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Some Australian Polyclads
(Turbellaria)

By
LIBBIE H. HYMAN

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Figs. 1-21

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SOME AUSTRALIAN POLYCLADS

(*Turbellaria*)

By LIBBIE H. HYMAN

American Museum of Natural History, New York
(Figures 1-21)
(Manuscript received 4.7.58)

The material of this article was kindly furnished by Miss Elizabeth Pope, Curator of Worms and Echinoderms, the Australian Museum, Sydney, who was assisted in collecting by Misses P. McDonald, F. Wilson and B. Dew, and by Mr. Ederic Slater, who also took a series of kodachromes, which have been of great aid in establishing the colour in nature. Miss Pope also sent valuable notes and colour sketches.

All the specimens were collected in the intertidal zone at Long Reef, near Collaroy, north of Sydney, New South Wales, during the summers of 1955 and 1956. The material comprised 30 specimens, belonging to 10 species, of which three are identical with species in Haswell's (1907) report; the remainder are considered new.

Extensive definitions of families and genera appear in my 1953 monograph but are repeated here for the benefit of Australian zoologists. Unfortunately, acotylean polyclads cannot be identified except by means of serial sections of the copulatory apparatus. Cotylean polyclads may often be identified by the colour pattern. The eye arrangement can be made out accurately only in dehydrated, cleared specimens. Field identification is generally impossible except in the case of species with striking colour patterns.

Order POLYCLADIDA Suborder ACOTYLEA

Polyclads without a sucker behind the female gonopore; eyes never in a pair of clusters on the anterior margin; tentacles when present of the nuchal type; copulatory complex usually in the posterior body half.

SECTION CRASPEDOMMATA

Acotylea with eyes in a band along the whole or the anterior part of the body margin; eyes usually also present elsewhere; rarely completely devoid of eyes; pharynx ruffled; copulatory apparatus in the posterior body half behind the pharynx, with male apparatus directed backward and uteri extending forward.

Family Discocelidae Laidlaw, 1903

Craspedommata with eyes, apart from the marginal band, limited to definite cerebral and tentacular clusters; tentacles wanting or rudimentary; penis massive, muscular, lobulated, depending vertically from the dorsal wall of the male antrum; penis edged with numerous small prostatic apparatuses, which may also be present in the antral wall; Lang's vesicle present, usually crescentic.

Genus *Discocelis* Ehrenberg, 1832

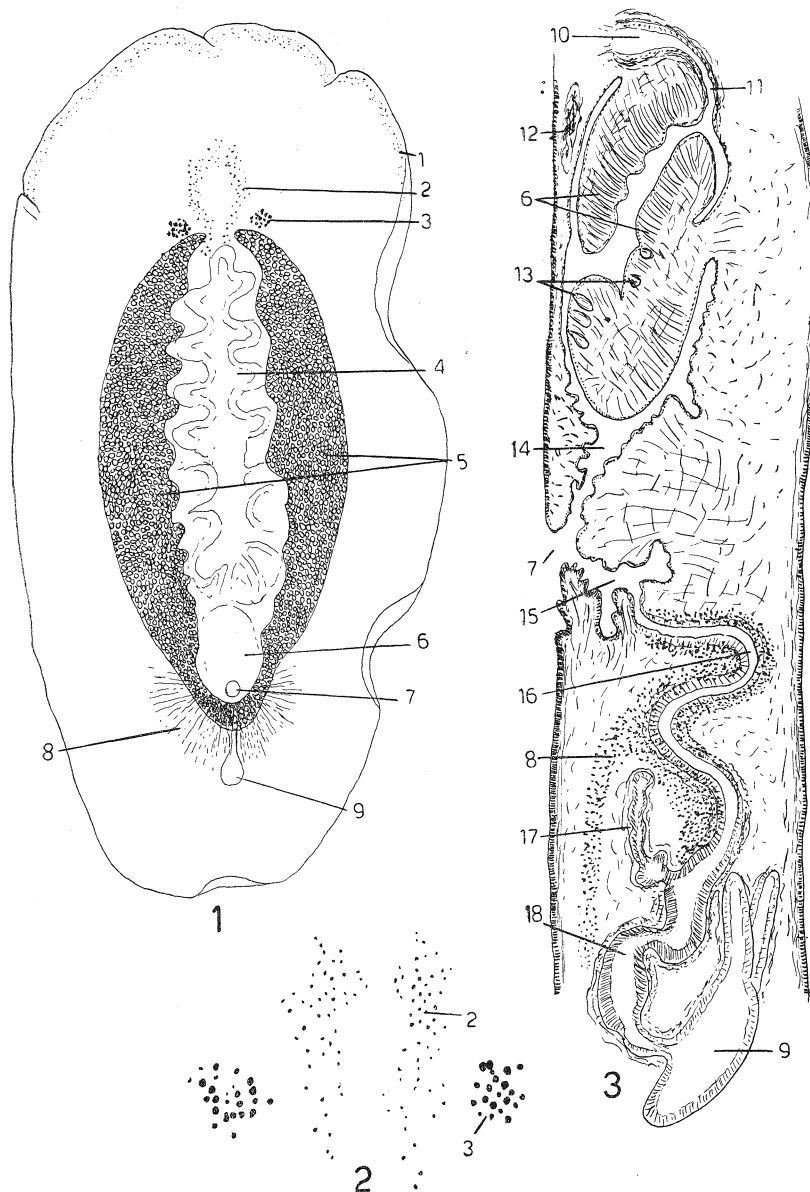
Discocelidae without prostatic vesicle or without antral pockets occupied by a large prostatoid.

Discocelis australis, sp. nov.

(Figures 1-4)

This is evidently one of the common species of the area as the collection contains five specimens. The form is broadly oval (Fig. 1), anteriorly rounded, tapering somewhat posteriorly to an obtuse end. The largest specimen preserved is 31 mm long by 13 mm across the middle but the fully extended worm is no doubt considerably longer. The colour is given in notes, colour sketches and kodachromes as fawn, dotted with dark brown spots, more concentrated medially. This is a common colour pattern in the genus, hence is not distinctive. Figure 4 is an attempt to represent the form and appearance from a kodachrome.

The eye arrangement is shown in Figure 1 from a cleared specimen. There is a pair of tentacular clusters, evident in life, of about 25 eyes each. The cerebral clusters are elongated groups, beginning thinly behind the level of the tentacular clusters and widening as they extend forward between the latter. The pattern of the cerebral and tentacular clusters is given in Figure 2, drawn with the aid of a camera lucida. The band of marginal eyes extends to about the level of the brain.



Figs. 1 to 3.—*Discocelis Australis*. 1. Cleared whole specimen, showing general structure. 2. Eyes, enlarged. 3. Sagittal view of copulatory complex, anterior end above.

Key for anatomy: 1. marginal eyes; 2. cerebral eyes; 3. tentacular eyes; 4. pharynx; 5. uteri filled with eggs; 6. penis; 7. common gonopore; 8. cement glands; 9. Lang's vesicle; 10. seminal vesicle; 11. ejaculatory duct; 12. spermiducal vesicle; 13. prostatois; 14. male antrum; 15. female antrum; 16. vagina; 17. common stem of uteri; 18. duct of Lang's vesicle.

In the cleared worm (Fig. 1) is seen the elongated ruffled pharynx, also evident in some of the kodachromes, bounded laterally by the broad uteri stuffed with eggs. The uteri are not confluent anteriorly but terminate to the medial side of the tentacular eye clusters. Behind the pharynx a mass indicates the penis; behind this is seen the common gonopore with radiating cement glands. The flask-shaped median part of Lang's vesicle terminates the female copulatory apparatus.

A median sagittal view of the copulatory apparatuses is given in Figure 3. The sperm ducts ascending from below enter separately a small but muscular seminal vesicle from which the ejaculatory duct continues, curving backward to enter the penis. This is not the usual conical projection but as typical of the genus a massive lobulate body depending from above into the male antrum. It here consists of two main lobes which are edged with little pyriform prostatic apparatuses. Very few of these appear in the median section and they are rather scanty altogether in this species where they are also wanting from the wall of the male antrum. Behind the penis the male antrum extends inward to demarcate the posterior lobe of the penis and here is lined with a glandular epithelium. Behind the penis, the male antrum exits by a slanting passage to the common gonopore.

From the common gonopore a chamber that may be considered the female antrum ascends with a slight backward slant and receives the vagina. This takes a long sinuous horizontal course, receiving numerous cement glands and having a good muscular provision. Its lining epithelium is much taller ventrally than dorsally, no doubt because the cement glands enter the ventral wall. The cement glands cease at the entrance of the common stem of the uteri and at this place the vagina widens and becomes continuous with the canal of Lang's vesicle. This canal is also sinuous with a broad lumen lined by a tall epithelium underlain by circular and longitudinal muscle fibres. The canal finally narrows and enters the main sac of Lang's vesicle, which has the usual crescentic shape typical of the genus with two anterior prolongations.

Of the seven previously described species of *Discocelis*, two have separate male and female gonopores. Of the other five, four lack a seminal vesicle and the fifth, *D. lichenoides* (Mertens, 1832), which actually is the type species of the genus, is so poorly known that comparisons are impossible. The original description gives its colour as yellowish-brown with dark streaks.

Holotype: One specimen, anterior half as whole mount, posterior half as sagittal serial sections (7 slides) deposited in the Australian Museum. [Reg. No. W.3684.]

Family *Stylochidae* Stimpson, 1857

Craspedommata of oval form and usually thick consistency; with or without tentacles; with tentacular and cerebral eye clusters, also often with frontal eyes; with or without true seminal vesicle and spermiducal bulbs; prostatic vesicle free.

Genus *Leptostylochus* Bock, 1925

Stylochidae of oval to elongate form and thin to moderate consistency; marginal eyes limited to anterior body half; tentacles small or wanting; pharynx elongated with mouth posterior to the middle; gonopores separate; with no or slightly developed seminal vesicle; with spermiducal bulbs; glandular vagina widened; with well-developed Lang's vesicle.

Leptostylochus novacambrensis, sp. nov.

(Figures 5-6)

This species also appears common in the locality as the collection contains nine specimens. The worm is of broadly oval form and somewhat thin consistency. It is rather small, measuring 15 by 11 mm in the largest specimen in the material. The colour as shown by a colour sketch and a kodachrome is brown, mottled or dotted with dark brown. Small tentacles are present as shown in Figure 5.

The marginal eyes form a somewhat wide band around nearly the anterior half of the body margin (Fig. 5). The small tentacles each contain a few eyes. The definitely paired cerebral groups begin slightly behind the brain and expand laterally as they extend forward but do not quite reach the marginal band. The cerebral eyes are fewer in number than in other species of the genus.

The pharynx is elongated with short lateral folds as usual in the genus (Fig. 5); the mouth is somewhat posteriorly located with reference to the pharynx. Laterally the pharynx is bounded on each side by the coils of the uteri filled with eggs. The uteri are confluent at the anterior end of the pharynx just behind the brain. Behind the pharynx is seen the vagina surrounded by radiating cement glands and behind these the sac of Lang's vesicle.

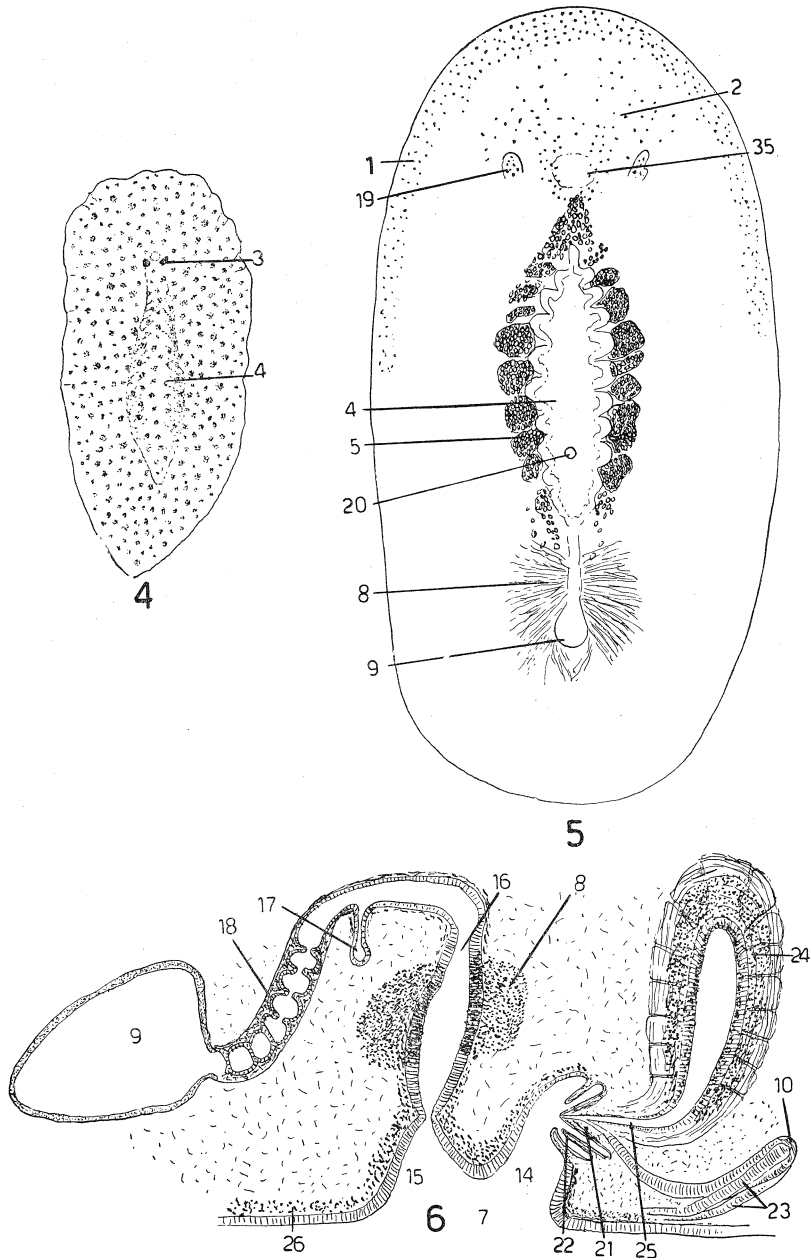


Fig. 4.—*Discocelis australis*, sketch from kodachrome, showing appearance in life.

Figs. 5 to 6.—*Leptostylochus novacambrensis*. 5. Cleared whole specimen, showing general structure. 6. Sagittal view of the copulatory complex, anterior end to right.

Key for anatomy: 1. marginal eyes; 2. cerebral eyes; 3. tentacular eyes; 4. pharynx; 5. uteri filled with eggs; 7. common gonopore; 8. cement glands; 9. Lang's vesicle; 10. seminal vesicle; 14. male antrum; 15. female antrum; 16. vagina; 17. common stem of uteri; 18. duct of Lang's vesicle; 19. tentacles; 20. mouth; 21. penis papilla; 22. penis sheath; 23. spermiducal bulbs; 24. prostatic vesicle; 25. prostatic duct; 26. muscle layer; 35. brain.

The copulatory region was removed from two specimens and sectioned sagittally. The ovaries occur in a dorsal position but testes were not in evidence in the pieces sectioned. A sagittal view of the copulatory apparatuses is given in Figure 6. The male apparatus, situated immediately behind the pharynx, is of the stylochid type. The terminal parts of the sperm ducts, approaching the apparatus from behind near the ventral wall, are muscularized, having a coat of circular fibres, hence they constitute what I have termed spermiducal bulbs. They enter separately the proximal end of the ejaculatory duct, here slightly enlarged as a seminal vesicle, also with a strong coat of circular muscle fibres. This proceeds posteriorly as an ejaculatory duct of steadily decreasing diameter and finally joins the prostatic duct inside the penis papilla. The prostatic vesicle is a relatively large oval body with a thick muscular wall of fibres paralleling its external contour, and a glandular lining epithelium. In one of the sectioned series, the prostatic vesicle has a vertical orientation as in Figure 6, but in the other series is almost horizontal in position. The glandular epithelial lining, permeated with eosinophilous granules, is not thrown into folds, as reported for the other species of the genus. The glands that provide the eosinophilous secretion appear located in the muscular wall. They could not be detected outside the vesicle. However, in one of the sectioned specimens the typical passages through the prostatic wall are present and have been added to Figure 6, although apparently not present in the series from which this drawing was made. These passages carry the ducts of the extraprostatic glands but could not be traced to glands and in fact seemed to consist of muscle fibres. Extraprostatic glands are usual in the genus. Distally the lumen of the prostatic vesicle narrows to become the prostatic duct that passes along the centre of the conical penis papilla within which it is joined by the ejaculatory duct. The penis papilla, fairly muscular, is provided with a penis sheath, that is, a fold of the male antrum; this is very evident in one series, less so in the other. A penis sheath is not usual in the genus, being reported only for *L. capensis* Palombi, 1938, where its form is peculiar. The penis papilla projects into the anterior side near the inner end of the vertically oriented male antrum. This has the shape of a funnel and is lined distally with a high epithelium at the male gonopore.

The female gonopore lies not far behind the male pore and as the intervening body wall is short, not reaching the level of the general body wall, the two pores could almost be said to open in common. From the female gonopore the female antrum, also of funnel shape and lined by an epithelium of tall, slender cells underlain by a strong musculature, ascends, gradually narrowing to the beginning of the glandular vagina. This very narrowed beginning of the vagina is reported as encircled by a sphincter muscle in the type species, *L. elongatus*, but this is wanting here. The vagina immediately widens into a broad tube lined by an epithelium of tall narrow cells underlain by a strong musculature and permeated by the eosinophilous secretion of the cement glands. The glandular vagina ascends vertically, then narrowing abruptly and ceasing to receive cement glands, turns posteriorly and after a short horizontal course receives from below the common stem of the uteri. It then continues as the duct of Lang's vesicle which curves ventrally and enters the sac of Lang's vesicle, of moderate size. The epithelium of the duct of Lang's vesicle is thrown into a succession of scallops supported by muscle fibres. This condition is also seen in other species of the genus. The sac of the vesicle is devoid of musculature.

Of the five previously described species of the genus, one, *L. ovatus* Kato, 1937, is very atypical of the genus and family in that the ejaculatory duct enters the proximal part of the prostatic vesicle. The present species differs from all the others in having definite, if small, tentacles. Its Lang's vesicle is only about half the size of that of *L. elongatus* Bock, 1925, *L. gracilis* Kato, 1934, and *L. capensis* Palombi, 1938. *Leptostylochus polysorus* (Schmarda, 1859), reinvestigated by Stummer-Traunfels (1933), has a Lang's vesicle of moderate size but its penis papilla is long and slender, its spermiducal bulbs are small and globular, and a constriction is lacking at the beginning of the glandular vagina. The present species also differs from all the others in the lack of a scalloped lining of the prostatic vesicle.

Holotype: Anterior half as whole mount, copulatory region as serial sections (4 slides), deposited in the Australian Museum. [Reg. No. W.3686.]

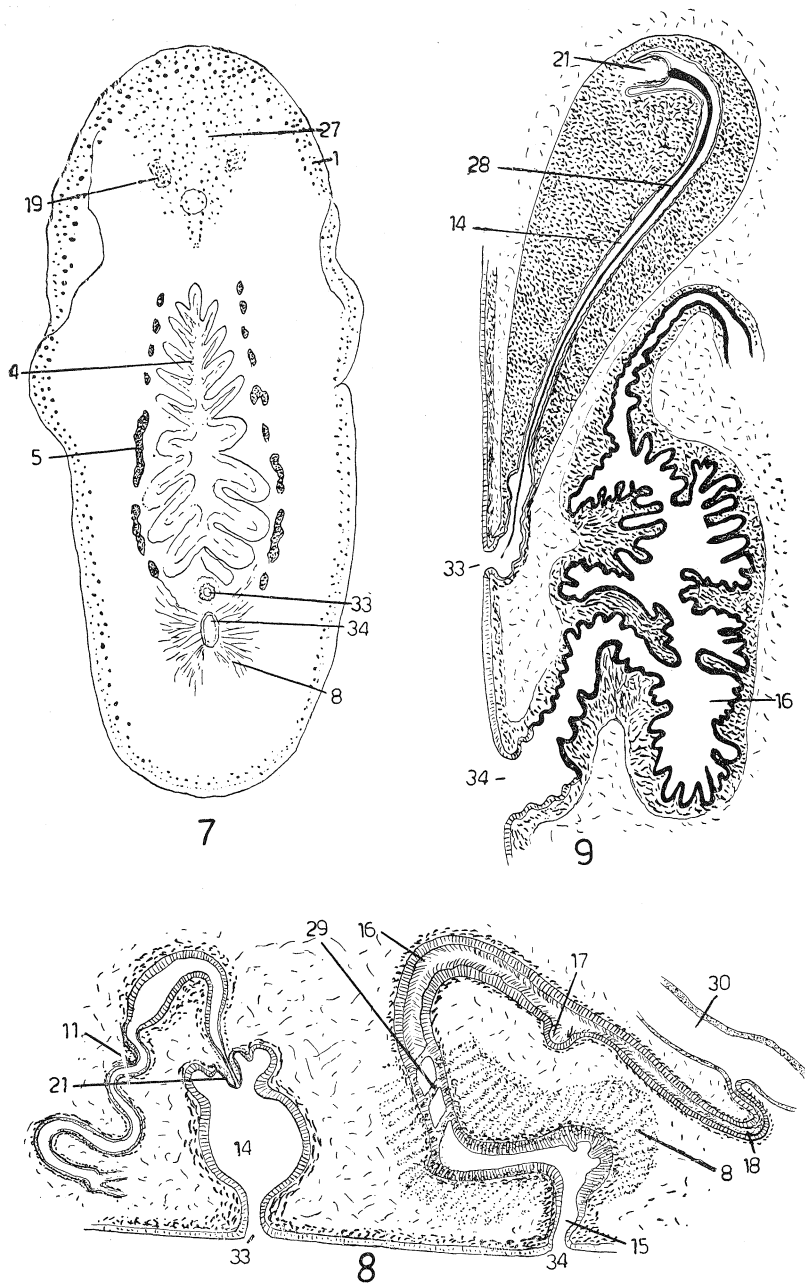
Genus *Enterogonia* Haswell, 1907

Stylochidae with rudimentary tentacles; marginal eyes completely encircling the margin; with cerebrofrontal eyes; with or without very small free prostatic vesicle; seminal vesicle wanting; vaginal duct entering the intestine.

Enterogonia pigrans Haswell, 1907

(Figures 7-8)

This is one of the more interesting species in Haswell's well known article of 1907 on Australasian polyclads. The collection contained four specimens of which some appeared juvenile. There is also a colour sketch and three kodachromes.



Figs. 7 to 8.—*Enterogonia pigrans*. 7. Cleared whole specimen, showing general features. 8. Sagittal view of copulatory complex, anterior end to left.

Fig. 9.—*Notoplana australis*, distal parts of copulatory complex, anterior end above.

Key for anatomy: 1. marginal eyes; 4. pharynx; 5. uteri filled with eggs; 8. cement glands; 11. ejaculatory duct; 14. male antrum; 15. female antrum; 16. vagina; 17. common stem of uteri; 18. duct of Lang's vesicle; 19. tentacles; 21. penis papilla; 27. cerebrofrontal eyes; 28. penis stylet; 29. spiral ridge; 30. intestine; 33. male gonopore; 34. female gonopore.

This is a small worm of oval form (Fig. 7); the largest measured 15 mm in length by about 6 mm in width. Reports of the colour are discrepant. The three kodachromes show the ground colour as light brown dotted with darker brown. Haswell gave the colour as greenish or grey, seen under magnification to be composed of dots. Miss Pope's colour sketch is greenish-brown and her description gives the colour as pale olive green or a light brown ground.

The band of marginal eyes completely encircles the margin. It is rather wide in larger specimens but narrower and indistinct posteriorly in smaller ones. It is characteristic of the marginal eyes that the inner members of the band are larger than the more peripheral ones. The centre of the anterior end bears numerous small eyes that form a fan-shaped cerebrofrontal group. This begins narrowly behind the brain and expands anteriorly, merging into the marginal band. There appears to be present a pair of rudimentary tentacles as a white slightly elevated area on each side containing more concentrated eyes than the rest of the cerebrofrontal group. These tentacular elevations are very difficult to see in cleared specimens but seem to be more evident in life as a pair of spots. They are not mentioned by Haswell.

The postpharyngeal region of the largest specimen was removed and sectioned sagittally. The contained copulatory apparatuses (Fig. 8) were found in agreement with Haswell's description and figure. The male system is positively devoid of any indication of a prostatic vesicle and also lacks a seminal vesicle. The male gonopore leads into a rather roomy muscular male antrum into whose upper end projects the small rounded penis papilla. This appears smaller than in Haswell's figure and the slight fold at its base, which seems to be an incipient penis sheath, is also lacking from Haswell's figure. From the penis papilla the ejaculatory duct ascends and then curves backward, gradually widening. There is produced a curved chamber of some width provided with a layer of mainly circular muscle fibres outside the epithelium. From this chamber the ejaculatory duct, much narrowed but still with a muscular coat, descends in coils to a point near the ventral wall where it receives the sinuous spermiducal vesicles.

The female gonopore lies well behind the male pore. From it the short narrow female antrum ascends and soon widens into the glandular vagina lined by a columnar epithelium and receiving the numerous cement glands. The vagina soon curves posteriorly, continues horizontally for some distance, then ascends with an anterior slant. This slanted ascending portion contains the spiral ridge mentioned by Haswell. At the level of the dorsal end of this spiral ridge the cement glands cease. The vagina now curves posteriorly, being lined by a columnar ciliated epithelium underlain by circular musculature and after receiving from below the common stem of the uteri continues posteriorly as a vaginal duct. This is also ciliated and provided with a muscular coat. It proceeds posteriorly parallel to and just beneath the main intestine which it enters by a short upward curve.

In 1925, Bock described some specimens from New Zealand as *Enterogonia pigrans novae-zealandiae*. These differ from the Australian specimens in their larger size (to 34 mm), less roomy male antrum, larger penis papilla, lack of expansion at the beginning of the vagina, and above all by the presence of a small free prostatic vesicle springing from the enlarged chamber of the ejaculatory duct, just before the latter descends in coils. In 1933, Stummer-Traunfels, reinvestigating the material of Schmarda (1859), found that Schmarda's species *Polycelis orbicularis*, also from New Zealand, is identical with *Enterogonia pigrans novae-zealandiae*. If the New Zealand form is regarded as specifically distinct from the Australian form, a view that could be justified by the differences mentioned above, then Bock's name becomes *Enterogonia orbicularis* (Schmarda). If the two forms are considered of only subspecific value it would become necessary to call Bock's subspecies *Enterogonia orbicularis orbicularis* and Haswell's form *Enterogonia orbicularis pigrans*. It seems desirable to avoid this by regarding the two as distinct species.

Whole mounts and sections of *Enterogonia pigrans* have been deposited in the Australian Museum. [Reg. Nos. W.3688, W.3689.]

SECTION SCHEMATOMMATA

Acotylea without marginal eyes; eyes usually limited to paired tentacular and cerebral clusters but sometimes otherwise; with or without nuchal tentacles; pharynx ruffled or tubular; copulatory complexes behind the pharynx with uteri extending forward.

Family LEPTOPLANIDAE Stimpson, 1857

Schematommata of small to moderate size, with or without tentacles; pharynx ruffled; uteri usually confluent at the anterior end of the pharynx; usually with true seminal vesicle, sometimes wanting; usually without spermiducal bulbs; prostatic vesicle interpolated, absent in some genera; with or without penis stylet; with or without Lang's vesicle.

Genus *Notoplana* Laidlaw, 1903

Leptoplanidae generally without tentacles; with true seminal vesicle; prostatic vesicle always present, its interior subdivided into longitudinal chambers that surround the central ejaculatory duct which therefore projects well into its interior; usually with Lang's vesicle.

Notoplana australis (Schmarda, 1859)

(Figure 9)

Polycelis australis Schmarda, 1859.*Leptoplana australis* Laidlaw, 1904.*Leptoplana australis*, Haswell, 1907.*Notoplana australis*, Bock, 1913.

The collection contains two specimens of this species, stated by Haswell to be the commonest and largest Australian polyclad, reaching a length of 75 mm. The larger of the two specimens was 25 mm long, 9-10 mm wide. The colour was described as olive grey; the accompanying colour sketch is greenish-grey. Haswell described the larger specimens as very dark, some almost black, whereas the smaller specimens are a light general shade of brown, often with olive-green intestinal branches. The coloured figure of Schmarda (1859) shows the colour of a 30 mm specimen as dark brown.

Stummer-Traunfels (1933), reinvestigating Schmarda's material, showed that his *Polycelis australis* is identical with Laidlaw's species. It appears that by accident both authors selected the same specific name.

My identification was based on serial sagittal sections of the posterior part of the larger worm. As several descriptions of this species exist in the literature, of which the most extensive is that of Haswell, I will refrain from a full description. I will remark that in my sections the convolutions of the vagina are far more complicated than in other published figures and that the muscular wall of the male antrum is far thicker than represented by Bock, resembling instead Haswell's figure. Hence, I present Figure 9. Further, the musculature of the antral wall courses mainly in a circular direction, not longitudinally as shown by Bock, also by Marcus (1954) for a variant *huina* from Chile. The stylet in the Australian specimen springs from a rounded penis papilla, not shown in other existing figures.

Specimens: Both specimens in alcohol have been returned to the Australian Museum; also the set of sagittal serial sections (4 slides) made from the posterior part of one of them. [Reg. No. W.3691.]

Notoplana longisaccata, sp. nov.

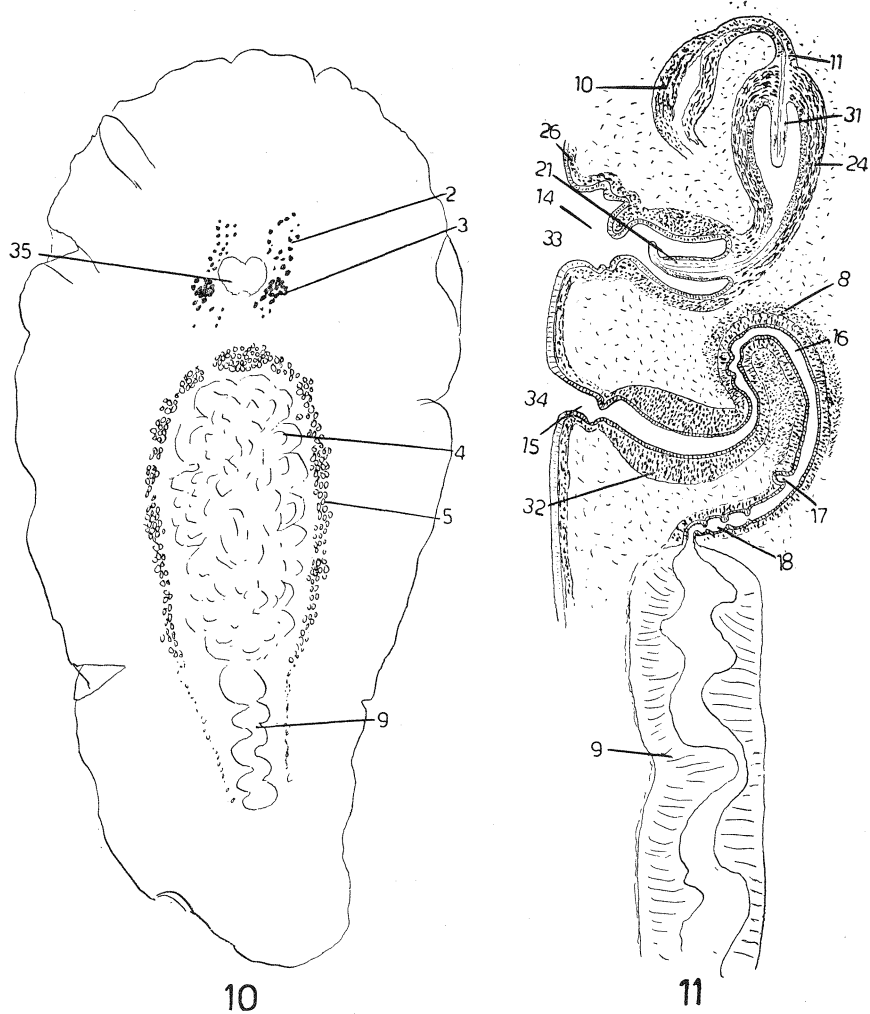
(Figures 10-11)

The single specimen (Fig. 10) is of obovate shape, 16 mm long by 8 mm in width at the widest part. The accompanying kodachrome (10c) shows a more slender, elongated shape. In life the animal is pale and transparent with the pharynx showing brown.

The cleared worm (Fig. 10) shows the eyes, the greatly ruffled pharynx, and the extremely long Lang's vesicle. The eyes occur in the usual cerebral and tentacular clusters. The latter form compact groups of about 8-10 eyes on each side. The smaller cerebral eyes occur in elongated groups, with a few eyes behind the tentacular clusters, most anterior to the latter.

The posterior part of the worm was removed and sectioned sagittally. The copulatory apparatuses are shown in sagittal view in Figure 11. They are notable for excessive muscularity. The fairly extensive male antrum ascends vertically, soon acquiring a thick coat of mostly circular muscles. Into its upper end projects the elongated, only slightly muscular penis papilla. This is directly continuous with the oval prostatic vesicle, with the usual thick muscular wall and glandular epithelium. No extra-capsular prostatic glands were in evidence. As typical of the genus the ejaculatory duct projects into the prostatic vesicle. Beneath the prostatic vesicle is the fusiform, muscular seminal vesicle leading to the proximal end of the prostatic vesicle by an arched ejaculatory duct.

The female gonopore lies not far behind the male pore but well separated from it. It leads into a short antrum which is narrowed at the entrance of the vagina. The vagina with very thick muscular wall, hence constituting a bulbous vagina, ascends vertically, then makes an anterior curve. The muscular wall diminishes greatly, beginning with this curve, but is still evident along the whole course of the vagina. The latter curves backwards, descends, and after receiving from below the common stem of the uteri continues as the short duct of Lang's vesicle. This has the scalloped epithelium often seen in this duct and soon enters the Lang's vesicle. The whole curve of the vagina to the entrance of the common uterus received cement



Figs. 10 to 11.—*Notoplana longisaccata*. 10. Cleared whole specimen, showing general features. 11. Sagittal view of copulatory complex, anterior end above.

Key for anatomy: 2. cerebral eyes; 3. tentacular eyes; 4. pharynx; 5. uteri filled with eggs; 8. cement glands; 9. Lang's vesicle; 10. seminal vesicle; 11. ejaculatory duct; 14. male antrum; 15. female antrum; 16. vagina; 17. common stem of uteri; 18. duct of Lang's vesicle; 21. penis papilla; 24. prostatic vesicle; 26. muscle layer; 31. projection of ejaculatory duct into prostatic vesicle; 32. bulbous vagina; 33. male gonopore; 34. female gonopore; 35. brain.

glands throughout its wall. The Lang's vesicle is of extraordinary length. Because of limitations of space only half its length is shown in Figure 11. Actually it is about 2.6 mm long, about one-sixth the length of the (preserved) worm. The vesicle consists of a very high, granular epithelium covered with a thin fibrous coat.

Among the many species of *Notoplana*, the present species differs from all others in the remarkable length of Lang's vesicle. Other differentiating characters are the bulbous vagina, unusual in the genus, the muscular male antrum, and the elongated slender penis papilla.

Holotype: Anterior part as whole mount, copulatory region as sagittal serial sections (3 slides) deposited in the Australian Museum. [Reg. No. W.3692.]

***Notoplana longiducta*, sp. nov.**

(Figures 12-13)

The collection contains two specimens of this species. It is of long and slender form (Fig. 12); the specimens are 19 and 15 mm long, respectively, and 3-4 mm wide. The kodachrome (6c) however, shows the anterior end as more expanded than in the preserved specimens. The colour is given as a transparent brown to olive green. The species is stated by Miss Pope to be extremely common on the coast of New South Wales.

The cleared whole worm (Fig. 12) shows the eyes, the pharynx embraced by the coils of the uteri containing eggs, and the location of male and female gonopores. The pharynx is notable for its somewhat anterior position also shown on the kodachrome. Tentacular and cerebral eye clusters form a continuous group on each side, in which the tentacular eyes are distinguishable by their larger size. They are relatively few in number. The much smaller and more numerous cerebral eyes occur in part behind the tentacular clusters but most are located anterior to these.

The appropriate part of the larger specimen was removed and sectioned sagittally. A sagittal view of the copulatory complex is given in Figure 13. The male system was found in rather poor histological condition, and further was not cut exactly in the sagittal plane; hence its structure was made out with some difficulty but probably corresponds fairly well to Figure 14. The male antrum ascends and widens into a chamber that appeared more irregular in contour than as represented in the figure. It has a strong muscular wall and houses the fairly elongated pointed penis papilla. From its upper end the ejaculatory duct curves anteriorly and pursues a long sinuous course in the anterior direction, finally joining the oval prostatic vesicle. The latter is chambered in typical *Notoplana* fashion and is lined by a glandular epithelium underlain by the usual thick muscular wall continuous with a thin muscular investment of the ejaculatory duct. At its proximal end the prostatic vesicle narrows and as a curved duct connects with the relatively large seminal vesicle with thick wall of lengthwise muscle fibres. The seminal vesicle was cracked and distorted in the specimen, hence its contour in Figure 13 is conjectural.

The female gonopore lies not far behind the male pore. The small female antrum ascends and shows a constriction before opening into the vagina. The latter is a fairly wide tube with ciliated epithelium underlain by a moderately thick layer of circular fibres and receiving a cloud of cement glands. The vagina as usual ascends, then curves backwards and descends, receiving the common stem of the uteri. Beyond this point it continues as a short duct with beaded interior that soon enters the lower part of the very small, oval, erectly oriented Lang's vesicle.

Notoplana longiducta is distinguished by the very long sinuous ejaculatory duct between the prostatic vesicle and the penis and further by the small, vertically oriented Lang's vesicle.

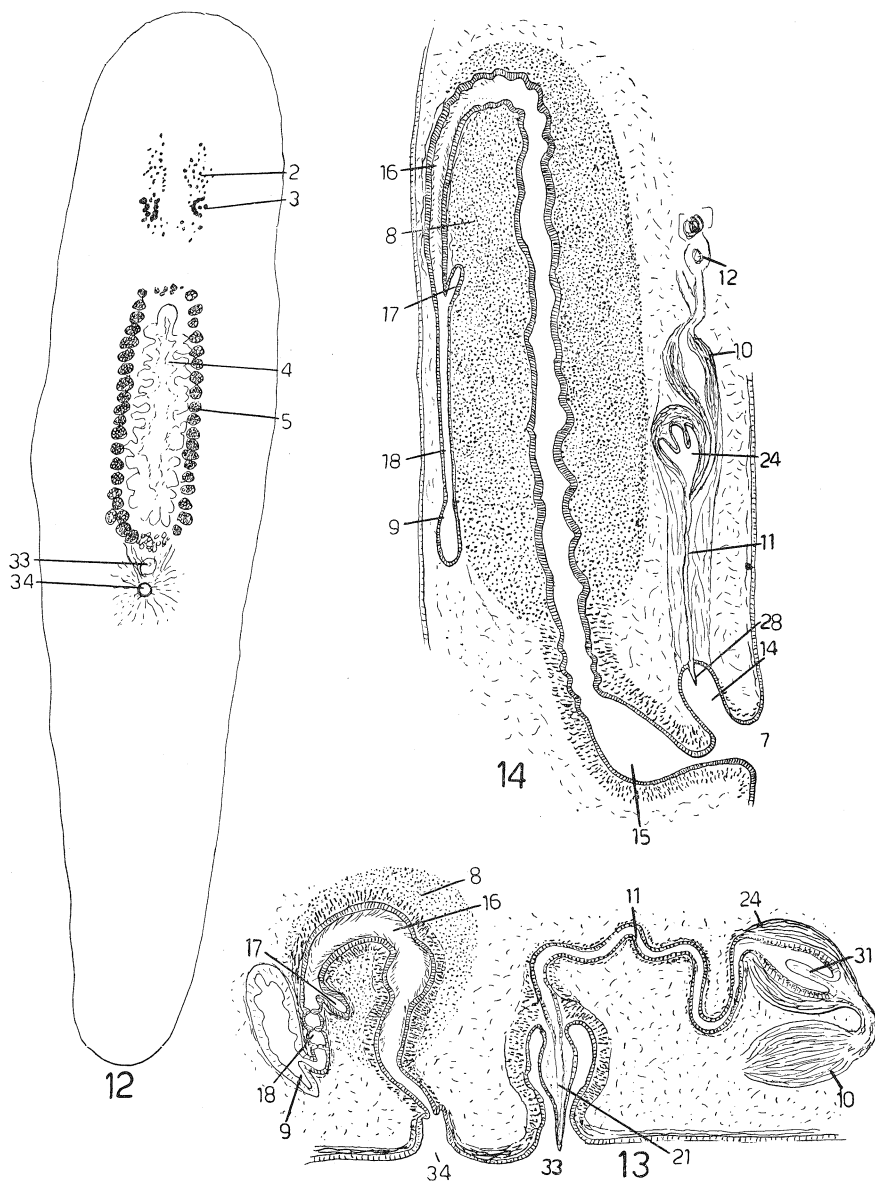
Holotype: Anterior part as whole mount, copulatory region as sagittal serial sections (3 slides) deposited in the Australian Museum; further, the second specimen mounted entire. [Reg. Nos.: Holotype W.3693; second specimen W.3694.]

Family **Callioplanidae** Hyman, 1953.

Schematommata of oval form and firm consistency, with or without tentacles; with cerebral and tentacular eye clusters; pharynx ruffled; with true seminal vesicle; prostatic vesicle free, sometimes chambered; Lang's vesicle usually present, single or double.

Genus **Callioplana** Stimpson, 1857

Callioplanidae with prominent tentacles, well-developed penis papilla, and pair of Lang's vesicles extending anteriorly.



Figs. 12 to 13.—*Notoplana longiducta*. 12. Cleared whole worm, showing general features. 13. Sagittal view of copulatory complex, anterior end to right.

Fig. 14.—*Pseudostylochus bellus*, sagittal view of copulatory complex, anterior end above.

Key for anatomy: 2. cerebral eyes; 3. tentacular eyes; 4. pharynx; 5. uteri filled with eggs; 7. common gonopore; 8. cement glands; 9. Lang's vesicle; 10. seminal vesicle; 11. ejaculatory duct; 12. spermiducal vesicle; 14. male antrum; 15. female antrum; 16. vagina; 17. common stem of uteri; 18. duct of Lang's vesicle; 21. penis papilla; 24. prostatic vesicle; 28. penis stylet; 31. projection of ejaculatory duct into prostatic vesicle; 33. male gonopore; 34. female gonopore.

Callioplana marginata Stimpson, 1857*Stylochus oxyceraeus* Schmarda, 1859.*Diplosolenia johnstoni* Haswell, 1907.*Callioplana marginata*, Yeri and Kaburaki, 1918.

The collection contains two specimens of this well-known species, a small and a large one. The latter is of oval form, with slightly frilled margin, 38 mm long by 20 mm wide. Schmarda (1859) and Haswell (1907) gave the dimensions as 60 by 30 mm, Yeri and Kaburaki (1918) as 50 by 30 mm. Schmarda's coloured figure depicts the dorsal surface as almost black with a red margin. Haswell described the colour as almost black with a narrow light margin. In Kato's 1944 description the colour is given as velvety black with a colourless margin subtended by a band of tawny brown. Miss Pope's description and colour sketch give the dorsal surface as sepia brown with a white margin subtended by an orange brown band to the inner side of which the sepia brown is somewhat deepened. Evidently the colour varies somewhat but the general pattern is a dark dorsal surface with a contrasting tawny brown to orange margin bordered thinly by white. Dakin (1952) in his book *Australian Seashores* presents a photograph of the worm under the old Haswell name. The prominent tentacles are pale with a distal or middle band of brown, orange, or red.

Stummer-Traunfels (1933), reinvestigating the material of Schmarda (1859), first suggested the identity of *Callioplana marginata* and *Diplosolenia johnstoni*. As accounts of the sexual anatomy have been given by Yeri and Kaburaki (1918), Stummer-Traunfels (1933), and Kato (1944), I have considered it unnecessary to make any sections, although Haswell's account is unclear and poorly illustrated. The species has been found at Japan, Ceylon, and south-eastern Australia. [Reg. Nos. W.3695, W.3696.]

Genus Pseudostylochus Yeri and Kaburaki, 1918

Callioplanidae with single Lang's vesicle.

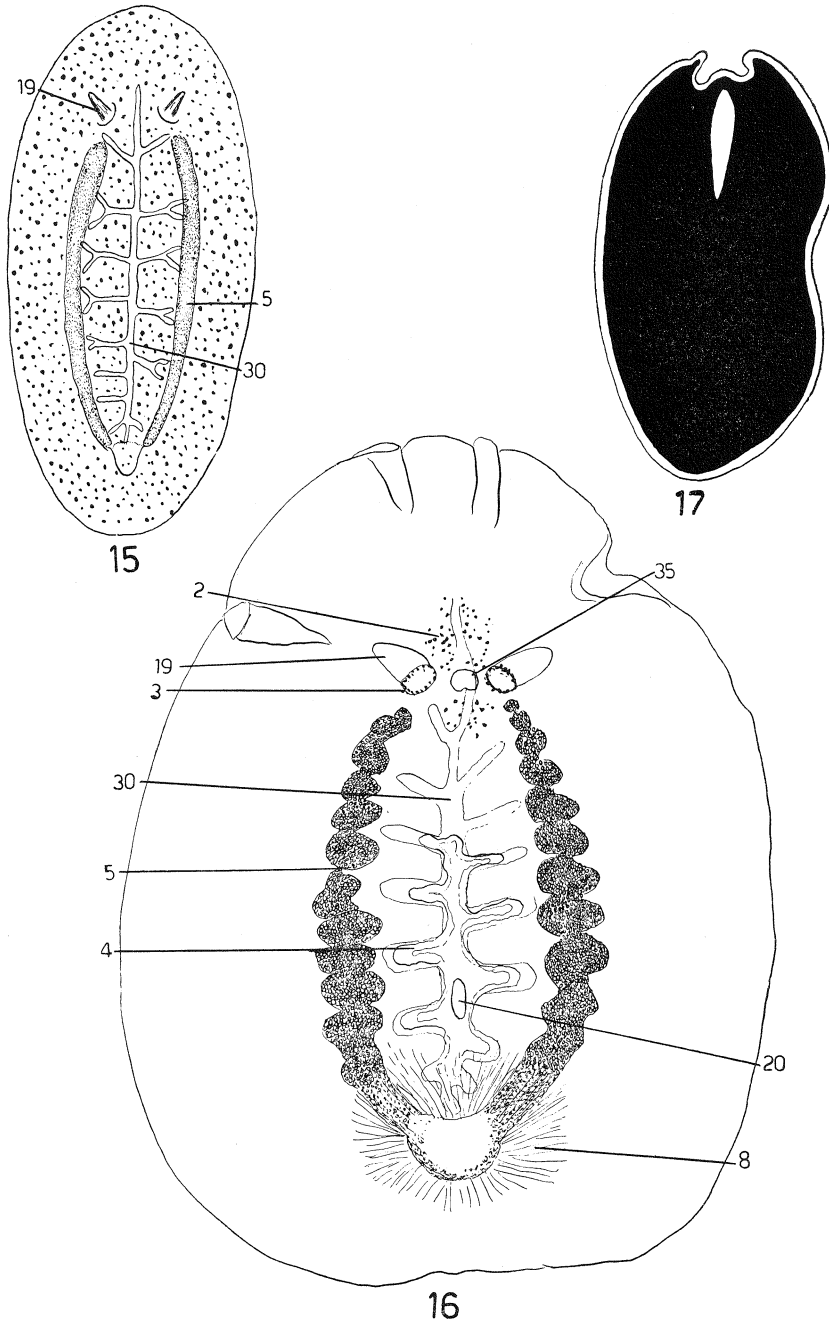
Pseudostylochus bellus, sp. nov.

(Figures 14-16)

The single specimen is of broadly oval form (Fig. 16), measuring 26 by 20 mm, but is evidently contracted as Miss Pope's colour sketch, redrawn as Figure 15, gives the shape as moderately oval. There is a pair of prominent tentacles with a ring of eyes at the base. It is rather interesting that Miss Pope noticed the resemblance to *Callioplana* in appearance, shape, and firm consistency. The colour of the dorsal surface is a light brownish-grey dotted with conspicuous rusty brown spots. The worm is described as a beautiful species, hence the specific name.

In the cleared entire worm (Fig. 16) are seen the tentacles, eyes, pharyngeal branches, mouth, and uteri filled with eggs. The tentacular eyes encircle the tentacle bases. The cerebral eyes occur in two loose clusters, one behind the brain, the other anterior to the brain. In the whole mount the ruffled pharynx is not clearly distinct from the intestinal branches which seem to have been plain in the living worm as a brown tree-like structure with the oval mouth somewhat posterior in position. The prominent coils of the uteri, bright orange in life, take a curved course alongside the pharynx on each side, and terminate anteriorly just behind the tentacles. Behind the pharynx is seen the great mass of cement glands, forming an apricot spot in life.

The usual sagittal serial sections were made of the copulatory region and a sagittal view of the copulatory complex is given in Figure 14. The small slender male apparatus, taking a horizontal course near the ventral wall, is overshadowed by the massive female apparatus that leans far forward above the former. The male apparatus is entered distally by the sperm ducts, narrowed after forming expansive spermiducal vesicles. They join at the seminal vesicle of fusiform shape with thick muscular wall. The ejaculatory duct issuing from its distal end is joined after a short course by the prostatic duct from the free prostatic vesicle, situated dorsal to it. The prostatic vesicle, of oval form with thick muscular wall, has a chambered interior, as also in a few other species of the genus. After receiving the prostatic duct, the ejaculatory duct runs posteriorly in a sheath of connective tissue to the male antrum where it projects as a small pointed penis stylet. The male antrum is a fairly deep rounded cavity that opens below in common with the female antrum by the common gonopore. The female antrum begins as a narrow passage that soon expands into a considerable cavity with strongly muscularized wall of circular fibres. This curves anteriorly and becomes the glandular vagina which pursues a long horizontal course in the anterior direction. In this horizontal course the vagina is entered by a tremendous mass of cement glands. After continuing anteriorly to a point considerably



Figs. 15 to 16.—*Pseudostylochus bellus*. 15. General appearance in life, after colour sketch by Miss Elizabeth Pope. 16. Cleared whole worm, showing general features.

Fig. 17.—*Pseudoceros albomarginatus*, after colour sketch by Miss Elizabeth Pope.

Key for anatomy: 2. cerebral eyes; 3. tentacular eyes; 4. pharynx; 5. uteri filled with eggs; 8. cement glands; 19. tentacles; 20. mouth; 30. intestine; 35. brain.

beyond the proximal end of the male apparatus, the vagina makes an upward and backward curve, then paralleling its previous course. After receiving from below the common stem of the uteri, the vagina continues posteriorly as a long slender duct of Lang's vesicle which terminates in a small oval sac.

Of the eighteen previously described species of *Pseudostylochus*, only one, *P. burchami*, from the Pacific coast of the United States (Hyman, 1953) also has conspicuous, projecting tentacles; but *P. bellus* differs from this altogether in the details of the copulatory complex, having a small penis stylet in place of a penis papilla, common gonopore (unusual in the genus), small chambered prostatic vesicle, in contrast to the large unchambered one of *P. burchami*, and much more massive and more anteriorly slanted female apparatus than *burchami*. All the other species inhabit Japanese waters, hence the present species greatly extends the range of the genus.

Holotype: One whole mount, copulatory region as serial sagittal sections (6 slides), deposited in the Australian Museum. [Reg. No. W.3697.]

Suborder COTYLEA

Polyclads with a sucker behind the female gonopore (but sometimes wanting); tentacles when present of the marginal type (some exceptions); with cerebral and marginal eyes; marginal eyes in a pair of clusters on the anterior margin, associated with the tentacles when present, or as a short band along the anterior margin, sometimes along the entire margin; pharynx usually anterior, ruffled or tubular; when tubular directed forward; copulatory or prostatic apparatuses sometimes numerous; when single or paired in the anterior body half close to the pharynx with penis directed forward and uteri extending backward; prostatic vesicle free, rarely interpolated; Lang's vesicle almost always wanting.

Family PSEUDOCERIDAE Lang, 1884

Cotylea of oval or oblong shape with smooth or papillate dorsal surface and prominent marginal tentacles, formed of the upfolding of the anterior margin; pharynx ruffled, anteriorly located; intestinal branches numerous, anastomosing to a network; male copulatory apparatus single or paired, close behind or partly beneath the pharynx; penis usually armed with a short stylet; female apparatus single (rarely multiple in a longitudinal row); uteri when ripe greatly branched.

Genus *Pseudoceros* Lang, 1884

Pseudoceridae with smooth dorsal surface; male apparatus single or paired; female apparatus single.

Pseudoceros albomarginatus, sp. nov.

(Figures 17-18)

The single specimen was stated in Miss Pope's notes to be a strikingly handsome species, velvety jet black above with a white margin and a white blaze in the median anterior region. This pattern is shown in Figure 17, copied after Miss Pope's colour sketch. The ventral surface is dusky with a longitudinal white band running the entire body length. The tentacular folds on the anterior margin appear better developed in the preserved worm than in the colour sketch. The general form is oval; on preservation the margin was thrown into frills. The dimensions in life were not given but the preserved specimen is 16 mm long by 10 mm wide.

In the dehydrated cleared worm the heavy black pigment obscured most structures but main features could be discerned in the central white stripe. There are evident a few eyes on one of the tentacular folds, indications of the folds of the ruffled pharynx, the mouth, the single male gonopore, the female gonopore encircled by cement glands, and the sucker. The pores and sucker are more evident in alcohol. These features are shown in Figure 18 in their relative positions. The distance from the anterior margin to the male gonopore is 4.4 mm; from the male to the female gonopore, 0.5 mm; and from the latter to the sucker 1.6 mm. The sucker is thus located slightly anterior to the middle.

Of the many species of the genus *Pseudoceros* (over 100) there is only one other that is black with a white border, namely *P. bicolor* Verrill, 1901, from Bermuda. This, however, lacks median white markings and the black dorsal area sends out pointed rays into the white margin. The reproductive system of Verrill's species is unknown.

Holotype: The specimen in alcohol deposited in the Australian Museum. [Reg. No. W.3698.]

Family DIPOSTHIDAE Woodworth, 1898

Cotylea with a pair of marginal tentacles of the euryleptid type, bearing eyes; also with cerebral eyes; with central ruffled pharynx; copulatory complex behind the pharynx, near the posterior end; prostatic vesicle in the male antrum, alongside the penis.

Genus *Diposthus* Woodworth, 1898

Diposthidae with the prostatic vesicle behind the penis; sucker wanting.

Diposthus popeae, sp. nov.

(Figures 19-21)

This species is reported as very common in the area. The collection contains four specimens, all distorted, and one in such bad condition that it was discarded. Miss Pope's notes state that the species is almost impossible to preserve. When handled it secretes quantities of mucus and fragments; further contracts and turns brown in the fixative.

In life the species is opaque white, of cuneate shape (Fig. 19) with a pair of pointed tentacles of the euryleptid type at the anterior margin. It is mostly around 15 mm in length. Preserved specimens are brown and distorted to a broadly oval shape as in Figure 20, measuring 11 by 10 mm. In the cleared specimen (Fig. 20) are seen the marginal eyes, in and around the base of the tentacles as paired clusters, the few cerebral eyes over the brain, the relatively large and greatly ruffled pharynx, the vagina behind the pharynx, and some very large eggs marking the course of the invisible uteri.

One of the specimens was sectioned sagittally but proved in such poor histological condition that it is unfortunately impossible to give a good account of the copulatory complex of this, the most interesting species in the collection. Especially the male complex is in poor condition. Immediately behind the pharynx is seen a cavity, the male antrum, containing a cylindroid penis papilla. No male gonopore was present but there was evidence that the male antrum connects by a tubular passage with the female antrum. However, evidence for such connection is so fragmentary it has not been included in Figure 21, which represents what could be seen of the copulatory complex. Above the penis papilla is an evident seminal vesicle with thick muscular wall and an exit curving down in the direction of the penis papilla. Alongside the seminal vesicle but not in the same plane is an oval body that might be a prostatic vesicle. The female system is better preserved. The female gonopore leads into a vertical female antrum from which the vagina ascends. At its beginning the vagina is entered on its anterior and posterior side by a distinct cement pouch that receives the cement glands. The vagina then ascends, and makes the usual backward and downward curve, terminating in an enlargement that was not clearly delineated in the sections. A possible duct enters this from before and very likely this enlargement receives the uteri. The latter were not definitely discernible but marked by a procession of remarkably large eggs. The vagina is lined by a tall scalloped epithelium underlain by a thin muscular stratum.

The present species is considered distinct from the only other species placed in the genus, *D. corallicola* Woodworth, 1898, in having a definite seminal vesicle and a pair of cement pouches. Woodworth claimed two seminal vesicles for his species but his figure shows that these are not seminal vesicles, but spermiducal bulbs, that is, muscular enlargements of the sperm ducts. Such spermiducal bulbs are definitely wanting in the present species as the spermiducal vesicles, or greatly expanded terminal parts of the sperm ducts, can be traced up to the male apparatus. Woodworth founded the genus and family on a projection that he termed prostatic vesicle paralleling the penis papilla in the male antrum. The nature of this projection remains uncertain and no such appearance could be found in the present specimen. Instead there was evidence of a fusiform body alongside the seminal vesicle that is probably a typical free prostatic vesicle as usual in *Cotylea*. Woodworth gives two figures of the vagina but does not indicate any cement pouches. He claims the presence of uterine vesicles and figures three pairs. I did not find any indications of uterine vesicles and wonder if Woodworth did not mistake the huge eggs for vesicles. Woodworth did not mention a sucker and this is definitely absent from the present species.

Holotype: The better of two specimens mounted whole on one slide; also set of sagittal serial sections (6 slides) deposited in the Australian Museum. [Reg. Nos.: Whole mount including holotype, W.3699; Serial sections, W.3700.]

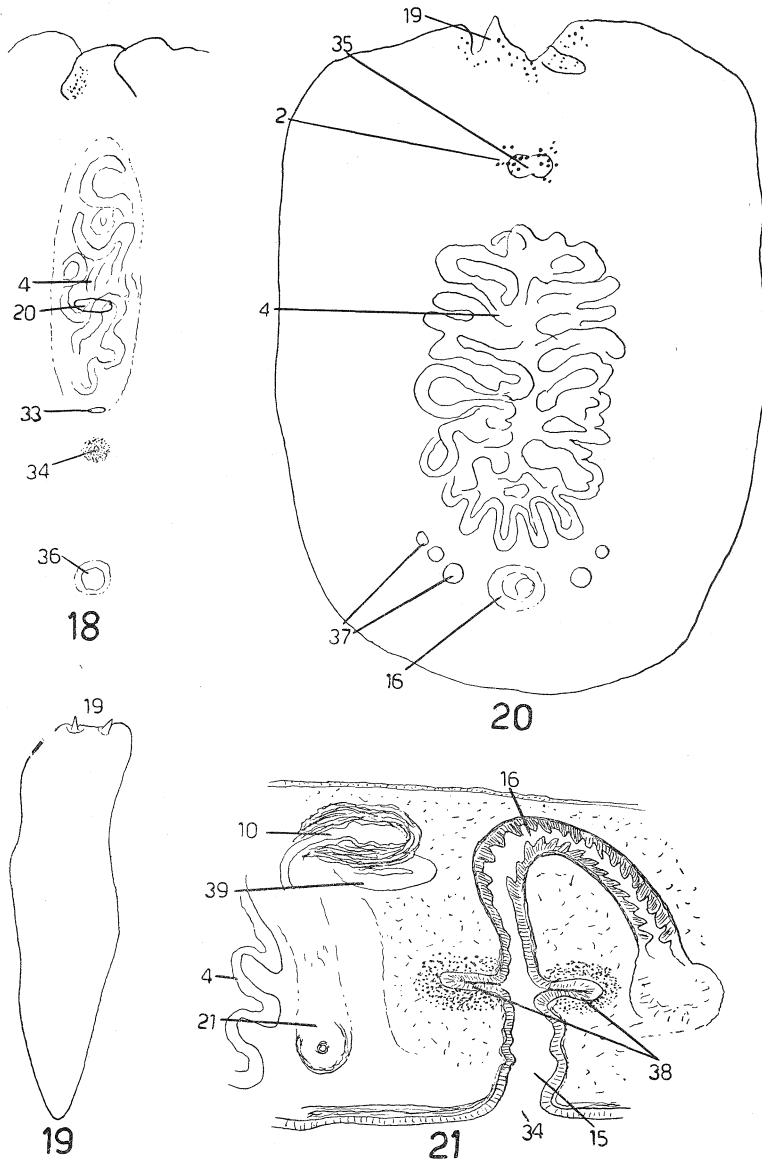


Fig. 18.—*Pseudoceros albomarginatus*, central anterior region of cleared worm, showing pharynx, gonopores, and sucker, anterior end above.

Figs. 19 to 21.—*Diplosthus popeae*. 19. Appearance in life, after colour sketch by Miss Elizabeth Pope. 20. Cleared preserved worm, showing general features. 21. Sagittal view of copulatory complex, imperfect from bad fixation, anterior end to left.

Key for anatomy: 2. cerebral eyes; 4. pharynx; 10. seminal vesicle; 15. female antrum; 16. vagina; 19. tentacles; 20. mouth; 21. penis papilla; 33. male gonopore; 34. female gonopore; 35. brain; 36. sucker; 37. eggs; 38. cement pouches; 39. prostatic vesicle.

CONCLUDING REMARKS

In the present collection there have been recovered only three of the eleven species mentioned in Haswell's well-known article (1907) on Australian polyclads, namely, *Enterogonia pigrans*, *Notoplana australis*, and *Callioplana marginata*. Others of Haswell's species need reinvestigation, notably *Echinoplana celerrima* which presumably belongs to the Planoceridae. Haswell reviews earlier findings from Australia. There has been no systematic collecting of polyclads along Australian shores since Haswell's work until the present collection and undoubtedly many species remain to be discovered there. In 1954, I added two cotyleans from the Great Barrier Reef, at Heron Island, namely *Pseudoceros bedfordi* and *P. corallophilus*. The present article adds seven species to the list from Australian shores: *Discocelis australis*, *Leptostylochus novacambrensis*, *Notoplana longisaccata* and *longiducta*, *Pseudostylochus bellus*, *Pseudoceros albomarginatus*, and *Diposthus popeae*. It is hoped the present contribution will stimulate further study of Australian polyclads.

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