

# American Museum Novitates

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PUBLISHED BY THE AMERICAN MUSEUM OF NATURAL HISTORY  
CENTRAL PARK WEST AT 79TH STREET, NEW YORK 24, N.Y.

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NUMBER 1943

JUNE 17, 1959

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## Some Turbellaria from the Coast of California

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The present article is a further contribution to the knowledge of the turbellarian fauna of the Pacific coast of North America, a subject to which I have already devoted four articles (Hyman, 1953, 1954, 1955, 1956). Clearly much still remains to be discovered about this fauna, especially as regards the smaller forms. The material of this article was kindly sent to me by Californians interested in marine life, to whom I am indebted for their efforts.

### FOR ALL FIGURES

1, Ovocytes; 2, food body; 3, penis; 4, cilia; 5, epicytium; 6, outer longitudinal fibers; 7, circular muscle layer; 8, longitudinal muscle layer; 9, nuclei of epidermis; 10, statocyst; 11, statolith; 12, lithocyte; 13, brain; 14, superficial mesenchyme; 15, ovogonia; 16, central mesenchyme; 17, sperm; 18, seminal vesicle; 19, penis stylet; 20, male gonopore; 21, cerebral eyes; 22, tentacular eyes; 23, pharynx; 24, uteri with eggs; 25, Lang's vesicle; 26, spermiducal vesicles; 27, prostatic vesicle; 28, penis papilla; 29, cement glands; 30, female gonopore; 31, male antrum; 32, female antrum; 33, vagina; 34, entrance of common uterine duct; 35, duct of Lang's vesicle; 36, tentacular folds; 37, mouth; 38, sucker; 39, penis sheath; 40, ejaculatory duct; 41, outline of uteri;

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42, white border; 43, white spots; 44, red streaks; 45, uterine vesicles; 46, male apparatus.

ORDER ACOELA

FAMILY HAPLOPOSTHIIDAE

*Childia groenlandica* (Levinsen, 1879)

Figures 1-7

*Convoluta groenlandica* LEVINSEN, 1879.

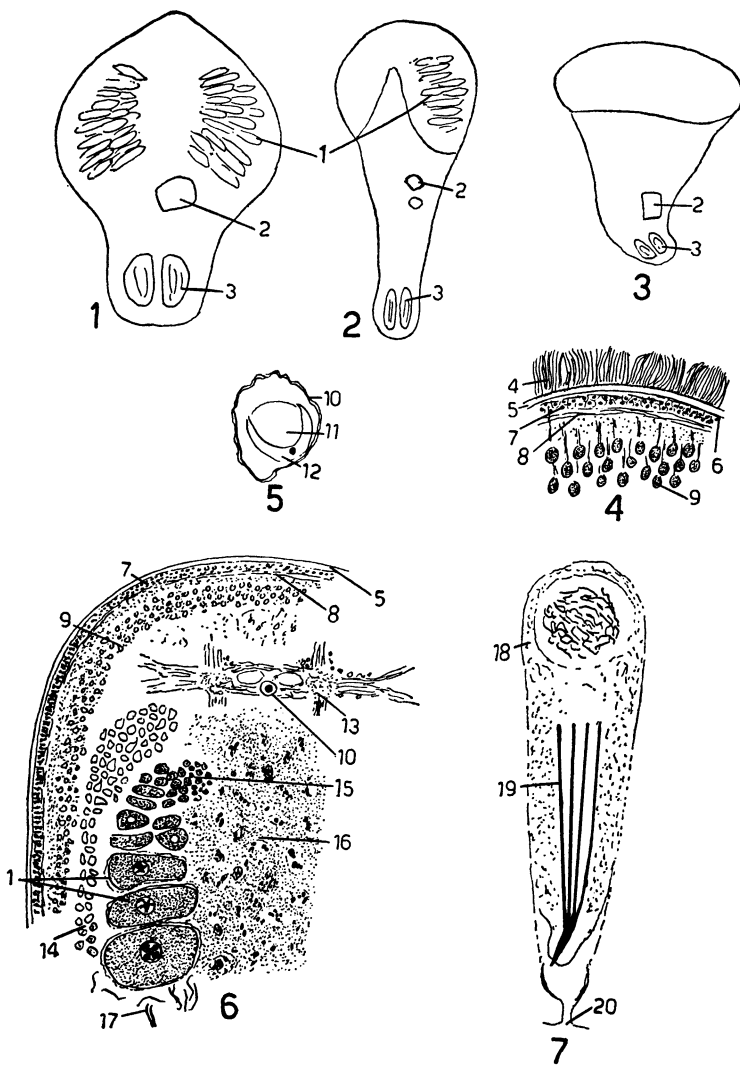
*Childia spinosa* GRAFF, 1911.

*Childia baltica* LUTHER, 1912.

*Childia groenlandica*, MEIXNER, 1925.

A number of specimens of this species were kindly sent by Dr. Meredith Jones, who had collected them from a mud bottom off Point Richmond in San Francisco Bay from April to October, 1955, at a depth of 30 feet. Dr. Jones also generously presented me with two sets of sections he had made. All the dredged material had been preserved in 10 per cent formalin, from which the worms were subsequently picked out. Hence there is no information available as to the shape, dimensions, and color in life. All the specimens were contracted to the shapes shown in figures 1-3. Further, they had been stained in a red whole-mount stain that gave little differentiation and prevented the sections from taking further stains. Some of the specimens were mounted whole, and others were sectioned serially in various planes. An attempt was made to stain the sections with haematoxylin-eosin and Mallory's triple stain, but scarcely any dye was retained by the sections.

As noted by Westblad (1945) specimens preserved without previous anesthetization take on a pronounced pyriform shape (fig. 1), caused by contraction of longitudinal muscles. Often also the sides of the anterior end are curved inward (fig. 2), or the anterior end is folded back (fig. 3). Graff (1911) reported that attitudes such as shown in figure 2 were often assumed in life. He illustrated the shape in life as oval, with a pointed posterior end, and gave the maximum length as 1.4 mm. The contracted specimens in the present material are slightly below 1 mm. in length. No trace was found in either the whole specimens or the sections of the sensory bristles depicted by Graff as characteristic of the species and also described by Luther (1912). They could presumably be obliterated by the rough method of preservation employed. In the interior of the specimens mounted whole could be seen a succession of ovocytes in the lateral regions of the expanded anterior half, the two penes in the narrowed posterior end, and rounded or rectangular



FIGS. 1-7. *Childia groenlandica*. 1-3. Various attitudes of preserved specimens. 4. Section through the body wall. 5. Statocyst. 6. Histological structure as seen in a frontal section. 7. Longitudinal section of male apparatus.

bodies that seemed to be the exoskeletons of ingested food organisms (fig. 1).

The findings from sections agreed well with the accounts of Luther (1912) and Westblad (1945). The body is zoned into a surface layer composed of epidermis and subepidermal musculature, beneath this a

layer of peripheral mesenchyme, and an interior mass of central mesenchyme (fig. 6). The clear zonation in some sets of sections, as in the set from which figure 6 was drawn, is presumably artificial. The surface is completely ciliated with a thick coat of rather long cilia (fig. 4). As noted by previous workers, the epidermis is insunk, that is, forms at the surface a structureless band, called epicytium by some authors, devoid of nuclei; the nuclei have sunk to the inner side of the subepidermal musculature where they form a conspicuous zone two or three nuclei deep (figs. 4, 6). Beneath the epicytium occurs a layer of circular muscles followed by a layer of longitudinal muscles. Both layers appeared well developed over the entire body. The epicytium often appears bounded internally by lines, and these lines are presumably the outer longitudinal muscle fibers, discovered by Luther (1912) and regarded by him as intra-epidermal fibers.

The peripheral mesenchyme is quite distinct from the central mesenchyme (fig. 6), but its histological nature is obscure. It is composed of separate bodies, but these do not seem to be cells. As they showed a tendency to take the blue stain in Mallory preparations, they are probably of a mucous nature. The peripheral mesenchyme is thinned over the ovaries.

The central mesenchyme forms a granular mesh, with bright droplets, apparently digestion products, in the interstices of the mesh. The ovaries appear embedded in the central mesenchyme.

The brain was well evident on one series of frontal sections (fig. 6) and conforms to the excellent figure given by Westblad (1945), that is, there are two main ganglionic masses connected by two commissures and sending off about four main nerves each. In the posterior of the two commissures is embedded the statocyst, composed of a membranous wall enclosing a round statolith embraced by a crescentic lithocyte (fig. 5). In sections favorably cut, a frontal organ quite like Westblad's figure (1945, fig. 16B) was identified, but it certainly differs greatly from the usual concept of a frontal organ and from Graff's figure (1911, pl. 2, fig. 5) of the frontal organ of *Childia spinosa*, represented as a cluster of pyriform glands. The postcerebral organ described by Westblad was not found.

Testes could not be identified but are said by previous workers to occupy a median dorsal position. The conspicuous ovaries occur laterally in the central mesenchyme in the anterior body half. Each is a loose, longitudinal aggregation, grading from numerous small oogonia anteriorly to large ovocytes posteriorly (fig. 6). As noted by Westblad large ovocytes not in continuity with the ovary may occur in the pos-

terior body half. The two penes are conspicuous in all whole mounts and series of sections. Westblad has described and fully illustrated their structure from histologically better material than mine. They consist of an anterior rounded seminal vesicle containing a ball of sperm and a long penis stylet invested with a circular musculature. In agreement with Westblad I find that the stylet consists proximally of a number of separate cuticularized strands that are fused only distally. As noted by Meixner (1925), Graff (1911) was mistaken in describing the two penes as opening by a common pore. In fact each has its own pore, preceded by a little chamber (fig. 7) that seems to have been overlooked by Westblad. No tracts of sperm leading to the penes could be found, but sperm, presumably the result of copulation, are present around the large ovocytes (fig. 6).

If in fact *C. spinosa* and *baltica* are synonyms of *C. groenlandica*, then the latter is a circumpolar and circumboreal species, distributed southward as far as Cape Cod on the Atlantic coast of North America and to San Francisco Bay on its Pacific coast.

#### ORDER POLYCLADIDA

#### SUBORDER ACOTYLEA

#### SECTION SCHEMATOMMATA

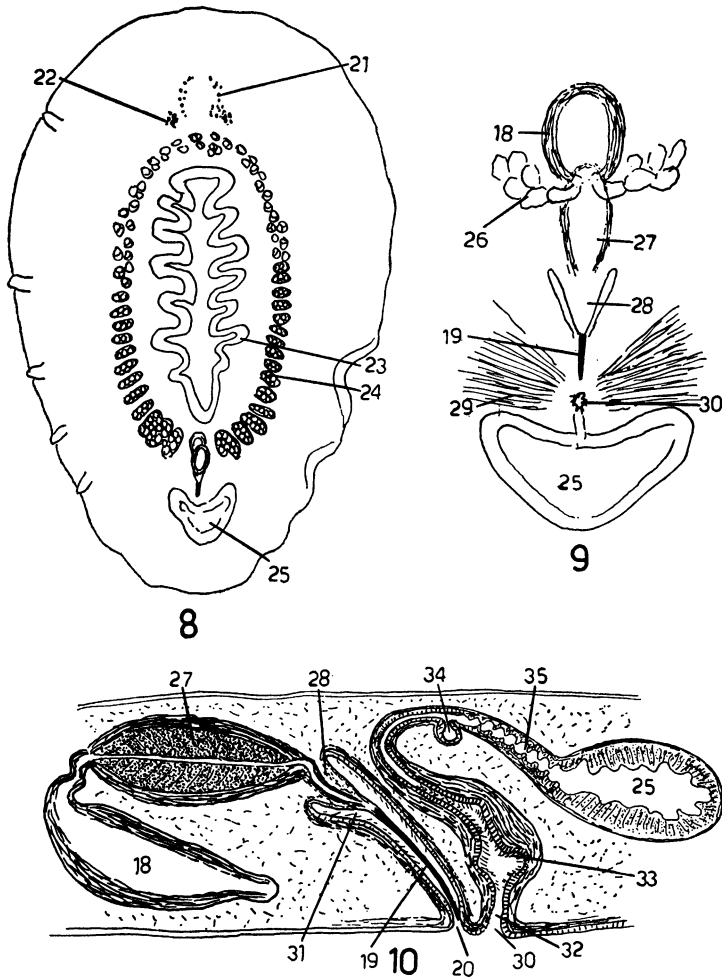
#### FAMILY LEPTOPLANIDAE

#### *Stylochoplana reishi*, new species

Figures 8-10

Four specimens were found in polyclad material sent for identification by Dr. Donald Reish, who was carrying on a pollution investigation in Los Angeles Harbor and regularly visited a number of stations. All four worms came from the same station, designated as Newport station, three in January, 1954, and one in August, 1951. The best of the specimens was mounted whole, and the other three were sectioned sagittally.

This is a small worm, measuring (preserved) 6 by 4 mm., of obovate shape (fig. 8) and pale coloration. In the cleared whole mount (fig. 8) may be seen the eyes, the central ruffled pharynx, the uteri filled with eggs coursing along the sides of the pharynx and encircling its anterior end, and the copulatory apparatus immediately behind the posterior end of the pharynx. The eyes are arranged in definite tentacular clusters of about six eyes each and cerebral groups of 18 to 20 eyes extending forward in a linear manner. Tentacles are wanting. A notable feature of the copulatory apparatus as seen in the whole mount is the crescentic Lang's vesicle.



FIGS. 8-10. *Stylochoplana reishi*. 8. Dorsal view of whole mount. 9. Copulatory apparatuses as seen in whole mount. 10. Median sagittal section of copulatory apparatuses.

A view of the copulatory apparatus from the whole mount is given in figure 9, but details can be ascertained only by means of sections. A sagittal view of the apparatus based on sections appears in figure 10. The coiled spermiducal vesicles enter the proximal end of the seminal vesicle (fig. 9). This is a fusiform body, with the usual thick muscular wall. It narrows distally to an ejaculatory duct which curves up and back to enter the prostatic vesicle, an oval body with a muscular wall

and glandular interior of eosinophilous columns. From the narrowed distal end of the prostatic vesicle the ejaculatory duct proceeds into the conical penis papilla, provided with a stylet of moderate length. Stylet and papilla occupy an elongated male antrum that exits by the male gonopore.

The female gonopore opens close behind the male pore and leads into a vertical female antrum. This continues into the widened vagina with thick muscular walls. The vagina ascends with a forward slant, receiving cement glands not shown in figure 10, and gradually narrows as it makes a posterior bend. Shortly beyond the bend it is entered from below by the common ovovitelline duct and is then continued by the duct of Lang's vesicle which terminates in the laterally broadened Lang's vesicle (fig. 9).

Of some 40 species assigned to *Stylochoplana*, of some of which the validity cannot be determined on available information, nine are provided with a stylet. In three of these the stylet is excessively long, fully twice as long relative to the male apparatus as in the present species, and in three others the stylet is short. There remain three species with a stylet comparable to that of the present species. *Stylochoplana aulica* Marcus, 1947, is a large species with tentacles and without a Lang's vesicle, and *S. divae* Marcus, 1947, is also large, with tentacles and numerous eyes, and with a considerable length of ejaculatory duct between the prostatic vesicle and the base of penis stylet, which is borne directly without the intercalation of a penis papilla. Most resemblance to *S. reishi* is shown by *S. affinis* Palombi, 1940, West Africa, but here also a penis papilla is lacking, and Lang's vesicle is described as provided with two accessory vesicles.

**HOLOTYPE:** One whole mount deposited in the American Museum of Natural History; also the best set of sagittal sections (one slide).

#### SUBORDER COTYLEA

#### FAMILY PSEUDOCERIDAE

#### *Pseudoceros perviolaceus* Hyman, 1958

Figures 11, 12

*Eurylepta violacea* SCHMARDT, 1859.

*Pseudoceros violaceus*, STUMMER-TRAUNFELS, 1933.

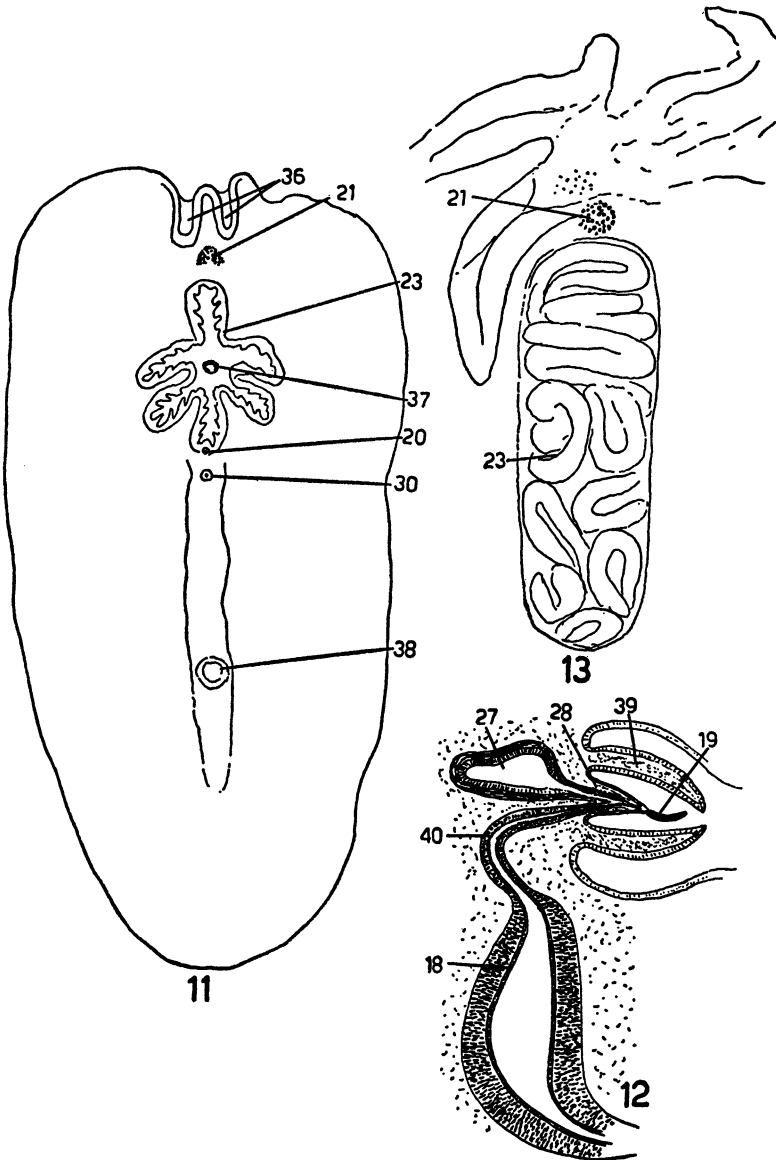
Not *Planaria violacea* Kelaart, 1858.

An immature specimen that measured 19 mm. in length, preserved, was kindly sent by Mr. W. E. Pequegnat, who had collected it off Corona del Mar, California, March 31, 1957, at a depth of 25 feet. The worm was concealed under a purple sea urchin, *Strongylocentrotus*

*franciscanus*, and was revealed when the urchin was pried from the rocks. The color was stated to be a deep purple, showing under magnification purple and red punctations. On being informed that the specimen was immature, Mr. Pequegnat kept on the lookout for a larger one and succeeded on April 29, 1957, in finding a large, fully mature worm in the same locality in a crevice on a vertical rock face in 30 feet of water. This was stated to be of the same uniform dark purple color as the preceding specimen. The finding of the second specimen apart from a purple urchin dispelled the suspicion that the purple color might have resulted from ingestion of parts of the purple urchin; further the collector informed me that the color remained unaltered during a sojourn of several days in the laboratory. Colors of polyclads caused by ingested food fade rapidly when the worms are kept without food. The second specimen measured 59 by 20 mm. in life, comparing favorably with the original specimen of Schmarda, stated by him to have been 60 mm. in length alive, 40 mm. in width across the broadest part. Unfortunately the second specimen fragmented during transit, but I was able to recover the most important part, the median anterior region, which was sectioned sagittally and revealed a single male apparatus, as characteristic of the species.

The smaller specimen was mounted whole, and such features as it revealed after clearing are represented in figure 11. Because of the dark color, which appeared black in the preserved specimen, details were difficult to ascertain. The form is oval, broadened anteriorly, where the tentacles appear as the usual upfolds of the anterior margin. Of the eyes only the bilobed cerebral cluster could be seen; this sufficiently resembles Stummer-Traunfels' figure made from the original Schmarda specimen. He found numerous eyes along the tentacular folds. The pharynx is of the butterfly type, with pronounced lateral lobulations; Stummer-Traunfels shows a similar shape, with more numerous lobulations as consistent with the larger size of the Schmarda worm. Stummer-Traunfels discovered that there is but one male apparatus, and this I have verified in the specimen from the Palau Islands (Hyman, 1959) and in the present material.

A sagittal view of the male apparatus of the larger specimen is given in figure 12. There is a large, fusiform, seminal vesicle with a thick muscular wall of circular fibers. This narrows distally to an arched tube that enters the conical penis papilla where it unites with the duct of the vertically oriented, rather small prostatic vesicle. This has a thin muscular coat and the usual eosinophilous glandular lining.



FIGS. 11, 12. *Pseudoceros perviolaceus*. 11. Dorsal view of cleared smaller specimen. 12. Median sagittal section of male copulatory apparatus from larger worm.

FIG. 13. *Pseudoceros griseus*, anterior end and pharynx.

The conical penis papilla bears a curved stylet and is protected as usual by a rather large penis sheath.

The identification of these purple pseudocerids from California with Schmarda's species appears reasonably secure. Because of the existence of the combination *Planaria violacea* Kelaart, 1858, of prior date, it was necessary to propose a new name for Schmarda's species, and in a recent article (Hyman, 1959) I suggested *Pseudoceros perviolaceus*. Presumably Kelaart's species is a *Pseudoceros*, although this is not determinable on available information. It is clearly not identical with Schmarda's *Eurylepta violacea*, for it has a bright yellow border and yellow middorsal line. One must also take into consideration *Planaria purpurea* Kelaart, 1858, of which a colored figure appears in Collingwood (1876). This presumably also belongs in *Pseudoceros*. It might be identical with Schmarda's *violacea*, being also of a purple color, but appears more oblong in shape and has a darker border and middorsal streak.

If the synonymy is correct, then *P. perviolaceus* must be widely spread in the Indo-Pacific. It has been recorded from Ceylon (Schmarda, 1859), the Red Sea (Boutan, 1892), the Palau Islands (Hyman, 1959), and now is recorded from California.

#### ***Pseudoceros griseus*, new species**

Figures 13, 14

The single specimen of this large, handsome polyclad was also sent by Mr. W. E. Pequegnat, who found it swimming on a sandy bottom, in 1 foot of water, in Newport Harbor, California, on September 1, 1958.

The worm (fig. 14) is of broadly oval shape, measuring when alive 70 by 43 mm.; preserved it has taken on a rounded form, measuring 40 by 40 mm. The color pattern is distinctive; the general color is gray, obscurely mottled with white, and shading marginally into dark gray or almost black, without, however, forming any demarcated marginal band. The middorsal ridge is practically black, as are the borders of the tentacles. Figure 14 attempts to depict the color pattern. Because of injury along the middle part of the anterior margin, the tentacles were much distorted. Because of the dark color, the eye arrangement could not be ascertained, except that a round cluster of cerebral eyes was visible in the cleared worm (fig. 13). The position of the sucker is indicated in figure 14.

When the worm was cleared, the large ruffled pharynx of oval form (fig. 13) became visible, as also the uteri the outline of which is de-

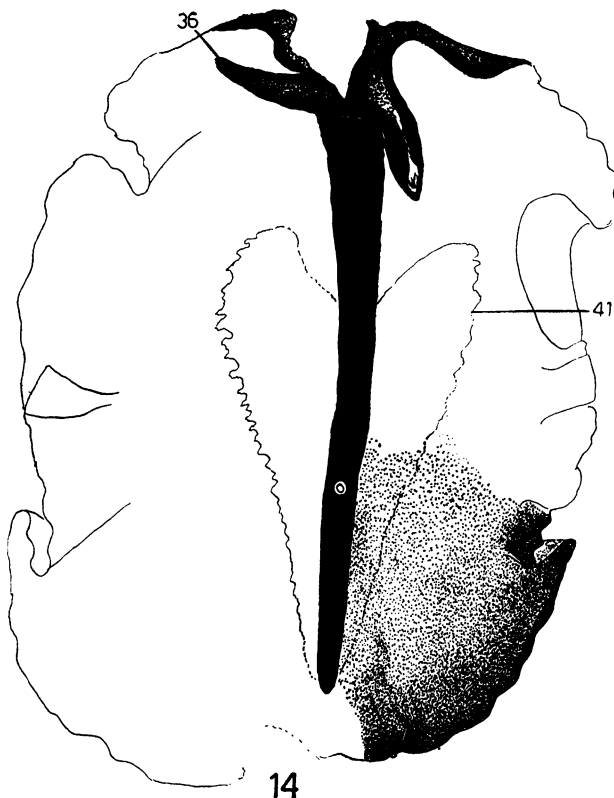


FIG. 14. *Pseudoceros griseus*, entire worm to show color pattern.

picted in figure 14. Because of damage and folding in the critical region, the number of male apparatuses could not be ascertained, but probably there is a single such apparatus.

**HOLOTYPE:** The specimen preserved in alcohol is deposited in the invertebrate section of the American Museum of Natural History.

**FAMILY EURYLEPTIDAE**

***Eurylepta californica*, new species**

Figures 15, 16

The single specimen was kindly sent by Mr. David Montgomery, of the State Polytechnic Institute at San Luis Obispo, who also furnished a sketch of the animal in life and notes on the coloration. The worm had been collected February 28, 1958, in shallow water near Cambria, California, on a rocky shore in coralline algae.

The form in life is shown in figure 15, based on the sketch sent with the specimen. The dimensions in life were stated to be 17.5 by 3–4 mm.; the preserved worm measures 8 by 6 mm. At the anterior end are seen the fully extended tentacles and in the median line shortly behind them the bilobed cluster of cerebral eyes. The cylindrical pharynx, gonopores, and uteri have been added from the cleared specimen. The sucker occurs somewhat anterior to the middle. Figure 16 gives the appearance of the anterior end of the preserved worm and shows the shape assumed by the tentacles on contraction and the distribution of the tentacular eyes.

The color pattern is distinctive. The worm is grayish white, with a pure white border, white middorsal ridge, and 11 irregularly distributed small white spots. This pattern is crisscrossed with black lines, as shown in the figure, and these lines usually terminate in red tips that invade the white border. There are also a few short red streaks here and there. In figure 15, black is represented by continuous lines, red by dotted lines. At the base of the tentacles there is a heavy mark, distally red, proximally black, and between these is a small median black dash.

The worm is judged to belong to *Eurylepta* by the small number, about eight on each side, and wide spacing of the intestinal branches, although these do seem to have some cross connections. Whether uterine vesicles are present could not be ascertained.

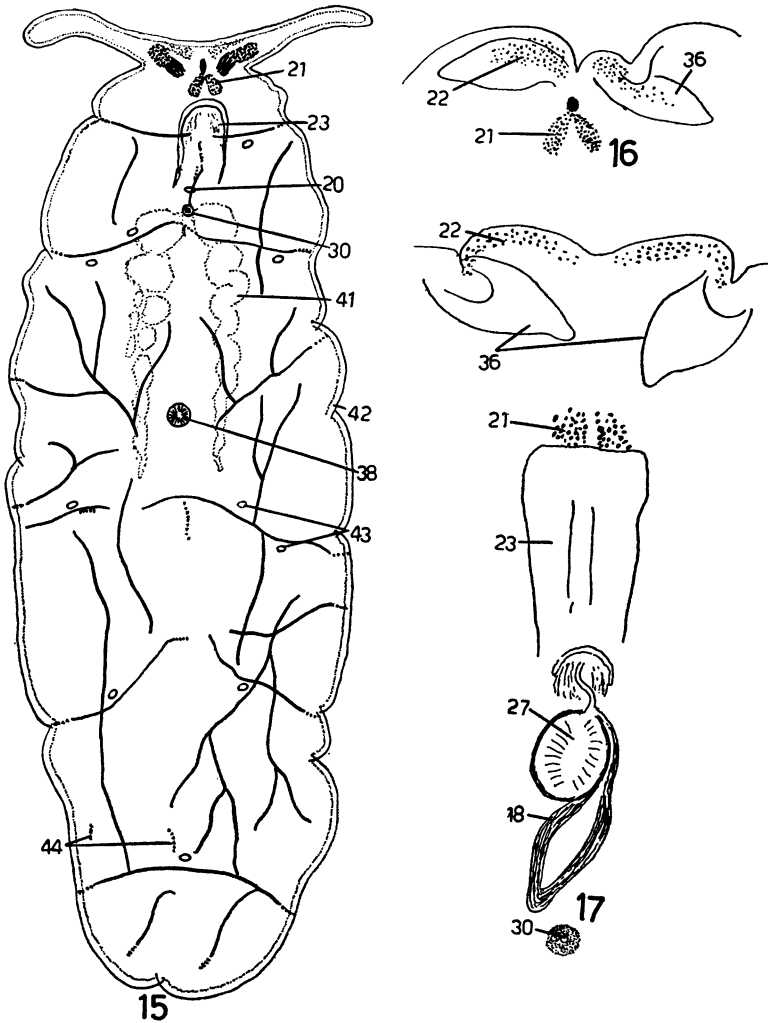
**HOLOTYPE:** The worm mounted whole is deposited in the invertebrate section of the American Museum of Natural History.

*Eurylepta leoparda* Freeman, 1933

Figure 18

A collection of polyclads made by Mrs. D. W. Orihel during the summer of 1953 at Friday Harbor and Woodah Island in Puget Sound was kindly forwarded by Dr. Paul Illg of the University of Washington. The collection was found to consist almost wholly of common, well-known, Puget Sound polyclads, mostly of the genus *Notoplana*, and contained only one specimen of interest, a specimen of *Eurylepta leoparda*, hitherto known only by the holotype.

The worm was stated to have been found on a dredged tunicate, August 5, 1953. It was sexually ripe and laid eggs in the laboratory on the following day. It was 20 mm. long when alive, measures 15 by 12 mm. preserved, and has an oblong shape. The color was described as light brownish cream closely dotted with small dark brown to black spots, except along the margin and the tentacle bases which are wholly



FIGS. 15, 16. *Eurylepta californica*. 15. Entire worm in life, after a sketch furnished by D. Montgomery. 16. Median anterior region of preserved cleared worm.

FIG. 17. *Prostheceraeus bellostriatus*, median anterior region of preserved cleared worm.

of the ground color. The preserved worm had lost considerable epidermis, but the color pattern is evident on the remaining patches of epidermis.

The worm was mounted whole, and its features are illustrated in

figure 18; they compare favorably with those of the original description. The typically euryleptid tentacles and the anterior margin between them are heavily provided with eyes, wanting on the tentacular tips. The cerebral eyes occur in two separate oval clusters. Directly behind the tubular pharynx, contracted to the usual oval shape, is seen the male apparatus, of which details were not ascertainable. This is followed by the female gonopore, surrounded by cement glands. Of special interest is the fact that on one side two uterine vesicles are plainly visible, in confirmation of the original description; they could not be discerned on the other side. Laterally behind the female gonopore occur on each side uterine convolutions filled with eggs.

*Prostheceraeus bellostriatus* Hyman, 1953

Figures 17, 19

Two specimens of this pretty species were presented by Mr. W. E. Pequegnat who had collected them in Newport Harbor, Corona del Mar, California. The larger specimen, measuring 27 by 11.5 mm. when alive, extended, was taken on a vertical cement wall in 5 feet of water, August 10, 1956; the smaller one, measuring 13 by 7 mm. when moving alive, came from a shale substrate in 40 feet of water.

In the original description, some points were left unsettled, and hence I was pleased to obtain additional material of the species. In the smaller specimen, mounted whole, the intestinal mesh is fairly evident, an indication that the worm was correctly placed in the genus *Prostheceraeus*. The larger specimen is fully mature and was used to settle the question whether there is in fact a median vesicle extending forward from the vagina as seemed to be the case in the original specimen. After being cleared, the median anterior region of the larger specimen was drawn and is shown in figure 17. The tentacular eyes occur along the anterior margin between the bases of the typically euryleptid tentacles but are absent from the tentacles themselves. As previously found, the cerebral eyes occur in two separate clusters. Behind the cylindrical pharynx is seen the male copulatory apparatus, closely followed by the female gonopore. There are no indications of a median vesicle between the seminal vesicle and the female gonopore, but to determine this certainly it was necessary to remove the whole median anterior region and section it sagittally.

From this series of sections a sagittal view of the copulatory region is depicted in figure 19. The male system is typically cotylean. The penis papilla, armed with the usual stylet, is protected by a well-developed penis sheath. Inside the penis papilla the prostatic duct joins the ejacu-

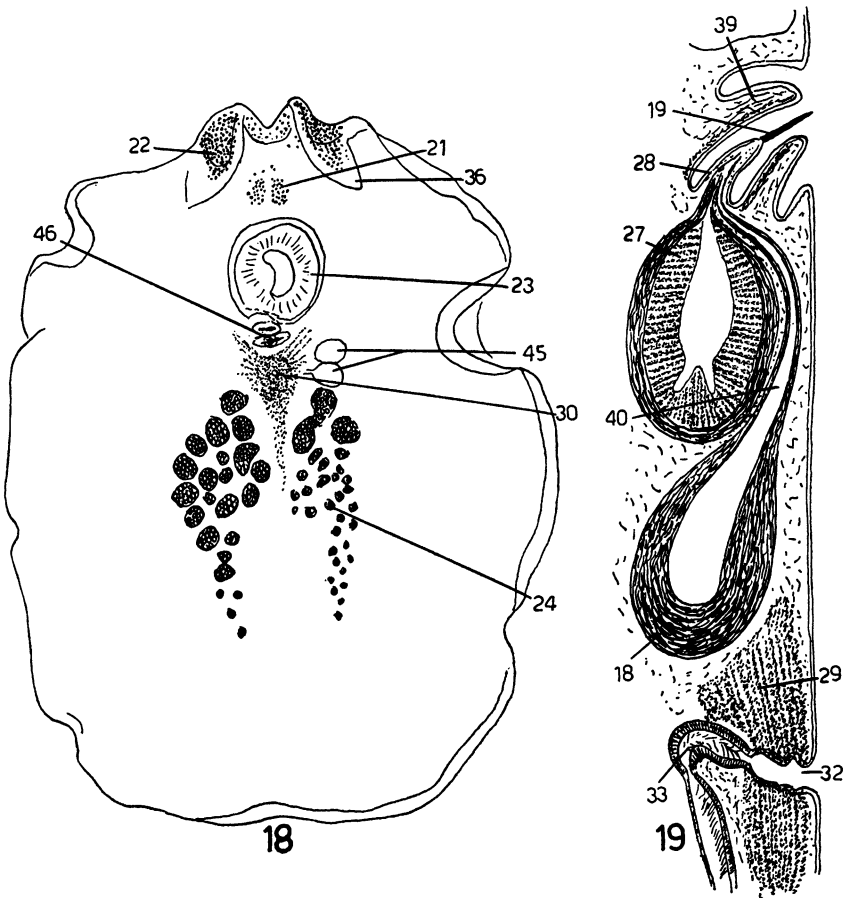


FIG. 18. *Eurylepta leoparda*, details of entire cleared worm.

FIG. 19. *Prostheceraeus bellostriatus*, median sagittal section of copulatory apparatuses.

latory duct. The prostatic vesicle is a large oval body with muscular wall and glandular interior of eosinophilous columns. The seminal vesicle, more expanded than in the original description, presents an oval, very muscular proximal region that narrows distally to the ejaculatory duct, curving below the prostatic vesicle.

There is no indication whatever of a vesicle between the vagina and the seminal vesicle. The presence of this in the original specimen presumably represents some sort of anomaly. The very short female antrum continues vertically as the vagina which receives from all sides

numerous cement glands. The vagina then continues dorsally as a widened tube with more definite epithelial lining and, curving posteriorly, receives the two uteri. Uterine vesicles in the longitudinal series characteristic of the genus are evident immediately lateral to the uteri. The sections were not carried far enough posteriorly to reveal more than the three or four most anterior vesicles.

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