

Three New Species of Minoninae (Turbellaria, Proseriata, Monocelididae) from the North Sea, with Remarks on the Taxonomy of the Subfamily

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Three new species of Minoninae are described and a new genus is proposed for one of them: *Minona degadti* sp.n., *Duplominona septentrionalis* sp.n. and *Duploperaclistus circocirrus* gen. et sp.n. All three species occur in sublittoral sandy habitats in the Southern Bight of the North Sea, but *D. circocirrus* has also been found at a littoral station. The taxonomy within the subfamily Minoninae is discussed. Seven genera are considered as valid, and they are briefly diagnosed. "*Peraclistus itaipus*" sensu Westblad (1952) (= *Duplominona westbladi* Karling, 1966) is included in the new genus as *Duploperaclistus westbladi* (Karling, 1966) comb.n.

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Introduction

Turbellaria from sublittoral habitats are mostly poorly known. Studies on sublittoral communities of the southern part of the North Sea are being carried out at the Zoological Institute of the University of Ghent (Belgium) and at the Netherlands Institute for Sea Research at Texel. The species described in this paper were collected from samples of sandy bottoms during sampling campaigns of these institutes. A number of species from sublittoral stations in the southern part of the North Sea and adjacent estuaries have been dealt with in prior contributions (Martens & Schockaert 1981; Van Damme *et al.* 1980).

There exist conflicting ideas about the delimitation of the genera and their relationship within the subfamily Minoninae (see Karling 1966, 1978 *versus* Ball & Hay 1977; Fleming & Burt 1978a). This matter is discussed at the end of the paper and a practical and pragmatic solution for the time being is proposed.

Materials and methods

For sublittoral sampling a Van Veen grab and a Reinecker box-corer were used. The stations are indicated by the coordinates under "Localities" for each species. The sediments were analysed on subsamples (Heip *et al.* 1979) and classified according to the Wentworth scale (Buchanan & Kain 1971). Turbellaria were extracted from the sand using the MgCl₂ method (Boaden 1963; Sterrer 1968) or the Uhlig icewater method (Uhlig 1964, 1966).

Whole mounts were prepared with lactophenol from the individuals studied alive. Other representatives of each species were fixed in Bouin's fluid and serially sectioned. Sections were stained with Heidenhain's iron hematoxylin, using eosine as counterstain.

Figures without a scale are freehand.

Type material is deposited in the zoological collection of Department SBM, Limburgs Universitair Centrum, Diepenbeek, Belgium.

Descriptions

Minona degadti sp.n. (Figs. 1–4)

Localities. North Sea: 51°12'32"N, 2°39'48"E, fine sand at 15 m depth, 28 Sept. 1972 (type locality); 51°15'25"N, 2°53'24"E, silt with clay at 6 m depth, 4 April 1972.

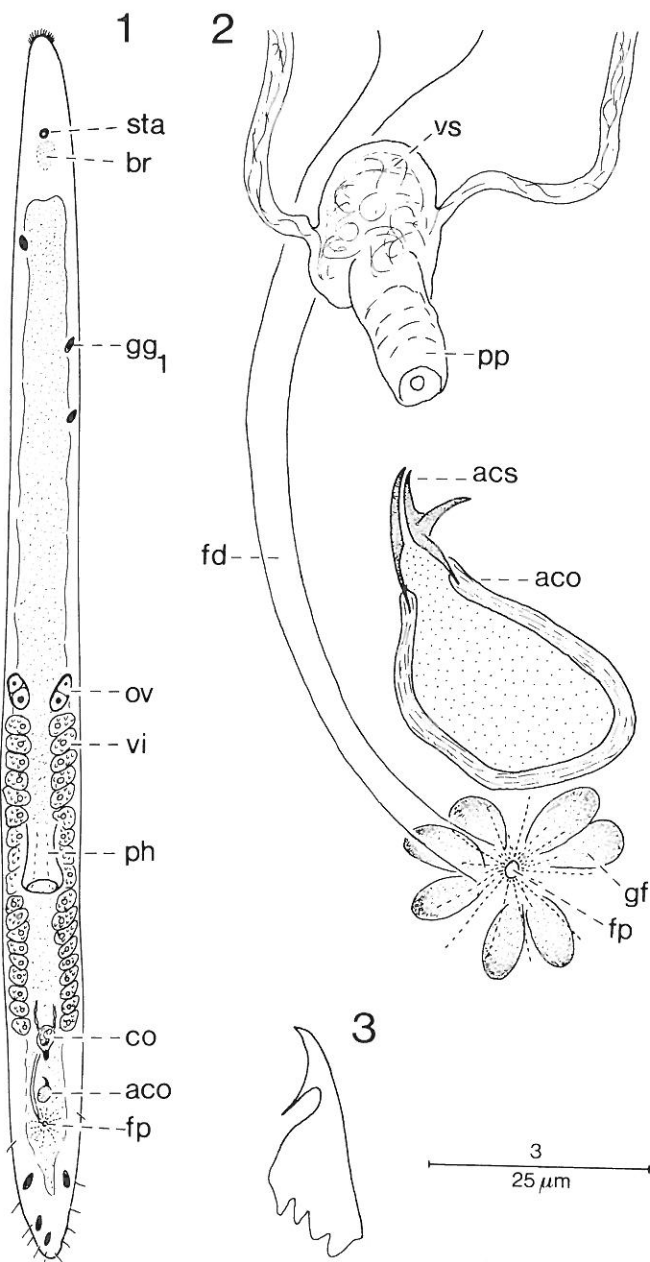
Material. Drawings made by Daniël Degadt, who studied living specimens and conserved them as whole mounts. One specimen sectioned; anterior part damaged (holotype).

Derivation of the species name. Species name in acknowledgement of Daniël Degadt, who collected the material and presented a preliminary description of this species (Degadt 1973, unpublished).

Description

The living animals are white, about 2.5 mm long, 0.2 mm broad and without eyes. The anterior tip is provided with sensory bristles. Sensory bristles also occur at the caudal end. The epidermis with depressed nuclei has a syncytial appearance and is about 1.5 μ m thick with cilia about 2 μ m long. There are a few irregularly distributed large glands (with adhesive papillae?—gg₁ in Fig. 1).

The pharynx is situated well behind the middle of the body. In a whole mount it is 150 μ m long and 75 μ m broad. According to Degadt's drawings (Fig. 1), the ovaries are situated at some distance in front of the pharynx and no vitellary follicles occur anteriorly to them. Unfortunately this cannot be confirmed in the whole mounts nor in the sectioned specimen. Posteriorly, the vitellaries end at the level of the copulatory organ, which in the living animal appears as a single sperm-containing vesicle with an elongated straight and blunt penis (Fig. 2). The number of testes is unknown.



Figs. 1-3. *Minona degadti*.—1. General organization of living animal (dorsal view).—2. Genital organs in living animal.—3. Stylet of the accessory organ, from whole mount.

In sectioned material the copulatory organ is clearly of the simplex type (Fig. 4), surrounded by strong inner circular and outer longitudinal muscles. The epithelium lining the seminal vesicle is thick and glandular at the penis side and contains an eosinophilic secretion.

The accessory organ is found at some distance behind the copulatory bulb. The bulb of the accessory organ is filled with an eosinophilous secretion and surrounded by two muscle layers, which form spirals at right angles to each other, the inner layer being the thicker one. The 26 µm long stylet (in the whole mount) is slightly curved and provided with a lateral tooth (Fig. 3). The pore of the accessory organ is located about mid-way between the male pore and the female pore.

In front of the copulatory organ, the common oviduct is widened to form a bursa, lined by a thick epithelium with nuclei (i.e. not depressed). This bursa opens through a "vaginal" pore in front of the male pore. This pore may be a transitory feature. Further back the common oviduct is surrounded by inner circular and outer longitudinal muscles. The end of the female duct and the female gonopore are surrounded by numerous erythrophilic glands.

Diagnosis. *Minona* species with a length of about 2.5 mm, without eyes but with an unarmed penis. Accessory stylet 26 µm long, slightly curved with a tooth. Vagina short and not muscular.

Discussion

Ten species have been described within the genus *Minona* Marcus, 1946, including the new species but excluding *M. amnica* Ball & Hay, 1977 which is transferred to the genus *Duplominona* Karling, 1966 (see discussion below). Of these species *M. peteraxi* Karling, 1978, *M. evelinae* Marcus, 1946 and *M. obscura* Karling, 1966 have eyes; *M. trigonopora* Ax, 1956, *M. fernandensis* Ax & Ax, 1977

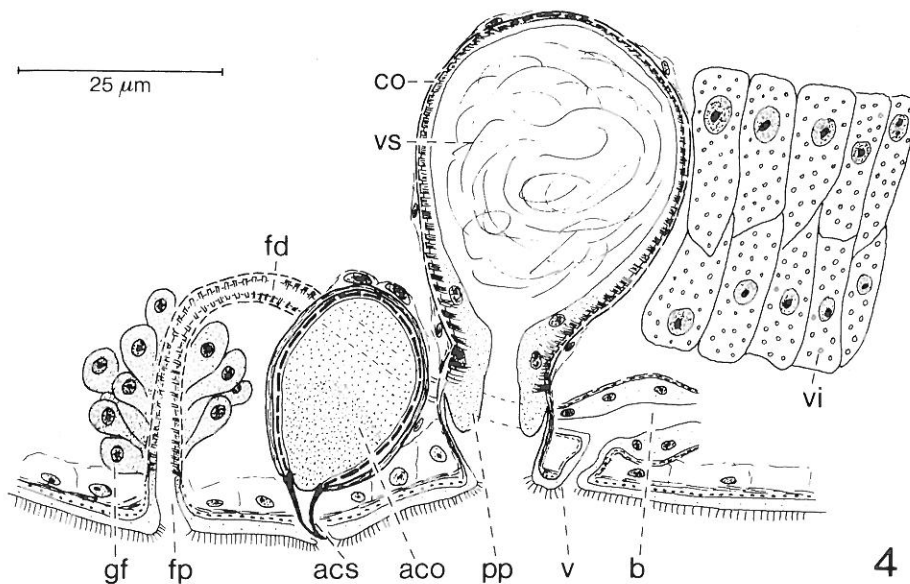
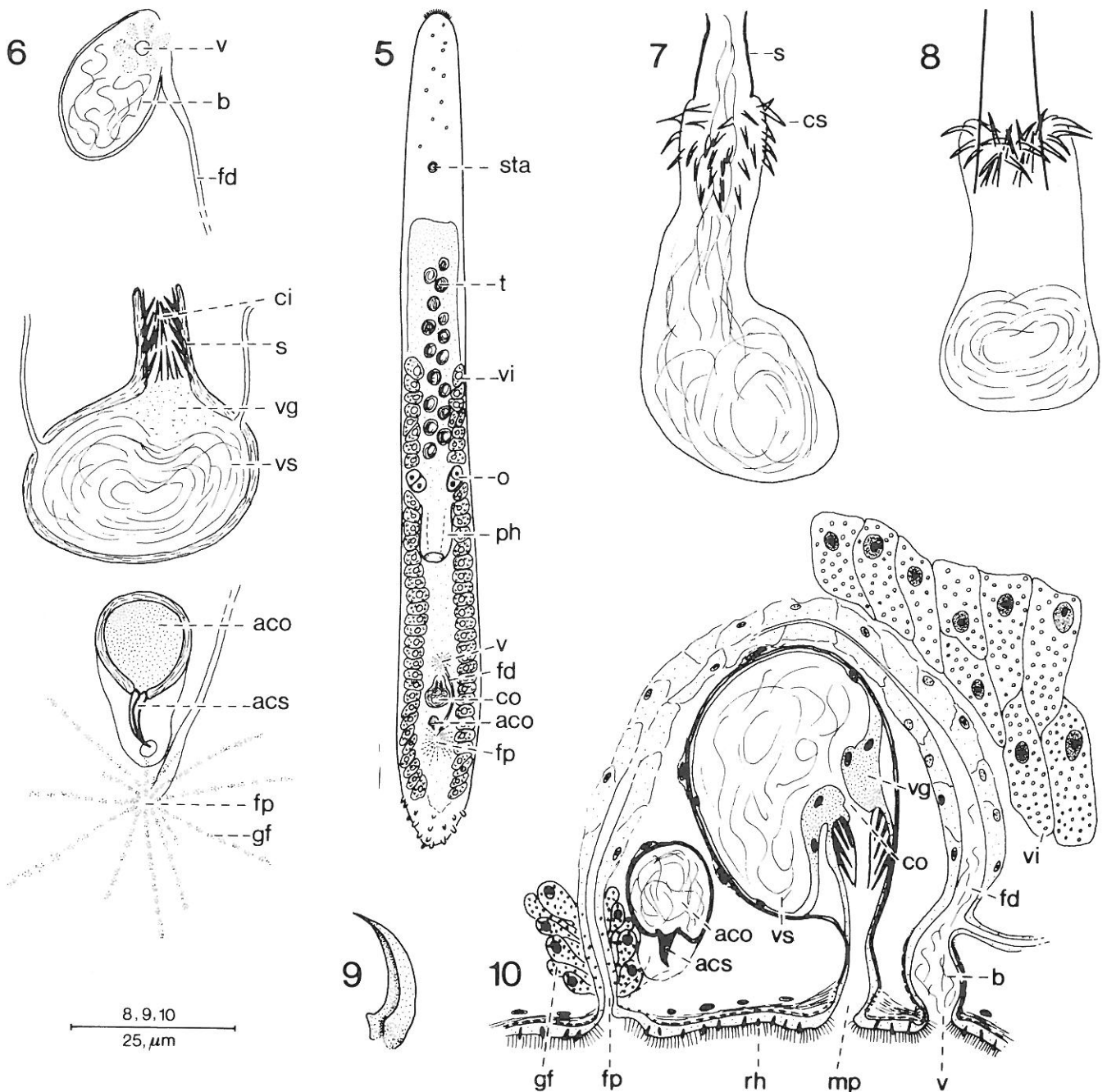


Fig. 4. *Minona degadti*, reconstruction of genital organs, from serial sagittal sections (from the right) (holotype).



Figs. 5–10. *Duplominona septentrionalis*.—5. General organization of living animal (dorsal view).—6. Genital organs in living animals.—7. Copulatory organ with everted cirrus, from squeezed living individual.—8. Copulatory organ with everted cirrus, from whole mount.—9. Stylet of the accessory glandular organ, from whole mount.—10. Reconstruction of genital organs, from serial sagittal sections (from the right) (holotype).

and *M. baltica* Karling & Kinnander, 1953 lack a vagina; *M. divae* Marcus, 1951 and *M. peteraxi* Karling, 1978 have paired vaginae; *M. bistylifera* Karling *et al.*, 1972 has a copulatory organ with a stylet. *M. degadti* indeed differs from these species since it has no eyes, an unpaired vagina and a penis papilla as copulatory organ. The new species resembles *M. cornupenis* Karling, 1966 in its general organisation, but it has a curved accessory stylet with a tooth. The presence of this tooth is indeed the most conspicuous character to distinguish *M. degadti* from the other *Minona* species.

***Duplominona septentrionalis* sp.n. (Figs. 5–10)**

Localities. North Sea: 51°16'52" N, 2°33'00"E, medium sand at 22 m depth, 29 Aug. 1972; 51°34'01"N, 2°51'08"E, medium sand at 35 m depth, 25 Sept. 1972; 51°56'31"N, 2°33'00"E, medium sand at 40 m depth, 14 Sept. 1972; 52°36'30"N, 4°33'00"E, sand at 17 m depth, 30

June 1982 (type locality); 52°00'N, 3°15'E, medium sand at 34 m depth, 30 June 1982.

Material. Several animals studied alive and mounted, one specimen sectioned (holotype).

Derivation of the species name. Septentrionalis = from the North. *Duplominona septentrionalis* sp.n. is the most northerly *Duplominona* species. Previously, *Duplominona* species were only known from tropical or subtropical regions.

Description

The living animals (Fig. 5) are about 1.6–1.8 mm long and 0.2 mm broad, without eyes or pigment. The anterior tip is provided with a bundle of sensory bristles. The part in front of the gut is transparent and contains oily drops anterior to the statocyst. The posterior end is broad and rounded with several adhesive papillae. The body wall and the pharynx are of the same construction as in most

Monocelididae (see Karling 1966). The epidermis contains eosinophilous rhabdites, 1–1.5 μm long.

The pharynx lies just in front of the posterior third of the body. The topography of the genital organs in the living animal is shown in Figs. 5 and 6. The 14–18 testes lie in two non-symmetrical rows medially anterior to the pharynx. The paired ovaries lie laterally in front of the pharynx and the vitellaries stretch from about half way along the testes to the caudal end of the animal.

The copulatory organ (Figs. 7–8, 10) is a globular and muscular bulb containing the seminal vesicle, prostatic secretion and a spiny cirrus surrounding a stylet. The cirrus spines are almost uniform in shape and size, 6–8 μm long and 2 μm broad at their base, and the stylet is 25 μm long and 11 μm broad proximally (measurements in holotype). The cirrus opens in an elongated atrium, surrounded mainly by circular muscles.

The accessory organ is found behind the male copulatory bulb. It is surrounded by a muscular wall, which is less developed than in *Minona degadti*. The stylet of the accessory organ is slightly curved and 20 μm long. From my observations on the sectioned material no clear information on its pore can be given. In the living animals, however, it seems to be separated from the female pore (Fig. 6).

The common oviduct is differentiated into a large bursa in front of the copulatory bulb. The wall of this bursa is lined with a thick and ciliated epithelium. The vagina, surrounded by muscles, opens through a pore in front of the male pore and is distinctly separated from the latter. From the bursa, the female duct continues backwards and opens through the female ovipository pore situated behind the accessory organ. The duct is surrounded by a weakly developed muscle layer and the pore, with numerous erythrophilic glands, is guarded by a weak sphincter.

Diagnosis. Animals 1.6–1.8 mm long, without eyes or pigment. Cirrus with spines and stylet within the cirrus. Cirrus spines uniform, 6–8 μm long and 2 μm broad, stylet 25 μm long. Vagina separated from the male pore. Female pore and pore of the accessory organ (probably) separated.

Discussion

Like *D. galapagoensis*, *D. karlingi*, *D. krameri* and *D. sieveri* (Ax & Ax 1977) the new species has a stylet within the cirrus. In contrast to these species, the vaginal pore in *D. septentrionalis* sp.n. is not combined with the male pore and the pore of the accessory organ is not combined with the female pore. All other *Duplominona*-species lack the stylet within the cirrus: *D. mica* (Marcus, 1951), *D. tridens* (Marcus, 1954), *D. kaneohei* Karling *et al.*, 1972, *D. canariensis* Ehlers & Ehlers, 1980 and *D. amnica* (Ball & Hay, 1977).

Duploperaclistus circocirrus gen. et sp.n. (Figs. 11–20)

Localities. North Sea, eulittoral: Netherlands (Zeeland), sandy beach in front of the Veerse dam, 30 Aug. 1981. North Sea, sublittoral: 52°36'30"N, 4°04'45"E, medium sand at 21 m depth, 26 Sept. 1972; 52°36'30"N, 4°33'00"E, fine sand at 15 m depth, 26 Sept. 1972; 52°36'30"N, 4°33'00"E, sand at 17 m depth, 30 June 1982; 52°30'N, 4°15'E, fine sand at 23 m depth, 30 June 1982 (type locality); 52°30'N, 3°30'E, fine sand at 31 m depth, 30 June 1982.

Material. Several animals studied alive, some of them preserved as whole mounts. Ten specimens sectioned, one of them designated as holotype.

Derivation of the species name. Refers to the form of the cirrus in the living animal.

Derivation of the genus name. In analogy to the formation of the genus name *Duplominona*. The relative position of genital organs and pores in the new genus is the same as in *Peraclistus*, but it has a copulatory bulb of the duplex type (simplex in *Peraclistus*).

Description

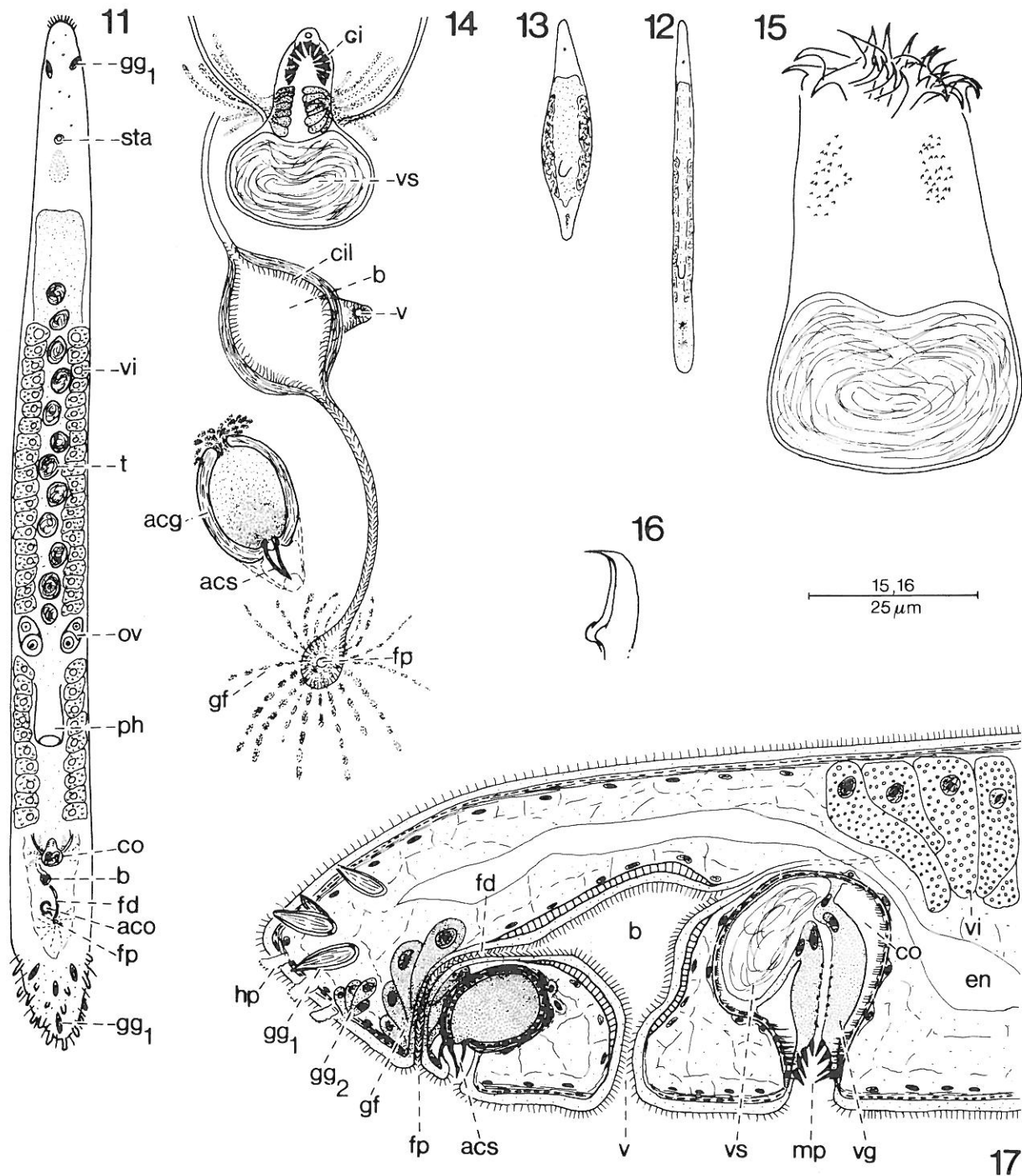
The whitish slender animals (Figs. 11–13) lack eyes, are 1–1.7 mm long and 0.2 mm broad and have a rounded posterior end with sensory bristles and numerous adhesive papillae. The anterior, elongated end is provided with a bundle of sensory bristles as well as oily drops in front of the statocyst. The pharynx lies in the posterior third of the body. The body wall and the pharynx are of the same construction as in most Monocelididae. The epidermis contains very fine rhabdites densely packed in the posterior end of the body. There are three different kinds of glands in the caudal end: (1) glands associated with the adhesive papillae; (2) a group of glands (Fig. 17, *gg*₂) with a strong basophilic secretion and lying ventrally behind the female pore; (3) large spindle-shaped glands (Figs. 11, 17, *gg*₁) (also present in *Minona degadti* sp.n.) comparable with the glands described by Marcus (1949) in *Monocelis scalopura* and *Mesoda gabriellae*.

The topography of the genital organs in the living animals is shown in Figs. 11 and 14. Twelve testes lie medially in one row in front of the pharynx. The anterior end of the vitellaries is situated behind the second testis and the vitellaries reach posteriorly to the level of the copulatory organ.

The copulatory organ (Fig. 15) is pear-shaped in the living specimens, with a posteriorly situated spheroid seminal vesicle and an anteriorly directed spiny cirrus. The accumulation of prostatic secretion is separated from the seminal vesicle by a septum (Fig. 17). The whole bulb is surrounded by a thick muscular envelope. Prostate glands and their nuclei can be found inside as well as outside the bulb (Figs. 14, 17). The spines of the cirrus are flat, triangular in shape, 7–9 μm long and with a 3–6 μm wide base. In whole mounts and in the serially sectioned material additional very fine spines (0.5 μm), arranged in two zones, can be seen proximal to the larger ones.

Behind the copulatory bulb the accessory organ is found. It is surrounded by two muscle layers which form spirals at right angles to each other. The stylet of this accessory organ is 20 μm long (Fig. 16) and its pore is distinct, situated clearly in front of the female pore (Fig. 17).

The bursa, differentiated from the common oviduct, and the vagina are situated behind the copulatory bulb but anterior to the accessory organ, with the vaginal pore between the male pore and the pore of the prostatoid. The oviduct and the bursa are lined with a strongly ciliated epithelium and surrounded by a rather thick muscle layer. The nuclei of this epithelium are to be found in the surrounding mesenchyme (depressed). Erythrophilic glands open into the common oviduct near the posterior female ovipository pore. As mentioned before, basophilic



Figs. 11–17. *Duploperaclistus circocirrus*.—11. General organization of living animal (dorsal view).—12–13. Free-swimming animals.—14. Genital organs in living animal.—15. Copulatory organ, from whole mount.—16. Stylet of the accessory glandular organ, from whole mount.—17. Reconstruction of genital organs, from serial sagittal sections (from the right) (holotype).

glands (gg_1) open on the epidermis behind the female pore.

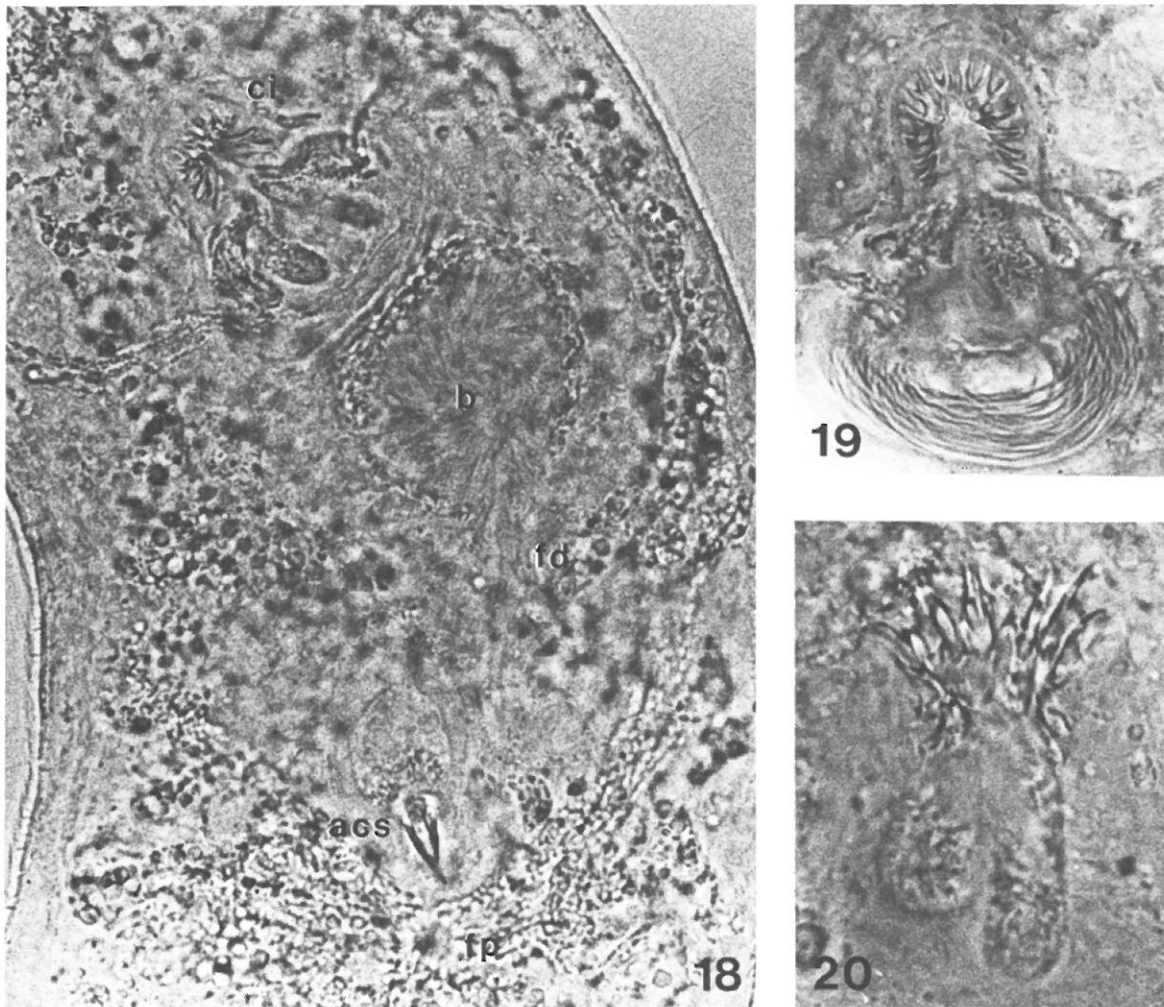
Diagnosis of the genus. Slender animals with the pharynx in the posterior body part, ovaries anterior to the pharynx. Copulatory bulb of the duplex type. Vagina and bursa postpenial but anterior to the accessory organ.

Diagnosis of the species. Animals 1–1.7 mm long, without eyes or pigment. Cirrus with two types of spines: distal ones 7–9 μm , proximal ones 0.5 μm long. Accessory stylet 20 μm long.

Discussion

The relative position of the genital organs in the new

species is the same as in "*Peraclistus itaipus*" sensu Westblad (1952) = *Duploperaclistus westbladi* Karling, 1966. I therefore propose to transfer Westblad's species to the new genus as *Duploperaclistus westbladi* (Karling, 1966) comb.n. (see also discussion below). Both species also share the character of a strongly muscular bursa, a set of basophilic glands behind the female pore and the nucleiferous parts of the glands of the accessory organ being located outside the muscular bulb of this organ. They differ from each other mainly in the construction of the cirrus. From fig. 16 (p. 36) in Westblad (1952) it can be derived that the cirrus in *D. westbladi* has numerous very fine spines, while in *D. circocirrus* fine proximal and larger distal spines are present.



Figs. 18–20. *Duploperaclistus circocirrus*.—18. Genital organs.—19. Copulatory organ.—20. Everted cirrus of the copulatory organ. (All from living animals.)

Remarks on the taxonomy within the subfamily Minoninae

The taxonomy of the family Monocelididae has been discussed and was provisionally revised by Karling (1966). In a later contribution Karling (1978) erected the subfamily Minoninae characterised by the presence of an accessory glandular organ or prostatoid. Six genera were included in the subfamily and now a seventh is added. The main characters used for the delimitation of these genera are:

- construction of the copulatory organ (simplex versus duplex),
- relative position of vagina, copulatory organ and accessory organ,
- position of the ovaries in relation to the pharynx,
- position of the pharynx itself.

The combination of these characters in the seven genera is as follows.

Minona Marcus, 1946. Pharynx posterior, ovaria in front of the pharynx, copulatory organ of the simplex type, accessory organ postpenial, vagina prepenial (paired in *M. divae* and *M. peteraxi*) or absent.

Premionona Karling, 1966. Pharynx posterior, ovaria in front of the pharynx, copulatory organ of the simplex type, accessory organ prepenial, vagina prepenial in front of the accessory organ.

Duplominona Karling, 1966. Pharynx posterior, ovaria in front of the pharynx, copulatory organ of the duplex type, accessory organ postpenial, vagina prepenial.

Peraclistus Steinböck, 1932. Pharynx posterior, ovaria in front of the pharynx, copulatory organ of the simplex type, accessory organ postpenial behind the postpenial vagina.

Duploperaclistus gen.n. Pharynx posterior, ovaries in front of the pharynx, copulatory organ of the duplex type, accessory organ postpenial behind the postpenial vagina.

Pseudominona Karling, 1978. Pharynx posterior, ovaria behind the pharynx, copulatory organ of the duplex type, accessory organ postpenial behind the postpenial vagina (paired in *P. dactylifera*).

Ectocotyla Hyman, 1944. Pharynx anterior, ovaria behind the pharynx, copulatory organ of the simplex type (?), accessory organ postpenial behind the postpenial vagina. (For a revision of this genus see Fleming & Burt 1978b).

From the above it is clear that I reject the suggestion of Ball & Hay (1977) to reassemble species with a prepenial (or absent) vagina in the one genus *Minona*, as well as that of Fleming & Burt (1978a), who reassemble species with a postpenial vagina in the genus *Peraclistus*. I indeed attribute a high taxonomic importance to the simplex–duplex situation of the copulatory organ (for an explanation of the terms see Karling 1956), but I consider the position of the vagina and/or of the accessory organ (pre- or postpenial) as equally important, at least provisionally. At the present state of knowledge we cannot assert that all genera with duplex type belong to one monophyletic group. In many turbellarian taxa representatives with

copulatory organs of both the simplex and of the duplex organisation can be found (e.g. within the Monocelidinae). This obviously indicates that the transition simplex to duplex (or vice versa?) can have arisen independently several times in evolution. The same can be said for the accessory organ: in *Preminona* this organ has basically a different position than in the other genera and one may wonder if it is homologous with the accessory organ in other genera. So it is possibly not a synapomorphy, which is contrary to Karling's opinion (1978, 231). The position of the bursal organs may also vary in the Monocelidinae. So again, should this character have priority as a diagnostic character with phylogenetic significance? The position of the ovaries in relation to the pharynx is another problematic character used in phylogenetic speculations. Which migrated, the pharynx or the ovaries? A variable position of the ovaria also occurs in the Monocelidinae (e.g. *Pseudomonocelis* Meixner, 1943 versus *Monocelis* Ehrenberg, 1831).

In conclusion we can say that, as in many (or most) turbellarian groups, so called "evolutionary trends" or "symparallels" occur also in the Minoninae (Karling 1977, 1978). A careful analysis of characters other than those of the reproductive organs may be necessary before any successful kinship diagram can be drawn and true monophyletic relationships indicated.

The same problem is illustrated when we try to fit *Duplominona septentrionalis* into the diagram of Ax (1977) for the genus *Duplominina*. According to this author the stylet within the cirrus is a synapomorphy for *D. galapagoensis*, *D. karlingi*, *D. krameri* and *D. sieversi*. This species group, together with *D. kaneohei*, is considered as monophyletic because the vagina and the male pore are united. *D. septentrionalis* also has a stylet within the cirrus, but the vagina and male pore are separated, so it does not fit into the diagram.

From the considerations above, and at our present state of knowledge of the Minoninae, no sound basis is present to indicate true synapomorphies shared by two or more genera. From a practical point of view and for the time being, I think it is appropriate to attribute "equal weight" to the diagnostic characters used so far. With the nomination of *Duploperaclostus*, all genera are now homogeneous with respect to these diagnostic characters and obvious anatomical differences are reflected in the taxonomic arrangement of the species known.

Acknowledgements

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Abbreviations in the figures

<i>acg</i>	accessory glandular organ
<i>acs</i>	accessory stylet
<i>aco</i>	accessory organ
<i>b</i>	bursa
<i>br</i>	brain

<i>ci</i>	cirrus
<i>cil</i>	cilia
<i>co</i>	copulatory organ
<i>cs</i>	cuticular spines
<i>en</i>	intestine
<i>fd</i>	female duct
<i>fp</i>	female pore
<i>gf</i>	female glands
<i>gg</i>	glands
<i>hp</i>	adhesive papillae
<i>mp</i>	male pore
<i>ov</i>	ovary
<i>ph</i>	pharynx
<i>pp</i>	penial papilla
<i>rh</i>	rhabdites
<i>s</i>	stylet
<i>sta</i>	statocyst
<i>t</i>	testes
<i>v</i>	vagina
<i>vg</i>	prostate vesicle
<i>vi</i>	vitellary
<i>vs</i>	seminal vesicle

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