glands. The cnidosacs in the tips of the cerata are 0.4 to 0.5 mm. long. They are transparent and separated from the rest of the cerata by a white, orange, yellow, purple or sometimes blue ring. On the outer side of the ceras runs a white line up to this ring. The smooth digestive diverticulum in the ceras is sand-colored, reddish to chocolate-brown or black. In the present preserved specimens the upper part of the diverticulum is darker than the lower one. In the posterior part of the back the branches of the digestive gland shine through the skin. A brilliant white, opalescent, yellow or blue line runs forward from the tip of the tail. Posteriorly this line is broad, then it subdivides into two to three streaks which surround an orange, sometimes absent patch. Orange spots may occur at the bases of the rhinophores. Along the margin of the foot runs a light line and there is also one beneath the cerata which passes far on to the back between the groups.

The brownish preserved animals show one to three white dorsal lines, the lines along the pedal margin and below the cerata, and white marks on the tips of the tentacles. The head is rather large; the tentacles of the living animal are up to 18 mm. long, considerably longer than the rhinophores which have up to 24 perfoliations. The eyes lie behind the rhinophores. The foot is broader than the back, its anterior border is bilabiate and notched; the lateral angles are produced into horns about four mm. long in living animals. The tail is pointed.

The anus is dorsal and situated behind the second group of cerata. The genital apertures lie below the posterior part of the first group, about seven mm. behind the anterior end in preserved specimens. The renal pore is lateral and located between the first and second group of cerata.

The conical cerata are arranged in about 11 groups. The right digestive gland has two lobes, one with five and the other with four rows. Each row contains about nine cerata. The right posterior digestive gland has about eight rows with ten cerata each in the second group, the number of cerata decreasing to three in the eleventh group. The total number of cerata is about 500.

The masticatory border of the jaw bears a single series of up to 50 denticles which increase in size posteriorly (pl. 10, figs. 188, 189). The inner surface of these denticles is set with knobs whose bases are crenulate. The uniserial radula has up to 28 teeth with four to six sharp spines on either side of the middle cusp whose under surface bears a row of up to 15 small points (pl. 10, figs. 190, 191). The alimentary tract of the specimens examined contains hydroids, diatoms, and in one animal it was full of tufts of fungal threads.

The hermaphrodite gland is a follicular organ which fills the posterior part of the body cavity. In a sectioned specimen of eight mm. length this gland was in the male phase with small ovocytes at the periphery. The muscular hermaphrodite duct (pl. 10, fig. 192[60]) runs forward over the female gland mass. It is continued into a winding ampulla [62] containing sperm followed by a short spermoviduct [63] which divides into a narrower oviduct [65] and a wider vas deferens [66]. The wall of the latter is glandular and coated with muscles. The part of the vas deferens that runs through the penis [70] is ciliated and glandular. The penis, a muscular tube, is projected to an extent of seven mm. in most of the present specimens; its root is surrounded by the remaining invaginated part of the atrium [75] and fastened to the body wall by a strong retractor [73]. The penial cylinder bears a flap on its dorsal surface. Farther distally it has a girdle of about three rows of round knobs followed by a cuticularized zone. The cuticle is thrown into crisscross folds underlain by lamellar structures. The penis terminates with a ciliated lobe on whose bottom the vas deferens opens.

Where the oviduct [65] enters the female gland mass [91] there lies a small ciliated spermatheca [86], without alien sperm in the sectioned specimen (which is in the male phase). A narrow, thickly muscular nidamental duct [95], about 0.2 mm. long, leaves the folded gland mass. The female atrium [81] is a strongly muscular sac greatly extended backwards behind its outer opening [80]; it receives the blue-staining secretion of glands [79] in its outer part.

The color of the egg string varies from white to pink. The egg capsules within the spiral ribbon are arranged as an imperfect helix and number up to 90'000 (Ch. and E. O'Donoghue 1922, p. 136; Costello 1938, l. c.). At Dillon Beach the species spawns in May and June as in the Vancouver Island region, while February and March are recorded farther southward on the California coast (Costello 1938, p. 327).

49. *Aeolidia papillosa* (Linnaeus, 1761)
(Plate 10, Figures 193 to 195)

REFERENCES to NORTH PACIFIC MATERIAL: Bergh 1879b, pp. 74-77 (papillosa and var. pacifica, pl. 1, figs. 1-6); 1894, pp. 128-129, pl. 1, figs. 8-12 (herculea); O'Donoghue 1921, pp. 199-201, pl. 3, fig. 31 (var. pacifica suppressed); 1922b, p. 141 (herculea a synonym); 1922c, p. 125 (color variation); 1926, p. 232 (literature); 1927a, pp. 108-109, pl. 3, fig. 77; Baba 1935b, pp. 121-123, pl. 8, figs. 3-5 (alive white with black cerata); Abbott 1954, p. 308 (colored figure: pl. 15, g).

OCCURRENCE: Dillon Beach, 8. III. to 15. VII. 1958; five specimens.

Further distribution: North Pacific: Laguna Beach; Santa Barbara, in 760 m.; Monterey Bay (Smith and Gordon 1948, p. 181); Vancouver Island region; Alaska; East coast of Hokkaido; Sakhalin. Elsewhere: North Atlantic Ocean southward to France and Portugal, possibly to the Mediterranean (Pruvot-Fol 1954, p. 427, note 1); East coast of North America, south to Rhode Island. Perhaps the great number of denticles on the radular tooth allows for a varietal separation of the antiboreal South American specimens from Valparaiso to Falkland Islands (var. serotina Bergh, 1874).

The largest of the preserved specimens from Dillon Beach was 30 mm. long alive whereas in the preserved condition it was 25 mm. long and 8 mm. broad (pl. 10, fig. 193). The color of the living animal was pink, especially the cerata, which were sometimes red. The densely branched digestive diverticula shine dark through the skin of the cerata. The back may bear silvery dots. After preservation the animals were yellowish, in part with dark digestive diverticula.

The tentacles and smooth rhinophores are contracted to small warts. The foot has a bilabiate anterior border and slightly produced lateral angles. The tail is quite short.

The flattened cerata, broad below and pointed at the tip, form 19 oblique rows of about 12 cerata each. The middle of the back is free of cerata in the anterior region over the heart. The anus lies between the eighth and ninth rows of cerata, the renal pore a little in front of it to the right of the cerata.

The masticatory process of the jaw plate (pl. 10, fig. 194) is very broad in the present specimens. Its edge is smooth. The radula of the largest animal has 21 teeth whose denticles, up to 58 in number, are not interrupted in the mid line (pl. 10, fig. 195).

The genital aperture is lateral to the fifth row of the right cerata. The hermaphrodite gland is lobed, the ampulla long and twisted. The vas deferens forms a voluminous coil whose inner windings are glandular, the outer ones muscular. The conical penis is unarmed. The spermatheca is connected with the inner oviduct by a long duct before the entrance of the latter into the gland mass. The anterior male and the posterior female opening are united and share a common external aperture. An average member of this species lays about 70'000 eggs in one spawning (Ch. and E. O'Donoghue 1922, p. 136).

Discussion of
Aeolidia papillosa (Linnaeus, 1761)

The range of variation in Aeolidia papillosa is great as in many other widely distributed species. It involves the number of rows of cerata and radular teeth, the more or less vaulted mandibular plate (A. herculea), and the broader or narrower masticatory process. A slightly deeper incision between the median denticles of the radular tooth (O'Donoghue 1921, fig. 31; 1927 a, fig. 77) also does not constitute a specific character.

The position of anus and genital aperture in the Dillon Beach material agrees with Odhner's description (1939, p. 82, fig. 49). The location of the renal pore is not constant, as we noted in our discussion of slugs from Southern Chile (Marcus 1959, p. 84).

50. *Spurilla chromosoma* (Cockerell & Eliot, 1905)
(Plate 10, Figures 196 to 199)

REFERENCES: Cockerell and Eliot 1905, pp. 51-52 (one specimen, not figured); O'Donoghue 1927a, pp. 109-110, pl. 3, fig. 78 (radular tooth; one specimen; name: Eolidina orientalis).

OCCURRENCE: Cooling galleries of San Diego Power and Light plant; Point Loma; a total of five specimens.

Further distribution: Laguna Beach; San Pedro.

The preserved specimens are up to 12 mm. long, four mm. high including the cerata, and five mm. broad (pl. 10, fig. 196). Alive they were white with brilliant orange, white - tipped cerata and an orange dorso-median band broadened in front. The orange tone varied in the three specimens of the first lot; the color of the two from Point Loma was light brown. Groups of silvery dots occur on the cerata. The preserved animals are opaque whitish with two black eyes behind the rhinophores.

The tentacles [2] of the living animals were longer than the perfoliated rhinophores[5]. The anterior angles [23] of the foot are produced and bent backwards. The anterior pedal border is bilabiate with a slight median recess. The collector noted a long thin tail in life, while in the preserved specimens it is quite short. The edge of the foot is undulated. Evidently these animals contract considerably when preserved, as does Spurilla neapolitana, which loses one third of its length even when completely anaesthetized.

The cerata are two mm. high in the preserved condition, curved and with pointed ends. Those of the type specimen were easily deciduous, possibly because the specimen had been preserved without special techniques. The cnidosacs are 0.3 mm. long. The right digestive gland and the anterior left digestive gland are pectinate with five to six rows of about four cerata each. The posterior digestive gland of the largest animal comprises four horseshoe arches followed by three single rows. The cerata of the first two arches are not quite uniserial. The anus [45] lies in the first arch and the renal pore [25] in front of the anterior limb of this arch. The two genital apertures are situated close together, ventrally to the middle of the right digestive diverticula. The heart [27] is located in the interhepatic space.

The yellow jaws have smooth masticatory borders(pl. 10, fig. 198). The maximum number of radular teeth was 21. The median cusp is short and broad; the denticles (about 30 in number) on either side are longer and thinner. The base of the tooth is narrowest in the middle and broadened towards the sides (pl. 10, fig. 199). The range of variation known for Spurilla neapolitana (Marcus 1955, pl. 30) makes the difference between the radular tooth of O'Donoghue's material (1927a, fig. 78) and the present one (pl. 10, fig. 199) insignificant.

The hermaphrodite gland consists of voluminous lobes; the ampulla is a wide tube. The vas deferens begins with a long and coiled glandular, so - called prostatic part. It is followed by a thick and muscular, but not glandular, tube which ends as a small, unarmed and conical penis in the male atrium. Oviduct and vagina open close behind the male aperture. The vagina is an extensive organ which leads to a spermatheca lying far inwards. Thus the reproductive organs are rather similar to those of Spurilla neapolitana (Marcus 1957, figs. 234, 235), but in this latter species the entire vas deferens is glandular.

Discussion of
Spurilla chromosoma (Cockerell & Eliot, 1905)

The Eolidacea Cleioprocta with pectinate radular teeth constitute the family Aeolidiidae. Phyllodesmium Ehrenberg, 1831, which Bergh (1892a, p. 1021) included with his Aeolidiadae propriae, does not belong to the Aeolidiidae; its radular tooth is not pectinate (Baba 1933, fig. 7, c). The remaining genera of the family can be classified by aid of the following key:

1) Rhinophores smooth, sometimes wrinkled in preserved specimens 2
- Rhinophores with papillae or perfoliated . 5

2) Radular tooth regularly arched. 3
- Radular tooth emarginated in the middle . 4

3) Many series of cerata on either side of the back . . . . . . Aeolidia Cuvier, 1798
- A single series of cerata on either side of the back . Aeolidiopsis Pruvot-Fol, 1956

4) Anus between the cerata of the posterior digestive gland . . Aeolidiella Bergh, 1876
- Anus lateral to the cerata of the posterior digestive gland . Protaeolidiella Baba, 1955

5) Rhinophores with papillae. 6
- Rhinophores perfoliated 8

6) Right and anterior left digestive gland with one arch or two rows of cerata 7
- Right and anterior left digestive gland with more than two rows of cerata . . . . Baeolidia Bergh, 1888

7) Right and anterior left digestive gland with one arch of cerata Berghia Trinchese, 1877
- Right and anterior left digestive gland with two rows of cerata . . . . Limenandra Haefelfinger and Stamm, 1958

8) Radular tooth with regularly graded, smooth denticles Spurilla Bergh, 1864
- Radular tooth with denticles of different sizes, some of them bearing secondary prongs . . . . . Cerberilla Bergh, 1873 (synonym: Fenrisia Bergh, 1888; see Pruvot-Fol 1934, pp. 51, 81).

The two Californian species of Spurilla are said to differ by color and length of tail, both precarious characters in this genus. In S. neapolitana the color varies greatly in animals from one and the same locality, as Vayssière's figures show (1888, pl. 1, fig. 9; 1901, pl. 1, fig. 24). The last figure refers to S. inornata (A. Costa, 1866) whose independence (Vayssière 1903, p. 86) was justly abolished later on (1913a, p. 300). The digestive gland of a variety of S. neapolitana was described as dark green (Pruvot-Fol 1953, p. 56). A single specimen does not permit evaluation of the specificity of a short tail, as that might be regenerating. The arrangement of the digestive diverticula in S. chromosoma and S. orientalis was not described. The radulae do not differ, and therefore we prefer to apply the oldest name given to a Spurilla from Southern California to the present material. If S. orientalis O'Donoghue is indeed a separate species, it must be re-named, because it is homonymous with S. orientalis Bergh (1905a, p. 223).

In Spurilla neapolitana the right and the anterior left digestive glands each form a single arch. The masticatory border of the jaw is denticulated in S. orientalis Bergh, a strange feature in Spurilla, and the anus lies behind the second series of cerata of the posterior digestive gland. The species from Indochina with perfoliated rhinophores that Risbec (1956, p. 31) called Aeolidiella (? takonosimensis Baba, 1930) must be allocated to Spurilla. Baba's species (1949, pp. 111, 183) has smooth rhinophores, and its radular teeth have fewer denticles. Risbec's species must receive a new name and we propose Spurilla risbeci nom. nov., for it. It differs from Sp. chromosoma by a bilobed radular tooth.

Zoogeographic Remarks

The richness of the Pacific coast of North America in species and individuals of opisthobranchs (Ricketts and Calvin 1952, p. 79) is illustrated by the present collection. In the Monterey area Mr. Edmund H. Smith collected 80 specimens of 16 species in a tide-pool within two hours. Certainly the total of known Mediterranean opisthobranchs is greater, to judge from O'Donoghue's lists of nudibranchs (1926, 1929b), probably because in the Mediterranean research was started some hundred years earlier and was carried on with greater intensity. Novelties from the American West coast can still be expected in the genera with small species, principally Ascoglossa and Eolidacea, and in collections from warm-temperate and tropical coasts. Re-examination of some older species, e. g. Triopha catalinae, Tritonia palmeri, and Armina californica, is urgent, because the original localities are menaced by increasing industrialization.

Most of the North American Pacific opisthobranchs are confined to the boreal and warm-temperate littoral of this region (see Hedgpeth 1957, pl. 1) and do not occur elsewhere. In the present collection the endemic element amounts to 70%. Of the remaining, 16% transgress the southern limit, San Diego. Aeolidia papillosa var. serotina was included in this group. Six percent extend beyond the western limit, the Aleutians and another 6% beyond the western and northern limit, the Bering Strait. The last group comprises the typical Aeolidia papillosa, though its former Arctic records, Spitsbergen and East Greenland have been cancelled (Lemche 1941, pp. 4, 27). But it can be expected to live on the coast of Siberia, because a boreal Atlantic and Pacific cold-water species (Løyning 1922, p. 71) must be connected by Arctic occurrences. Species found on the Pacific coast of North America and Japan, as well as in the Arctic, are northern natives spreading southwards on both coasts of the Pacific Ocean.

Tritonia exsulans, whose range extends from the Gulf of Mexico to Sakhalin, and Fiona pinnata, a pelagic species of all warm and temperate seas, were excluded from the preceding geographic groups.

In contrast to its occurrence in the European intertidal zone (Odhner 1939, p. 84) Aeolidia papillosa shows a wide vertical range on the American Pacific coast. Possibly this indicates an equatorial submergence of the species whose closely related variety serotina has reached the Middle and South Chilean littoral, whence it extends to the Magellanic region. The broad interval in the horizontal range of Cadlina sparsa and Rostanga pulchra, both also found in Chile, is probably due to gaps in our knowledge regarding the Pacific South American opisthobranch fauna.

The present collection comes chiefly from the cool Dillon Beach area. Probably therefore it contains few warm-water testimonies of the Tertiary Carribbean - Pacific sea-connection mentioned in the discussion of Elysia hedgpethi. Rostanga pulchra and Capellinia rustya seem to belong to this group, since their nearest related species, R. byga Marcus (1958b, p. 22) and C. conicla (ibid., p. 41) occur in the warm West Atlantic. A striking example of this ancient marine continuity is the eurythermic Tritonia exsulans from the Gulf coast of Florida and the Pacific coast of Lower California (see species 31, above).

The range of the two cold-water species, Onchidoris bilamellata and Dendronotus frondosus, both hitherto known only from as far south as Vancouver, is now extended further southwards to Dillon Beach and Monterey respectively. Onchidoris hystricina, heretofore recorded only from one island of the Aleutians, was found at Dillon Beach.

There are two connections between Japan and the West American littoral. A current favorable for cold-water species is the Oyashio which originates in the Seas of Bering and Okhotsk and courses along the East coast of Hokkaido and Honshu in winter. The other current is known to transport buoys from the mouth of the Amur, camphor trees, driftwood, wrecks and vessels from Japan to the Aleutians, Alaska, Vancouver, and even to Point Conception. This West Wind Drift originates from the warm Kuroshio. It bifurcates where it meets the American coast, in February at Cape Mendocino, in August off Juan de Fuca Strait. The distribution of the following species in the present collection seems to be related with the West Wind Drift: Aldisa sanguinea, Triopha carpenteri, and the five new species: Chelidonura phocae, Crimora coneja, Doto ganda, D. wara and Coryphella piunca, whose closest relatives are known from Middle Japan. The two old species of this list have been found on the coast of California long before oysters were imported from Japan. The Oyashio may be responsible for the Asiatic occurrences of three North American species of Tritonia:

1) Tritonia undulata (O'Donoghue 1924, p.3) from the Vancouver area and South East Hokkaido (var. muroranica Baba 1940, p. 106)
2) Tritonia exsulans found on the coasts of Northern Japan and Sakhalin, and in the Sea of Japan.
3) Tritonia diomedea Bergh (1894, p. 146) found off San Diego and Santa Barbara (in 657 and 757 m.), the area of Vancouver (in 27 to 46 m.), Shumagin Islands, Sea of Okhotsk and North Japan from the littoral to 500 m. (Volodschenko 1955, p. 182).

Diaulula sandiegensis, a littoral species occurring on the warm-temperate and boreal coasts of West America, from San Diego to the Aleutians, and in Northern Japanese waters, may have reached Japan from the Bering Sea or America by the West Wind Drift.

The southern branch of this Drift, the California current, substitutes the water that is removed by the north-easterly trade wind towards West to the North Equatorial Current. Therewith cold upwelling water is brought up on the terrestrial flank of the California Current (Ricketts and Calvin 1952, p. 347), especially in the warmer months (Krümmel 1911, pp. 704 to 708). The northern Pacific coast of North America is warmed by the northern branch of the West Wind Drift and therefore its winter temperatures are higher than what corresponds to the latitude; the summer temperatures of the central and southern coasts are lower. In spite of these, on the whole balanced, thermic conditions, Point Conception represents a certain limit between northern and southern West coast opisthobranchs, as for other littoral animals (Hedgpeth in Light's Manual, 1954, p. 202). This statement may be modified by further research, chiefly in Southern and Lower California whose inventory is far less complete than that of Central California north of Point Conception. We only count species represented in our collection, because we know their exact systematic status. Then we obtain two species, Bulla gouldiana and Spurilla chromosoma, not yet found North of Point Conception, and nine, without the new ones, not yet found South of it: *Onchidella borealis, Aglaja diomedea, *Onchidoris bilamellata, *Onchidoris hystricina, Tritonia festiva, Hancockia californica, *Dendronotus frondosus, *Doto columbiana, and *Armina columbiana. The range of the six species marked with asterisks has now been extended from Oregon (Armina columbiana), Vancouver, or the Aleutians to the area of Dillon Beach or even Monterey. With the exception of Dendronotus frondosus the species marked with asterisks occur in the Dillon Beach area, but not at Monterey. Four other species known from Monterey Bay were not yet verified at Dillon Beach: Hancockia californica only found at Monterey; Navanax inermis, a mainly southern species, rare at Elkhorn Slough (MacGinitie 1935, p. 737; Smith and Gordon 1948, p. 179); and the likewise more southern elements Ancula pacifica and Dendrodoris fulva. The Dendrodoridae live in warm and warm-temperate seas, so that the frequent occurrence of D. fulva in Monterey Bay is remarkable.

Two species, Leila cockerelli and Acanthodoris rhodoceras, are not known from Dillon Beach and Monterey Bay respectively, although their total ranges include these areas. These cases must be considered as fortuitous results of collecting.

The present collection contains six cases in which the northernmost occurrence is extended from Monterey Bay to Dillon Beach; and four in which the southernmost occurrence is extended from Laguna Beach to San Diego.

{Some idea of the complexities of oceanic conditions along the Pacific Coast of North America may be gained from the recent Report of the California Cooperative Oceanic Fisheries Investigations (Volume 7, January, 1960). Current patterns and consequent water temperature distributions are not the unchanging stable factors for distribution that classical biogeography implies. Thus, while our marine coastal faunas do indicate in a general way such general temperature conditions as cool and warm temperate, there are many species that may fluctuate in their occurrence from place to place. Many years ago, for example, Lonax was reported at Dillon Beach but it has not been seen there for at least ten years. With such changing conditions it is surprising, not that so many new extensions of range are recorded, but that there are endemic species.

— J. W. Hedgpeth.}

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Plates and Figure Explanations

Explanation of Plate 1

Onchidella borealis Dall

Figure 1: Dorsal aspect of living animal, from sketch by Dr. Diva Diniz Corrêa.
Figure 2: Male copulatory organ.

Bulla gouldiana Pilsbry

Figure 3: Half row of radula.
Figure 4: Male copulatory organ.

Haminoea virescens (Sowerby)

Figure 5: Shell seen from aperture.
Figure 6: Shell seen from below.
Figure 7: Apex of shell.
Figure 8: Radular teeth.
Figure 9: Male copulatory organ.

Aglaja diomedea (Bergh)

Figure 10: Dorsal view of living animal, from sketch by collector.
Figure 11: Shell seen from below.
Figure 12: Male copulatory organ.
Figure 13: Tip of penis.

Navanax inermis (Cooper)

Figure 14: Frontal and right side view of preserved specimen. The furrow between right parapodium and head shield unfolded.
Figure 15: Shell.
Figure 16: Male copulatory organ; dorsal side of atrium opened.

Chelidonura evelinae Marcus (from Brazil)

Figure 17: Male copulatory organ.

Chelidonura phocae spec. nov.

Figure 18: Dorsal view of living animal, from sketch by collector.
Figure 19: Anterior region of preserved specimen.
Figure 20: Outer side of shell.
Figure 21: Inner side of shell.
Figure 22: Inner reproductive organs.
Figure 23: Retracted male copulatory organ.
Figure 24: Protruded male copulatory organ.

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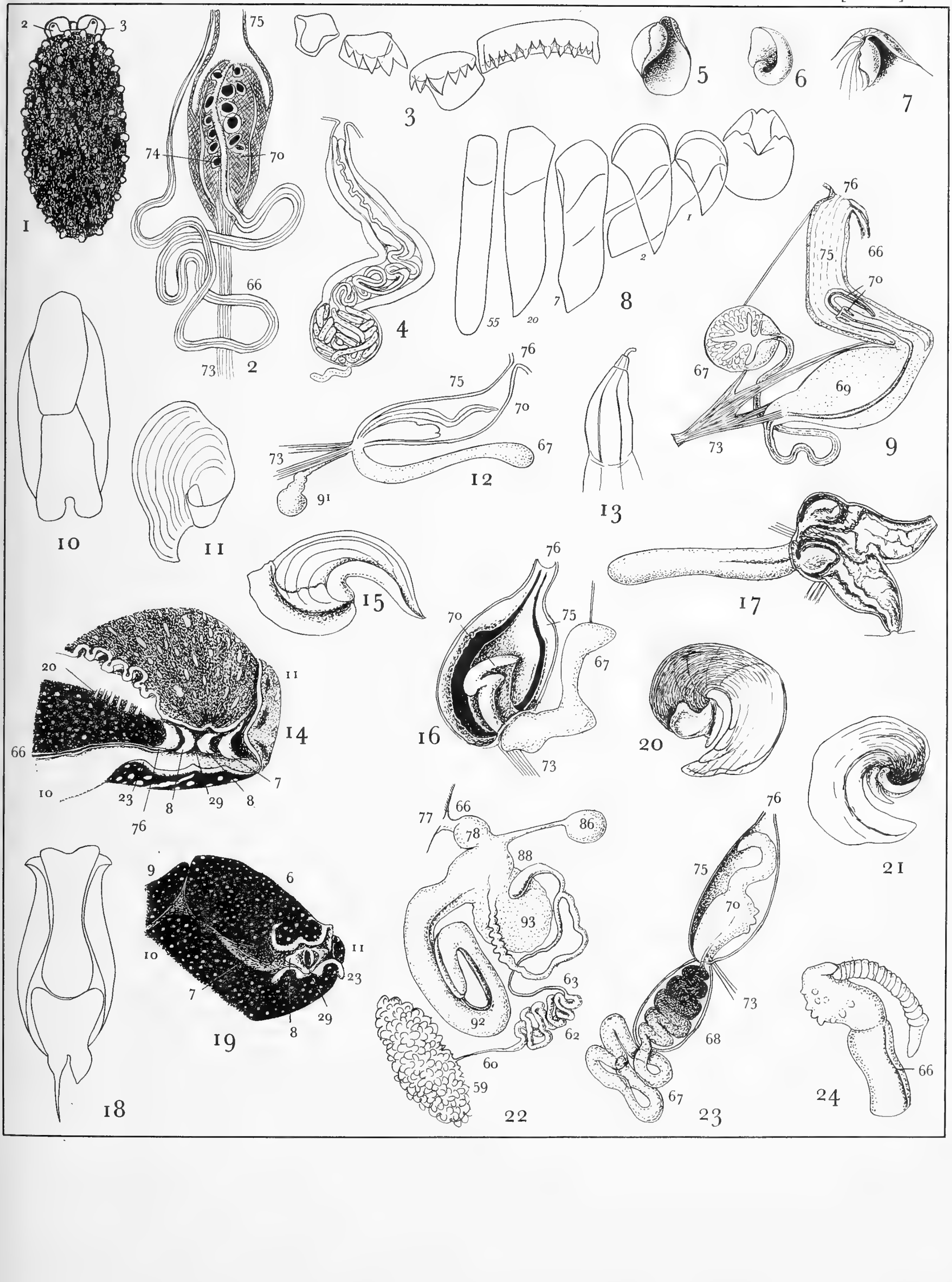
2 - tentacle
3 - sensory lobes
6 - head shield
7 - outer fold of head shield
8 - inner fold of head shield
9 - mantle shield
10 - right parapodium
11 - left parapodium
20 - organ of Hancock
23 - corner of the foot
29 - mouth
59 - hermaphrodite gland
60 - hermaphrodite duct
62 - ampulla
63 - spermoviduct
66 - seminal groove; efferent duct
67 - prostate; prostatic part of male duct
68 - prostatic sac
69 - muscle sac
70 - penis
73 - retractor
74 - calcareous concretions
75 - male atrium
76 - male aperture
77 - genital aperture
78 - common atrium
86 - spermatheca
88 - spermatocyst; seminal receptacle
91 - female gland mass
92 - mucus gland
93 - albumen gland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Explanation of Plate 2

Aplysia californica Cooper

Figure 25: Rachidian and tenth lateral tooth of radula.

Figure 26: Dorsal aspect of alimentary organs; digestive gland drawn transparent.

Phyllaplysia zostericola McCauley

Figure 27: Dorsal view of preserved specimen.

Figure 28: Ventral view of head.

Figure 29: Diagram of internal organs.

Figure 30: Male copulatory organ, collar opened from dorsal side.

Figure 31: Teeth of radula.

Figure 32: Diagram of reproductive organs.

Hermaeina smithi spec. nov.

Figure 33: Ventral view of anterior end, preserved specimen.

Figure 34: Longitudinal section of ceras.

Figure 35: Transverse section of the same.

Figure 36: Radular tooth.

Figure 37: Section of male atrium with penis.

Elysia hedgpethi spec. nov.

Figure 38: Ventral view of preserved specimen.

Figure 39: Radular tooth.

Figure 40: Diagram of internal organs, salivary glands omitted.

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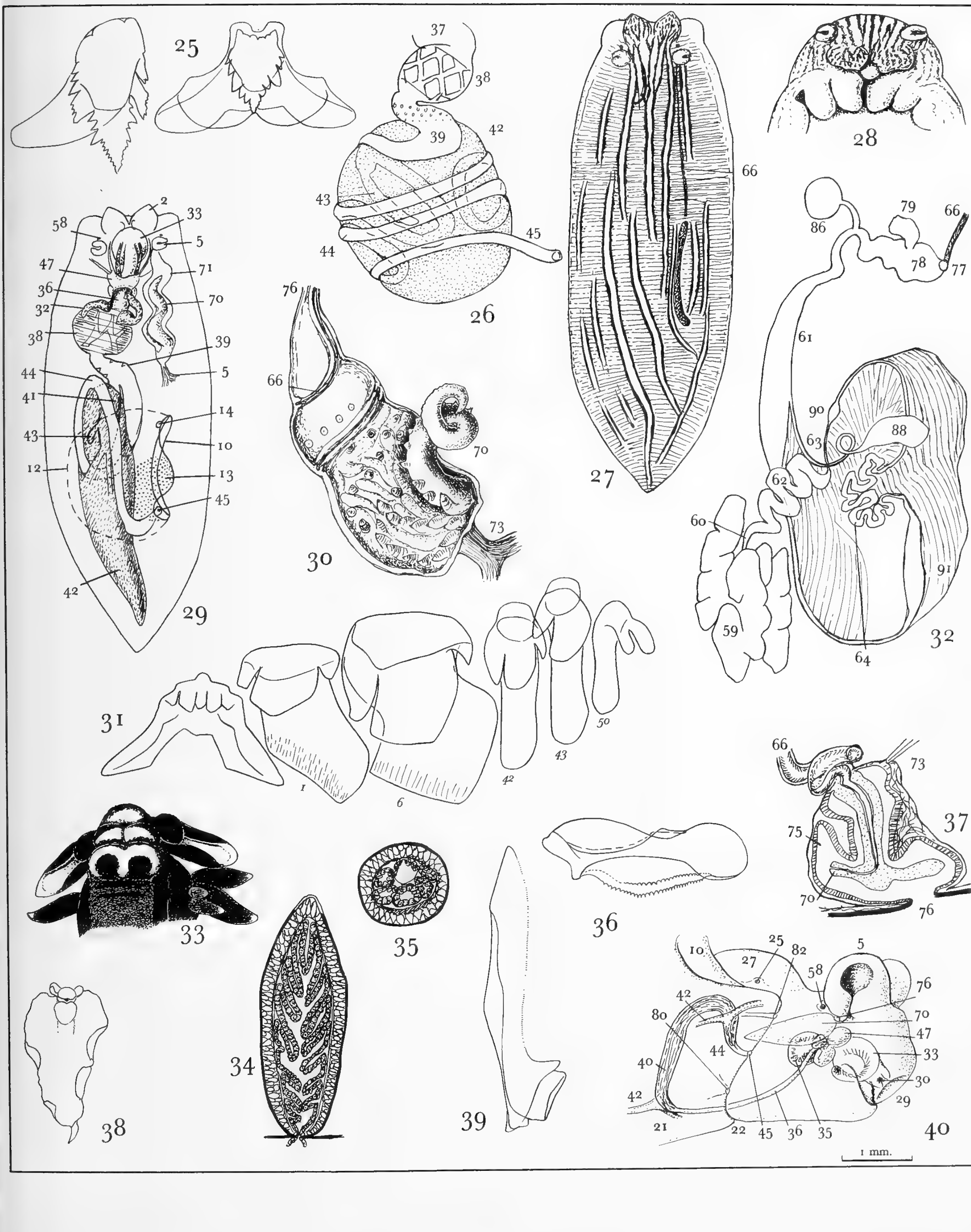
2 - tentacle
5 - rhinophore
10 - right parapodium
12 - parapodial cavity
13 - gland cells of Blochmann
14 - osphradium
21 - foot
22 - transverse fold of foot
25 - nephropore
27 - heart
29 - mouth
30 - pigmented cells of oral cavity
32 - salivary gland
33 - pharynx
35 - muscular pouch
36 - esophagus
37 - crop
38 - anterior gizzard
39 - second gizzard
40 - stomach
41 - diverticulum of stomach
42 - digestive gland; digestive diverticulum
43 - caecum
44 - intestine
45 - anus
47 - cerebral ganglion
58 - eye
59 - hermaphrodite gland
60 - hermaphrodite duct
61 - large hermaphrodite duct
62 - ampulla
63 - spermoviduct
64 - winding gland
66 - efferent duct; seminal groove
70 - penis
71 - penial sheath
73 - retractor
75 - male atrium
76 - male aperture
77 - genital aperture
78 - common atrium
79 - atrial gland
80 - female aperture
82 - vagina
86 - spermatheca
88 - spermatocyst; seminal receptacle
90 - fertilization chamber
91 - nidamental duct or opening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Explanation of Plate 3

Cadlina flavomaculata MacFarland

Figure 41: Right side view of preserved specimen.
Figure 42: Radular teeth.

Cadlina sparsa (Odhner)

Figure 43: Dorsal view of preserved specimen; sculpture omitted.
Figure 44: Sculpture of notum.
Figure 45: Radular teeth.

Rostanga pulchra MacFarland

Figure 46: Dorsal view of preserved specimen.
Figure 47: Ventral view of the same.
Figure 48: Notum papillae.
Figure 49: Radular teeth.

Aldisa sanguinea (Cooper)

Figure 50: Dorsal view of preserved specimen.
Figure 51: Ventral view of the same.
Figure 52: Notum papillae.
Figure 53: Distal ends of four radular teeth.

Archidoris montereyensis (Cooper)

Figure 54: Notum papillae.
Figure 55: Diagram of reproductive organs.

Anisodoris nobilis (MacFarland)

Figure 56: Notum papillae.
Figure 57: Diagram of reproductive organs.
Figure 58: Evaginated tip of vas deferens (penis).

Diaulula sandiegensis (Cooper)

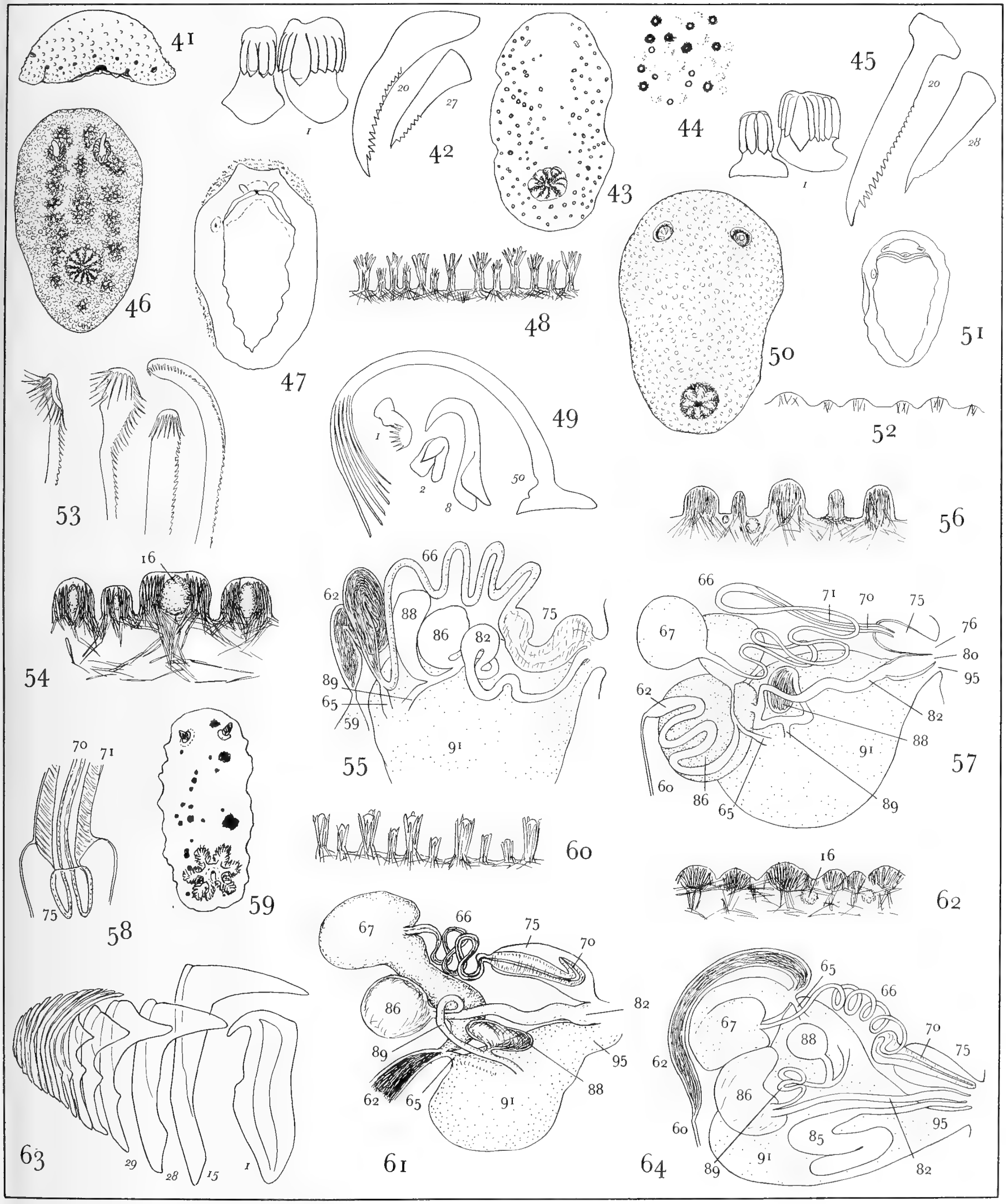
Figure 59: Dorsal view of preserved specimen with scattered spots.
Figure 60: Notum papillae.
Figure 61: Diagram of reproductive organs.

Discodoris heathi MacFarland

Figure 62: Notum papillae.
Figure 63: Radular teeth.
Figure 64: Diagram of reproductive organs; windings of ampulla and vas deferens simplified.

---

16 - notum gland
59 - hermaphrodite gland
60 - hermaphrodite duct
62 - ampulla
65 - oviduct
66 - efferent duct; seminal groove
67 - prostate; prostatic part of male duct
70 - penis
71 - penial sheath
75 - male atrium
76 - male aperture
80 - female aperture
82 - vagina
85 - vaginal gland
86 - spermatheca
88 - spermatocyst; seminal receptacle
89 - insemination duct
91 - female gland mass
95 - nidamental duct or opening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Explanation of Plate 4

Aegires albopunctatus MacFarland

Figure 65: Right side view of preserved specimen.

Figure 66: Diagram of reproductive organs.

Laila cockerelli MacFarland

Figure 67: Right side view of preserved specimen.

Figure 68: Ventral view of central nervous system.

Figure 69: Radular teeth.

Figure 70: Diagram of reproductive organs.

Triopha carpenteri (Stearns)

Figure 71: Central nervous system, dorsal aspect.

Triopha maculata MacFarland

Figure 72: Labial rodlets.

Figure 73: Half row of radula of twelve millimeter long animal.

Figure 74: Half row of radula of six millimeter long animal.

Figure 75: Inner part of fourth, sixth, eighth, and tenth row of radula of seven millimeter long animal.

Figure 76: Diagram of reproductive organs.

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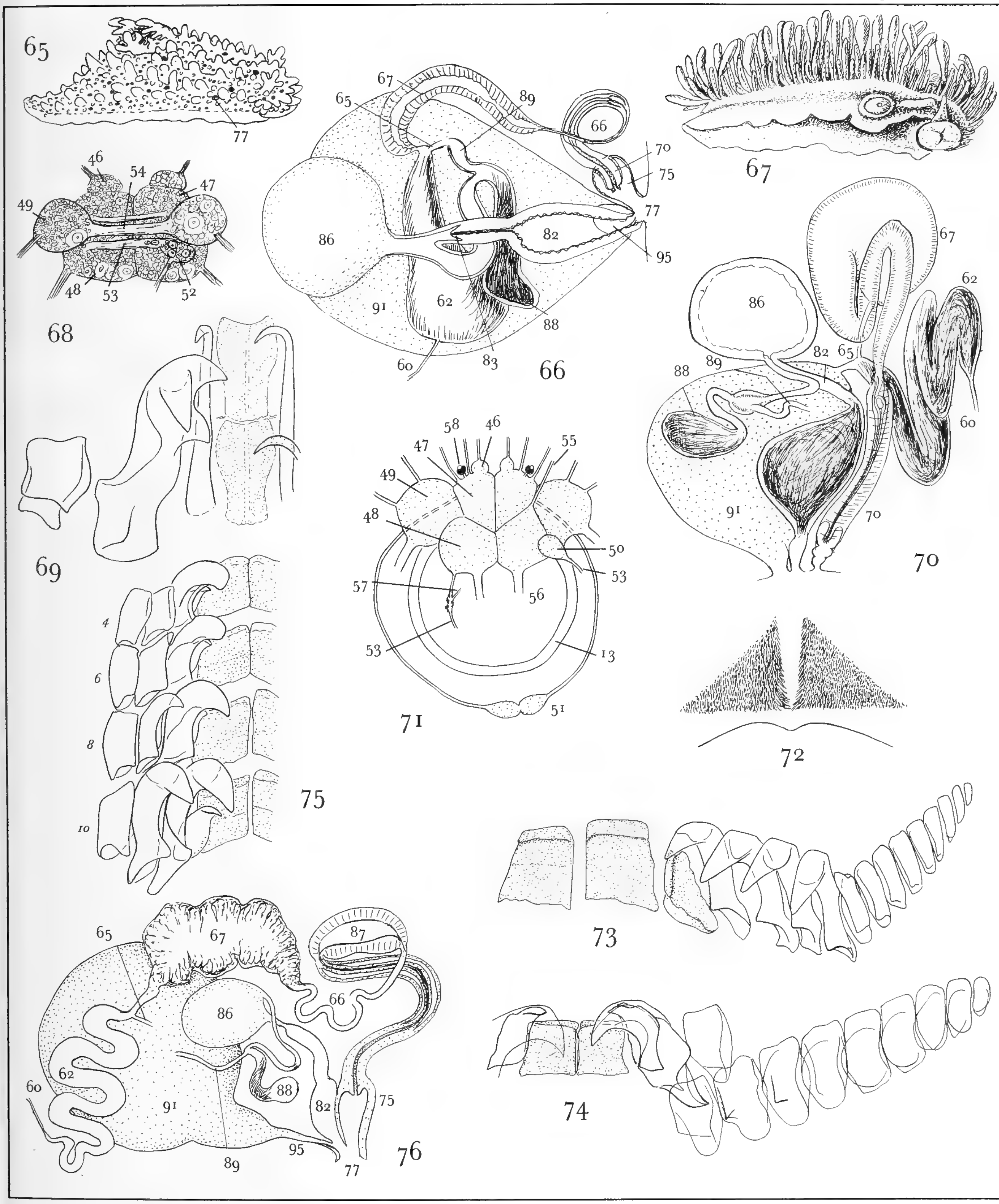
13 - gland cells of Blochmann
46 - rhinophore ganglion
47 - cerebral ganglion
48 - pleural ganglion
49 - pedal ganglion
50 - abdominal ganglion
51 - buccal ganglion
52 - ganglion
53 - visceral loop
54 - pedal commissure
55 - anterior pallial nerve
56 - posterior pallial nerve
57 - left visceral nerve
58 - eye
60 - hermaphrodite duct
62 - ampulla
65 - oviduct
66 - efferent duct; seminal groove
67 - prostate; prostatic part of male duct
70 - penis
75 - male atrium
77 - genital aperture
82 - vagina
83 - valve
86 - spermatheca
87 - seminal vesicle
88 - spermatocyst; seminal receptacle
89 - insemination duct
91 - female gland mass
95 - nidamental duct or opening.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Explanation of Plate 5

Crimora coneja spec. nov.

Figure 77: Dorsal view of preserved specimen.
Figure 78: Right side view of the same.
Figure 79: Radula.
Figure 80: Half row of radula.
Figure 81: Diagram of male reproductive organs.
Figure 82: Diagram of female reproductive organs.
Figure 83: Transverse section of gill with branchial glands.

Acanthodoris rhodoceras Cockerell & Eliot

Figure 84: Dorsal view of preserved specimen.
Figure 85: Notum papillae.
Figure 86: Single notum papilla from life.
Figure 87: Half row of radula.
Figure 88: Marginal teeth under higher power.

Onchidoris hystricina (Bergh)

Figure 89: Dorsal view of preserved specimen.
Figure 90: Notum papillae.
Figure 91: Half row of radula.

Onchidoris bilamellata (Linnaeus)

Figure 92: Dorsal view of animal.
Figure 93: Notum papillae.
Figure 94: Papilla with spicules, from sketch by Dr. Diva Diniz Corrêa.
Figure 95: Half row of radula.
Figure 96: Diagram of reproductive organs.

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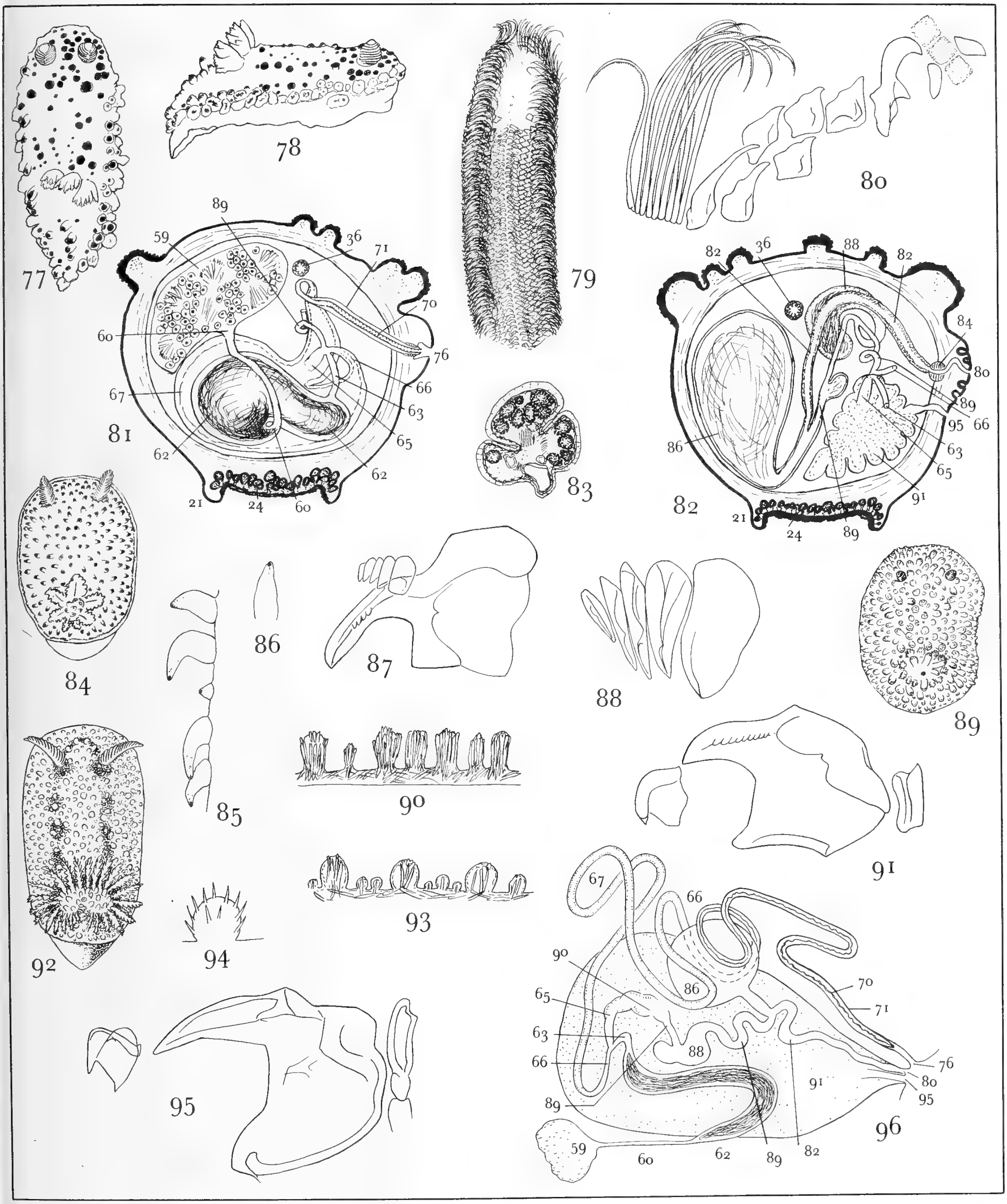
21 - foot
24 - pedal gland
36 - esophagus
59 - hermaphrodite gland
60 - hermaphrodite duct
62 - ampulla
63 - spermoviduct
65 - oviduct
66 - efferent duct; seminal groove
67 - prostate; prostatic part of male duct
70 - penis
71 - penial sheath
76 - male aperture
80 - female aperture
82 - vagina
84 - sphincter
86 - spermatheca
88 - spermatocyst; seminal receptacle
89 - insemination duct
90 - fertilization chamber
91 - female gland mass
95 - nidamental duct or opening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Explanation of Plate 6

Ancula pacifica MacFarland

Figure 97: Right side view of preserved specimen.
Figure 98: Central nervous system, dorsal aspect.
Figure 99: Labial armature and one element of the same.
Figure 100: Two rachidian teeth and first and second lateral tooth.
Figure 101: Diagram of reproductive organs.
Figure 102: Penis.

Hopkinsia rosacea MacFarland

Figure 103: Right side view of cleared pharynx.
Figure 104: Radular teeth.
Figure 105: Dorsal view of preserved specimen.
Figure 106: Ventral view of anterior end.

Dendrodoris fulva MacFarland

Figure 107: Dorsal view of preserved specimen; stipples indicate white dots.
Figure 108: Bosses of notum with glands.

Tritonia festiva (Stearns)

Figure 109: Dorsal view of preserved specimen.
Figure 110: Ventral view of head of the same.
Figure 111: Rachidian, intermediate, and lateral tooth.
Figure 112: External reproductive organs isolated in clove oil.
Figure 113: Jaw plates.
Figure 114: Anterior and posterior piece of masticatory border under higher power.

Tritonia exsulans Bergh

Figure 115: Preserved specimen.
Figure 116: Masticatory border of jaw.
Figure 117: Rachidian, intermediate, and lateral tooth.
Figure 118: Diagram of reproductive organs.

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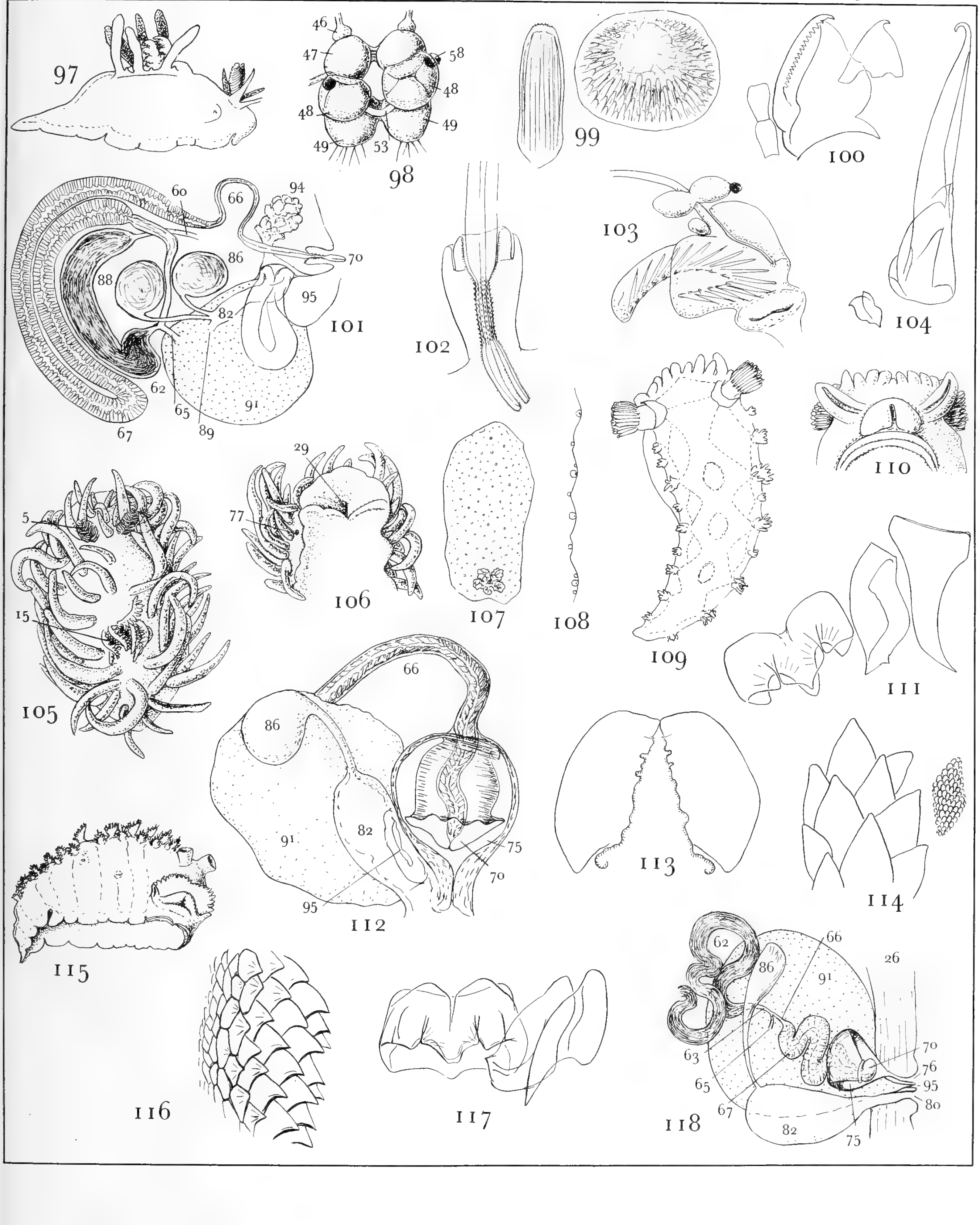
5 - rhinophore
15 - gill
26 - body wall
29 - mouth
46 - rhinophore ganglion
47 - cerebral ganglion
48 - pleural ganglion
49 - pedal ganglion
53 - visceral loop
58 - eye
60 - hermaphrodite duct
62 - ampulla
63 - spermoviduct
65 - oviduct
66 - efferent duct; seminal groove
67 - prostate; prostatic part of male duct
70 - penis
75 - male atrium
76 - male aperture
77 - genital aperture
80 - female aperture
82 - vagina
86 - spermatheca
88 - spermatocyst; seminal receptacle
89 - insemination duct
91 - female gland mass
94 - accessory gland
95 - nidamental duct or opening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Explanation of Plate 7

Hancockia californica MacFarland

Figure 119: Diagram of reproductive organs.
Figure 120: Right side view of preserved specimen.

Dendronotus frondosus (Ascanius)

Figure 121: Right side view of living animal, from sketch by Dr. Diva Diniz Corrêa.
Figure 122: Central tooth and two half rows of lateral teeth.
Figure 123: First and ninth row of radula, drawn to same scale as figure 122.
Figure 124: Male duct, cleared.

Doto columbiana O'Donoghue

Figure 125: Living specimen, from sketch by collector.
Figure 126: Radular tooth.
Figure 127: Right side view of preserved specimen.
Figure 128: Inner side of third ceras.
Figure 129: Diagram of reproductive organs.

Doto amyra spec. nov.

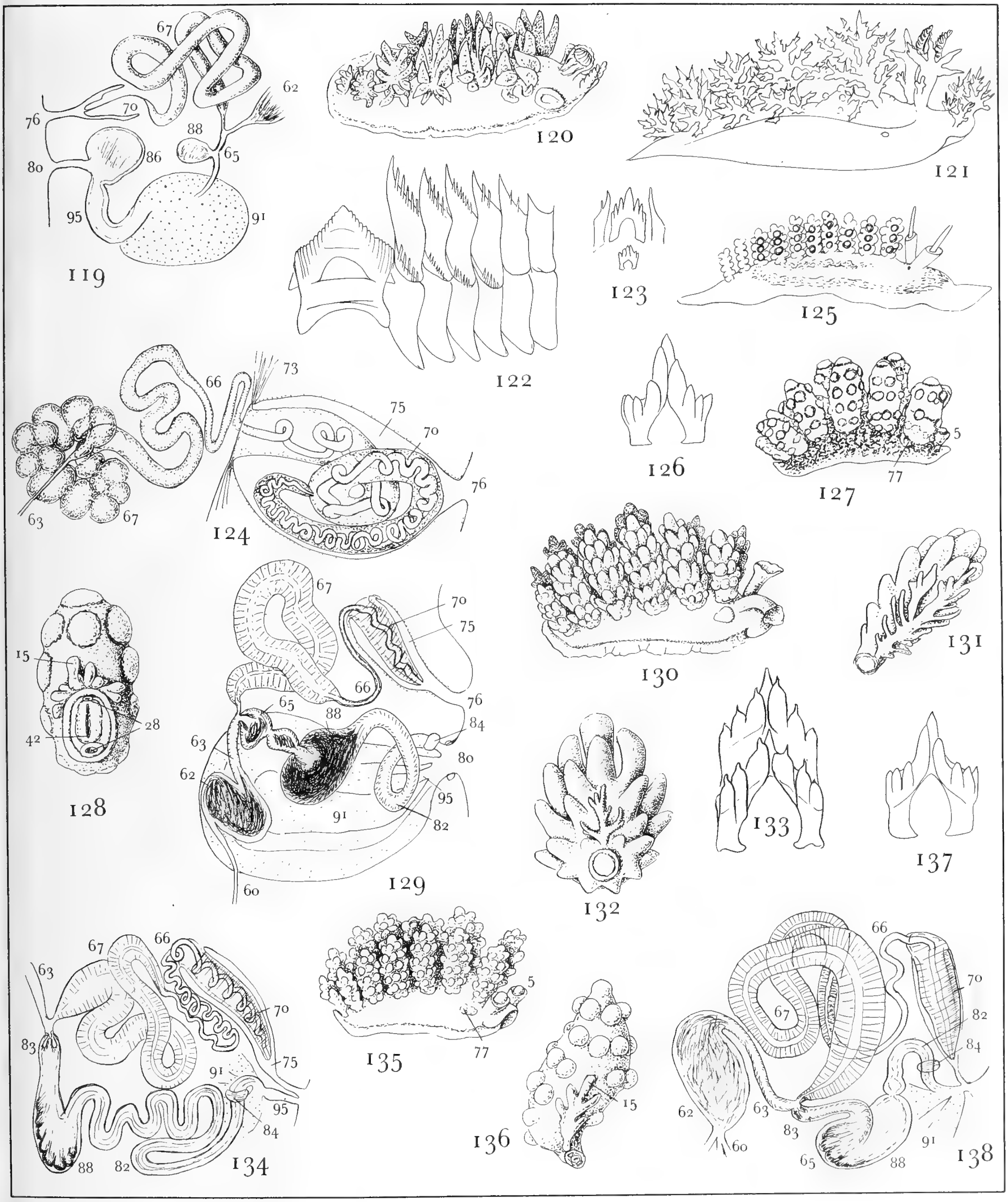
Figure 130: Right side view of preserved specimen.
Figure 131: One of the bigger cerata with long gill.
Figure 132: One of the bigger cerata with short gill.
Figure 133: Radular teeth.
Figure 134: Diagram of reproductive organs.

Doto ganda spec. nov.

Figure 135: Right side view of preserved specimen.
Figure 136: Inner side of third ceras.
Figure 137: Radular tooth.
Figure 138: Diagram of reproductive organs.

---

5 - rhinophore
15 - gill
28 - blood sinus
42 - digestive gland; digestive diverticulum
60 - hermaphrodite duct
62 - ampulla
63 - spermoviduct
65 - oviduct
66 - efferent duct; seminal groove
67 - prostate; prostatic part of male duct
70 - penis
73 - retractor
75 - male atrium
76 - male aperture
77 - genital aperture
80 - female aperture
82 - vagina
83 - valve
84 - sphincter
86 - spermatheca
88 - spermatocyst; seminal receptacle
91 - female gland mass
95 - nidamental duct or opening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Explanation of Plate 8

Doto kya spec. nov.

Figure 139: Right side view of preserved specimen.
Figure 140: Diagram of reproductive organs.
Figure 141: Radular tooth.
Figure 142: One of the larger cerata with gill.

Doto wara spec. nov.

Figure 143: Right side view of preserved specimen.
Figure 144: Inner side of second ceras.
Figure 145: Radular tooth.
Figure 146: Diagram of reproductive organs.

Armina californica (Cooper)

Figure 147: Dorsal view of preserved specimen.
Figure 148: Diagram of reproductive organs.
Figure 149: Lateral view of preserved specimen.
Figure 150: Rachidian and intermediate tooth, tip of first, and three further lateral teeth.

Armina columbiana O'Donoghue

Figure 151: Lateral view of preserved specimen.
Figure 152: Rachidian and intermediate tooth, first lateral tooth and tips of further lateral teeth.
Figure 153: Dorsal view of anterior part of preserved specimen.
Figure 154: Diagram of reproductive organs.

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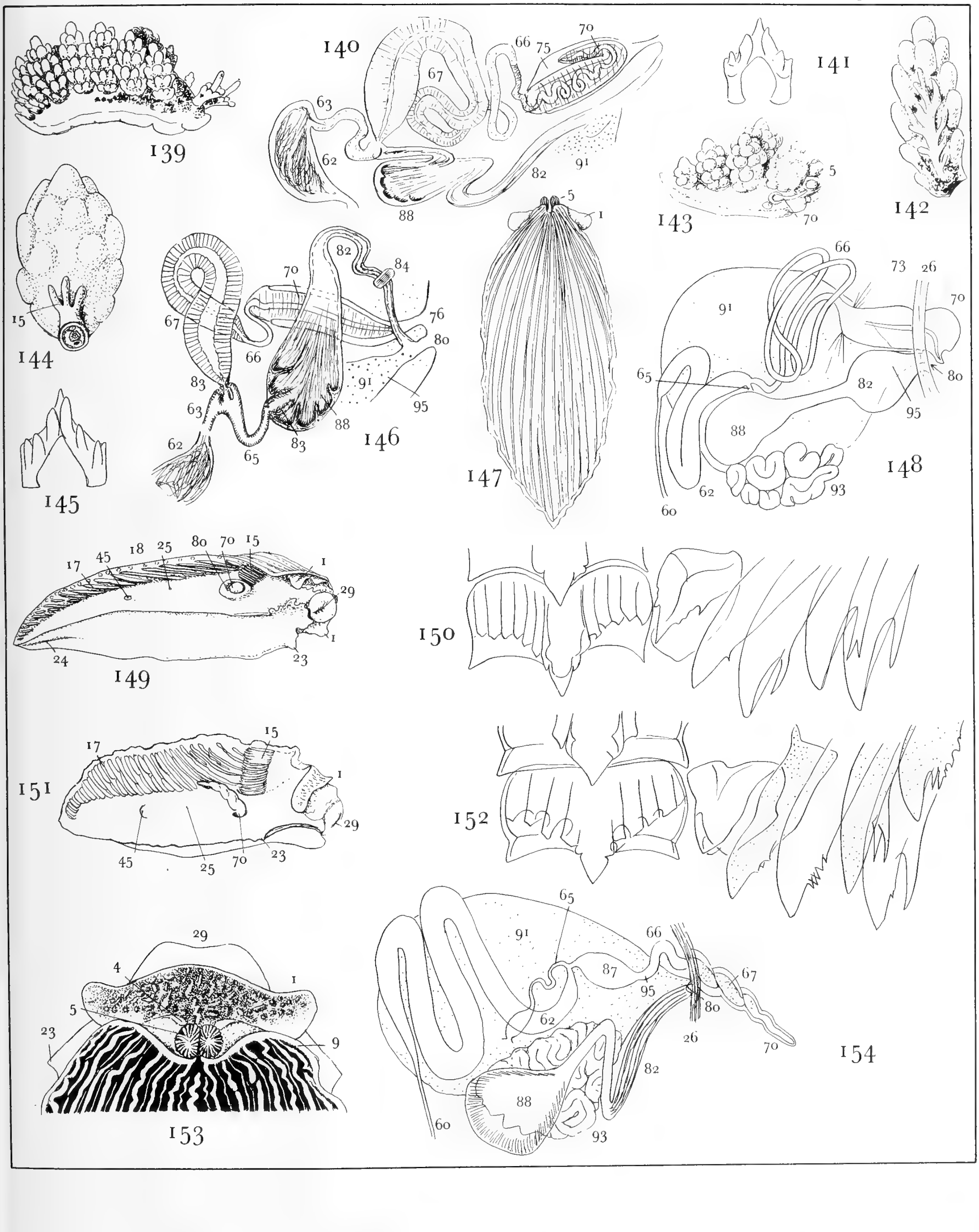
1 - frontal veil
4 - caruncles
5 - rhinophore
9 - mantle shield
15 - gill
17 - lateral lamellae
18 - glandular sacs
23 - corner of foot
24 - pedal gland
25 - nephropore
26 - body wall
29 - mouth
45 - anus
60 - hermaphrodite duct
62 - ampulla
63 - spermoviduct
65 - oviduct
66 - efferent duct; seminal groove
67 - prostate; prostatic part of male duct
70 - penis
73 - retractor
75 - male atrium
76 - male aperture
80 - female aperture
82 - vagina
83 - valve
84 - sphincter
87 - seminal vesicle
88 - spermatocyst; seminal receptacle
91 - female gland mass
93 - albumen gland
95 - nidamental duct or opening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Explanation of Plate 9

Dirona picta Cockerell & Eliot

Figure 155: Right side view of preserved specimen.
Figure 156: Jaw plates, seen from inner side.
Figure 157: Half row of radula.
Figure 158: Diagram of external reproductive organs; male part from whole mount, female part from serial sections.

Dirona albolineata Cockerell & Eliot

Figure 159: Right side view of preserved specimen.
Figure 160: Radular teeth.

Coryphella piunca spec. nov.

Figure 161: Right side view of preserved specimen.
Figure 162: Dorsal view of anterior end of living animal, from sketch by Dr. Diva Diniz Corrêa.
Figure 163: Rhinophores of preserved specimen from Monterey Bay, boat harbor.
Figure 164: Masticatory border of jaw.
Figure 165: Median tooth of radula.
Figure 166: Lateral tooth of radula.
Figure 167: Diagram of reproductive organs.

Capellinia rustya spec. nov.

Figure 168: Right side view of preserved specimen.
Figure 169: Branching of digestive gland.
Figure 170: Jaw and denticles of masticatory border.
Figure 171: Diagram of reproductive organs.
Figure 172: Teeth of radula.

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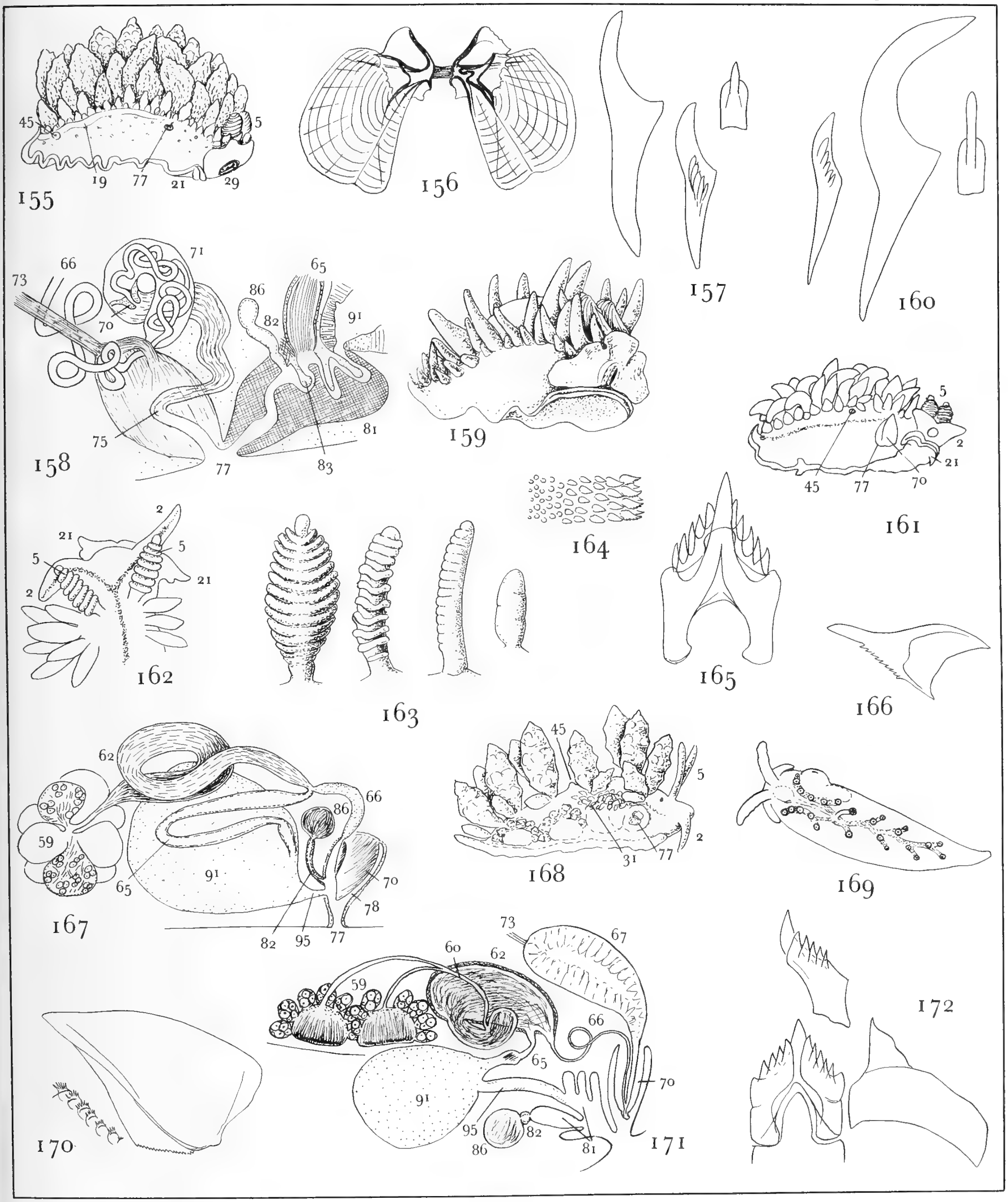
2 - tentacle
5 - rhinophore
19 - glandular strand
21 - foot
29 - mouth
31 - glands of oral cavity
45 - anus
59 - hermaphrodite gland
60 - hermaphrodite duct
62 - ampulla
65 - oviduct
66 - efferent duct; seminal groove
67 - prostate; prostatic part of male duct
70 - penis
71 - penial sheath
73 - retractor
75 - male atrium
77 - genital aperture
78 - common atrium
81 - female atrium
82 - vagina
83 - valve
86 - spermatheca
91 - female gland mass
95 - nidamental duct or opening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Explanation of Plate 10

Fiona pinnata Eschscholtz

Figure 173: Right side view of preserved specimen.
Figure 174: Four cerata and scar of a fifth.
Figure 175: Jaw plate.
Figure 176: Denticles of masticatory border.
Figure 177: Radular tooth.
Figure 178: Penis.
Figure 179: Egg ribbon.

Precuthona divae spec. nov.

Figure 180: Right side view of preserved specimen.
Figure 181: Right side view with cerata removed.
Figure 182: Radular tooth with prolonged base [34] of a second.
Figure 183: Jaw and dènticles of masticatory border.
Figure 184: Penis.

Catriona ronga spec. nov.

Figure 185: Ventral view of anterior end.
Figure 186: Right side view of preserved specimen.
Figure 187: Radular tooth.

Hermissenda crassicornis (Eschscholtz)

Figure 188: Four denticles from masticatory border of jaw.
Figure 189: One denticle of the same under higher power.
Figure 190: Radular tooth.
Figure 191: Lateral view of the same.
Figure 192: Diagram of reproductive organs.

Aeolidia papillosa (Linnaeus)

Figure 193: Right side view of preserved specimen.
Figure 194: Jaw.
Figure 195: Radular tooth.

Spurilla chromosoma (Cockerell & Eliot)

Figure 196: Right side view of preserved specimen.
Figure 197: Specimen with cerata removed.
Figure 198: Jaw.
Figure 199: Radular tooth.

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2 - tentacle
5 - rhinophore
15 - gill
23 - corner of the foot
25 - nephropore
27 - heart
34 - prolonged base of radular tooth
42 - digestive gland; digestive diverticulum
44 - intestine
45 - anus
60 - hermaphrodite duct
62 - ampulla
63 - spermoviduct
65 - oviduct
66 - efferent duct; seminal groove
70 - penis
72 - penial gland
73 - retractor
75 - male atrium
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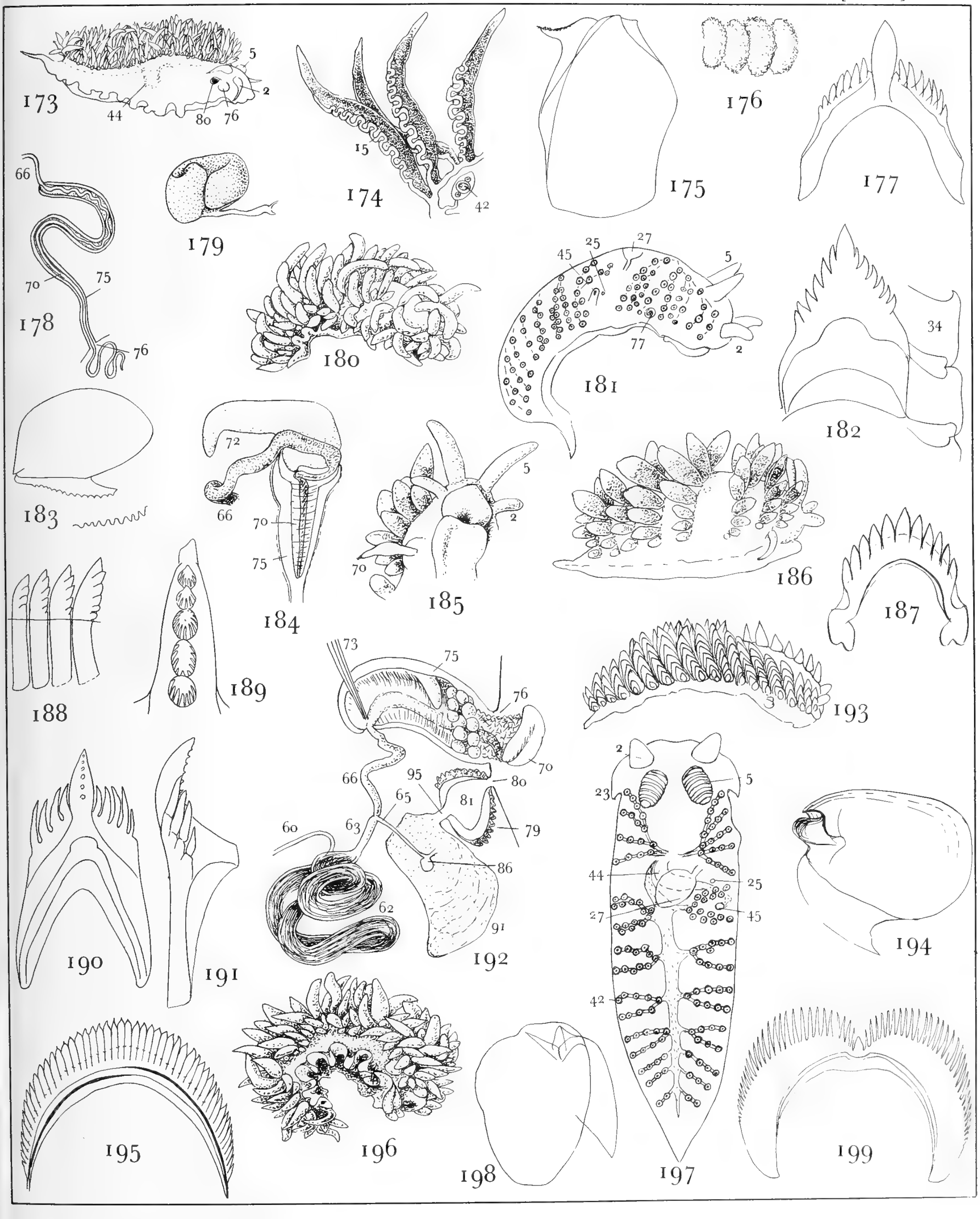
77 - genital aperture
79 - atrial gland
80 - female aperture
81 - female atrium
86 - spermatheca
91 - female gland mass
95 - nidamental duct or opening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THE
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VOLUME 3 | MAY 1, 1968 | SUPPLEMENT [2]

Part Two

The Order Anaspidea

BY

ROBERT D. BEEMAN

Thecosomata AND Gymnosomata

BY

JOHN A. McGOWAN

Foreword to Part II

MORE THAN SEVEN YEARS have passed since part one of this Supplement was published. At that time we had a firm commitment that a second part, planned to include all opisthobranchs known to occur in the Eastern Pacific, from San Diego to British Columbia, would be prepared in a very short time. The author, however, found it impossible to fulfill the promise for a variety of reasons: first, a bout of ill health made a temporary postponement imperative; but after recovery the long awaited monograph by MacFarland seemed to be ready to be published at long last. The appearance of this work would affect many taxonomic problems of the groups involved. Technical difficulties delayed the publication of that work and thereby, indirectly, the work on the second part of this publication. In the intervening years an unusually large amount of work was being done on the groups here involved. Many papers resulted, all of which had to be considered in the work under way. But, unfortunately for the progress on our supplement, the author had had to assume duties which kept her effectively away from the promised work. In the meantime the California Malacozoological Society, Inc. had assumed the assets and liabilities of the Veliger and among the liabilities was the redemption of the promise made in 1961. All efforts made in this direction, however, were without success. The Executive Board of the Society, at last, decided to do the best possible under the circumstances by presenting the two papers which had been ready for publication almost since the early part of 1961 as part 2 of the supplement. Although the costs of printing have gone way up, it was decided to distribute this second part to those of the original purchasers of part 1 whose names and addresses are on record at no additional cost, just as promised in 1961. However, at the same time it was hoped that many of the recipients may find it possible to contribute perhaps two or three dollars - strictly on a voluntary basis - toward the considerable deficit we have incurred. Such donations would be acknowledged with the issuance of a suitable receipt.

Should the originally promised work on the groups of opisthobranchs not now covered be completed, we will, of course, consider the manuscript for possible publication as a supplement to a later volume of our journal.

The Order Anaspidea

BY

ROBERT D. BEEMAN

Biology Department, San Francisco State College, San Francisco, California 94132

(Plate 11; 12 Text figures)

THE CALIFORNIA ANASPIDEANS, although comprising only a few species, are abundant, very conspicuous, and include some of the giants of the invertebrate world.

During the course of the author's studies on some of these animals, it became apparent that the existing definitions of the higher taxa which govern the Anaspidea were confusing and sometimes contradictory. It seemed appropriate to synthesize new descriptions of these taxa. These syntheses were derived largely from BEEMAN (1963a, 1963b), BOETTGER (1954), EALES (1944, 1960), ENGEL & HUMMELINCK (1936), GHISELIN (1964, 1965), HOFFMANN (1932-1940), MACFARLAND (1918, 1966), THIELE (1931), PILSBRY (1895), PRUVOT-FOL (1954), and ZILCH (1959-1960). EALES (1944, 1960) has given excellent lists of features useful for the diagnosis of the anaspideans. These were considered in the following descriptions as much as was practical (Figures 1 to 4 and glossary). Sections of this paper have been extended in the hope that it may serve as a foundation for additional studies of anaspideans in California and elsewhere.

ANASPIDEA

The lack of a cephalic shield is the basis for the name of this order. BOETTGER (1954) and ZILCH (1959-1960) prefer to refer to the order as the Aplysiacea, presumably because one genus, *Akera,* contained therein is not shieldless. LEMCHE (personal communication, 1966) would like to see the name Anaspidea (as used in LEMCHE, 1948) replaced by Aplysiacea because the former name is also used for a group of early fishes. It seems to me that discarding the very well known name of Anaspidea for either of these reasons would cause unwarranted confusion.

Parapodia are present in all members of this group. These are flaplike, lateral upgrowths derived from the edge of the foot. They enclose a distinct pallial cavity containing a conspicuous plicate gill that deviates greatly from the typical structure of a ctenidium as outlined by YONGE (1947). A mantle shelf over the gill is often

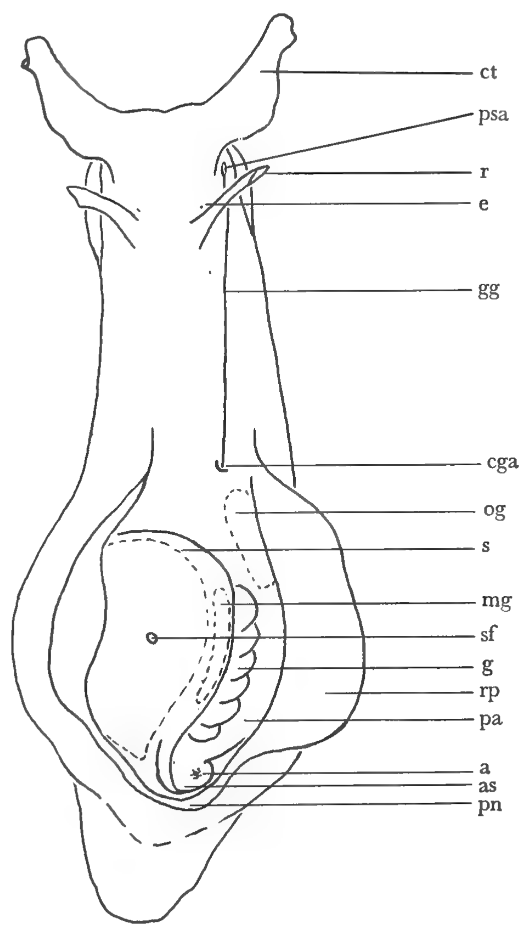

Figure 1

Diagrammatic dorsal aspect of an aplysid
[Modified from GUIART, 1901]

a – anus as – anal siphon cga – common genital aperture
ct – cephalic tentacle e – eye g – gill gg – genital groove
mg – mantle gland og – opaline gland pa – pallial cavity
pn – pseudosiphon psa – penis sheath aperture
r – rhinophore rp – right parapodium s – shell
sf – shell foramen

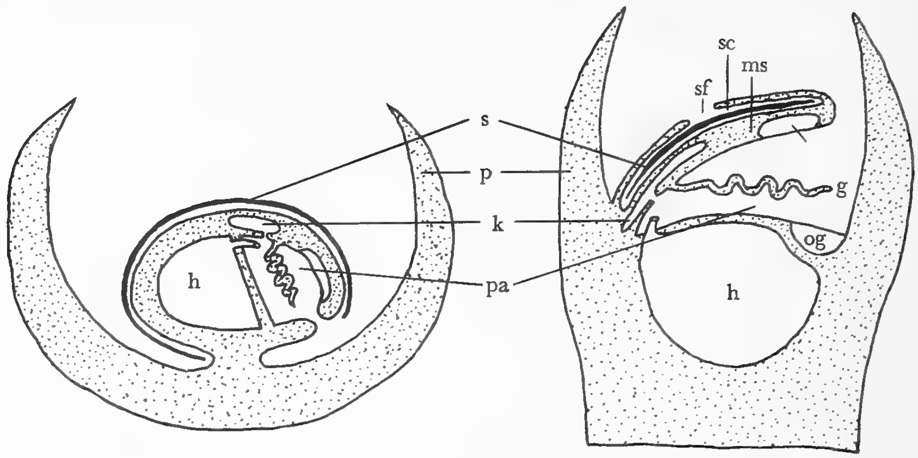

Figure 2

Highly diagrammatic transverse sections comparing *Akera* (left) and *Aplysia* (right)

[Modified from Guiart, 1901]

g – gill h – hemocoel k – kidney mg – mantle gland ms – mantle shelf og – opaline gland p – parapodia pa – pallial cavity s – shell sc – shell chamber sf – shell foramen

present. Additional space enclosed by the parapodia supplements the volume of the pallial cavity. A thin shell, usually covered by the mantle, is present in most species.

The digestive system is adapted to an herbivorous diet. It includes a multiserial radula and vertical corneous jaws. There is a triturating stomach with well delineated anterior and posterior sections containing large, corneous, angular grinding teeth.

The reproductive system (Figure 4) is especially distinctive. It is a hermaphroditic system which contrasts most strongly with those of other opisthobranchs by the presence of a few complex diverticula containing an oviducal tract that is traversed only by the developing egg string. These diverticula are tightly grouped as the female gland mass. An external ciliated genital groove on the right side leads both the finished egg string and semen, at

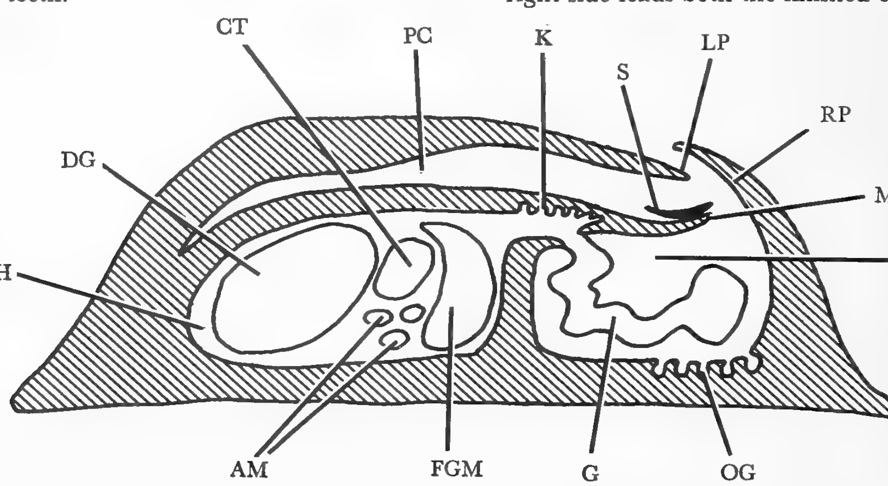

Figure 3

Diagrammatic transverse section of *Phyllaplysia taylori* at the gill cavity level

am – ampulla dg – digestive gland fgm – female gland mass lp – left parapodium ms – mantle shelf og – opaline gland g – gill gc – gill cavity h – hemocoel k – kidney ot – ovotestis pc – parapodial cavity rp – right parapodium s – shell

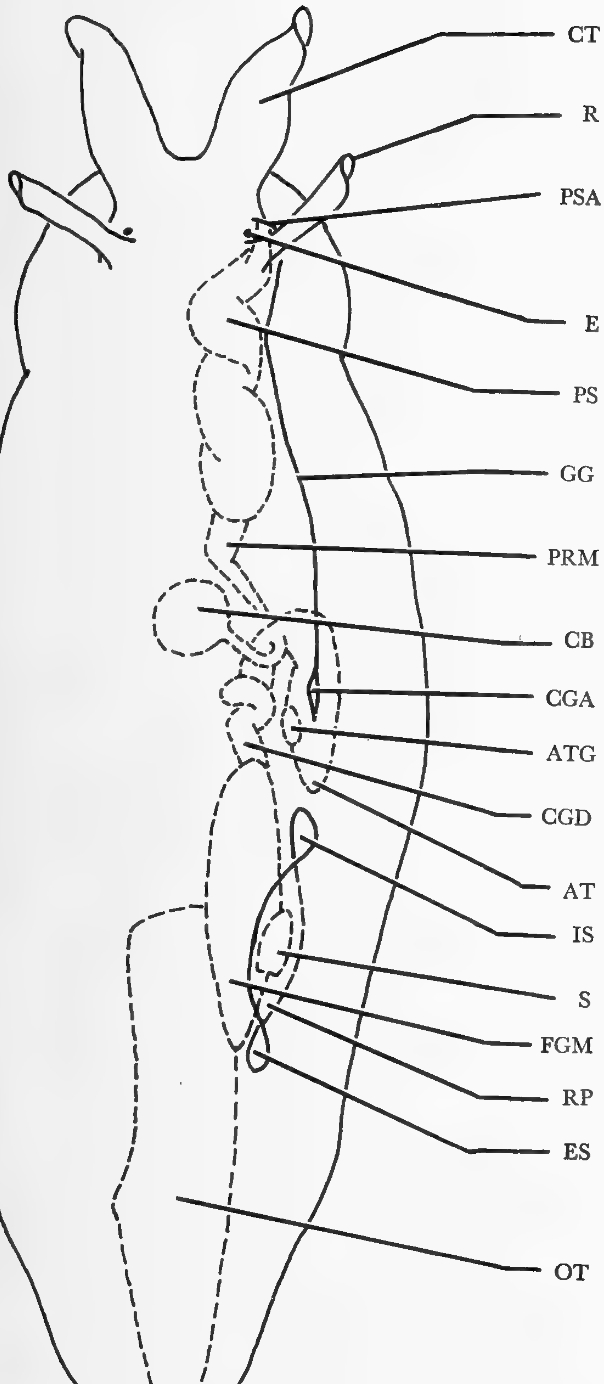

Figure 4

different times, from a common genital aperture to the anterior end of the body. The egg string is affixed to the substratum at this point. The open groove continues beyond this point carrying semen along the wall of the penis sheath and up along the eversible glans to its tip. Neither a closed ejaculatory duct nor a prostate gland is found in conjunction with the penis.

The nervous system is also distinctive (frontispiece, Bullock & Horridge, 1965). Boettger (1954) noted that the pharyngeal nerve ring is posterior to the buccal mass and that the parietal ganglia are posterior to this ring; they may even be fused with the intestinal and visceral (abdominal) ganglia.

The order is composed of two families, the monogeneric Akeridae, and the Aplysiidae.

Akeridae

This family contains a single genus, *Akera* Müller, 1776. As noted below, *Cylindrobulla,* although included here by some authors, should not even be considered as a member of this order. Neither genus has yet been recorded from this coast.

Akera has a cephalic shield, a thin, enrolled, external, bulloid shell and lacks tentacles (Pruvot-Fol 1954, fig. 21; Guiart, 1901, fig. 69, pl. VI). The parapodia, which project from the lateral edge of the foot (Figure 2), are used for swimming or for covering the shell. Thus *Akera* superficially resembles a cephalaspidean. Pelseneer (1894) evidently was the first to notice its resemblance to the anaspideans. Guiart (1901) placed it within the Anaspidea. He demonstrated that the digestive, reproductive, and nervous systems of *Akera* closely match those described for the order Anaspidea. Furthermore, he felt that the development of this animal was also anaspidean-like. Hanström (1929) and Ingier (1906) confirmed Guiart's conclusion for the nervous and reproductive systems respectively. Hurst (1965) confirmed the homology of the digestive system. Boettger (1954), Pruvot-Fol (1954), Zilch (1959-1960), Minichev (1963),

<-- Explanation to Figure 4

Semi-diagrammatic outline of the dolabriferean *Phyllaplysia taylori* indicating main external features and reproductive system

at – atrium atg – atrial gland cb – copulatory bursa
cga – common genital aperture cgd – common genital duct
ct – cephalic tentacle e – eye es – exhalent siphon
fgm – female gland mass gg – genital groove
is – inhalant siphon ot – ovotestis ps – penis sheath
psa – penis sheath aperture prm – penis retractor muscle
r – rhinophore rp – right parapodium s – shell

Morton & Holmes (1965), and others have accepted *Akera* as an anaspidean.

Cylindrobulla (see Marcus & Marcus, 1956, pls. 1-2) has been placed in the Akeridae by Thiele (1931), Hoffmann (1932-1940), and Pruvot-Fol (1954), but Boettger (1954) and Zilch (1959-1960) consider it to be in the cephalaspidean family Diaphanidae. Marcus & Marcus (1956) consider it close to the Diaphanidae, the sacoglossans, and the anaspideans. I agree with Ghiselin (1964, 1965) that its sacoglossan-like nervous system, pharynx, uniserial radula, and the closed ejaculatory duct exclude *Cylindrobulla* from the Anaspidea.

Interest in the family Akeridae stems mainly from its proposed key position in the phylogeny of the order Anaspidea. Boettger (1954), followed by Zilch (1959-1960), believes that the Akeridae arose from the cephalaspidean Scaphandridae and that the Akeridae then gave rise to the Aplysiidae and the Gymnosomata. Minichev (1963) disagrees with this; he considers that the Akeridae have evolved from *Acteon*-type cephalaspideans, but he does not offer any convincing evidence. It seems more likely that the anaspideans developed from early cephalaspidean stock within a clade that also contains the Diaphanidae. The similarities in the reproductive systems of the Diaphanidae, Acochlidiacea, Cylindrobullidae, Sacoglossa, and Anaspidea were noticed by Odhner (1927, 1937, 1939, 1952) and Ghiselin (1964, 1965). Since reproductive systems are probably more conservative in response to the functional evolutionary selections which caused the cladogenesis of these forms than are superficial features, I believe that such internal similarities are much more significant than external differences.

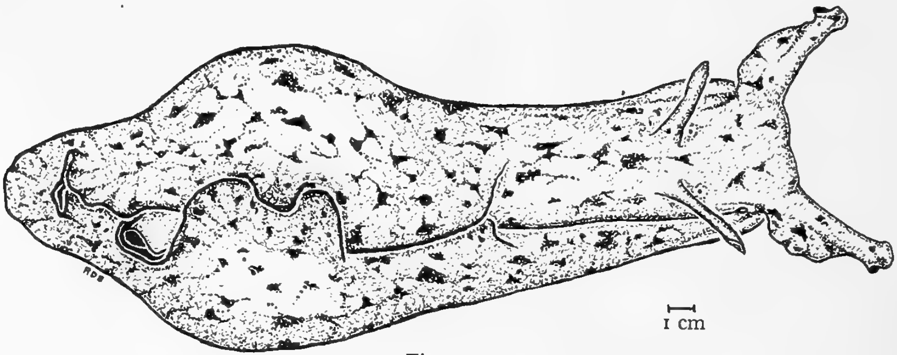

Figure 5

Aplysia californica from Elkhorn Slough, California
dorsal aspect, from life

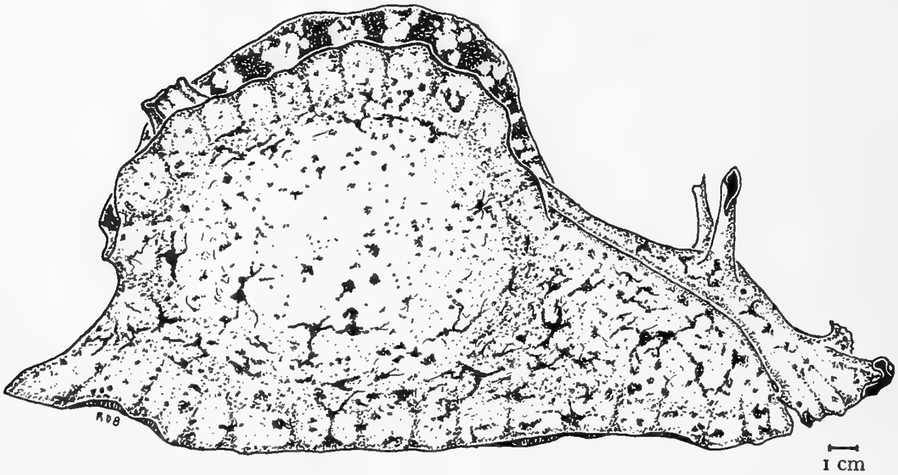

Figure 6

Aplysia californica from Elkhorn Slough, California
right lateral aspect, from life

Aplysiidae

The members of this very distinct group are known as "sea hares" because the body outline sometimes resembles that of a sitting hare and the rhinophores resemble hares' ears (see Linton, 1966 for a popular account).

Hoffmann (1932-1940) argues convincingly that the cephalic shield of the cephalapideans is here represented by the four sensory tentacles (the broad cephalic tentacles and the auriculate rhinophores). Tiny, lensatic eyes are found anterior to the rhinophores. A pair of parapodia is present on the dorsal surface or high on the sides of the body. The parapodia surround a more or less closed pallial cavity that contains a single plicate gill, anus, anal siphon, and opaline gland pores (Figures 1 to 4). The opaline gland (gland of Bohadsch) represents an aggregation of individual mucous glands. This gland may be multiporous (Eales 1960, fig. 9), consisting of many simple units dispersed in the body wall discharging externally through many tiny pores; or it may be uniporous (Johnson & Snook 1927, fig. 500), consisting of a single compound organ projecting deeply into the main body cavity (hemocoel), and discharging through a single pore. The common genital aperture is found within the pallial cavity or just anterior to it. The mantle often forms a shelf over the gill and extends to the rear as an anal siphon consisting of a flap twisted into a tube around the anus. Mantle glands are present on the right side of the mantle shelf. When irritated, some species produce a colored fluid from these glands (Tobach, Gold & Ziegler, 1965). The tale that this fluid ("aplysiopurpin, etc.") is used as a smoke-screen for escape seems highly unlikely. It probably is an excretory product offensive to potential predators. A thin primary shell, usually rather flat and almost completely or wholly covered by the mantle, is present in most species. The development of the tremendous plate-like outgrowth of the veliger shell which produces the primary shell was beautifully illustrated by Mazzarelli (1893a, pl. XIII). In some species of *Phyllaplysia* and in some specimens of *P. taylori* the primary shell may be replaced by a secondary shell (Figure 14) not developed from the veliger shell (Beeman, 1963b). Or the secondary shell may be absent. The same may be true of some species of *Notarchus*.

Twelve species of aplysids have been reported from California; only four of these are presently considered as valid California species (Beeman, 1963a, 1963b).

The family Aplysiidae consists of four subfamilies: Aplysiinae, Dolabriferinae, Notarchinae, and Dolabellinae. Typical representatives of these subfamilies are illustrated by Guiart (1901, fig. 27) and by numerous figures in Pilsbry (1895). Syntheses of the characteristics of each of these taxa are given below for the convenience of the reader.

Aplysiinae

Parapodia symmetrical, widely separated from one another anteriorly, joined or free posteriorly, usually well developed and mobile, often natatory. Shell relatively large, rather flat, chitinous, sometimes calcified, with anal sinus on right posterior side, enclosed by mantle. Skin smooth, without filaments. Radula with broad, denticulate rachidian (center) tooth, and many bi-serrate lateral teeth. Penis without spines; penis sheath infrequently spiny. Common genital opening within pallial cavity, anterior to the gill. Mantle glands present; opaline gland uniporous or multiporous.

The nervous system has very long visceral connectives. Forms such as *Aplysia*[1] contain giant nerve cell bodies (over 800μ in diameter). Scharrer's (1935) description of these immense nerve cells as neurosecretory opened the study of molluscan neurosecretion and helped to establish *Aplysia* as a key animal in present neurophysiological research. The ease of identifying individual nerve cells in *Aplysia* enabled Kandel, Frazier, & Coggeshall (1967) to discover that different branches of a single neuron could have opposite synaptic actions. Much of the neurophysiological work on *Aplysia* has been very well reviewed by Bullock & Horridge (1965) and Simpson, Bern & Nishioka (1966).

The subfamily Aplysiinae consists of two genera: *Syphonata* (= *Paraplysia*) and *Aplysia*; only the genus *Aplysia* is known from the California coast. Several aspects of the anatomy of *Aplysia* are illustrated and discussed by Eales (1921), Guiart (1901), MacFarland (1966), and Winkler (1957).

Aplysia are found along almost the entire length of the California coast in habitats ranging from estuarine to all but the most wave-battered open coast. They occur from the midtidal zones down to about 100 feet. Great numbers of both large and small individuals are often seen in tide-pools, and on seaweed and other surfaces exposed during low tides. *Aplysia vaccaria* Winkler, 1955 (Figures 7, 8, and Plate 11, Figure 5) is typically found only along rocky coasts and in kelp beds. *Aplysia californica* Cooper, 1863 (Figures 5, 6, and Plate 11, Figures 7 and 8) is common in rocky coast areas, in kelp beds, in bays, and in estuaries. The normal habitat of *Aplysia reticulopoda*

[1] Opinion No. 200, 1954, International Commission on Zoological Nomenclature recognized *Aplysia* as the genus of this anaspidean and referred the name *Tethys* to a nudibranch.

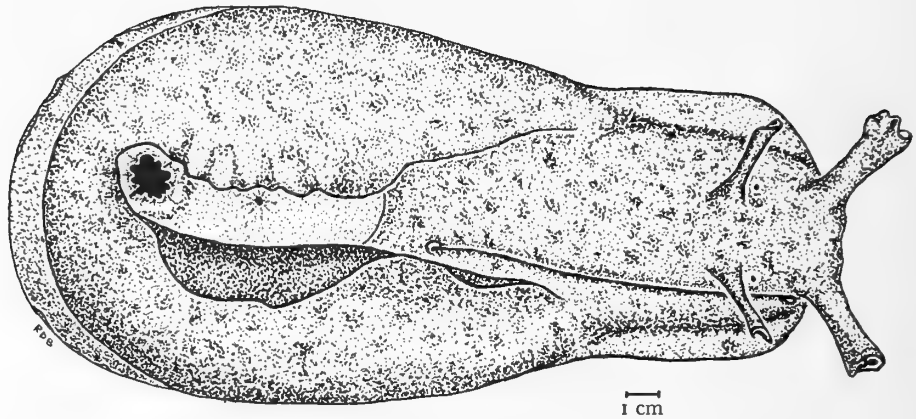

Figure 7

Aplysia vaccaria, dorsal aspect, from life

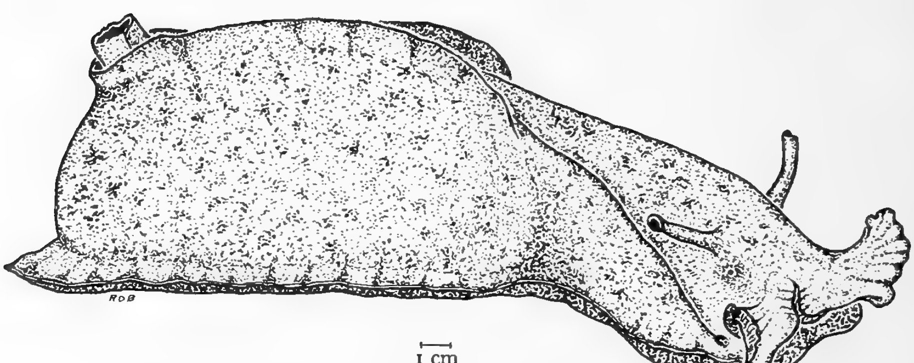

Figure 8

Aplysia vaccaria, right lateral aspect, from life

BEEMAN, 1960 (Figures 9, 10, and Plate 11, Figure 6) is difficult to ascertain as only four specimens are presently known and these were collected in varied habitats (BEEMAN, 1960).

The author has observed *Aplysia californica* in northern California feeding on the red alga *Gracilariopsis* sp., the green algae *Ulva* spp., *Enteromorpha* spp., and occasionally the eel grass, *Zostera marina.* WINKLER & DAWSON (1963) note that, in southern California, *Aplysia californica* feeds mainly on "fleshy red algae" and occasionally on *Ulva* and *Enteromorpha,* while *A. vaccaria* seems to feed only on the brown alga, *Egregia.* LEIGHTON (1966)

Explanation of Plate 11

Figure 1: Dorsal view of a *Phyllaplysia taylori* postsettlement larva covered by a 2 mm long shell; the cephalic tentacles project anteriorly
Figure 2: A 3.6 mm secondary shell on the mantle shelf of a 55 mm *Phyllaplysia taylori*
Figure 3: *Phyllaplysia taylori* and its nidosome on a blade of *Zostera marina* in Elkhorn Slough, California. Note mm marks at edge of picture
Figure 4: *Phyllaplysia taylori,* dorsal aspect of a 4.5 cm individual from Elkhorn Slough, California, from life
Figure 5: *Aplysia vaccaria,* dorsal aspect of a 33 cm individual at Point Loma, California, from life
Figure 6: *Aplysia reticulopoda,* right dorso-lateral aspect, from a 19.3 cm preserved specimen from Laguna, California
Figure 7: Left dorso-lateral aspect of a young, 16 cm *Aplysia californica* captured at 10 m depth in Monterey Bay, California
Figure 8: Right lateral view of the same *Aplysia californica* shown in Figure 7, five months later, after being reared on a laboratory diet of *Zostera* and *Gracilariopsis.* The yellow strand around the right parapodium is a vinyl tube with tagging information printed on it

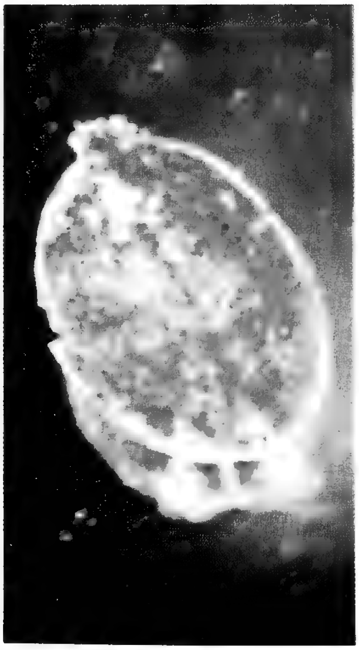

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

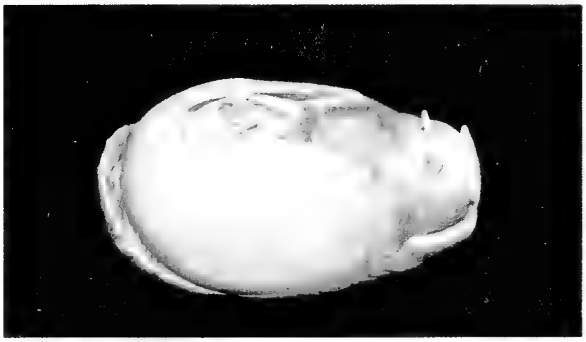

Figure 6

Figure 7

Figure 8

photographs by R. D. BEEMAN

reports that southern California *A. californica* exhibited a laboratory preference for *Egregia, Macrocystis,* and *Gigartina.* The color and pattern of these animals is quite variable. They often closely match the food species in color (Plate 11, Figures 7, 8), but it should not be assumed (as in WINKLER, 1959 and LINTON, 1966) that the colors of the animals are directly obtained from the food. DARLING & COSGROVE (1966) were not able to find expected precursors of *Aplysia* products in red algae. LEE (1966) found that the body pigments of isopods which match the color of their food species were not directly derived from this food.

Aplysia deposits long tangled strings of yellow, yellow-green, orange, or pink eggs among the rocks and seaweeds. Although copulation and egg-laying are most frequently observed intertidally, these activities are commonly accomplished sub-tidally (BEEMAN, MS 1958-1966; MILLER, 1960). The number of eggs is enormous; one adult sea hare may produce over three-quarters of a million ova in one season. Slight decreases in the usual huge larval mortality may be responsible for the frequently observed explosive increases in local populations.

The typically large body size of some species is also notable. *Aplysia vaccaria* is evidently the world's largest

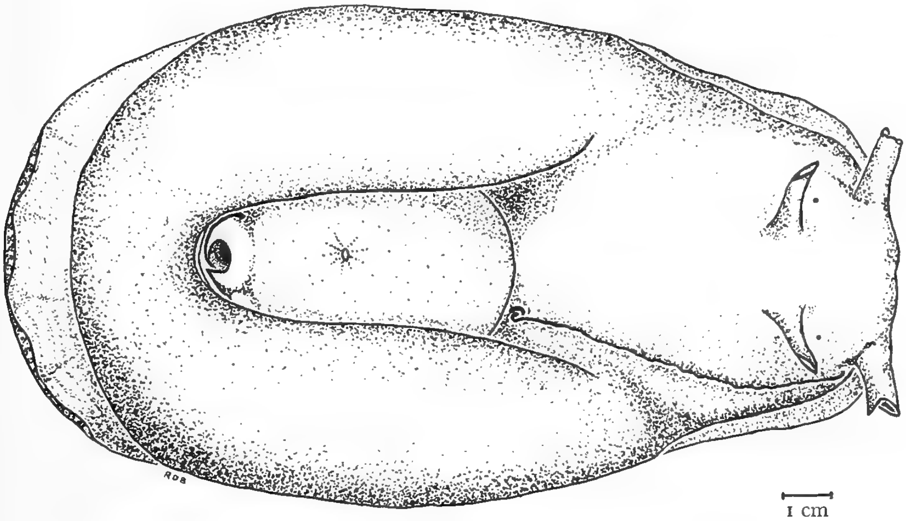

Figure 9

Aplysia reticulopoda, dorsal aspect, from preserved specimen

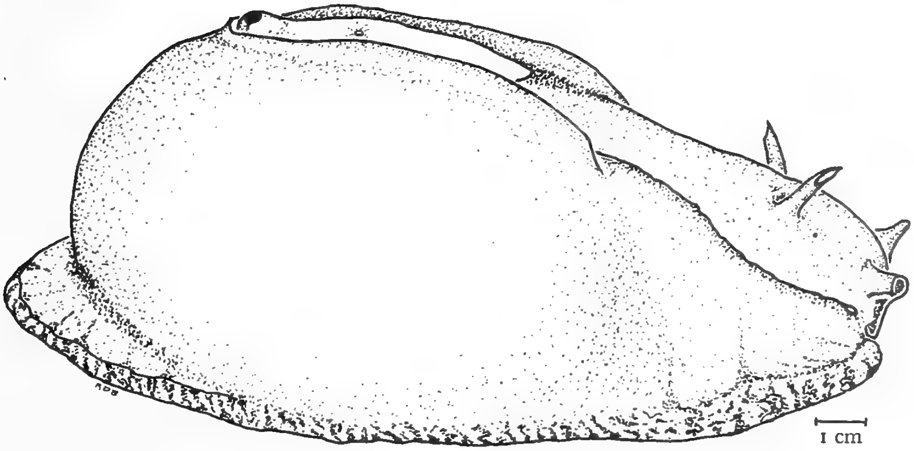

Figure 10

Aplysia reticulopoda, right lateral aspect, from preserved specimen gastropod. Conrad Limbaugh, late Scripps Institution of Oceanography diving officer, reported (Winkler & Dawson, 1963) subtidal specimens from the La Jolla region measuring up to 30 inches in length and weighing an estimated 35 pounds. Their remarkable growth rate is a reflection of their unusual ecological role as grazers of large seaweeds. Aplysids could be referred to as "annual animals" as their life span appears to be about one year.

The immense size of these mollusks, and perhaps some physiological factors as well, prevents the effective use of many anesthetics that are fast and successful when applied to other gastropods (Runham, Isarankura & Smith, 1965). This has made it difficult to dissect or preserve fresh specimens without having them contract violently. The author has found that intrahemocoelic injections of seawater solutions of succinic acid bis-(β-dimethylaminoethyl) ester dimethochloride (also called succinylcholine chloride or Anectine, Burroughs, Wellcome) or sodium α-di-1-methyl-5-allyl-5-(1-methyl-2-pentynyl) barbiturate (also called methohexital sodium or Brevital Sodium, Lilly) gave very rapid and excellent results. The former acts as a relaxant due to its action as a myoneural blocking agent; the latter is a barbiturate anesthetic. Dosages of 0.5 and 1.5 mg, respectively, per 10 gms of live weight gave preparations satisfactory for almost immediate dissection. Lower dosages are slower and sub-lethal. Specimens may be fixed in seawater formalin or Bouin's solution for periods of days, or even months, and then preserved in 70% alcohol. The hemocoel should be injected with fixative or opened along the right edge of the foot. Colors may fade or change greatly as a result of these preservation methods.

Dolabriferinae

Parapodia separated anteriorly only by genital groove, broadly joined posteriorly, small, not freely mobile, often asymmetrical and displaced to right. Shell small, rather flat, calcareous, secondary, or entirely missing. Skin frequently rough. Radula with broad rachidian tooth, larger than serrated laterals. Penis often with spines. Common genital aperture anterior to gill and within, or just forward of, pallial cavity. Nervous system with very much shortened visceral connectives. Body rather flattened. Greatest height and excurrent siphon posterior to midpoint of body. Foot as wide, or wider than, body.

This subfamily contains the genera *Dolabrifera, Petalifera* (= *Aplysiella*), and *Phyllaplysia. Phyllaplysia* is the only genus known from the California coast.

Phyllaplysia P. Fischer, 1872

Fischer's original description, with *Phyllaplysia lafonti* (Fischer, 1870) as the type species, has been repeated and referred to by Crosse (1875), Fischer (1887), Mazzarelli (1893b, 1901), Pilsbry (1895), Bergh (1902), Thiele (1931), and others. The genus was inadequately revised by Engel (1936) who reiterated that the only key difference between *Phyllaplysia* and the other two genera of the Dolabriferinae was the lack of a shell in *Phyllaplysia*. This statement is undoubtedly one of the major reasons for the continuing confusion between the genera *Phyllaplysia* and *Petalifera* Gray, 1847. A shell has been reported to occur within the genus *Phyllaplysia* by at least three authors: Bergh (1905) for *P. inornata* Bergh, 1905; Marcus (1955) for *P. engeli* Marcus, 1955; and Beeman (1963 and below) for *P. taylori* Dall, 1900. Eales (1944) added to the confusion by indicating that two key characteristics of *Phyllaplysia* were the lack of a shell and the positioning of the common genital aperture inside the dorsal slit. Baba (1937), Marcus & Marcus (1957), McCauley (1960), and Beeman (1963b) have shown that the position of the genital aperture cannot be used as a generic or specific character in *Phyllaplysia* and *Petalifera*.

Phyllaplysia and *Petalifera* can both be separated from *Dolabrifera* Gray, 1847; the latter has the posterior one-third of its body broadly expanded, and possesses a small, narrow shell, with a knobbed spire, which is very well enclosed by the mantle (Eales, 1944).

A characterization of the genus *Phyllaplysia* alone at this time must be brief. *Phyllaplysia* are small, flattened Dolabriferinae which attach by a broad foot to marine plants. The skin is typically smooth; projections occur in some. The animals are commonly green, with both color and pattern matching their plant substrate (Plate 11, Figure 3). At present, the most important generic character is the nature of the shell. It is, however, very often lacking. If present, it is a thin, fragile, calcareous, dorsally concave, secondary structure adhering to the dorsal surface of the mantle shelf in the parapodial cavity. The mantle does not cover the dorsal surface of the shell, even at its edges (Figure 3). The shell of *Phyllaplysia* is distinctly not aplysiform or dolabriform (Plate 11, Figure 2). Kay (1964) reports that *Petalifera petalifera* (Rang, 1828) has an aplysiform shell. Until a large series of specimens from various parts of the world can be examined critically, the genus *Phyllaplysia* cannot be characterized further or contrasted with *Petalifera*.

The species of *Phyllaplysia* are very poorly known; there are perhaps 14 species throughout the world in tropical and temperate seas. The specific identity of the 2351 *Phyllaplysia* examined during the present study was not clear at first. Two species, *Phyllaplysia zostericola* McCauley, 1960 and *P. taylori* Dall, 1900 had been reported to occur here. It was later determined (Beeman, 1963b) that *P. zostericola* should be considered a junior

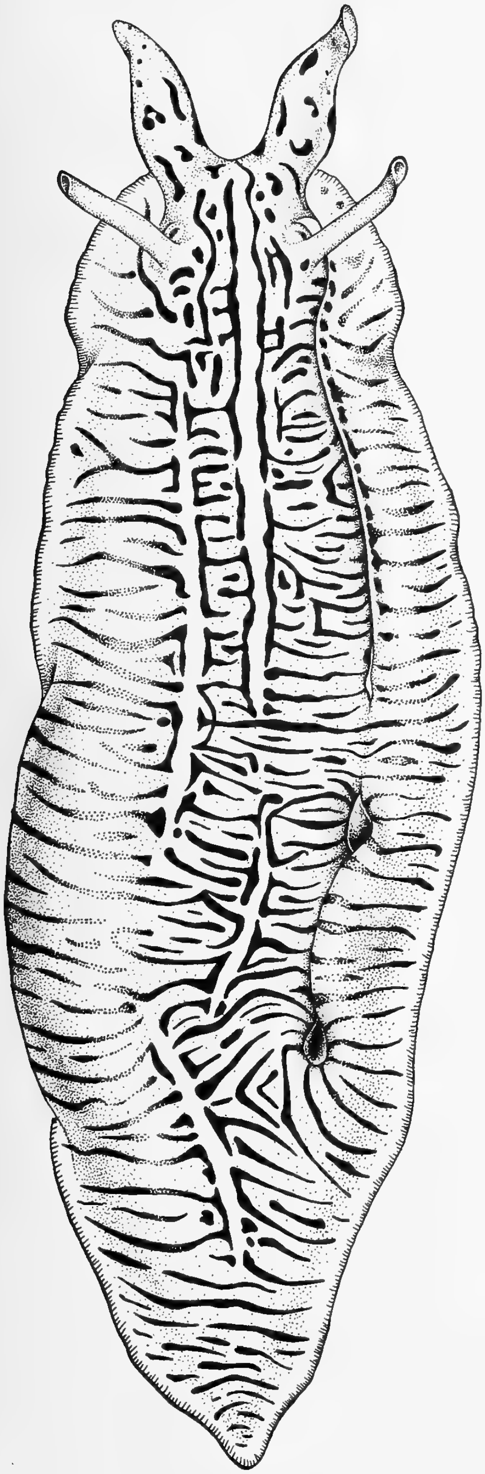

Figure 11

Phyllaplysia taylori from Elkhorn Slough, California dorsal aspect of a 4.5 cm individual, from life

synonym of *P. taylori*. *Phyllaplysia taylori* is thus the only representative of the genus known from the California coast.

Phyllaplysia taylori is the smallest of the California sea hares (Figures 3, 4, 11, 12, and Plate 11, Figures 1 to 4). Its maximum length is about 75 mm; most mature specimens are considerably smaller. The body appears to be bilaterally symmetrical, but the presence of the external genital groove and the gill cavity on the right side reveals, even externally, the effects of the characteristic opisthobranch detorsion. The gill cavity is much reduced, lying distinctly to the right of the longitudinal axis of the body and behind the common genital aperture. A large parapodial cavity is present over most of the left dorsal surface of the body (Figure 3).

The head region bears two pairs of tentacles. The anterior pair, the cephalic tentacles, are broad, flat structures which, judging from observations of behavior, appear to be involved in the sensing of food and substrate. Frings & Frings (1965) rather conclusively demonstrated that the cephalic tentacles of *Aplysia juliana* Quoy & Gaimard, 1832, are contact and distance receptors for food substances. A pair of labial lappets (Figure 12) which project ventrally from the cephalic tentacles are characteristic of *Phyllaplysia taylori*. The posterior tentacles or rhinophores, are slender structures with auriculate tips. As Frings & Frings (1965) noted, the function of these structures, so widely found in the opisthobranchs, is not olfactory as often reported. They report that the rhinophores are involved in current detection.

The dorsal markings of *Phyllaplysia taylori* are both beautiful and highly variable. Normally there is an attractive pattern of dark brown-black markings over a bright green body (Plate 11, Figures 3, 4). The markings consist of irregular spots and two types of stripes. The longitud-dinal stripes are made of a pair of broken dark lines on either side of a white line. These double stripes may anastomose with others or gradually taper out. The other stripes are transverse markings of much simpler design; they form simple lines with frequent breaks and a few branchings. The inner tips of these stripes often join, or even seem to form, the longitudinal stripes near the center line of the animal. Figure 11 shows a specimen with good development of both types of stripes. However, animals from a single collection from a single *Zostera bed* in Elkhorn Slough, California, have displayed patterns which range from those with a preponderance of transverse stripes to those with a preponderance of longitudinal stripes. MacGinitie & MacGinitie (1949), McCauley (1960), and MacFarland (1966) illustrate extreme examples of the longitudinal stripe pattern. It would be most interesting to know the genetic and/or environmental control of

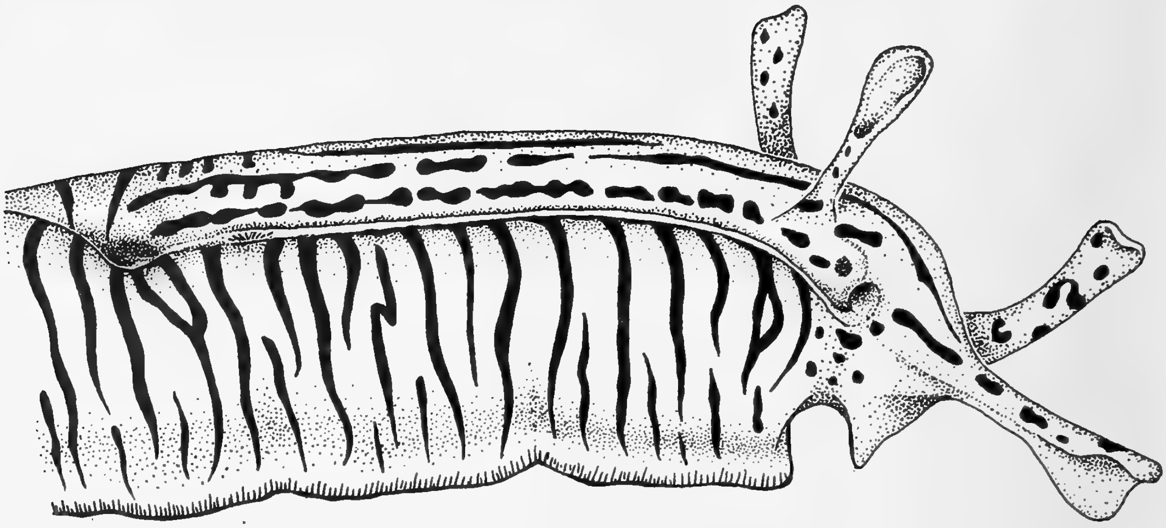

Figure 12

Phyllaplysia taylori from Elkhorn Slough, California
right lateral aspect of a 4.5 cm individual, from life

these patterns. In the meantime, one should be very cautious in the use of such patterns for taxonomic purposes. ENGEL & NIJSSEN-MEYER (1964) and BÜRGIN (1964) report that the nudibranchs *Glossodoris quadricolor* (RÜPPEL & LEUKART, 1828) and *Hermissenda crassicornis* (ESCHSCHOLTZ, 1831), respectively also display as great a variation in their markings.

The general anatomy of *Phyllaplysia taylori* has been described in some detail by MCCAULEY (1960), under the name *P. zostericola* MCCAULEY, 1960. A few details were added by MARCUS (1961). Some additions and corrections were made by BEEMAN (1963b, 1966). Details of the systematics, ecology, histology and anatomy of the reproductive system, spermatogenesis, and reproductive functional morphology of *Phyllaplysia taylori* are reported by BEEMAN (1966). A few aspects of this study, largely based on specimens from Elkhorn Slough, are summarized below.

Phyllaplysia taylori is often very numerous on *Zostera marina* LINNAEUS, 1758, the broad-blade eelgrass which is common in several of the west coast bays and estuaries. This animal grazes unselectively on the film of organisms, mainly sessile diatoms, which grow on *Zostera* blades. The feeding activities of *P. taylori* can be detected easily by an experienced eye from about March through October in Elkhorn Slough. The bright green surface of *Zostera* is revealed by the meandering swaths which are grazed through the thick superficial film by larger slugs. The diatom diet rapidly abrades the triturating stomach teeth. Migration of a radioactive band produced by tritiated thymidine injection and observed by autoradiography indicates that these teeth are totally replaced in about 25 days.

Phyllaplysia taylori in Elkhorn Slough appears to have two overlapping waves of reproductive activity per year. First, a "winter crop" with a slow early growth, a peak in mean size about July, and a probable life span of about 7 to 8 months. Second, a "summer crop" with rapid growth, a peak in mean size in October, and a probable life span of about 3 to 5 months.

Phyllaplysia taylori is a simultaneous hermaphrodite; its development is not clearly protandric. Gametogenesis seems to begin at an alcoholic body weight of about 20 mg. All stages of gametogenesis may be found in a single acinus of the ovotestis in mature animals. Field observations and deduction from seasonal changes in mean oocyte diameters reveal that eggs which yield the summer crop are laid from July to November. The eggs are laid in flat packets firmly attached to the *Zostera* blades (Plate 11, Figure 2). Hatching takes about 3 weeks; if a free-swimming larval period exists, it is probably very short. The post-settlement larva of *P. taylori* was discovered on *Zostera* (Plate 11, Figure 1). A limpet-like shell covers this larva until the shell is about 2 mm in greater diameter. At about this stage the primary shell simply pops off the young animal's back, and a pale scar marks its former position for a few days.

Direct development to juvenile and adult stages follows loss of the primary shell. The larger animals orient themselves longitudinally on the *Zostera* blades (Plate 11, Figure 3). At low tide most *Phyllaplysia taylori* are tightly packed between the basal sections of the *Zostera* leaves. This habit of concealment, plus the manner in which the animals mimic the surface of *Zostera* hides the species so well that even persons collecting in the *Zostera* may be unaware of the tremendous abundance of this opisthobranch. As high water returns, the animals move up the blade to feed, mate, and lay eggs.

Copulation is typically reciprocal with the common genital aperture then serving as a vaginal entrance. The functional morphology and other features of mating are considered in detail by BEEMAN (1966). Copulation is followed, in a few days or weeks, with egg-laying, and the life-cycle begins again.

Notarchinae

Very similar to Dolabriferinae except for the following features: Parapodia almost completely joined, often forming a large cavity around visceral mass and gill, capable of forcing out water to provide erratic squid-like swimming in some (GUIART, 1901, fig. 10). Shell very minute and orbicular, usually absent. Skin usually with filamentous appendages, frequently with brightly colored "ocelli." Greatest height and excurrent siphon may be near, or anterior to, midpoint of body.

According to EALES (1944, 1960) and ZILCH (1959 to 1960) the subfamily contains the genera *Notarchus, Stylocheilus* (= *Aclesia* in part), *Barnardaclesia,* and *Bursatella,* none of which is presently known from California. The placement of the Mexican notaspidean *Aclesia rickettsi* MACFARLAND, 1966 in the Aplysiidae section of MACFARLAND (1966) is surely an unfortunate error due to posthumous editing. *Aclesia rickettsi* is very likely a synonym of *Stylocheilus longicauda* (QUOY & GAIMARD, 1824) which KAY (1964) reports from Hawaii.

Dolabellinae

Parapodia separated anteriorly only by genital groove, united behind, barely mobile. Shell well developed, strongly calcified, flat, strongly curved, apex covered by heavily thickened axial edge, right side conspicuously concave. Skin sometimes rough or with appendages. Radula with all teeth very narrow and unicuspid; rachidian teeth much smaller than the very numerous, long, simple, lateral teeth. Common genital aperture usually under posterior part of gill. Nervous system with long visceral connectives as in *Aplysia*. Body truncated behind, bounded by unique transverse ridge (MACFARLAND, 1966, pl. 6, fig. 14).

Dolabella is the only definite genus; it has not yet been reported from California.

DISTRIBUTION OF SPECIES

Aplysia californica COOPER, 1863
Common intertidally and subtidally to at least 60 feet. Humboldt Bay, California (40° 45′ N, 124° 14′ W) to the Gulf of California, Mexico.

Aplysia vaccaria WINKLER, 1955
Common intertidally and subtidally to at least 60 feet. San Pedro, California (33° 44′ N, 118° 16′ W) to Gulf of California, Mexico.

Aplysia reticulopoda BEEMAN, 1960
Uncommon subtidally. Laguna Beach, California 33° 32′ N, 117° 44′ W) to San Clemente Island, California (32° 54′ N, 118° 25′ W).

Phyllaplysia taylori DALL, 1900
Common on *Zostera marina* plants from Nanaimo, British Columbia (49° 09′ N, 123° 57′ W) to San Diego, California (32° 42′ N, 117° 11′ W).

KEY TO THE CALIFORNIA ANASPIDEA

1. Ground color bright green with distinct longitudinal and/or transverse dark stripes. Adults small, maximum length about 8 cm. Body elongate, somewhat flattened. Gill cavity small, distinctly to right of body axis. Parapodia small, nearly touching anteriorly at bases. Shell chamber absent. Common genital aperture anterior to gill cavity (Figures 11, 12; and Plate 11, Figures 1 to 4) .... *Phyllaplysia taylori*

   Ground color not bright green, no obvious stripes. Adults large, over 10 cm in length. Body bulky; visceral hump prominent. Gill cavity in median line. Parapodia well developed, widely separated anteriorly. Shell chamber distinct. Common genital aperture within gill cavity 2

2(1). Purple secretion emitted in life when irritated and in first preserving fluids. Body soft. Parapodia joined low posteriorly near top of foot or separated. Opaline gland large, uniporous, projecting into hemocoel like a bunch of grapes. Shell foramen minute or closed. Shell with projecting rectangular plate ("accessory plate") ventral to rounded apex (Figures 4, 5; and Plate 11, Figures 7, 8) .... *Aplysia californica*

– No purple secretion. Parapodia posteriorly joined high up by anal siphon. Body firm. Opaline gland consisting of many simple glandular units buried in body wall; multiporous on inner side of right parapodium base. Shell foramen distinct. Shell without projecting rectangular plate 3

3(2). Ground color deep purplish black, usually with fine gray or white markings; dark mottling may be noticeable. Foot uniformly deep bluish black. Parapodia overlapping dorsally, frilled. Rhinophores ruffled (Figures 7, 8; and Plate 11, Figure 5) .... *Aplysia vaccaria*

– Ground color pale yellowish white. Purplish black network formed in grooves of foot. Parapodia short, not overlapping dorsally, edges smooth. Rhinophores smooth, bluntly tapering (Figures 9, 10; and Plate 11, Figure 6) .... *Aplysia reticulopoda*

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GLOSSARY

See also Henderson & Henderson (1960), Arnold (1965), and a good dictionary.

Accessory plate – A small rectangular plate ventral to the shell apex in *Aplysia californica*; the single distinctive feature of the subgenus *Neaplysia* Cooper, 1863 (Eales, 1960: fig. 12; Winkler, 1958: fig. 1)

Anal sinus – A broad indentation of a shell's margin near the apex (Eales, 1960: fig. 6)

Anal siphon – In anaspideans, a posterior section of the mantle edge twisted to form a tube around the anus. Respiratory currents through this tube flush fecal material away from the animal. Often interchangeable with the term exhalant siphon. Synonym: anal funnel (Figures 1, 4)

Apex – The point at the tip of the spire of a gastropod shell (Arnold, 1965: fig. 6; Eales, 1960: fig. 6)

Aplysid – A member of the family Aplysiidae, Order ANASPIDEA

Aplysiform shell – A primary shell resulting from tremendous plate-like outgrowth from the veliger shell in many aplysids. It is a thin, buried shell that has a fan shape, dorsal convexity, posterior apex, right sinus, chitinous composition, and often a calcareous lining (Pilsbry, 1895: plts. 16 - 44, 55 - 67; Mazzarelli, 1893a: plt. 12; MacFarland, 1966: plt. 6, figs. 16, 17)

Buccal mass – The strongly muscular portion of the digestive system posterior to the oral tube and anterior to the esophagus. Contains the radula and odontophore (MacFarland, 1966: plt. 51, fig. 1; plt. 53, fig. 1)

Bulloid – Having the appearance of a bubble; refers to shells with an involute spire and an aperture at least the length of the shell as in *Bulla* and *Haminoea* (Zilch, 1959-1960: fig. 181)

Cephalic shield – The fleshy plate, free at the edges, which covers the anterior part of cephalaspideans and *Akera*. Syn.: anterior shield, head shield, cephalic disk (MacFarland, 1966: plt. 2, fig. 4)

Cephalic tentacles – The most anterior paired tentacles. Syn.: head tentacles (Figures 1 and 4)

Clade – The limb of a hypothetical phylogenetic (evolutionary) tree

Denticulate – Having little teeth or raised points; with notches much finer than those referred to as serrate. May refer to the condition of having tiny teeth on the sides of serrations

Dorsal slit – In anaspideans, the dorsal opening between the right and left parapodia (Figure 4)

Exhalant siphon – The main point of respiratory current outflow, generally marked by a tube-like configuration of mantle or parapodial margin. Often interchangeable with the term anal siphon. Syn.: excurrent siphon (Figure 4)

Female gland mass – A compound gland consisting of the membrane (= winding) gland, albumen gland, and mucous gland. These glands are diverticula of a convoluted oviduct or egg-tube. Syn.: accessory or anterior gland mass, nidamental glands (of some authors). (Figure 4; Beeman, 1966: figs. 20, 21, 82, 84, 88)

Gill cavity – See pallial cavity

Gizzard – See triturating stomach

Glans – The anterior section of the penis from its tip to its attachment with the eversible penial sheath (Beeman, 1966: fig. 66)

Hemocoel – The major body cavity of mollusks and certain other invertebrates. It consists of an immense blood sinus which houses most of the internal organs (Fig. 3)

Labial lappets – Small projections from the ventral base of the cephalic tentacles. Syn.: oral tentacles, labial palps (Figure 12)

Mantle – The part of the outer integument of mollusks that is extended out around the visceral mass and hangs down as a fold, forms the mantle (= pallial) cavity posteriorly, and secretes the shell

Mantle cavity – See pallial cavity

Mantle glands – In anaspideans, a group of simple glands on the right ventral edge of the mantle shelf. They may exude a purple or whitish fluid and/or a musky odor. Syn.: purple glands, mantle edge glands Figures 1, 2)

Mantle shelf – A shelf-like outgrowth of the mantle from the left over the gill of the anaspideans (Figs. 1-3)

Mantle pore – See shell foramen

Membrane gland – The middle pallial gonoduct gland. This gland, the albumen gland, and the mucous gland comprise the female gland mass. The membrane gland covers the albumen-coated eggs with a membrane before the mucus coat is applied. Syn.: winding gland (Beeman, 1966: figs. 21, 76, 82, 84, 88; Marcus & Marcus, 1957: figs. 8 - 14; Ghiselin, 1965: figs. 1, 2)

Multiporous – Having many openings or pores; used of glands (Figure 3; Eales, 1960: fig. 9)

Nucleus – In adult shells the larval shell which is retained at the apex (Winkler, 1958: fig. 1; MacFarland, 1966: plt. 6, fig. 13a; plt. 12, figs. 15 - 18; Mazzarelli, 1893a: plt. 12)

Nidosome – The egg mass of an opisthobranch; esp. a compact, well-organized mass (Plate 11, Figure 3)

Opaline gland – A large gland which extrudes mucus into the pallial cavity near the anterior inner side of the right parapodial base. May be multiporous (Eales, 1960: fig. 9), consisting of many simple units diffused in the body wall or uniporous (Johnson & Snook, 1927: fig. 500), consisting of a single, compound gland projecting deeply into the hemocoel. Syn.: Organ of Bohadsch, hypobranchial gland of some authors (Figures 1-3; Pruvot-Fol, 1954: fig. 24)

Pallial cavity – A cavity formed by the infolding of the mantle or external surface of the body in the gill region. In anaspideans this consists of the gill cavity and, from an embryological point of view, the common genital duct, copulatory bursa, and female gland mass. Opposed to coelomic cavities, which are formed from within the body. The parapodial cavity is a special extension of the main pallial cavity. Syn.: mantle cavity (Figures 1 - 4; Ghiselin, 1965: figs. 1, 2)

Parapodia – Flap-like, lateral, upwardly directed extensions of the sides of the molluscan foot (Figures 1 - 4)

Parapodial cavity – A special extension of the pallial cavity which is under the left parapodium and is separated from the gill cavity by the mantle shelf. *Phyllaplysia* is one of the few animals showing this feature (Figure 3)

Plicate gill – A gill which is composed of loose, hollow folds of skin (MacFarland, 1966: plt. 9, fig. 10)

Primary shell – An adult shell which results from tremendous outgrowth of the veliger shell (Mazzarelli, 1893a: plt. 12; Winkler, 1958: fig. 1; MacFarland, 1966: plt. 6, fig. 13a; plt. 12, figs. 15 - 18)

Pseudosiphon – In anaspideans a slight extra wall around the anal siphon formed by a section of the dorsal edges of the parapodia, following the contour of the anal siphon (Figure 1)

Purple glands – See mantle glands

Rachidian tooth – The median tooth in a transverse row of radular teeth (MacFarland, 1966: plt. 8, figs. 4, 33)

Rhinophores – The posterior pair of sensory projections from the opisthobranch head (Figures 1 and 2)

Secondary shell – A shell that is developed independently of the veliger shell. It may be produced by the same mantle tissue which produced the veliger shell after the veliger shell has been shed (Figures 3, 4; and Plate 11, Figure 2)

Shell chamber – The cavity formed by the mantle overgrowing the dorsal surface of the shell (Figures 1, 2)

Shell foramen – The dorsal opening of the shell chamber. Syn.: mantle foramen, shell aperture (of some authors) in anaspideans (Figures 1, 2)

Siphon – In mollusks a folding of the mantle or parapodia which serves as a tube to direct water currents in the pallial cavity (Figures 1, 4)

Tectibranch – Belonging to the order TECTIBRANCHIA of opisthobranch mollusks, comprising those forms usually having shells borne either externally or concealed within the mantle or parapodia. This order has been divided into several orders and the term is often loosely applied to all opisthobranchs, especially those with shells, other than those assignable to the order NUDIBRANCHIA

Triturating stomach – A region of the digestive tract specialized for grinding. Anaspideans have two distinct regions: an anterior section composed of a heavy muscular band around a lining of heavy chitinous teeth which almost occlude the lumen and a posterior section of much lighter muscle and spines. Syn.: gizzard, grinding stomach (McCauley, 1960: figs. 2, 3; Pruvot-Fol, 1954: figs. 21e, 24d)

Truncated – Ending very bluntly; the proximal, basal end of the point may be marked by an obtuse angle (MacFarland, 1966: plt. 6, fig. 14)

Veliger – The larval stage of a mollusk which is furnished with a velum or ciliated swimming membrane. When hatched, veligers are usually free-swimming but they may also be seen rotating within the egg capsule just prior to hatching (Cover figure of The Veliger quarterly journal)

Visceral connectives – The nerve cords which connect the circumesophageal nerve ring to the ganglia (cluster of nerve cell bodies) in the abdominal area. Long in *Aplysia*. (Eales, 1944: fig. 6). Short in *Phyllaplysia* (McCauley, 1960: fig. 5)

Visceral hump – The posterior section of the body which is swollen due to the contained visceral mass (Fig. 1)

Visceral mass – The aggregation of soft internal organs in the posterior section of any gastropod mollusk; those soft internal organs contained within the shell of a gastropod mollusk with a well developed shell. Generally consisting mainly of the digestive gland and gonads (Figure 3; Eales, 1960: fig. 8b)

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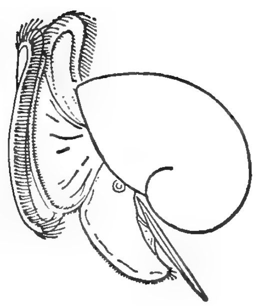


The Thecosomata and Gymnosomata of California

BY

JOHN A. McGOWAN

Scripps Institution of Oceanography, University of California at San Diego, La Jolla, California 92037

(Plates 12 to 20)

PART I

THECOSOMATA

THE THECOSOMATA ARE A GROUP of holoplanktonic opisthobranchs which were formerly lumped together with the Gymnosomata to form the order "Pteropoda." However, as early as 1886, BOAS, and the following year PELSENEER (1888), pointed out that this was an artificial grouping. Following this, MEISENHEIMER (1905), TESCH (1913, 1946, 1948), PRUVOT-FOL (1954) and MORTON (1958) have all maintained this separation. PELSENEER in particular presented a great deal of evidence that the two groups were really quite dissimilar in many ways. The only apparent similarity is the fact that both have epipodia modified into swimming wings.

It appears that the Thecosomata are derived from the Bulloidea. The foot is reduced, but the epipodia are greatly enlarged and are used for swimming. There is a gizzard armed with four hard plates. There are lateral jaws and generally a small, triserial radula. There is a pallial cavity, but only one genus (*Peraclis*) has a true ctenidium. The reproductive system consists of an hermaphroditic gland, a duct with an ampulla, a copulatory vesicle, a mucous and albumen gland, a ciliated groove and an unarmed penis. The species of three of the four families have calcareous shells. Those of the fourth family (Cymbulidae) have a transparent pseudoconch which has a firm gelatinous consistency.

MEISENHEIMER (1905) separated the order into two sub-orders, Euthecosomata and Pseudothecosomata. The fundamental difference between the two sub-orders is in the arrangements of the foot and fins. The fins of the Pseudothecosomata are united into a continuous "swimming plate" that is ventral to the mouth. The fins of the Euthecosomata are separate and dorsal to the mouth. At the dorsal margin of the swimming plate in the Pseudothecosomata there is a proboscis-like structure composed of two parts: lateral lips and a posterior "foot lobe." These form a ciliated gutter which leads to the mouth. The tentacles of the Pseudothecosomata are paired and symmetrical, while those of the Euthecosomata are not. In the Pseudothecosomata the visceral mass of the central nervous system includes a separate abdominal ganglion. The mantle cavity of the animals in this sub-order is not dorsal as it is in the Euthecosomata, but is either ventral or laterally displaced to the right. Plate 12 illustrates some of the basic differences between the two sub-orders.

The present concept of the taxonomy of the order is as follows:

THECOSOMATA

- Euthecosomata
  - LIMACINIDAE
  - CAVOLINIIDAE
- Pseudothecosomata
  - PERACLIDIDAE
  - CYMBULIDAE

LIMACINIDAE

The LIMACINIDAE are characterized by a sinistrally coiled shell that may be trochoid in form or more flattened and involute. All members have an eccentrically spiralled operculum attached to the posterior footlobe. The paired fins are large and their outer borders are not sub-divided. The right tentacle is much larger than the left. The mantle cavity is dorsal and the gland of the mantle cavity is asymmetrical. There is no ctenidium. The right visceral ganglionic mass is larger than the left. There are eight species in the family, all of the genus *Limacina*.

CAVOLINIIDAE

The shells of the species of this family are quite variable in shape, but are never coiled. They all have a straight median axis and are bilaterally symmetrical. They may be simple cones, or rather globular with pronounced lateral processes, or pyramidal. There is no operculum in the adult. The fins are notched on the free edge of their margins and the middle lobe of the foot is broad and semi-circular. The columellar muscle is dorsal, the intestinal loop ventral, and the anus opens to the left. The visceral ganglia are of almost equal size. There are seven genera and 26 species in this family.

Peraclididae

All species within this family have sinistrally coiled shells which possess a spirally twisted prolongation of the columella. The shells of most of the species are covered with a delicate, generally hexagonal meshwork that appears to be non-calcareous. The operculum is almost circular and is attached to the under side of the ventral portion of the fins. The proboscis is short. On the left side of the pallial gland, in the mantle cavity, there is a ctenidium. The heart and kidney are near it. There are six species in this family, all of the genus *Peraclis*.

Cymbulidae

These organisms do not possess a calcareous shell except in the larval stages. The adults bear a transparent gelatinous pseudoconch. This is generally large relative to the size of the animal. The pseudoconch is boat- or slipper-shaped and is enveloped by the integument of the animal. There is an excavation in this structure in which the visceral mass is situated. However, the animal cannot retract its entire body into the cavity of the pseudoconch. The fins are united into a continuous "swimming plate." At the dorsal margin of this is a proboscis consisting of two parts: the lateral lips (foot lobes) and the posterior foot lobe. Together these form a ciliated structure that leads to the mouth. The tentacles are symmetrical. There is no ctenidium.

GENERAL BIOLOGY

Because the thecosomes are oceanic there have been few opportunities for direct observations on various important aspects of their biology. However, a few have been shown to be ciliary mucous feeders. Judging from the similarity of the mouth parts of the others it seems safe to assume that they also feed in this way. This type of feeding behavior tends to select small organisms and particulate matter. Foraminifera, Radiolaria and diatoms have been observed in the gut of *Clio pyramidata,* but additional kinds of organisms are undoubtedly eaten as well.

Several species of the genus *Limacina* have been shown to be protandrous hermaphrodites (Morton, 1954, Hisao, 1939). The smaller individuals tend to have only spermatocytes, but as they grow larger, oocytes develop. As growth of the animal proceeds, the spermatocytes disappear and the gonad becomes purely female in the largest members of the population. Although it has not yet been shown to be the case, it seems probable that other thecosomes have a similar type of sexuality. There is very little reliable information on seasons of spawning or on growth rates.

All of the Limacinidae and some of the Cavoliniidae have been shown to perform diurnal vertical migrations. Populations tend to live at depths during the day and migrate toward the shallower levels at sundown. These populations tend to remain at shallow depths during the night and return to day-time depths at dawn. The vertical range of some species is as great as 300 meters.

Thecosomes are found in all oceans including the Antarctic. While most of them are epipelagic, some are mesopelagic and a few are bathypelagic. Their biomass is seldom as great as that of copepods or euphausiids, but at times they are abundant enough to serve as an important item in the diet of herring and other fishes. Concentrations of over 100000 individuals per $1000 m^3$ of water have been found (McGowan, 1967).

The empty shells of the thecosomes contribute significantly to the deep sea sediments in certain places. This material is referred to as "pteropod ooze." If long enough cores could be taken in these areas the history of the group could be studied. This has not, as yet, been done.

A KEY TO THE GENERA OF THECOSOMATA OF THE CALIFORNIA CURRENT

(Plates 13 to 17)

1. a. Calcareous shell present 2
   b. Shell not present, transparent, gelatinous pseudoconch .... *Cymbulidae*
2. a. Shell spirally coiled, sinistral 3
   b. Shell not coiled; shell conical and straight or pyramidal, or vase-shaped, or dorso-ventrally inflated with a wide, hooded, slot-like aperture 4
3. a. Shell with marked external ornamentation which usually appears as a hexagonal meshwork. Some species having little or no meshwork bear radiating axial sculpture on main body whorl. Operculum circular. Frequently, but not always, a light brown color .... *Peraclis*
   b. Shell surface with little or no ornamentation, very thin and usually unpigmented and trochoid in shape. However, one species (*L. inflata*) with an involute pigmented shell. Operculum ovoid .... *Limacina*

4. a. Shell perfectly conical and either straight or flexed to an angle of about 50° 5
   b. Shell vase-shaped or pyramidal or dorso-ventrally inflated with a wide, hooded, slot-like aperture 6
5. a. Shell conical with a circular cross section; either straight or flexed. External surface without ornamentation .... *Creseis*
   b. Shell conical, straight. Surface with obvious striae which may be either longitudinal or transverse 7
6. a. Shell vase-shaped, aperture unobstructed, posterior tip blunt and rounded, protoconch missing .... *Cuvierina*
   b. Shell either pyramidal with sharply pointed posterior and open, unobstructed aperture; or dorso-ventrally inflated with hooded, slot-like aperture and generally somewhat globular in shape 8
7. a. Conical shell with finely pointed posterior. A single longitudinal rib running from the anterior dorsal edge of the aperture, and **angling to the left,** and terminating near the tip .... *Styliola*
   b. Conical shell without protoconch, posterior tip truncate and open. Raised transverse annulations the entire length of the shell. Shell very flimsy. Animal (in formalin preserved specimens) usually extended showing large fins, or missing from shell entirely .... *Hyalocylix*
8. a. Shell pyramidal, with a pronounced central midrib dorsally. Aperture unobstructed. Posterior tip with a sharply pointed larval shell .... *Clio*
   b. Shell dorso-ventrally inflated or even globular. Aperture partially covered by a hood-like projection of the dorsal shell. Slit-like elongations of the aperture continuous to the lateral sides of the shell 9
9. The remaining two genera, *Cavolinia* and *Diacria,* cannot be easily separated on the basis of shell characters. The two differ anatomically, but since these soft parts are usually very much contracted in preserved material, dissection is a laborious and time-consuming job. Further, the shell must be destroyed for this purpose and thus the key characters for species determination are lost. These two genera also differ from one another in their mode of development. Species of the genus *Cavolinia* possess a thimble-shaped larval shell; during growth the edges of this "thimble" grow out and gradually diverge to form the inflated or globular adult shell. The *Diacria,* on the other hand, possess an almost spherical larval shell, and during their growth pass through a juvenile stage, the shell of which is very different from the adult. One species of this genus, *D. trispinosa,* retains this juvenile shell as an adult, the other, *D. quadridentata,* does not. The latter species, as an adult, superficially resembles several of the species of *Cavolinia.* Thus the larval and juvenile shell characters cannot be used in a key. There is one evident shell character that may be used to differentiate the two genera. The outer edges of the shell surrounding the aperture, in the genus *Diacria,* are rolled into fat lips. The lips of the aperture in *Cavolinia* are thin and sharp. However, the best way to determine these genera is to become familiar with the species of each. Since there are only six species of *Cavolinia* and two species of *Diacria,* this is not difficult. Outline drawings of the shells of these species may be found in Tesch (1946 and 1948).

DISTRIBUTION IN THE CALIFORNIA CURRENT

None of the species of thecosomes are endemic to the California Current, indeed, most of them are also found in the Atlantic and Indian Oceans as well as in the Pacific. However, within the Pacific, species tend to be limited to one, or at most two, of the major water masses. This tendency to occupy certain bodies of water results in definite patterns of distributions which are reflected in faunistics of the California Current system.

This current is not a simple north to south flow of water but rather a complex system of meanders, eddies and countercurrents. This current has been discussed by Reid, Roden & Wylie (1958). They show that there are four major sources of water. The northern part of the current is derived from the Subarctic water mass and the North Pacific Drift. On the outer boundaries and south of Point Conception this water mixes with water of the Central water mass from the west. Equatorial water enters, seasonally, from the south as a countercurrent. Superimposed on this system is a fourth source of deep water, upwelled near the coast.

Thus the central portion of the California Current, roughly from Point Conception to just north of Magdalena Bay, is an area of great hydrographic and faunistic mixing. One result of this is that the thecosome fauna here is exceedingly diverse. In the northern sector of this current the species are those of the Subarctic and North Pacific Drift; in the southern sector they are those of the Equatorial water mass. In the central-mixed area there is a combination of Subarctic, North Pacific Drift, Central and occasional Equatorial water mass species present in varying proportions (Plate 18).

The general areas of species occurrence are listed in Table 1. The data on which this table is based came from the examination of several hundred plankton tows taken by the California Cooperative Fisheries Investigations during the years 1949, 1950, and 1952. A detailed atlas showing species distribution and abundance, by month, for these years is available (McGowan, 1967).

During 1952 there were no great seasonal changes in abundance of any of the species populations of thecosomes in the California Current as a whole. There are, however, significant differences in abundance between years. This is probably due more to advection of various types of water into the area than to reproduction or unusual mortalities. This is a consequence of the fact that this current system is primarily an area of faunal boundaries of populations. These populations occupy gigantic areas (entire water masses) and their cycles of abundance are influenced primarily by events and processes which take place generally throughout their ranges rather than on the boundaries of them. Thus in areas such as the California Current only a small fraction of the total population of any species may be represented and population events that occur here are not necessarily representative of what is happening to the species in general. It seems to be generally true that in all such boundary areas the ecology of populations of many species tend to be different than in the main portions of their ranges.

Table 1

A Summary of Species Distributions in the California Current

Species	Area of California Current
Limacina helicina (Phipps, 1774)	Primarily north of Pt. Conception. Occasional patches south as far as Punta Eugenia. Epipelagic
Limacina inflata (d'Orbigny, 1836)	Outer fringes north of Pt. Conception. Further inshore south of here
Limacina trochiformis (d'Orbigny, 1836)	Extremely abundant off Magdalena Bay, and also occurring farther south. Epipelagic
Limacina bulimoides (d'Orbigny, 1836)	Outer fringes south of Pt. Conception but never abundant here. Epipelagic
Limacina lesueuri (d'Orbigny, 1836)	Outer fringes of the central portion. Strictly oceanic. Epipelagic
Clio pyramidata Linnaeus, 1767	Several varieties throughout the California Current. Epipelagic and Mesopelagic
Clio balantium (Rang, 1834)	California Current as far south as Magdalena Bay. Always rare. Epipelagic
Clio cuspidata (Bosc, 1802)	Outer fringes of the southern portion. Rare. Probably epipelagic
Clio polita Pelseneer, 1888	North of Pt. Conception. Bathypelagic, rare
Cavolinia inflexa Lesueur, 1813	Southern portion only, and well offshore. Epipelagic
Cavolinia tridentata (Forskal, 1773)	Outer fringes of central and southern portions. Epipelagic
Cavolinia uncinata (Rang, 1836)	Outer fringes of southern portion. Epipelagic
Diacria trispinosa (Lesueur, 1821)	Outer fringes of northern and central portions. Epipelagic
Diacria quadridentata (Lesueur, 1821)	Outer fringes of southern portion. Epipelagic
Hyalocylix striata (Rang, 1828)	Outer fringes of southern portion. Epipelagic
Styliola subula (Quoy & Gaimard, 1827)	Outer fringes, entire area. Epipelagic
Cuvierina columnella (Rang, 1827)	Outer fringes of the entire area. Epipelagic. Rare
Creseis virgula (Rang, 1828)	Three varieties south of Pt. Conception. Epipelagic
Creseis acicula Rang, 1828	South of Punta Eugenia only. Epipelagic
Corolla spectabilis Dall, 1871	North of Pt. Conception with occasional patches south to Punta Eugenia. Epipelagic
Cymbulia peroni de Blainville, 1818	Far southern portion of the area. Epipelagic
Peraclis reticulata (d'Orbigny, 1836)	Throughout central to southern portions. Generally rare and probably mesopelagic
Peraclis apicifulva Meisenheimer, 1906	Extreme southern portion only. Probably mesopelagic
Peraclis bispinosa Pelseneer, 1888	Southern portion only. Rare and probably mesopelagic

Explanation of Plate 12

A Diagrammatic Comparison of the Main Anatomical Features of the Families of Thecosomata

1. Tentacles
2. Wings
3. Mouth
4. Lateral Foot Lobe
5. Posterior Foot Lobes
6. Ciliary Field
7. Foot
8. Operculum
9. Shell

Explanation of Plate 13

Limacina inflata (d'Orbigny)
1.5 mm diameter
a. Dorsal view b. Apertural view c. Ventral view

Limacina bulimoides (d'Orbigny)
1.7 mm diameter
d. Apertural view g. Dorsal view

Limacina helicina (Phipps), type B
2.0 mm diameter
e. Apertural view

Limacina trochiformis (d'Orbigny)
0.95 mm diameter
f. Apertural view i. Dorsal view

Peraclis bispinosa Pelseneer
5.2 mm diameter
h. Apertural view

Explanation of Plate 14

Clio pyramidata Linnaeus
Length 9.3 mm
a. Dorsal view b. Ventral view

Clio balantium (Rang)
Length 18.5 mm
c. Dorsal view d. Ventral view

Explanation of Plate 15

Cavolinia uncinata (Rang)
Length 7.4 mm
a. Dorsal view b. Lateral view c. Ventral view

Cavolinia inflexa (Rang)
Length 6.1 mm
d. Dorsal view e. Lateral view f. Ventral view

Cavolinia tridentata Førskal
Length 14.0 mm
g. Dorsal view h. Lateral view i. Ventral view

Explanation of Plate 16

Corolla spectabilis Dall

Dorsal View of a Specimen from the Central Mixed Zone of the California Current
Width (long axis) of the swimming plate: 5.5 cm

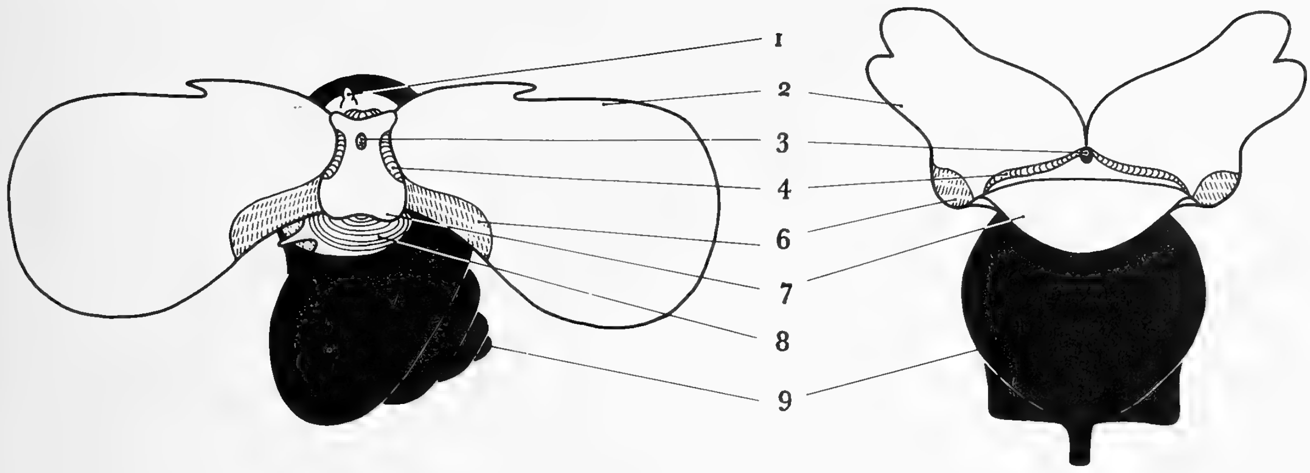
I: integument LF: lateral foot lobes M: mouth
MC: mantle cavity P: pseudoconch SP: swimming plate
T: tentacles VM: visceral mass

Explanation of Plate 17

Cymbulia peroni de Blainville

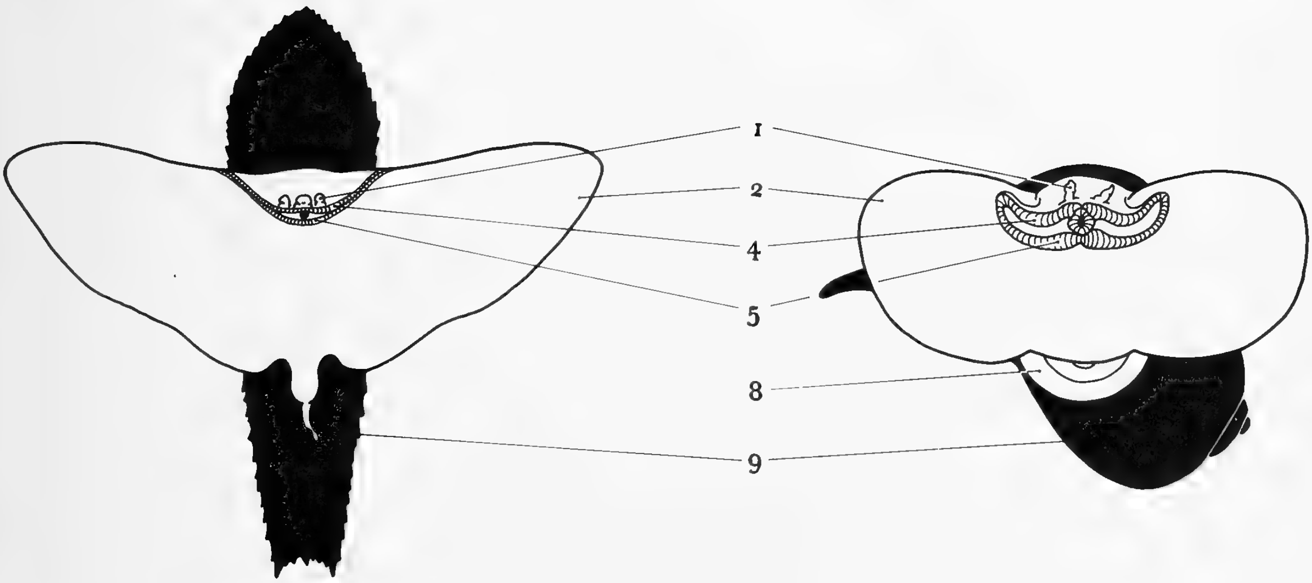
Dorsal View of a Specimen taken from the Southern Zone of the California Current
Width of swimming plate (long axis) 1.7 cm

LF: lateral foot lobe P: pseudoconch SP: swimming plate
VM: visceral mass



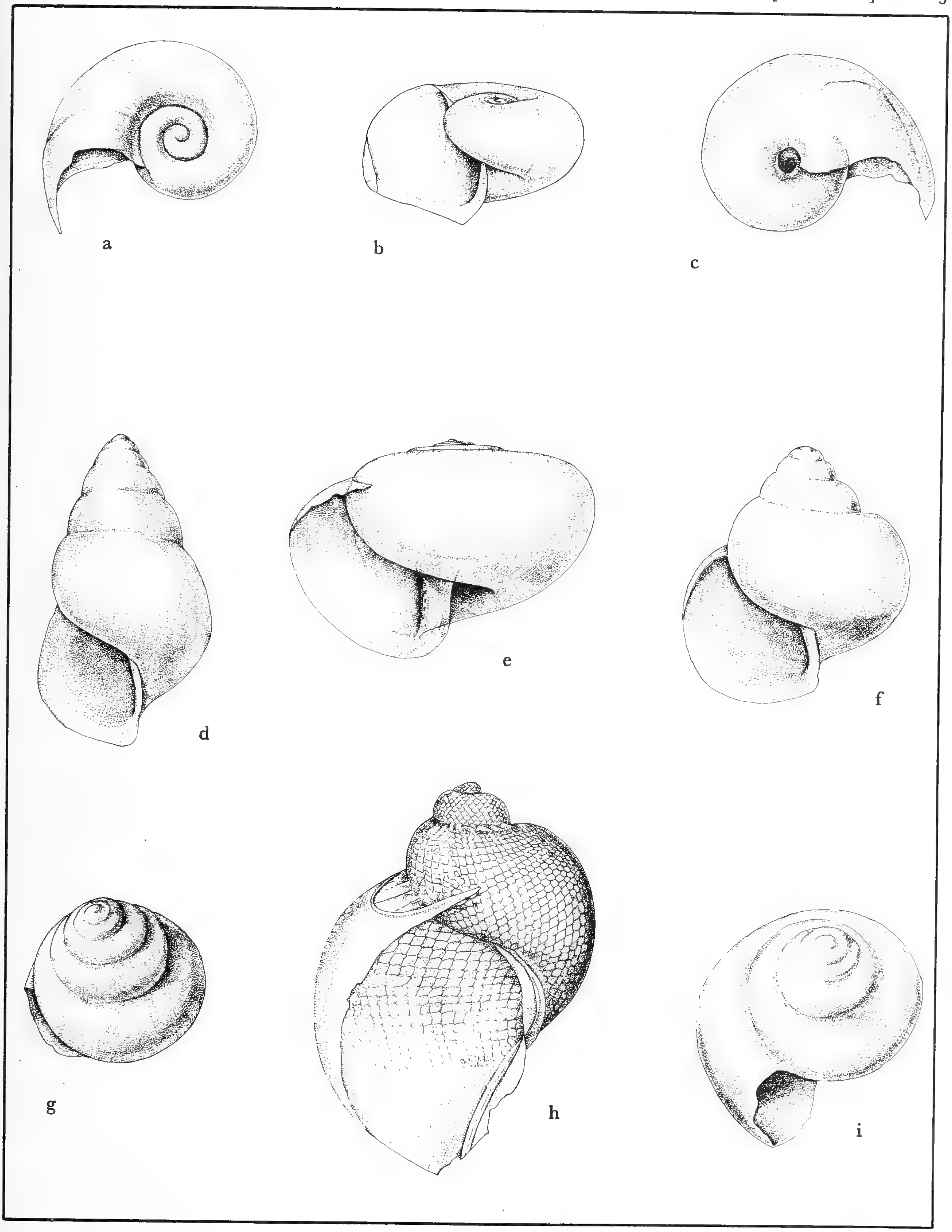
LIMACINIDAE CAVOLINIIDAE

EUTHECOSOMATA



CYMBULIDAE PERACLIDIDAE

PSEUDOTHECOSOMATA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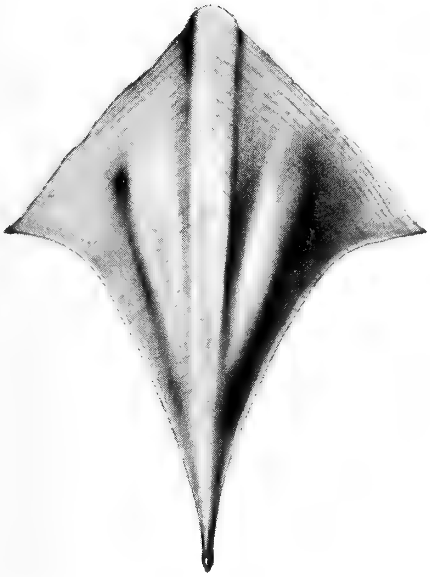

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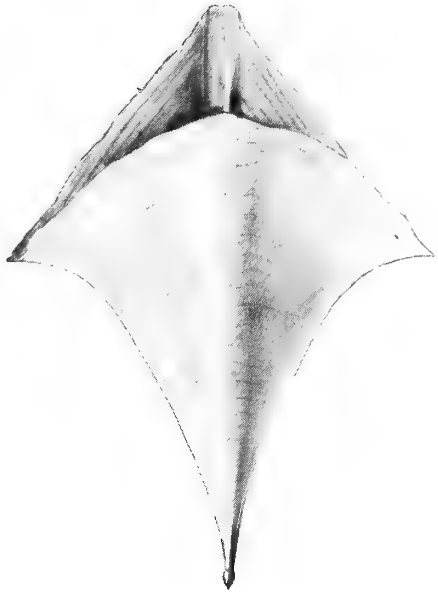

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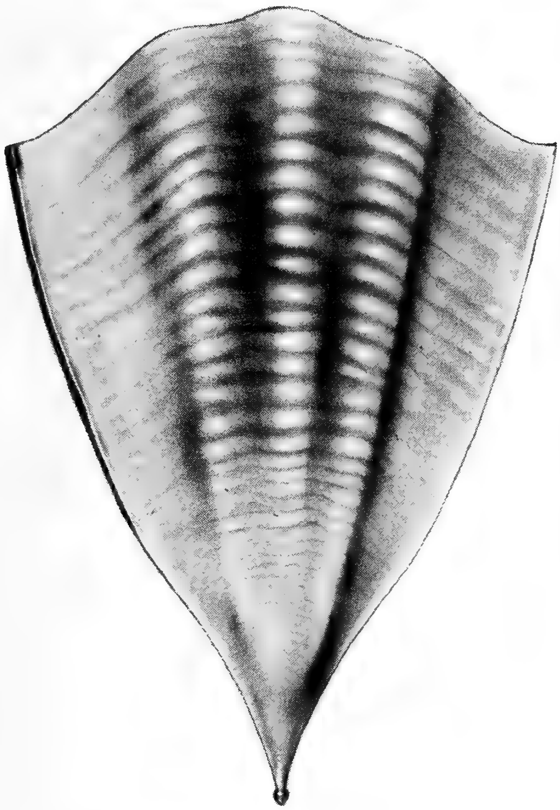

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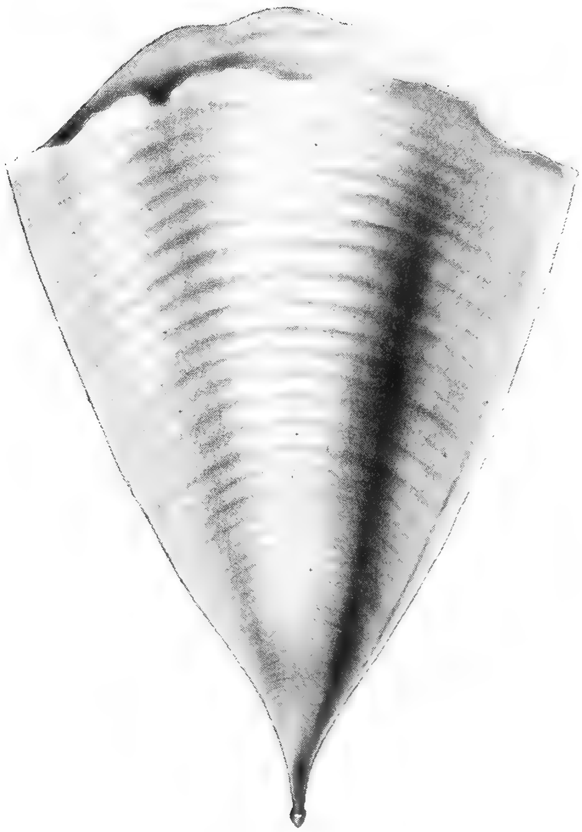

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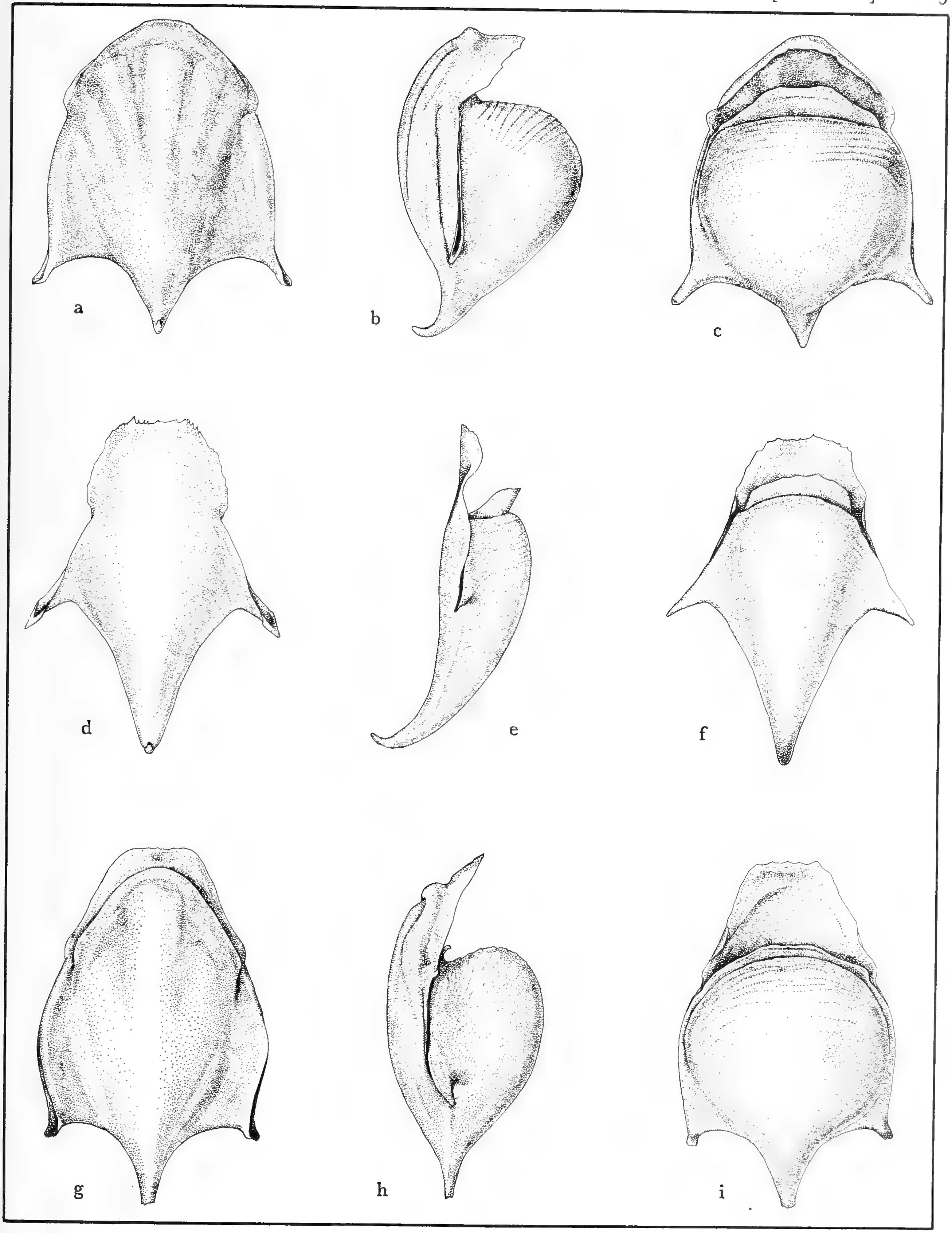
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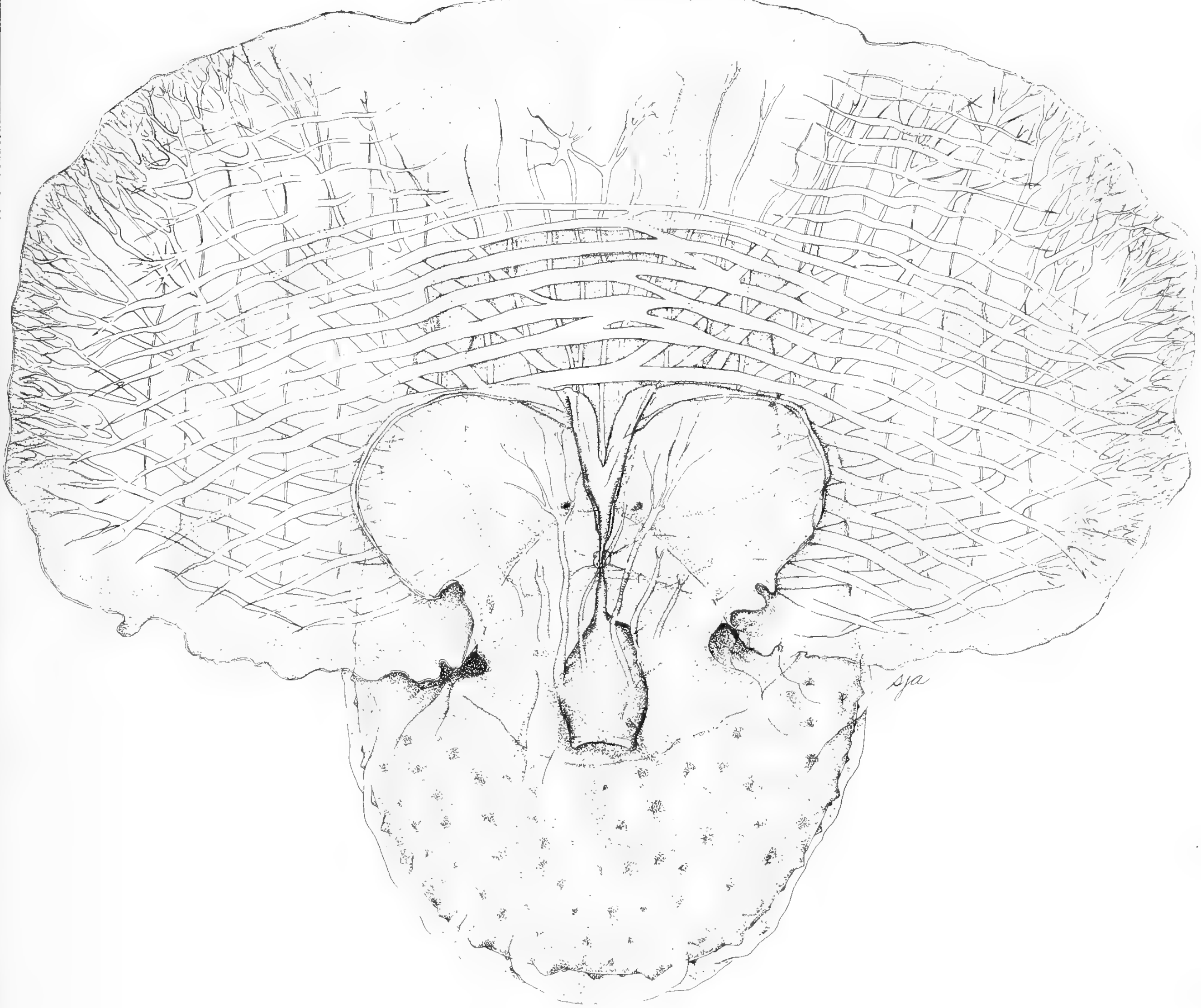

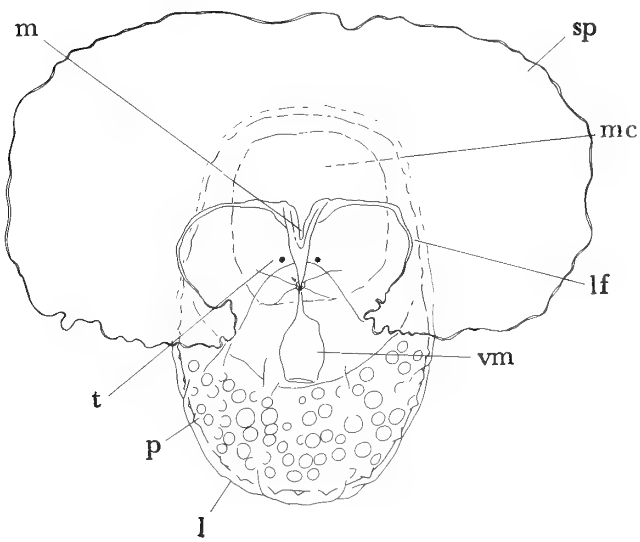
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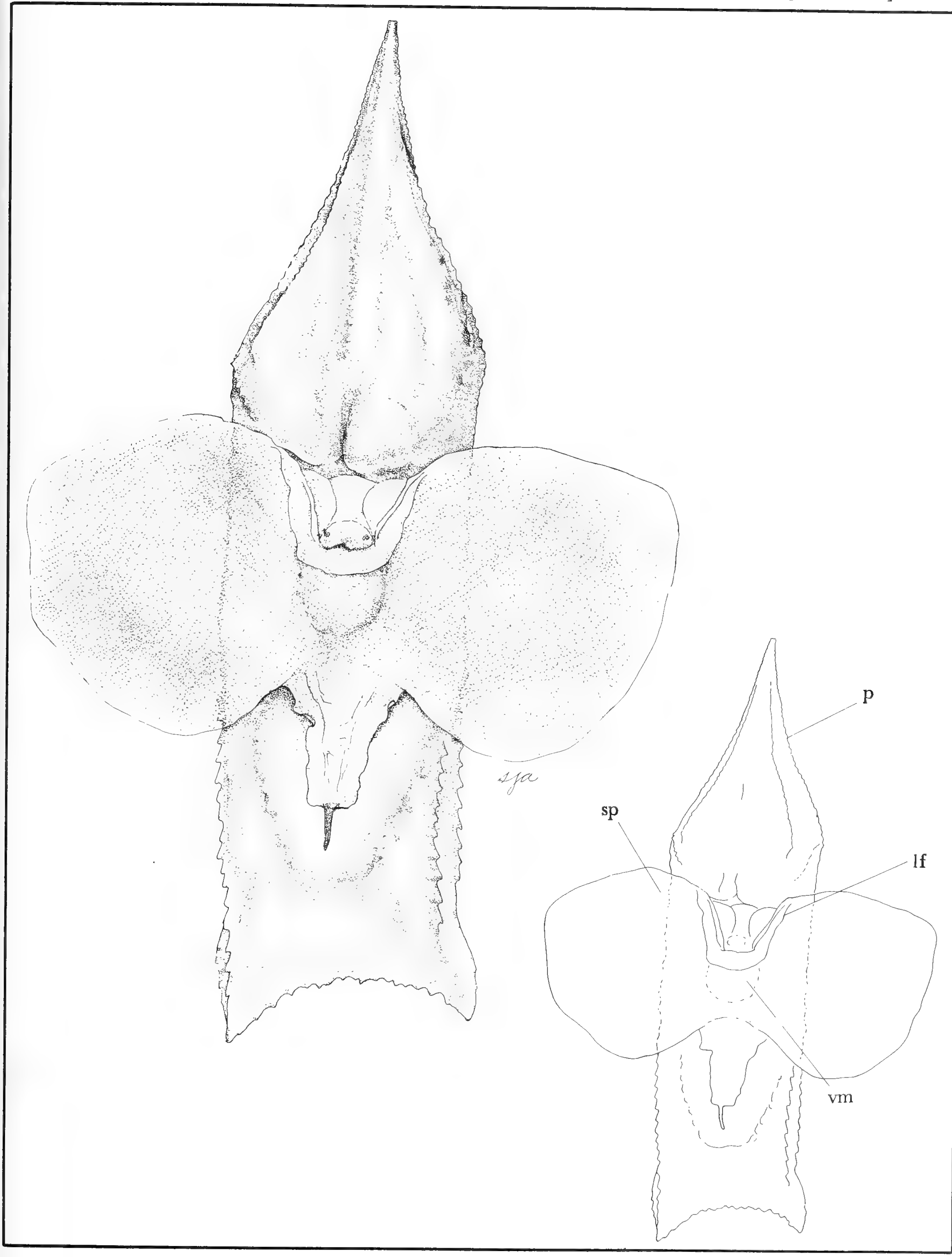
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PART II

GYMNOSOMATA

ALTHOUGH THE GYMNOSOMES are by no means "rare," they are a very poorly known group, both taxonomically and ecologically. The reasons for this are probably because they are holoplanktonic, oceanic and mainly mesopelagic. They are, therefore, difficult and expensive to collect. They are also small and very contractile. Because many of them have quite muscular bodies, preserved specimens are extremely difficult to study.

In spite of these difficulties, TESCH (1913) and PRUVOT-FOL (1954) have reviewed the group. Based on their original research and that of their predecessors, they have provided a taxonomy and a set of definitions for the order and the families. The following is a summary of their definitions.

The Gymnosomata are holoplanktonic opisthobranchs that have no mantle or mantle cavity and no shell in the juvenile or adult. They have a well developed head that is distinctly set off from the body. There are two pairs of tentacles and a mouth. They have jaws and a radula. The lateral teeth of the radula are long and have large basal plates. On either side of the radular pouch there are evaginable sacs lined with sharp chitinous hooks. There is also an evaginable proboscis which generally bears some sort of buccal appendages. The foot is quite distinct from the fins and is formed of a posterior lobe and two antero-lateral lobes which are joined anteriorly. The penis is latero-ventral on the right side of the foot. The anus is on the right side.

These animals are generally rather spindle shaped or spherical. Some species may be as much as 3 cm in length, but most are much smaller than this. They are vigorous swimmers and are all thought to be carnivores. Some species are epipelagic, but most are probably meso- to bathypelagic. Like most carnivores, they are never really abundant; however, *Clione limacina*, the best known species, has been found to be relatively numerous in boreal and temperate waters of the North Atlantic and the North Pacific. This species has been observed to feed on the thecosome *Limacina helicina*.

PELSENEER (1887) has placed the gymnosomes among the aplysioid (= Anaspidea) tectibranchs; however, they are now considered to be a separate order, perhaps derived from the Aplysiomorpha.

There are five or six families and some authors mention the possibility of a seventh (Plates 19 and 20).

GYMNOSOMATA

PNEUMODERMATIDAE
CLIOPSIDAE
NOTOBRANCHAEIDAE
CLIONIDAE
THLIPTODONTIDAE

Families of undetermined status:

HALOPSYCHIDAE
DESMOPTERIDAE

PNEUMODERMATIDAE

Members of this family have suckers on the ventral side of the protrusible proboscis. They have a lateral gill-like structure on their right side. They have a jaw and their integument is pigmented. There are four genera.

CLIOPSIDAE

The cliopsids have a very long protrusible proboscis but lack buccal appendages. There is a jaw. They have a quadriradiate posterior "gill" but no lateral "gill." They are not pigmented. There are two genera.

NOTOBRANCHAEIDAE

Members of this family have conical buccal appendages associated with the proboscis. They bear a posterior "gill" which is made up of three radiating crests, the dorsal of which is fringed. These meet posteriorly. The integument is pigmented. There is a single genus in this family.

CLIONIDAE

These are the best known of the gymnosomes. They have two or three pairs of conical buccal appendages. There are no jaws and no "gills." Their skin is not pigmented. There are four genera.

THLIPTODONTIDAE

The thliptodontids are easily recognized because of their extraordinarily large head. This part makes up almost one half of the entire body, is broad, and is not set off from the rest of the body by a constriction. There are large hooksacs present in one genus (*Thliptodon*), but in the other (*Thallassopterus*) these are very much reduced. The pharynx is large but there are no jaws. The radula is well developed, large, and may be differentiated from those of all other gymnosomes in that in each transverse row there are three kinds of teeth rather than two. There are no external "gills."

Halopsychidae

This family was created on the basis of a single species, *Halopsyche gaudichaudii* (= *Hydromyles globulosa*). It is a very aberrant form and there seem to be some reasonable doubts that it is a gymnosome. The arrangement of the fins, foot lobes, and tentacles are like those of the other gymnosomes; however, the body is enclosed in a tough, thick integument. This integument has a slot-like opening anteriorly through which the head parts, fins, and foot lobes may be retracted. Furthermore, there is no proboscis, no buccal appendages, no hooksacs and no gills. These animals are relatively abundant in the Indian Ocean and in the Pacific in the vicinity of the Indo-Australian Archipelago. See Meisenheimer (1905) for illustrations of this animal.

Desmopteridae

These organisms are generally placed in the order Thecosomata. However, they have no shell or pseudoconch and no proboscis. The only feature they have in common with the Pseudothecosomata is that of the swimming-plate which is attached to the cylindrical body at a small area of its midpoint. There is an epidermal fold beneath the mouth that is thought to represent the foot. The radula is small and resembles those of the Thecosomata. The family is based on a single genus. This genus is relatively common in the California Current.

GYMNOSOMES OF THE CALIFORNIA CURRENT

This group has not been intensively studied in the Pacific. However, the following genera are present in the California Current.

Clione	Clionidae	Northern
Clionina	Clionidae	Northern
Cliopsis	Cliopsidae	Northern
Provotella	Cliopsidae	Central
Pneumodermopsis	Pneumodermatidae	Northern
Pneumoderma	Pneumodermatidae	Southern
Spongiobranchia	Pneumodermatidae	Central
Thliptodon	Thliptodontidae	Central
Desmopterus	Desmopteridae	Central and Southern

ACKNOWLEDGMENTS

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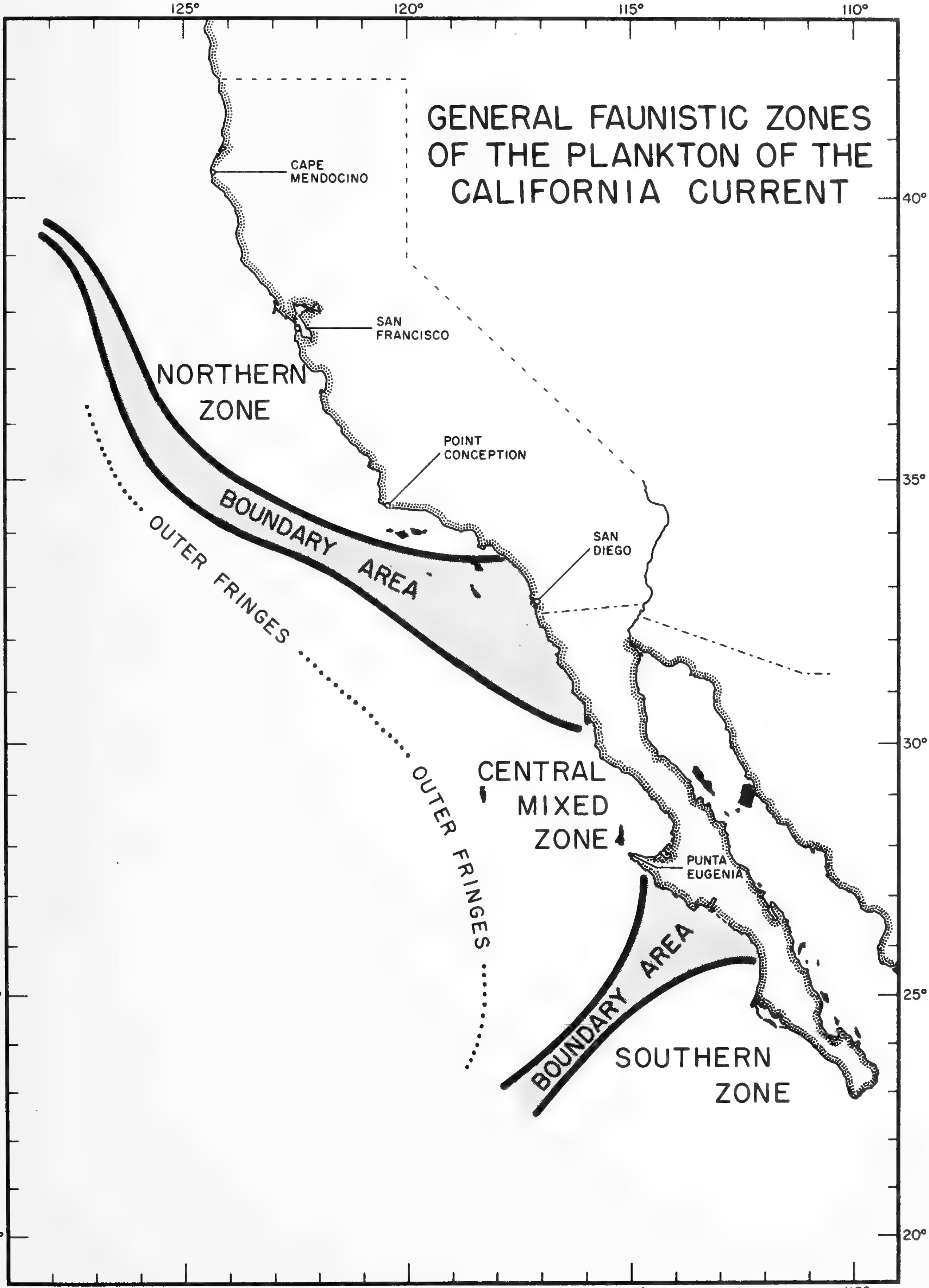
Explanation of Plate 18

A generalized chart of the faunistic zones of the zooplankton of the California Current. This is based primarily on the distribution of the thecosomes and heteropods whose zoogeographic affinities are known. The boundary areas represent estimates of the extremes of the ranges of the Subarctic and Transition water mass fauna and the Equatorial water mass fauna. The outer fringes represent the average eastern-most range of "pure" Central water mass fauna.


GENERAL FAUNISTIC ZONES
OF THE PLANKTON OF THE
CALIFORNIA CURRENT
125°
120°
115°
110°
40°
35°
30°
25°
20°
CAPE
MENDOCINO
SAN
FRANCISCO
POINT
CONCEPTION
SAN
DIEGO
PUNTA
EUGENIA
NORTHERN
ZONE
BOUNDARY
AREA
OUTER FRINGES
OUTER FRINGES
CENTRAL
MIXED
ZONE
BOUNDARY
AREA
SOUTHERN
ZONE

Explanation of Plate 19

Representative Members
of Four of the Families of the Gymnosomata

Notobranchaeidae

1. Buccal cones
2. Penis
3. Lateral foot lobes
4. Posterior foot lobes
5. Fins

Thliptodontidae

1. Esophagus
2. Radula
3. Esophageal bladder
4. Hook sacs
5. Fins
6. Ciliary ring

Pneumodermatidae

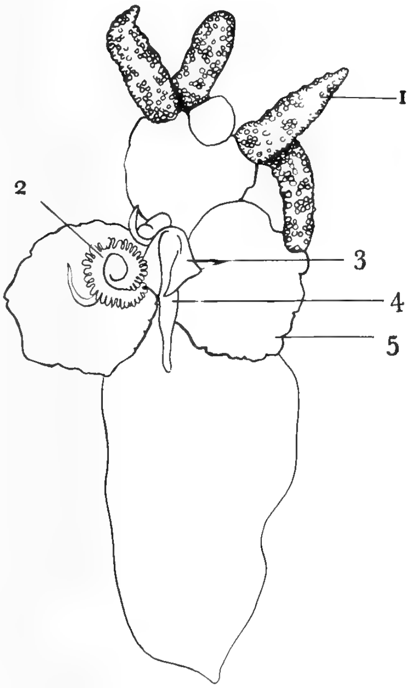
1. Buccal appendage
2. Penis
3. Tentacles
4. Lateral foot lobes
5. Fins
6. Posterior foot lobe
7. Gill
8. Ciliary ring

Clionidae

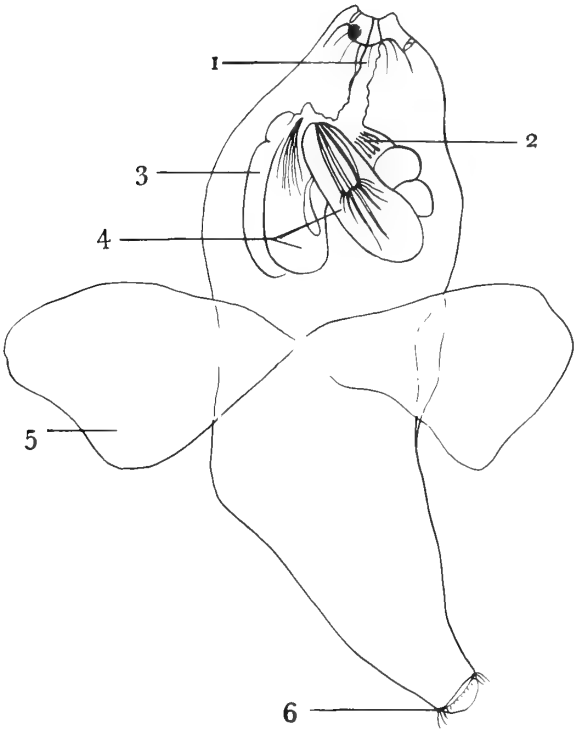
1. Buccal cones
2. Tentacles
3. Fins
4. Penis
5. Lateral foot lobes

Explanation of Plate 20

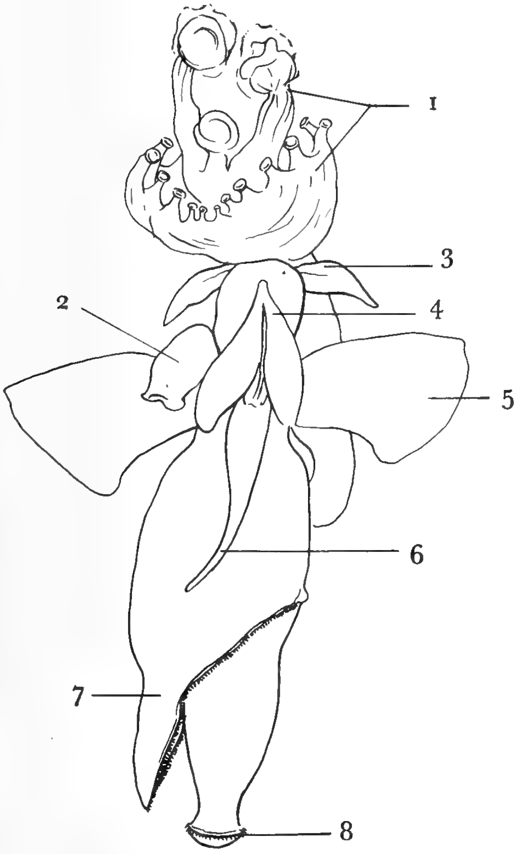
Desmopterus pacificus Essenberg, 1919
A Ventral View of a Specimen from the Central Mixed Zone
of the California Current
Width of swimming plate (long axis) 2.6 mm
M: mouth T: tentacle SP: swimming plate
ET: epipodial tentacle



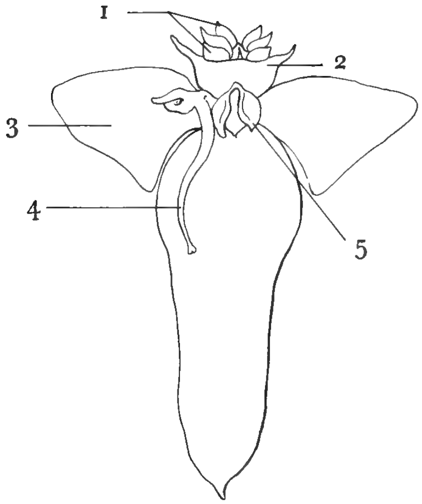
NOTOBRANCHAEIDAE



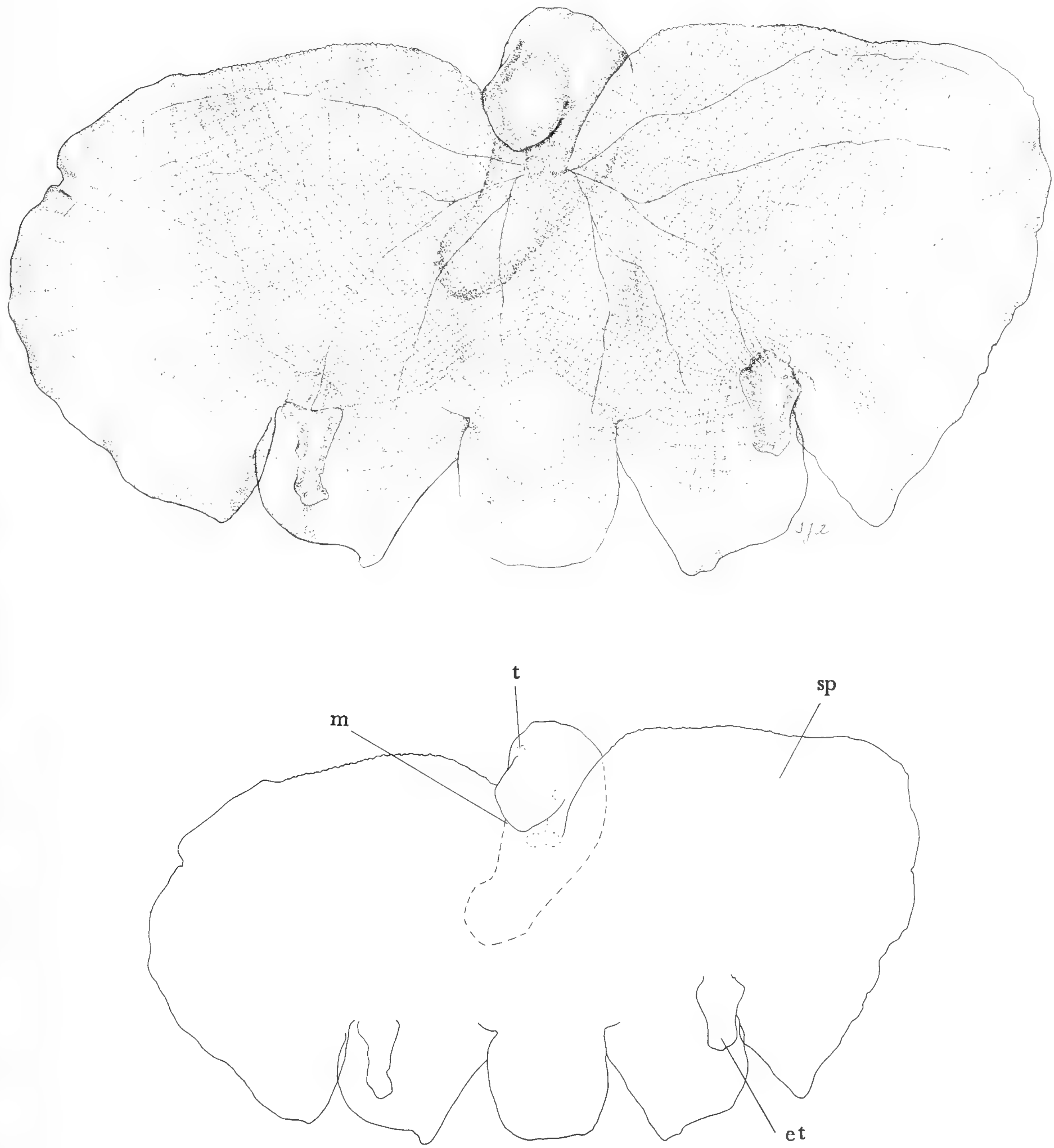
THLIPTODONTIDAE



PNEUMODERMATIDAE



CLIONIDAE


t
sp
m
et

Index

New taxa are printed in **bold face type**. A number preceded by the letter p refers to the plate on which illustrations appear, while the numbers in parentheses refer to the figures on the particular plate. **Bold face figures** refer to the pages on which the original description of the new taxon is given, while those in parentheses refer to figures pertaining to the new taxon.

Mr. James R. Lance of San Diego very carefully proof-read this index and supplied the authors and dates of the genera, for which time-consuming labor we express our appreciation.

A

B

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U

V

W

Z

Non-Opisthobranch Entries