

A new genus and five new species of acoel flatworms from the Pacific coast of North America, and resolution of some systematic problems in the families Convolutidae and Otocelididae

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Abstract: A new genus and five new species of acoel flatworms, found in marine sediments on San Juan Island, Washington, are described. These are: *Ancylocirrus* gen. nov. *ornatus* sp. nov. (Convolutidae); *Haploposthia erythrocephala* sp. nov. (Haploposthiidae); *Mecynostomum torquens* sp. nov., *Eumecynostomum luridum* sp. nov. (Mecynostomidae); *Notocelis rubidocula* sp. nov. (Otocelididae). *Raphidophallus* (Convolutidae) is removed from synonymy under *Conaperta*. *Parotocelis luteopunctata* (Otocelididae), described from the Galápagos Islands, is transferred to *Posticopora* gen. nov., because the genus of which it is the type species is preoccupied. *Notocelis gullmarensis* subsp. *maculata* (Otocelididae), found in Hawaii, is raised to the rank of species.

Résumé : Un nouveau genre et cinq nouvelles espèces d'Acoeles de la côte Pacifique de l'Amérique du Nord, et résolution de quelques problèmes systématiques dans les familles des Convolutidae et des Otocelididae. Un nouveau genre et cinq nouvelles espèces d'Acoeles marins de l'île de San Juan, Washington, sont décrits. Ce sont : *Ancylocirrus* gen. nov. *ornatus* sp. nov. (Convolutidae) ; *Haploposthia erythrocephala* sp. nov. (Haploposthiidae) ; *Mecynostomum torquens* sp. nov., *Eumecynostomum luridum* sp. nov. (Mecynostomidae) et *Notocelis rubidocula* sp. nov. (Otocelididae). Le genre *Raphidophallus* est retiré d'une synonymie avec *Conaperta*. *Parotocelis luteopunctata* (Otocelididae), décrite des Iles Galápagos, est transférée au genre *Posticopora* gen. nov., car le genre dont elle est l'espèce type est préoccupé. *Notocelis gullmarensis* sous-espèce *maculata* (Otocelididae), trouvée à Hawaï, est élevée au rang d'espèce.

Keywords : Platyhelminthes, Acoela, North America, Washington, Pacific, taxonomy

Introduction

Only five species of acoel flatworms reported from the Pacific coast of North America have been positively identified. Four that were described from the region are *Polychaerus carmelensis* Costello & Costello, 1938, *Diatomovora amoena* Kozloff, 1965, *Raphidophallus*

actuosus Kozloff, 1965, and *Otocelis luteola* (Kozloff, 1965). *Childia groenlandica* (Levinsen, 1879), whose type locality is in Greenland, has been found in San Francisco Bay, California (Hyman, 1959) and at Friday Harbor, Washington (Stricker et al., 1992; Kozloff, unpublished). A *Paratomella* seen by Ax in Washington is similar to *P. unichaeta* Dörjes, 1966, whose type locality is Helgoland, but sexually mature individuals were not encountered (see the comment by Ax in the discussion that follows Dörjes' description of the species). Crezée (1975) reported a species

Reçu le 20 janvier 2000; accepté après révision le 20 mai 2000.

Received 20 January 2000; accepted in revised form 20 May 2000.

of the family Solenofilomorphidae from San Juan Island, Washington, giving a brief description and assigning it provisionally to *Myopea*, but not proposing a species name.

The purpose of this paper is to describe additional species of acoels, and one new genus, that have been found in localities at or near Friday Harbor, San Juan Island, Washington, and also to deal with a systematic problem in the family Convolutidae and two problems in the family Otocelididae.

Material and methods

Living specimens of each species were studied in transmitted and reflected light. Neutral red was used to a limited extent as a supravital stain. Addition of a small amount of an isotonic solution of magnesium chloride to the sea water in which the animals were concentrated was helpful in quieting them so they could be observed and photographed. Specimens to be sectioned were relaxed in the same way, then fixed in Bouin's fluid and embedded in paraffin. Serial sections (transverse, sagittal, and frontal) were cut at 4, 5, or 6 μm and stained with iron hematoxylin, sometimes counterstained with orange G or fast green.

Type material has been deposited in the United States National Museum (USNM), Washington, DC.

Descriptions of Species

Family Convolutidae
Ancyllocirrus gen. nov.

Convolutidae without ciliated male antrum. Copulatory cirrus long and curved, within prominent seminal vesicle; lumen of cirrus filled with secretory granules. Vagina long, muscularized; in inseminated specimens, end of proximal third of vagina with aggregate of secretory granules introduced by cirrus during copulation. Seminal bursa conspicuous, without nozzle or obvious cellular or muscular cap.

Type species: *Ancyllocirrus ornatus* sp. nov.

Etymology. The genus name is based on Greek *ankylos*, bent, curved, and a zoological term (derived from Latin *cirrus*, a curl or lock of hair) applied, in literature on flatworms, to an eversible male copulatory organ.

Ancyllocirrus ornatus sp. nov.
Figs 1-8

Type material: Holotype. USNM 185986, a specimen sectioned frontally.

Type locality: Washington, San Juan Island, Friday Harbor, Friday Harbor Laboratories.

Etymology. The species name, based on Latin *ornatus* (decorated, adorned), refers to the masses of orange-red

eyespot pigment on both sides of the anterior end of the body.

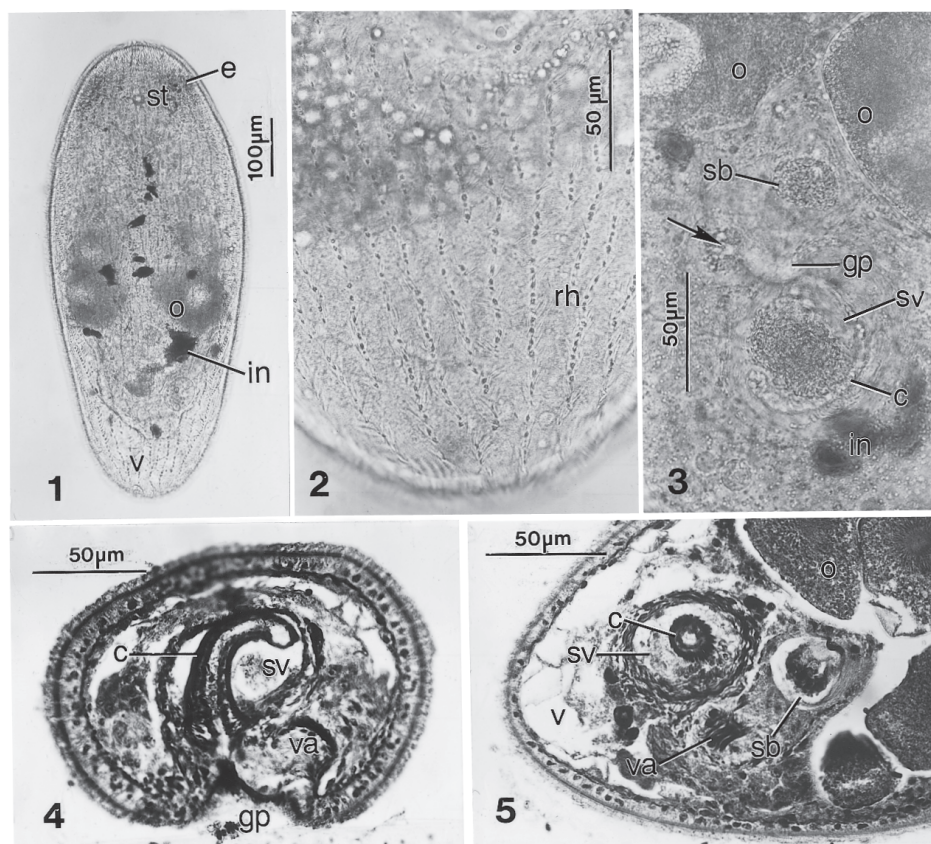
Description

Large specimens (Figs 1, 6), when extended and gliding over glass surface, up to about 740 μm long, 245 μm wide. Greatest width slightly anterior to middle of body. Anterior and posterior ends similarly rounded. General coloration, in reflected light, greenish, owing to presence of diatoms undergoing digestion in digestive syncytium, but also showing numerous opaque white patches in dorsal part of body; these patches, in transmitted light, consisting of small granular inclusions exhibiting Brownian movement. Body containing many lipid globules, some as large as 22 μm in diameter. Mass of orange-red eyespot pigment, sometimes accompanied by brown pigment granules, on both sides of body close to anterior end. Statocyst, located at end of first one-eighth of body, about 22 μm in diameter; statolith hemispherical, about 14 μm in diameter. Frontal gland substantial, its two lobes reaching posteriorly well beyond statocyst. Posterior portion of body with conspicuous U-shaped or V-shaped vacuolated area partly surrounding copulatory complex. Body completely covered by cilia about 8.5 μm long. Rhabdoids (Fig. 2) abundant in dorsal and ventral epidermis, closely spaced in lengthwise rows, these mostly about 8-13 μm apart.

Mouth, located on ventral surface near middle of body, leading directly into digestive syncytium, which extends posterior to level slightly behind male copulatory complex. Food appearing to consist entirely of diatoms.

Common genital pore (Figs 3, 4, 7) situated on ventral midline near beginning of fourth quarter of body. Sperm produced in two broad dorsolateral areas beginning at level slightly posterior to statocyst. Seminal vesicle (Figs 3-7) prominent, entered laterally by right and left sperm channels (Figs 6, 7) and containing long, eversible muscular cirrus, this joined to male pore located within common genital pore. Most of proximal portion of cirrus oriented nearly vertically; distal portion directed toward right (Fig. 4), above mass of sperm. Lumen of cirrus usually filled, in living specimens, with colorless granules mostly 3-5 μm in diameter. Similar granules sometimes associated with sperm mass. Sperm (Fig. 8) approximately 100 μm long, 1.7 μm thick near anterior end, and with prominent undulating membrane.

Vagina (Figs 4, 5, 7), originating at female genital pore on anterior side of common genital pore, with circular and longitudinal muscle fibers. Proximal third, with distinct lumen, directed rather sharply to right of midline; distal portion, appearing to lack permanent lumen, directed medially and joining seminal bursa. Deepest part of proximal portion, in specimens that have been inseminated, with concentration of granules (Figs 3, 7) identical to those



Figures 1-5. *Ancylocirrus ornatus* gen. nov., sp. nov.; photomicrographs. **1.** Entire living specimen, slightly flattened, dorsal view. **2.** Posterior portion of living specimen, slightly flattened, dorsal view. **3.** Reproductive structures in posterior portion of living specimen, slightly flattened, ventral view. **4.** Transverse section of posterior region of body, viewed from posterior side. **5.** Holotype: frontal section through posterior portion of body, viewed from dorsal side. (*arrow*) indicates granules in the vagina, identical to those in the cirrus; (*c*) cirrus; (*e*) eyespot pigment; (*gp*) genital pore; (*in*) opaque patch of granular inclusions; (*o*) oocyte; (*rh*) rhabdoids; (*sb*) seminal bursa; (*st*) statocyst; (*sv*) seminal vesicle; (*v*) posterior vacuolated region; (*va*) proximal portion of vagina.

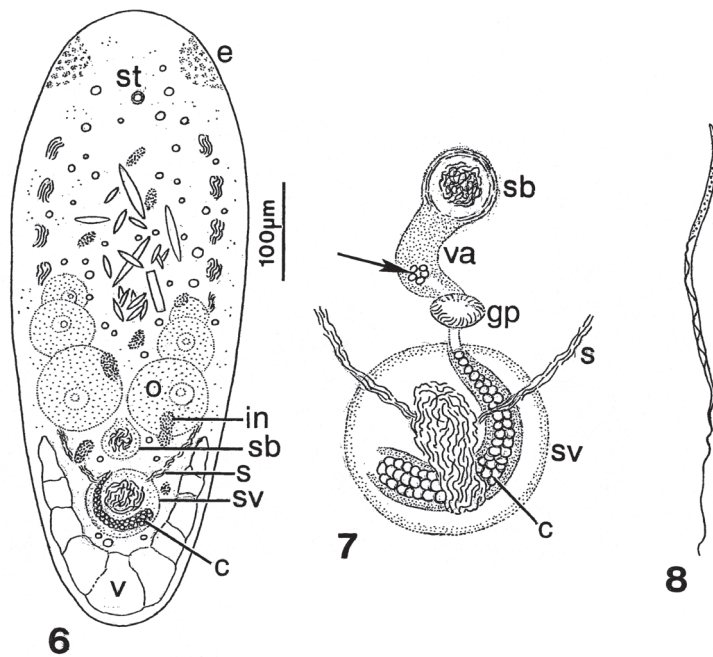
Figures 1-5. *Ancylocirrus ornatus* gen. nov., sp. nov.; photomicrographies. **1.** Spécimen vivant entier légèrement comprimé, vue dorsale. **2.** Partie postérieure d'un spécimen vivant légèrement comprimé, vue dorsale. **3.** Eléments de l'appareil reproducteur dans la partie postérieure d'un spécimen vivant, légèrement comprimé, vue ventrale. **4.** Coupe transversale de la partie postérieure, vue postérieure. **5.** Holotype: coupe frontale de la région postérieure du corps, vue dorsale. (*la flèche*) indique les granules du vagin, identiques à ceux du cirre; (*c*) cirre; (*e*) tache oculaire; (*gp*) pore génital; (*in*) tache opaque d'inclusions granulaires; (*o*) ovocyte; (*rh*) rhabdoïdes; (*sb*) bourse copulatrice; (*st*) statocyste; (*sv*) vésicule seminale; (*v*) région postérieure vacuolisée; (*va*) partie proximale du vagin.

in lumen of penis. Seminal bursa (Figs 3, 5-7) with definite wall of fibrous tissue, but lacking nozzle and without distinct cap of cells on anterior side. Sperm, when present in bursa, active. In some sectioned specimens, sperm protruding through wall of anterior side of bursa, but this perhaps an abnormality caused by muscular contractions of the body during fixation. Oogonia and oocytes (Figs 1, 3, 5, 6) in two ventrolateral chains. Largest oocytes, about 100 μm in diameter, located close to seminal bursa.

Remarks

This acoel, because of the long muscular cirrus lying within the seminal vesicle, prominent bursa without a nozzle, and well developed vagina, appears to be closely related to

certain species of *Aphanostoma* Ørsted, 1845, especially *A. album* Dörjes, 1968. According to Dörjes (1968), the four species he admitted to the genus *Aphanostoma* are characterized by the presence of a ciliated male antrum and a cellular-muscular cap on the anterior side of the seminal bursa. Both of these structures are absent in *A. ornatus*. Furthermore, the lumen of the cirrus is typically filled with secreted granules, a feature that has not been reported in *Aphanostoma* or other genera of Convolutidae in which the cirrus or the seminal vesicle, or both, have a glandular wall. Granules of the same type are invariably present in the vagina of specimens that have been inseminated, but are not present in the vagina of specimens that have reached sexual



Figures 6-8. *Ancylocirrus ornatus* gen. nov., sp. nov.; drawings based on sketches of living specimens. **6.** Entire specimen, slightly flattened, dorsal view. **7.** Copulatory organs, ventral view, schematic. **8.** Sperm. (arrow) indicates granules in the vagina, identical to those in the cirrus; (c) cirrus; (e) eyespot pigment; (gp) genital pore; (in) opaque patch of granular inclusions; (o) oocyte; (s) sperm channel; (sb) seminal bursa; (st) statocyst; (sv) seminal vesicle; (v) posterior vacuolated region; (va) vagina.

Figures 6-8. *Ancylocirrus ornatus* gen. n., sp. n.; dessins d'après des spécimens vivants. **6.** Spécimen entier, légèrement comprimé, vue dorsale. **7.** Appareil génital, vue ventrale, schématique. **8.** Spermatozoïde. (la flèche) indique les granules du vagin, identiques à ceux du cirre; (c) cirre, (e) tache oculaire; (gp) pore génital; (in) tache opaque d'inclusions granulaires; (o) ovocyte; (s) canal spermatique; (sb) bourse copulatrice; (st) statocyste; (sv) vésicule séminale; (v) région postérieure vacuolisée; (va) vagin.

maturity in isolation. Thus it is almost certain that the granules become lodged in the vagina during copulation, and perhaps they play a role in the activation of sperm.

Ancylocirrus ornatus is abundant on diatom-coated wood and plastic on floating docks at Friday Harbor Laboratories. It has also been found intertidally on a substratum consisting of sand, mud, and gravel, and in algal growths in a large outdoor aquarium supplied with running sea water. The acoel has been cultivated for over two years with a single species of *Navicula*, but bacteria have not been excluded from the cultures.

Family Haploposthiidae

Haploposthia erythrocephala sp. nov.

Figs 9-13

Type material: Holotype, USNM 185987, a specimen sectioned sagittally.

Type locality: Washington, San Juan Island, North Bay (near Friday Harbor).

Etymology. The species name, based on Greek *erythros*, red, and *kephale*, head, refers to the orange or red eyespot pigment close to the anterior end of the body.

Description

Large individuals (Fig. 9), when fully extended and moving over glass surface, up to about 1070 μm long, 180 μm wide. Greatest width usually near beginning of fourth quarter of body. Anterior end sometimes rounded, sometimes nearly truncate and with a slight median indentation; posterior end truncate.

Color, in reflected light, mostly yellowish, but eyespot pigment close to anterior end orange; in transmitted light, eyespot pigment (Figs 9, 10) more nearly red than orange, and concentrated in two lateral masses connected dorsally by bridgelike connection; flattening of specimen spreads pigment, making connection less conspicuous. Epidermis completely ciliated. Rhabdoids present in epidermis, but few, and obvious only when seen in profile. Statocyst (Figs 9, 10), located at end of first one-eighth of body, about 17 μm in diameter in large individuals; statolith nearly hemispherical, about 13 μm in diameter. Frontal gland prominent, its two lobes extending posteriorly beyond statocyst.

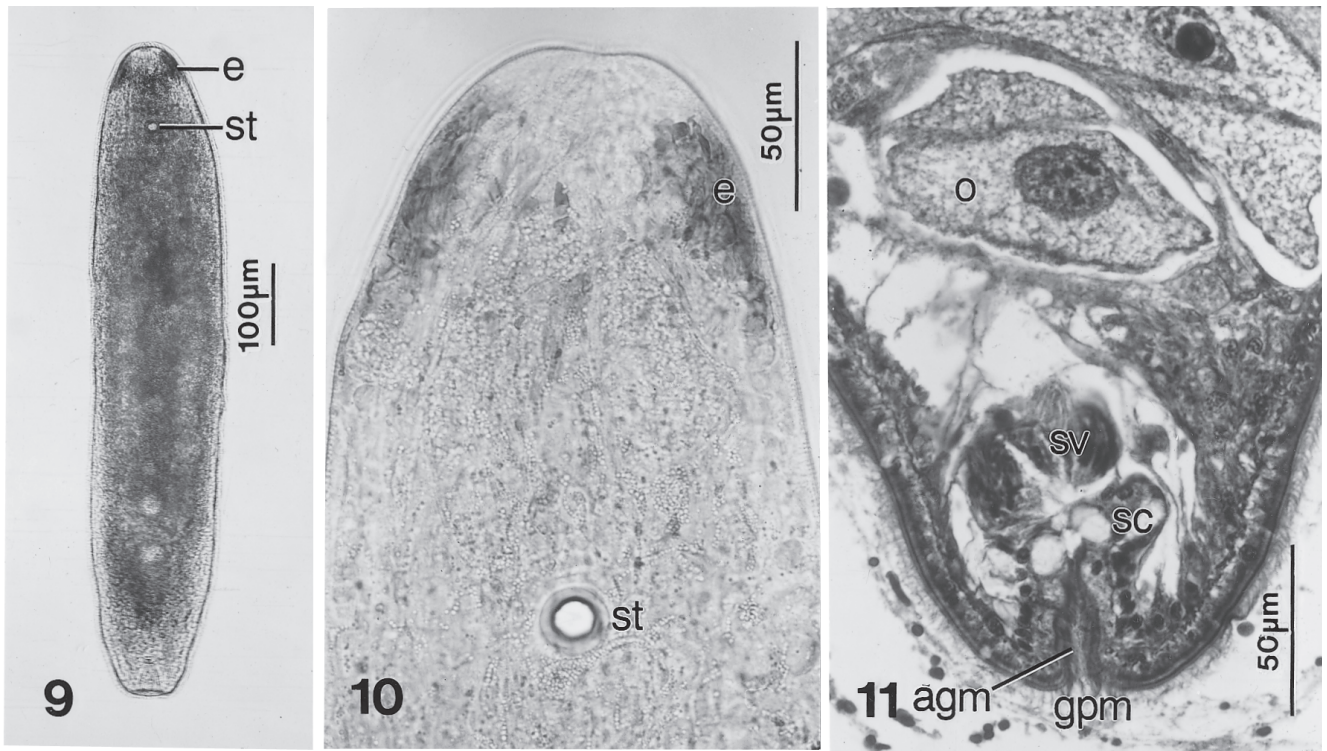
Mouth, located on ventral surface slightly anterior to middle of body, leading directly to digestive syncytium. Diet consisting mostly of small diatoms; ingested food more conspicuous in sections than in living worms.

Male genital pore (Figs 11, 12), at posterior end of body, nearly circular. Male antrum short, ciliated, narrowing anteriorly; cells presumed to be secretory present at level where antrum joins seminal vesicle. Seminal vesicle thin-walled, sperm within it inactive and sometimes concentrated mostly in anterior and dorsal portions. Sperm differentiating in two dorsolateral masses in second quarter of body. Sperm channels (Fig. 12) entering seminal vesicle anterolaterally. Sperm (Fig. 13) about 70 μm long, with prominent undulating membrane.

Oogonia and oocytes (Figs 11, 12), arranged in two ventrolateral rows; largest oocyte, up to about 115 μm in diameter, usually on or close to midline. As in other species of *Haploposthia*, no trace of seminal bursa, vagina, or female genital pore.

Remarks

Distinctions between the eight previously described species of *Haploposthia* were summarized by Mamkaev (1967). *Haploposthia viridis* (An der Lan, 1936) is closest to



Figures 9-11. *Haploposthia erythrocephala* sp. nov.; photomicrographs. **9.** Entire living specimen, dorsal view. **10.** Anterior portion of living specimen, dorsal view. **11.** Posterior portion, sagittal section. (*agm*) male genital antrum; (*e*) eyespot pigment; (*gpm*) male genital pore; (*o*) oocyte; (*sc*) secretory cells associated with seminal vesicle; (*st*) statocyst; (*sv*) seminal vesicle.

Figures 9-11. *Haploposthia erythrocephala* sp. nov.; photomicrographies. **9.** Spécimen vivant entier, vue dorsale. **10.** Partie antérieure d'un spécimen vivant, vue dorsale. **11.** Partie postérieure, coupe sagittale. (*agm*) antrum génital mâle; (*e*) tache oculaire; (*gpm*) pore génital mâle, (*o*) ovocyte; (*sc*) cellules sécrétrices associées à la vésicule séminale; (*st*) statocyste; (*sv*) vésicule séminale.

H. erythrocephala in having paired male and female gonads and a poorly developed seminal vesicle, and also in lacking a distinct penis and cuticularized spines in the male antrum. *Haploposthia viridis*, however, is rather stout-bodied; furthermore, it has a wrinkled body surface and its male antrum is proportionately longer than that of *H. erythrocephala*.

Haploposthia erythrocephala was first observed in sediment washed from thalli of *Ulva fenestrata* and other algae collected at tide levels between 0.5 and 1.5 m above mean lower low water in an inlet of North Bay, San Juan Island, Washington. The substratum at this site consists mostly of gravel and muddy sand. The inlet, joined by a saltwater stream to a small body of water known as Argyle Lagoon, is also the type locality of *Diatomovora amoena* Kozloff, 1965 and *Raphidophallus actuosus* Kozloff, 1965. In my experience, however, *H. erythrocephala* is much less abundant than either of these previously described acuels, and it is uncommon at tide levels below mean lower low water (0.0). Nevertheless, a few specimens were found in sediment washed from algae and the leaves of *Zostera*

marina, collected in Argyle Lagoon, where the tidal fluctuation is so slight that the algae and *Zostera* harboring *H. erythrocephala* are continuously submerged.

Family Mecynostomidae
Mecynostomum torquens sp. nov.
Figs 14-18

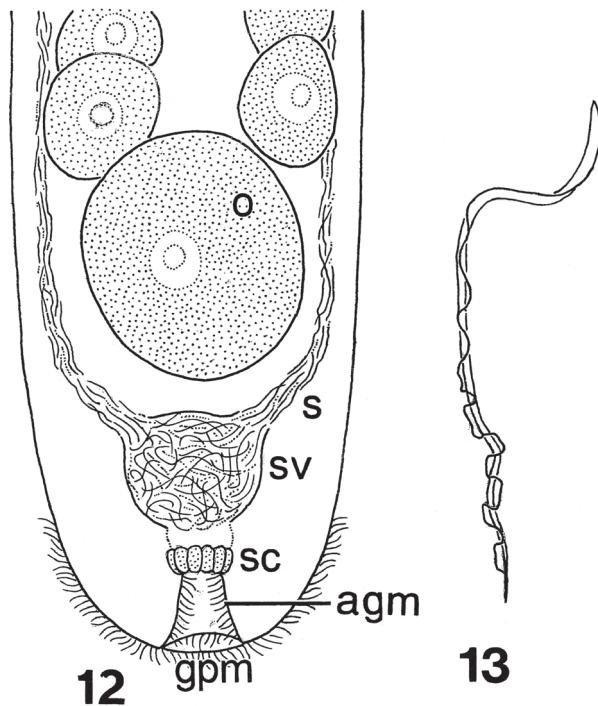
Type material: Holotype, USNM 185988, a specimen sectioned sagittally.

Type locality: Washington, San Juan Island, Friday Harbor, Friday Harbor Laboratories.

Etymology. The name, based on Latin *torquens*, twisting, alludes to the movements characteristic of this species.

Description

Large specimens (Fig. 14) about 740 µm long, 255 µm wide. Greatest width usually slightly behind middle of body. Anterior end broader than posterior end, but both ends rather bluntly rounded. Color of body as a whole faintly yellowish, but digestive syncytium, in middle third of body, decidedly brownish or yellowish in well fed individuals.



Figures 12-13. *Haploposthia erythrocephala* sp. nov.; drawings based on sketches of living specimens. **12.** Posterior portion, dorsal view. **13.** Sperm. (*agm*) male genital antrum; (*gpm*) male genital pore; (*o*) oocyte; (*s*) sperm channel; (*sc*) secretory cells associated with seminal vesicle; (*sv*) seminal vesicle.

Figures 12-13. *Haploposthia erythrocephala* sp. nov.; dessins d'après des spécimens vivants. **12.** Partie postérieure, vue dorsale. **13.** Spermatozoïde. (*agm*) antrum génital mâle; (*gpm*) pore génital mâle; (*o*) ovocyte; (*s*) canal spermatique; (*sc*) cellules sécrétrices associées à la vésicule séminale; (*sv*) vésicule séminale.

Most larger lipid droplets, especially those near anterior end, yellow. Statocyst diameter up to 15 μm ; statolith diameter up to 12 μm . Frontal gland prominent, its two lobes extending posteriorly beyond statocyst. Rhabdoids absent.

Male genital pore (Figs 15-17) on ventral surface close to posterior end. Ejaculatory duct leading to seminal vesicle rather poorly defined, bordered by hyaline material enclosed by thin sheath of muscle fibers, this surrounded by crowded small cells. Seminal vesicle (Figs 14-17), filled with inactive sperm, nearly spherical, its muscularized wall continuous with sheath enclosing hyaline material of ejaculatory duct. Penis apparently absent. Sperm originating in two dorsolateral germinal centers beginning slightly posterior to level of statocyst. Sperm channels (Fig. 17) entering seminal vesicle on its anterior side. Mature sperm (Fig. 18) about 40 μm long.

Oogonia and oocytes (Figs 14, 15, 17) in two ventrolateral chains, beginning at about midlevel of body; largest oocytes, up to about 100 μm in diameter, located anterior to male copulatory complex. Female genital pore and seminal bursa absent.

Remarks

This species was found in sediment washed from *Ulva fenestrata* and *Enteromorpha intestinalis* collected in shallow rock pools at tide levels of about 1.5 m above mean lower low water. In my experience, it was most common during the months of April and May, but I have found it in small numbers at other times of the year. During its forward locomotion, *M. torquens* commonly twists its body slightly, or lifts one side, then the other. Similar movements have been reported for the other three species currently assigned to the genus *Mecynostomum*.

The type species of *Mecynostomum* is *M. auritum* (Schultze, 1851), originally described as *Macrostomum auritum*. *Mecynostomum haplovarium* Dörjes, 1968 and *M. predatum* Faubel, 1976 are the only other acoels currently assigned to the genus, which differs from other genera of Mecynostomidae in lacking a seminal bursa. In having paired ovaries, *M. torquens* is similar to *M. auritum* and *M. predatum*. In *M. predatum*, however, the male genital pore is much farther forward than in the other two species. *Mecynostomum torquens* is almost certainly very closely related to *M. auritum*, whose morphology was carefully studied by Dörjes (1968). On the basis of his description and drawings, I conclude that *M. torquens* differs from *M. auritum* in the following respects: the seminal vesicle of *M. torquens* does not reach so far dorsally as that of *M. auritum*, is thin-walled, and is not surrounded by cells of the same sort as those below it; the canal leading from the genital pore to the seminal vesicle is shorter than that of *M. auritum*, and lacks the conspicuous muscular sphincter of this species; the size of *M. torquens* (length up to about 740 μm) is smaller than that of *M. auritum* (length up to 1500 μm). Furthermore, I have not found, in *M. torquens*, any subepidermal slime glands of the type observed by Dörjes in *M. auritum*.

Eumecynostomum luridum sp. nov.

Figs 19-23

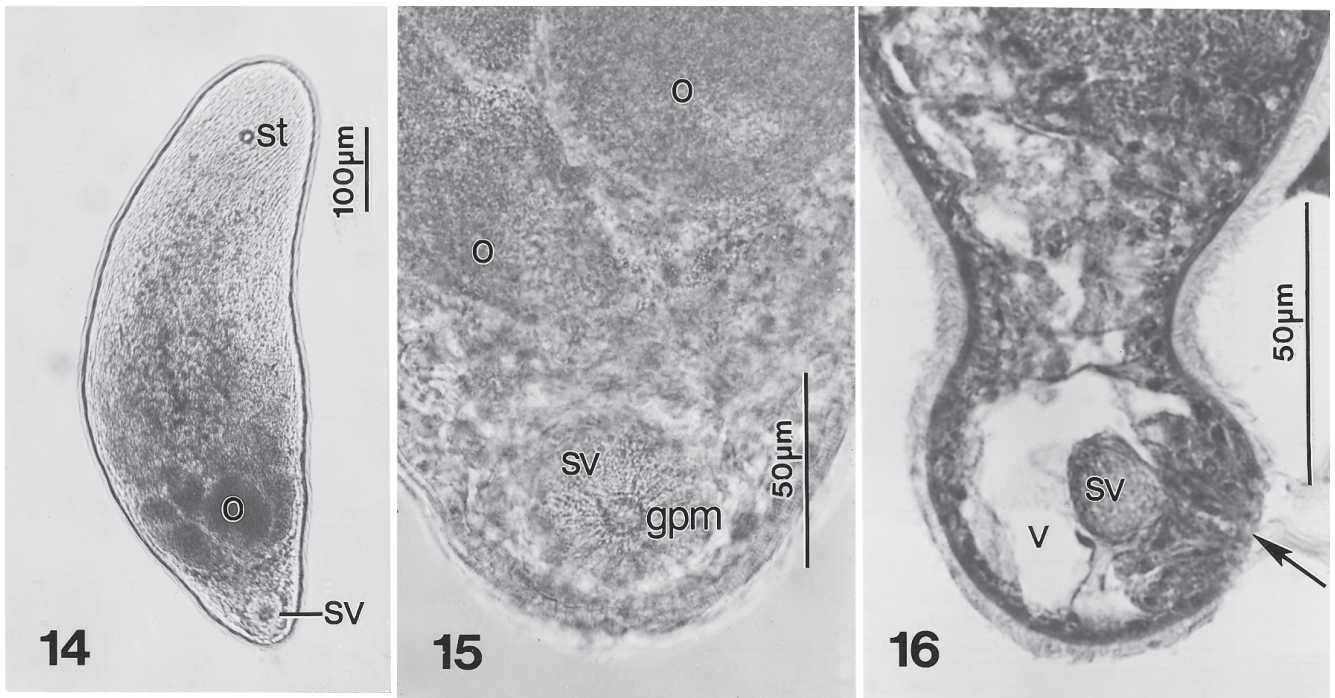
Type material: Holotype, USNM 185989, a specimen sectioned sagittally.

Type locality: Washington, San Juan Island, Argyle Lagoon (near Friday Harbor).

Etymology. The species name is based on Latin *luridus*, meaning pale yellow.

Description

Large specimens (Fig. 19), when gliding actively on glass



Figures 14-16. *Mecnostomum torquens* sp. nov.; photomicrographs. **14.** Entire living specimen, slightly flattened, dorsal view. **15.** Posterior portion of living specimen, considerably flattened, ventral view. **16.** Posterior portion, sagittal section; (*arrow*) indicates the location of the male genital pore; (*gpm*) male genital pore; (*o*) oocyte; (*st*) statocyst; (*sv*) seminal vesicle; (*v*) posterior vacuolated region.

Figures 14-16. *Mecnostomum torquens* sp. nov.; photomicrographies. **14.** Spécimen vivant entier, légèrement comprimé, vue dorsale. **15.** Partie postérieure d'un spécimen vivant, très comprimé, vue ventrale. **16.** Partie postérieure, coupe sagittale; (*la flèche*) indique l'emplacement du pore génital mâle; (*gpm*) pore génital mâle; (*o*) ovocyte; (*st*) statocyste; (*sv*) vésicule séminale; (*v*) région postérieure vacuolisée.

surface, about 590 µm long, 200 µm wide in middle third of body. Anterior end rounded, posterior third tapering to a blunt or pointed tip.

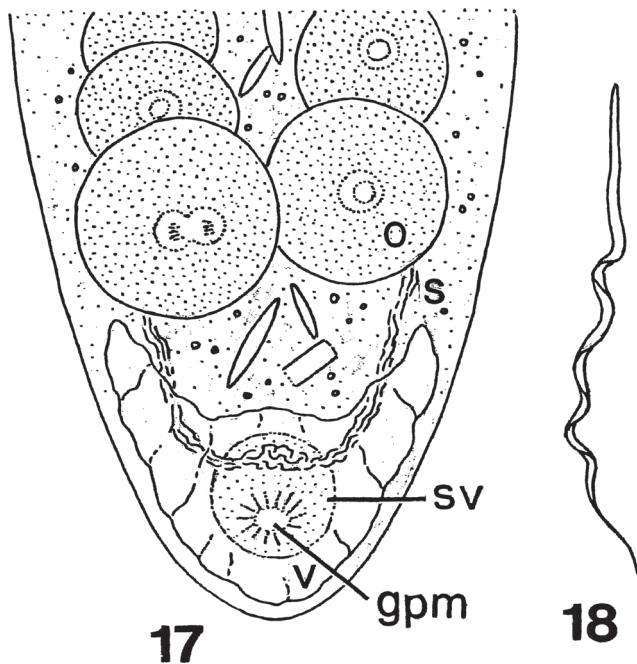
Color, in reflected light, whitish, but in transmitted light usually decidedly yellowish; yellow color most pronounced in the digestive syncytium, which has approximately triangular outline and whose gradually narrowed anterior portion reaches nearly as far forward as statocyst. Lipid inclusions, mostly light yellow or orange, especially abundant in anterior half of body. Statocyst, located near end of first one-eighth of body, about 16 µm in diameter; statolith about 11 µm in diameter. Mass of frontal glands not conspicuous in life, but both lobes reaching well behind statocyst. Vacuolated area, similar to that of most acoels, at posterior end of body. Cilia about 9 µm long. Neither rhabdoids nor stiff sensory cilia noted. Epidermal cells with crowded small granules, these made conspicuous by supravital staining with neutral red.

Mouth, located on ventral surface near middle of body, leading directly to digestive syncytium. Diet consisting primarily of diatoms, but digestive syncytium sometimes containing fragments of harpacticoid copepods. No

evidence, however, for ingestion of entire copepods.

Seminal vesicle (Figs 19-22), located just anterior to vacuolated region at posterior end of body, nearly spherical or slightly ellipsoidal structure about 35 µm in diameter; vesicular portion small. Numerous refractile, needlelike elements, up to about 18 µm long and evident in sections of fixed specimens as well as in living worms, converging on short canal leading to small male genital pore. Penis apparently absent. Right and left sperm-producing areas located dorsolaterally, reaching nearly as far forward as level of statocyst. Right and left sperm channels (Fig. 22) uniting just before entering seminal vesicle on its anterodorsal side. In intact worms, sperm in channels and in seminal vesicle not active. Sperm (Fig. 23) about 135 µm long, scarcely 1 µm wide where thickest, near anterior end.

Female genital pore (Fig. 22), on ventral surface anterior to male pore, connected by short duct, perhaps a rudimentary vagina, to inconspicuous seminal bursa, the complex as a whole likely to be overlooked in specimens that have not been inseminated. As in other species of *Eumecnostomum*, seminal bursa lacking sclerotized nozzle. Sperm in seminal bursa active. Oogonia and oocytes



Figures 17-18. *Mecynostomum torquens* sp. nov.; drawings based on sketches of living specimens. **17.** Posterior portion, dorsal view. **18.** Sperm. (*gpm*) male genital pore; (*o*) oocyte; (*s*) sperm channel; (*sv*) seminal vesicle; (*v*) posterior vacuolated region..

Figures 17-18. *Mecynostomum torquens* sp. nov.; dessins d'après des spécimens vivants. **17.** Partie postérieure, vue dorsale. **18.** Spermatozoïde. (*gpm*) pore génital mâle ; (*o*) ovocyte ; (*s*) canal spermatique ; (*sv*) vésicule séminale ; (*v*) région postérieure vacuolisée.

(Figs 19-22) in two ventrolateral rows; smallest recognizable oogonia at level of beginning of second one-third of body. Largest oocytes, about 90 μm in diameter, on or near midline anterior to seminal bursa.

Remarks

During the late spring, summer, and early autumn, this species is common on algae and leaves of *Zostera marina* in Argyle Lagoon, near Friday Harbor. The lagoon, as explained in connection with the description of *Haploposthia erythrocephala*, is joined by a saltwater stream to an inlet of North Bay. The acoele is scarce in the winter months, by which time the leaves of most plants of *Zostera* have decayed. I have found it throughout the year, however. *Otocelis luteola*, *Raphidophallus actuosus*, and *Haploposthia erythrocephala* are associated with it, but the last-named species is comparatively rare.

The genus *Eumecynostomum* was proposed by Faubel & Regier (1983) to include one new species, nine of the 13 that Dörjes (1968) had assigned to *Pseudmecynostomum*, and three others described by Faubel (1974, 1977) and by Ehlers & Dörjes (1979). These acoeles are similar in that they lack a nozzle on the seminal bursa; they also lack sclerotic

needlelike structures that form the styliform penis characteristic of *Pseudmecynostomum pelophilum* Dörjes, 1968, *P. bruneum* Dörjes, 1968, *P. bruneophilum* Faubel, 1974, and *P. pellucidum* Ehlers & Dörjes, 1979. Faubel & Regier established another genus, *Neomecynostomum*, to accommodate *Pseudmecynostomum granulum* Dörjes, 1968, which has a glandular prostatic vesicle associated with the male copulatory organ.

Among the distinctions separating the 14 previously described species of *Eumecynostomum* are the following: the extent to which the frontal glands are developed; the arrangement of the ovaries (paired, not paired, or indistinctly paired); the presence of separate male and female genital pores or of a common genital pore; the relative positions of the male and female organs with respect to one another and to the body as a whole; and details of the structure of the male and female organs.

In having separate male and female genital pores and distinctly paired ovaries, *E. luridum* fits into a cluster of species that consists of *E. altitudi* Faubel & Regier, 1983, *E. papillosum* (Faubel, 1974), *E. boreale* (Faubel, 1977), *E. bathycolum* (Westblad, 1948), *E. evelinae* (Marcus, 1948), and *E. tardum* (Ehlers & Dörjes, 1979). In *E. altitudi*, *E. papillosum*, and *E. boreale*, however, the male and female pores are comparatively far apart, and there are various other characteristics that distinguish them from *E. luridum*; in *E. bathycolum*, which has a rudimentary vagina, the male pore is rather far from the posterior end. The two species that seem to be nearest to *E. luridum* are *E. evelinae* and *E. tardum*. In the former, the seminal vesicle and seminal bursa are close together, and part of the seminal bursa consists of a sac in which numerous sperm are packed in a tight bundle. In the latter, the ovaries do not reach so far forward as the level at which the mouth is located; the seminal vesicle, furthermore, is disposed vertically, rather than tilted forward, and it seems not to consist of so many cells as that of *E. luridum*.

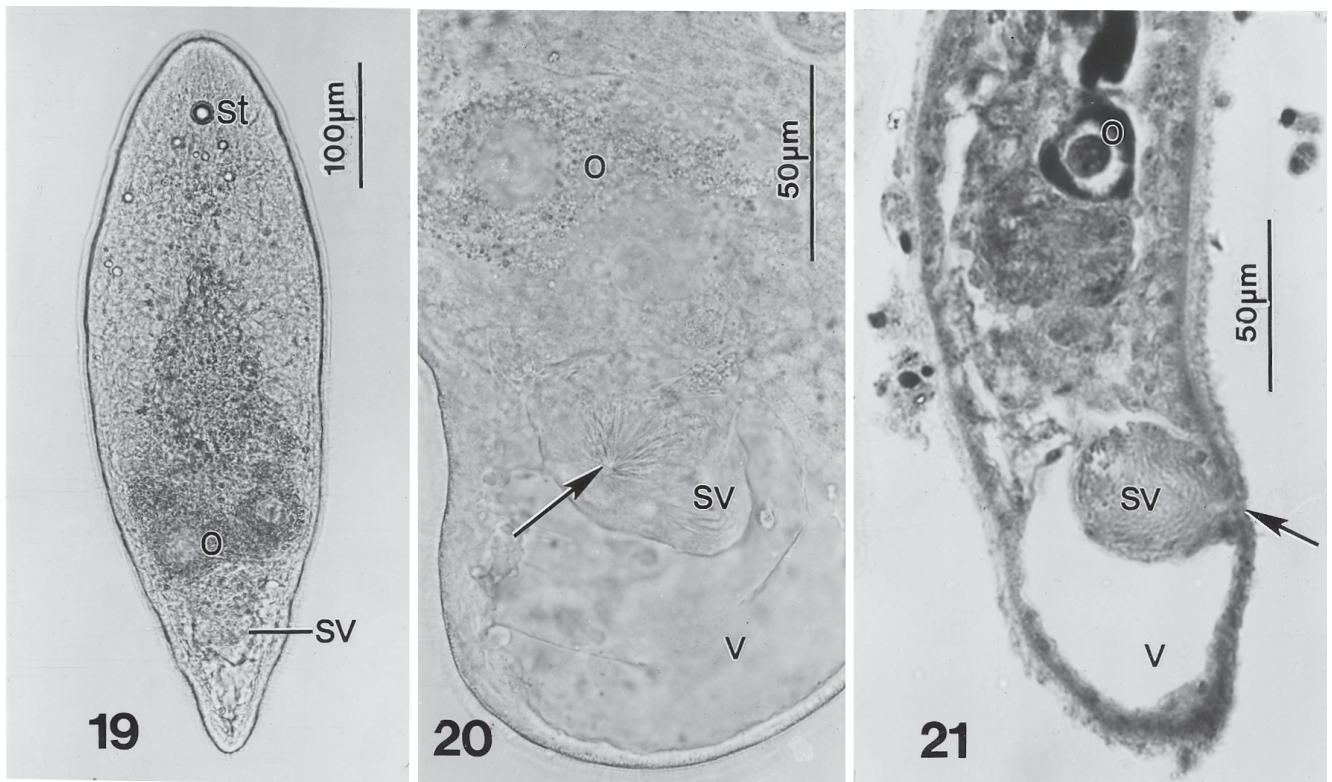
I have omitted consideration of two species, *E. sanguineum* and *E. pallidum*, which are symbiotic in sea cucumbers. They were described by Beklemishev (1915) and assigned by him to *Aphanostoma*. Dörjes (1968) placed them in *Pseudmecynostomum*, and they would now seem to fit the criteria of Faubel & Regier for membership in *Eumecynostomum*, but I suspect that detailed study of these worms will reveal some distinctive morphological features that will set them apart from known free-living mecynostomids.

Family Otocelididae

Notocelis rubidocula sp. nov.

Figs 24-31

Type material: Holotype, USNM 185990, a specimen sectioned sagittally.



Figures 19-21. *Eumecynostomum luridum* sp. nov.; photomicrographs. **19.** Entire living specimen, slightly flattened, dorsal view. **20.** Posterior portion, considerably flattened, dorsal view. **21.** Sagittal section of posterior portion. (*arrow*) indicates the location of the male genital pore; (*o*) oocyte; (*st*) statocyst; (*sv*) seminal vesicle; (*v*) posterior vacuolated region.

Figures 19-21. *Eumecynostomum luridum* sp. nov.; photomicrographies. **19.** Spécimen vivant entier, légèrement comprimé, vue dorsale. **20.** Partie postérieure, très comprimée. **21.** Coupe sagittale de la partie postérieure. (*la flèche*) indique l'emplacement du pore génital mâle ; (*o*) ovocyte ; (*st*) statocyste ; (*sv*) vésicule séminale ; (*v*) région postérieure vacuolisée.

Type locality: Washington, San Juan Island, Friday Harbor, Friday Harbor Laboratories.

Etymology. The species name is based on Latin *rubidus*, red, and *oculus*, eye, and refers to the two conspicuous masses of red eyespot pigment in the head region.

Description

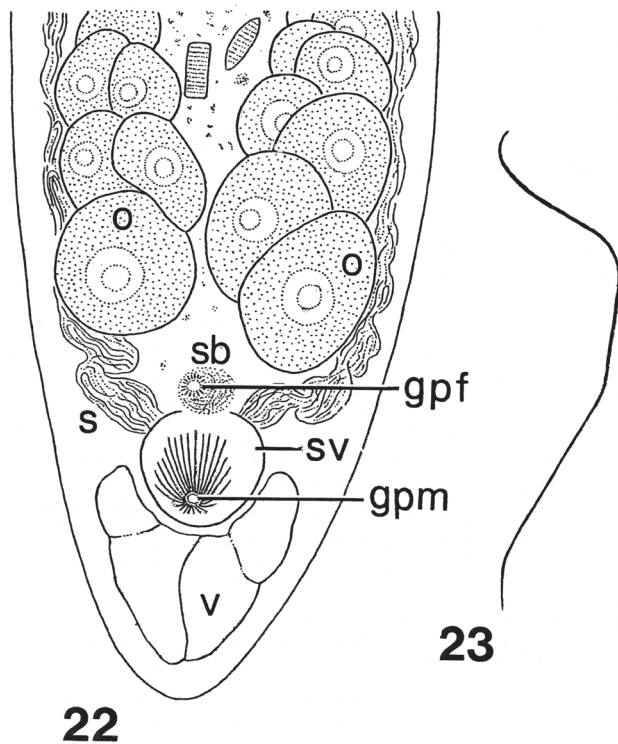
Large individuals (Figs 24, 28), when fully extended and moving over glass surface, up to about 485 µm long, 160 µm wide near middle, and slightly flattened. Anterior end almost evenly rounded; posterior half tapering to nearly pointed tip. When swimming, body nearly cylindrical. Color of body as a whole whitish, except for ingested diatoms, yellow or orange lipid droplets, and two conspicuous masses of red eyespot pigment near anterior end. Epidermis with numerous rhabdoids, mostly in conspicuous rows on ventral and dorsal surfaces. Statocyst (Figs 24, 25, 28), located near end of first one-eighth of body, about 14 µm in diameter; statolith hemispherical, about 11 µm in diameter. Frontal organ well developed, its right and left lobes reaching posteriorly beyond statocyst.

Mouth on ventral surface slightly anterior to middle of

body. Digestive syncytium extending nearly as far forward as statocyst, and posteriorly as far as conspicuously vacuolated region at hind end of body. Food apparently consisting entirely of diatoms.

Right and left sperm-producing areas (Fig. 28) beginning slightly behind level of statocyst, and contiguous along midline anteriorly. Mature sperm (Fig. 31) approximately 65-70 µm long, 1 µm thick in middle third. Right and left sperm channels, just before joining seminal vesicle, dilated, forming false seminal vesicles (Figs 28-30). Seminal vesicle proper (Figs 28-30) with thick muscularized wall and narrow lumen occupied by sperm, their heads oriented toward male pore on anterior side of common genital pore (Fig. 30). Portion of seminal vesicle nearest pore consisting of a rosettelike cluster of hyaline cells (Figs 28-30) filled with small colorless granules; these cells presumed to be secretory, but not associated with a copulatory organ distinct from seminal vesicle.

Vagina (Fig. 30) extending anterodorsally from genital pore to seminal bursa, and provided, near middle, with sphincter of circular muscle fibers. Seminal bursa (Figs 26,



Figures 22-23. *Eumecynostomum luridum* sp. nov.; drawings based on sketches of living specimens. **22.** Posterior portion, ventral view. **23.** Sperm. (*gpf*) female genital pore; (*gpm*) male genital pore; (*o*) oocyte; (*s*) sperm channel; (*sb*) seminal bursa; (*sv*) seminal vesicle; (*v*) posterior vacuolated region.

Figures 22-23. *Eumecynostomum luridum* sp. nov; dessins d'après des spécimens vivants. **22.** Partie postérieure, vue ventrale. **23.** Spermatozoïde. (*gpf*) pore génital femelle; (*gpm*) pore génital mâle; (*o*) ovocyte; (*s*) canal spermatique; (*sb*) bourse copulatrice; (*sv*) vésicule séminale; (*v*) région postérieure vacuolisée.

28-30), containing sluggishly active sperm, with sclerotic, annulated nozzle directed anteriorly. Nozzle up to 12 μm long, 5 μm wide, and located within mass of cells forming cap on anterior side of bursa. Oogonia and young oocytes (Figs 24, 28-30) in two ventrolateral chains, but large oocytes from both sides crowded together anterior to seminal bursa.

Remarks

From May to October, *P. rubidocula* is often encountered in sediment washed from *Ulva fenestrata* collected at low tide levels (0.5 m below to 0.5 m above mean lower low water) along the shore directly below the Fernald Laboratory at Friday Harbor Laboratories. The worm has also been found in sediment washed from various algae growing in rock pools nearby, at tide levels of from 0.5 to 2.0 m above mean lower low water. Attempts to find the worm during

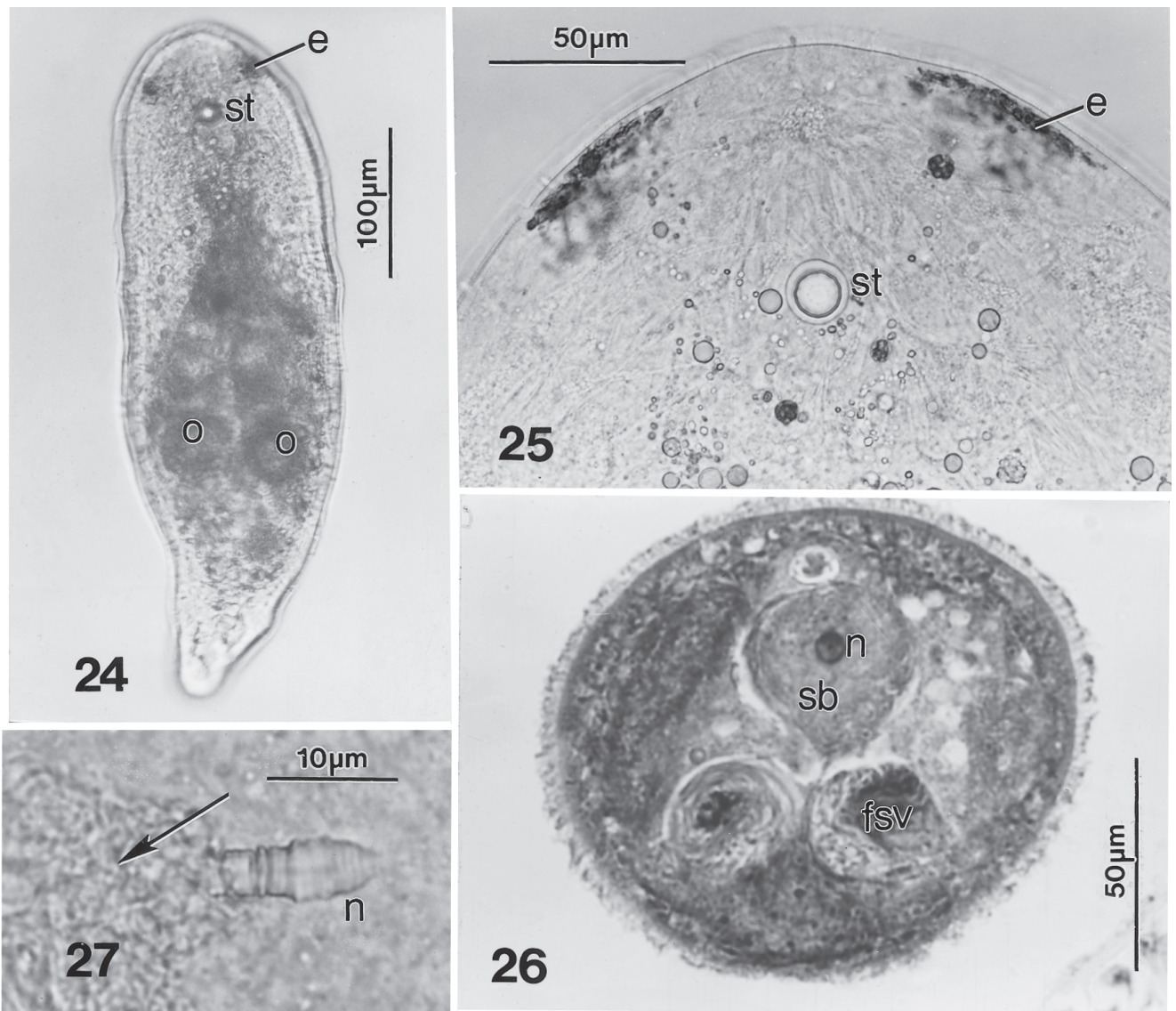
December and January, when algal growths are not well developed, have not been successful.

The spatial relationship of the vagina-seminal bursa-nozzle complex to the seminal vesicle of *N. rubidocula*, as well as the presence of eyepot pigment, suggest that this species is close to *N. gullmarensis* (Westblad, 1946). The latter was originally described as an *Otocelis*, but because of its presumably protrusible penis (instead of an eversible cirrus, such as is found in some other genera of Otocelididae), strongly muscularized seminal vesicle, and "fused ovary", Dörjes (1968) made it the type species of his genus *Notocelis*. With respect to the ovary of *N. gullmarensis*, it should be said that the young oocytes are clearly in two lateral chains, but as they enlarge, they gravitate toward the midline, so the distinction between the oocytes originating on the right and left sides is blurred. The same situation exists in *P. rubidocula*.

Another species transferred by Dörjes to *Notocelis* is *Convoluta subsalina* Ax, 1959. It has a distinctly single ovary, as well as a penis and a muscular seminal vesicle, and although Ax did not identify a vagina, he described and illustrated a somewhat tubular assemblage of gland cells above and behind the seminal vesicle. Dörjes, after studying Ax' sections, concluded that this structure is a vagina. In *N. subsalina*, however, the seminal bursa is decidedly anterior to the seminal vesicle, and its nozzle is directed anteroventrally. *Notocelis rubidocula* is probably closer to *N. gullmarensis* than it is to *N. subsalina*, but it differs from both species in two important respects: its seminal vesicle has only a small, narrow lumen, and there is not a copulatory organ distinct from the seminal vesicle. For the present, however, it seems best to leave it in *Notocelis*.

Raphidophallus Kozloff, 1965 removed from synonymy under *Conaperta* Antonius, 1968

Antonius (1968) segregated the species admitted to *Convoluta* by Dörjes (1968) into three genera: *Convoluta* Ørsted, 1843, *Conaperta* Antonius, 1968, and *Adenopea* Antonius, 1968. *Convoluta flavibacillum* Jensen, 1878 (mistakenly attributed to Graff, 1882) was designated as the type species of *Conaperta*; all but one of the other previously described species that Antonius assigned to the genus had also been placed originally in *Convoluta*. The exception is *Raphidophallus actuosus* Kozloff, 1965, the type species of *Raphidophallus*. According to the International Code of Zoological Nomenclature (ITZN, 1999), *Raphidophallus* would have priority over *Conaperta*. Because the lumen of the male copulatory organ of *R. actuosus* is characterized by the presence of slender sclerotized rods, this acodel is very unlike the species of *Conaperta* described by Antonius, and also unlike *Convoluta flavibacillum*. *Raphidophallus* is therefore



Figures 24-27. *Notocelis rubidocula* sp. nov.; photomicrographs. **24.** Entire living specimen, dorsal view. **25.** Anterior portion of living specimen, much flattened, dorsal view. **26.** Transverse section through false seminal vesicles and nozzle of seminal bursa. **27.** Nozzle of seminal bursa of living specimen; (arrow) indicates sperm in the seminal bursa. (e) eyespot pigment; (fsv) false seminal vesicle; (n) nozzle of seminal bursa; (o) oocyte; (sb) seminal bursa; (st) statocyst.

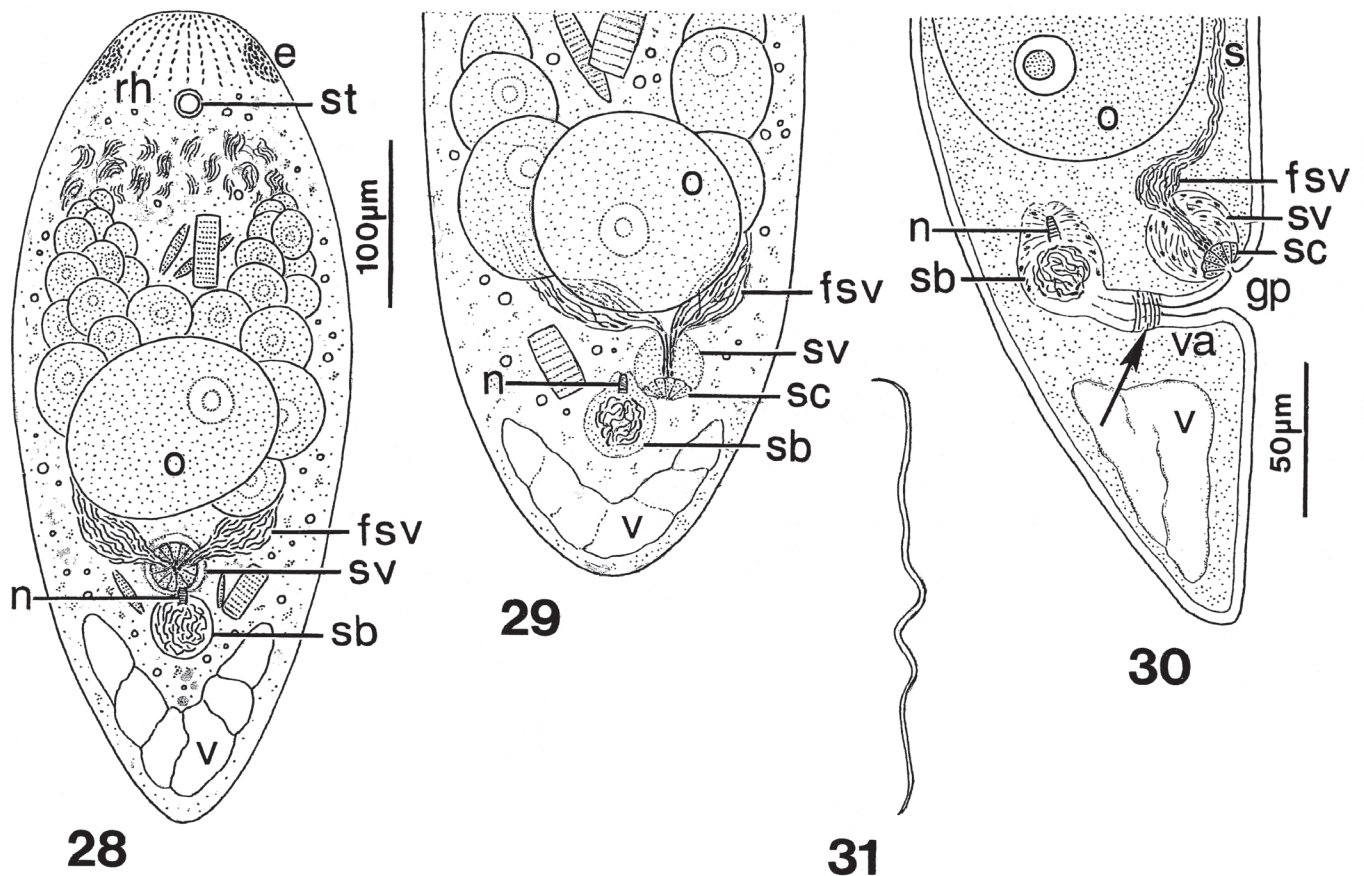
Figures 24-27. *Notocelis rubidocula* sp. nov. ; photomicrographies. **24.** Spécimen vivant, vue dorsale. **25.** Partie postérieure d'un spécimen vivant, considérablement comprimé, vue dorsale. **26.** Coupe transversale passant par les fausses vésicules séminales et la canule de la bourse copulatrice. **27.** Canule de la bourse copulatrice d'un spécimen vivant; (la flèche) indique les spermatozoïdes dans la bourse copulatrice. (e) tache oculaire ; (fsv) fausse vésicule séminale ; (n) canule de la bourse copulatrice ; (o) ovocyte ; (sb) bourse copulatrice ; (st) statocyste.

recognized here as a still monotypic genus. This seems more logical than summarily transferring to it all other species placed in *Conaperta* by Antonius.

Replacement of *Parotocelis* Ehlers & Dörjes, 1979 with *Posticopora* gen. nov.

A difficulty that needs to be resolved with respect to the Otocelididae concerns the genus *Parotocelis* Ehlers &

Dörjes, 1979, whose type species is *P. luteopunctata* Ehlers & Dörjes, 1979, found at Santa Cruz, in the Galápagos Islands. *Parotocelis* is, however, preoccupied, having been used for *P. luteola* Kozloff, 1965. Dörjes (1968), noting that the species I described does not differ enough from *Otocelis rubropunctata*, *O. westbladi*, and *O. sachalinensis* to require segregation in another genus, placed it in *Otocelis*. I agree with his judgment, but according to the rules of zoological



Figures 28-31. *Notocelis rubidocula* sp. nov. **28.** Entire living specimen, slightly flattened, dorsal view. **29.** Posterior portion of living specimen, slightly flattened, dorsal view. **30.** Posterior portion, drawing based on a series of successive sagittal sections. Only the right false seminal vesicle is shown. **31.** Sperm. (arrow) indicates the sphincter of muscle fibers encircling the vagina; (e) eyespot pigment; (fsv) false seminal vesicle; (gp) genital pore; (n) nozzle of seminal bursa; (o) oocyte; (rh) rhabdoids; (s) sperm channel; (sb) seminal bursa; (sc) secretory cells associated with seminal vesicle; (st) statocyst; (sv) seminal vesicle; (v) posterior vacuolated region; (va) vagina.

Figures 28-31. *Notocelis rubidocula* sp. nov. **28.** Spécimen vivant, légèrement comprimé, vue dorsale. **29.** Partie postérieure d'un spécimen vivant, légèrement comprimé, vue dorsale. **30.** Reconstruction de la partie postérieure d'après des dessins à la chambre claire de coupes sagittales successives. Seule la fausse vésicule séminale droite est montrée. **31.** Spermatozoïde. (la flèche) indique le sphincter des fibres musculaires encerclant le vagin; (e) tache oculaire; (fsv) fausse vésicule séminale; (gp) pore génital; (n) canule de la bourse copulatrice; (o) ovocyte; (rh) rhabdoïdes; (s) canal spermatique, (sb) bourse copulatrice, (sc) cellules sécrétrices associées à la vésicule séminale; (st) statocyste; (sv) vésicule séminale; (v) région postérieure vacuolisée; (va) vagin.

nomenclature, *Parotocelis* cannot be used again. This point was not dealt with by Bush (1981) in her valuable key to families and genera of acoels. *Parotocelis* Ehlers & Dörjes, 1979, as characterized in their diagnosis of the genus, is here replaced by *Posticopora* gen. n. (Latin *posticus*, posterior, and *-pora*, a combining form derived from Latin *porus*, pore). The name of the type species will therefore be *Posticopora luteopunctata* (Ehlers & Dörjes), comb. nov.

A proposal to raise *Notocelis gullmarensis* subsp. *maculata* Karling, Mack-Fira, & Dörjes, 1972 to the rank of species

Notocelis gullmarensis subsp. *maculata* Karling, Mack-

Fira, & Dörjes, 1972, found in Hawaii, differs rather significantly from typical *N. gullmarensis* with respect to proportions and spatial relationships of some components of the reproductive system. Furthermore, it has a prominent spot of brown pigment in the region of the statocyst, and its eyespot pigment is yellow, rather than orange. In consideration of these distinctions, I propose that subsp. *maculata* be accorded the rank of species, *Notocelis maculata* Karling et al., 1982.

Acknowledgements

I am indebted to Susan Shotwell for helping me collect and sort material, study living and sectioned specimens, and

process photomicrographs. Danny Grae prepared several of the enlargements illustrating this paper.

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