

**Monocelididae and Archimonocelididae
(Platyhelminthes Proseriata)
from South Sulawesi (Indonesia)
and Northern Australia
with biogeographical remarks**



Vlaams Instituut voor de Zee
Flanders Marine Institute

P.M. MARTENS¹ and M.C. CURINI-GALLETTI²

¹ Department SBM, Limburgs Universitair Centrum, 3610 Diepenbeek, Belgium

² Dipartimento di Scienze dell'Ambiente e del Territorio, Università degli Studi di Pisa, Via A. Volta 6, 56100 Pisa, Italy

Received 26 April 1989, accepted 6 July 1989

Thirteen new species of the Monocelididae and three Archimonocelididae from South Sulawesi and North Australia are described. More than 2/3 of the species belong to the subfamily Minoninae; among them, seven pertain to the genus *Duplominona*, which in tropical areas seems to be the dominant genus among the Proseriata, colonizing a wide range of habitats.

KEY WORDS: Monocelididae, Archimonocelididae, systematics, Indo-Pacific, biogeography.

Introduction	175
Descriptions and discussions	176
Family Monocelididae	176
Genus <i>Monocelis</i> Ehrenberg 1831	176
Genus <i>Archiloa</i> de Beauchamp 1910	178
Genus <i>Minona</i> Marcus 1946	180
Genus <i>Duplominona</i> Karling 1966	185
Genus <i>Duploperaclistus</i> Martens 1983	199
Family Archimonocelididae	201
Genus <i>Archimonocelis</i> Meixner 1938	201
Biogeographical considerations	203
Abbreviations used in the figures	204
Acknowledgements	204
References	205

INTRODUCTION

In comparison with the Boreal part of the northern hemisphere, and in particular with the North Atlantic, our knowledge concerning taxonomy and distribution of tropical Platyhelminthes Proseriata is scanty and limited to few areas (Brazil and

Bermuda in the Atlantic, Hawaii and Galapagos in the Pacific Ocean, Somalia in the Indian Ocean) (MARCUS 1946, 1949, 1950, 1951, 1954a, 1954b; KARLING et al. 1972; AX & AX 1977; KARLING 1978; EHLERS & EHLERS 1980; AX & SOPOTT-EHLERS 1985; SCHOCKAERT & MARTENS 1987). The scantiness of reports and the absolute lack of data from some geographical regions seriously jeopardize any attempt to draw the biogeographical distribution pattern of the group, and to make a phylogenetical reconstruction.

The first author (P.M. Martens) had the opportunity to spend 6 weeks in South Sulawesi (Indonesia), within the framework of the Dutch-Indonesian «Snellius II» expedition, and could perform a survey of the Platyhelminthes fauna of the area. Part of the results, concerning the families Monocelididae and Archimonocelididae, are presented here.

The second author (M.C. Curini-Galletti), while performing a karyological study on mesopsammic Platyhelminthes in Northern Australia (mainly at Darwin, N.T.) collected some Proseriate species which seemed new to the science. Though incomplete in some details due to the preparation for karyology, the material still yielded enough data to make species recognition and diagnosis possible.

Joining these data appeared to be of particular biogeographical interest since both refer to the area intermediate between the Indian and the Pacific Oceans, of which no data are at our disposal at present.

Sampling were performed on soft bottoms in intertidal areas or subtidally through scuba-diving; extraction of the animals from the sediment was with $MgCl_2$ decantation (MARTENS 1984).

Types are deposited in the Zoological collection of Department SBM, Limburgs Universitair Centrum (LUC), Diepenbeek, Belgium.

DESCRIPTIONS AND DISCUSSIONS

Family Monocelididae

Genus *Monocelis* Ehrenberg 1831

Monocelis pictocephala n. sp. (Fig. 1)

Locality. Indonesia, South Sulawesi, Kudingareng Keke, coral sand, litoral, 17.X.1984 (type locality) and Kajangan, coral sand, 0.3 m below the low water line, 22.X.1984.

Material. Two animals observed alive, one conserved as whole mount (holotype, LUC No. 112).

Derivation of name. Refers to the coloured (lat. *pictus*) head (greek: *kephalon*).

Description. Living animals are about 2 mm long and 0.2 mm broad. Under binoculars the animals appear opaquely white, with a coloured anterior end: the distal tip of the snout being bright white, the zone immediately behind it appears orange. This peculiar colouration is no longer visible in the holotype, which has been destained by fixation. No eyespot is present. The epidermis is provided with numer-

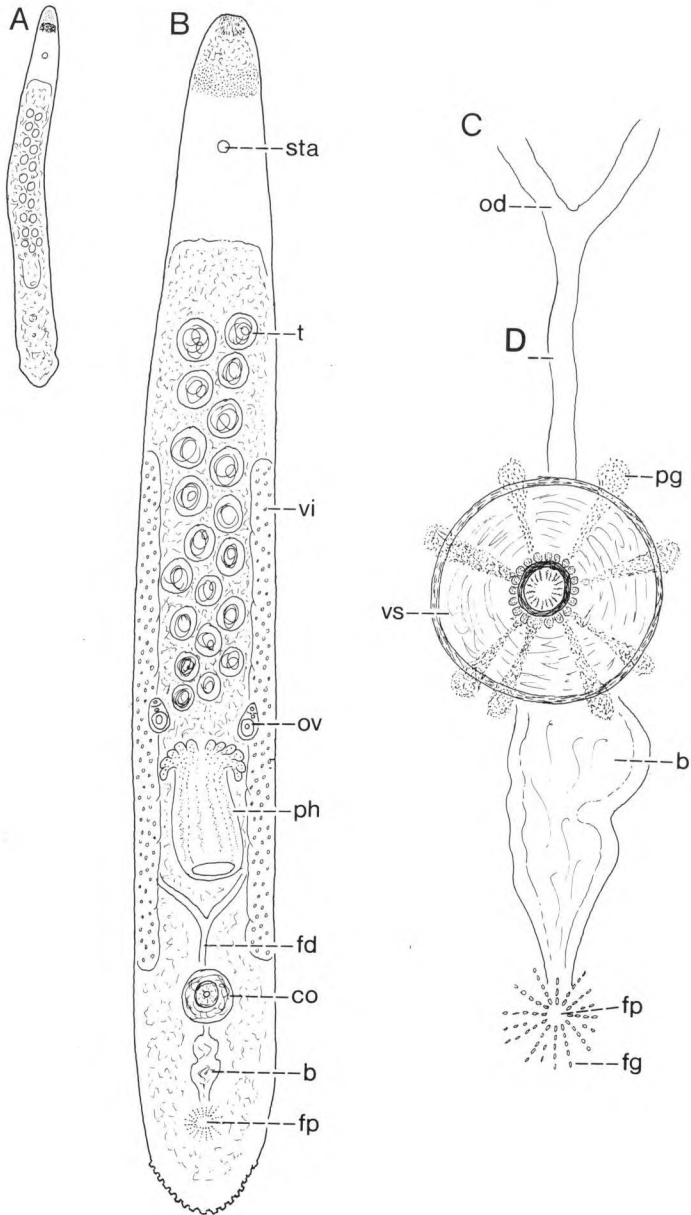


Fig. 1. — *Monocelis pictocephala* n. sp. A, habitus; B, general organisation from a living animal in dorsal view; C, genital organs in the living animal.

ous small banana-shaped rhabdoids. The posterior tip in free swimming animals is round, provided with numerous adhesive glands and can quickly modify its shape when adhering to the substrate. The pharynx lies just before the last third of the body and is rather broad.

There are about 20 to 25 testes. The copulatory bulb, of the simplex type, is a large spherical ventrally orientated bulb. It consists of a large seminal vesicle, with a diameter of 56 μm and a rather short and muscular penis papilla. At the basis of the papilla, prostate glands are present.

The ovaries lie in front of the pharynx; the vitellaria stretch out from the first third of the body to the copulatory organ. Both female ducts fuse behind the pharynx and form the common female duct. Neither a vagina nor a bursa are present at the place of this fusion. The common female duct runs over the copulatory organ to the female pore; behind the copulatory bulb it widens to form a bursa.

Discussion. Among the *Monocelis*-species without stylet and without eyes [*M. balanocephala* (Böhming 1902), *M. cincta* Karling 1966, *M. tenella* Karling 1966, *M. hopkinsi* Karling 1966, *M. galapagoensis* Ax & Ax 1977, *M. colpotroplicis* Tajika 1982, *M. spectator* Sopott-Ehlers & Ax 1985, *M. pictocephala* n. sp.] only *M. galapagoensis* and the new species lack a vagina. The new species clearly differs from *M. galapagoensis* in the following features: its cephalic region is pigmented and a prepenial bursa is absent whereas the common female duct widens postpenially.

Within the genus *Monocelis*, only *M. cincta* is known to display a girdle of pigment in the cephalic region. However, the colour in that species is brown and not orange as in the new species. Furthermore, *M. cincta* has a prepenial bursa and a vagina.

Genus *Archiloa* de Beauchamp 1910

Archiloa vanderlandi n. sp. (Figs 2; 9A, B)

Locality. Indonesia, Southern Sulawesi, Sankarang archipelago, Kudingareng Keke, fine coral sand, just below the low water line, 17.X.1984 (type locality).

Material. Two animals studied alive; one of them conserved as whole mount with lactophenol (holotype, LUC No. 110), the other used for paraffin sections.

Derivation of name. The species is named after Dr J. van der Land, of the Museum of Leiden, who was responsible for the Thema IV: Coral reef of the Snellius expedition.

Description. *Archiloa vanderlandi* is about 3 mm long, 0.1 to 0.2 mm broad, without pigmentation or eyespots. Both ends of the body are rounded; the posterior end is provided with numerous adhesive glands. Neither in the living nor in the sectioned material were rhabdoids or rhabdoid glands observed. The tip in front of the statocyst is provided with numerous oily droplets. The gut runs from the brain to the caudal tip of the animal. The pharynx lies in the second third of the body. It is provided with numerous glands at its base and the oesophageal part is poorly developed. Behind the pharynx a transversal septum («diaphragm») is present.

There are about 20 testes. The spherical copulatory bulb (70 to 90 μm in

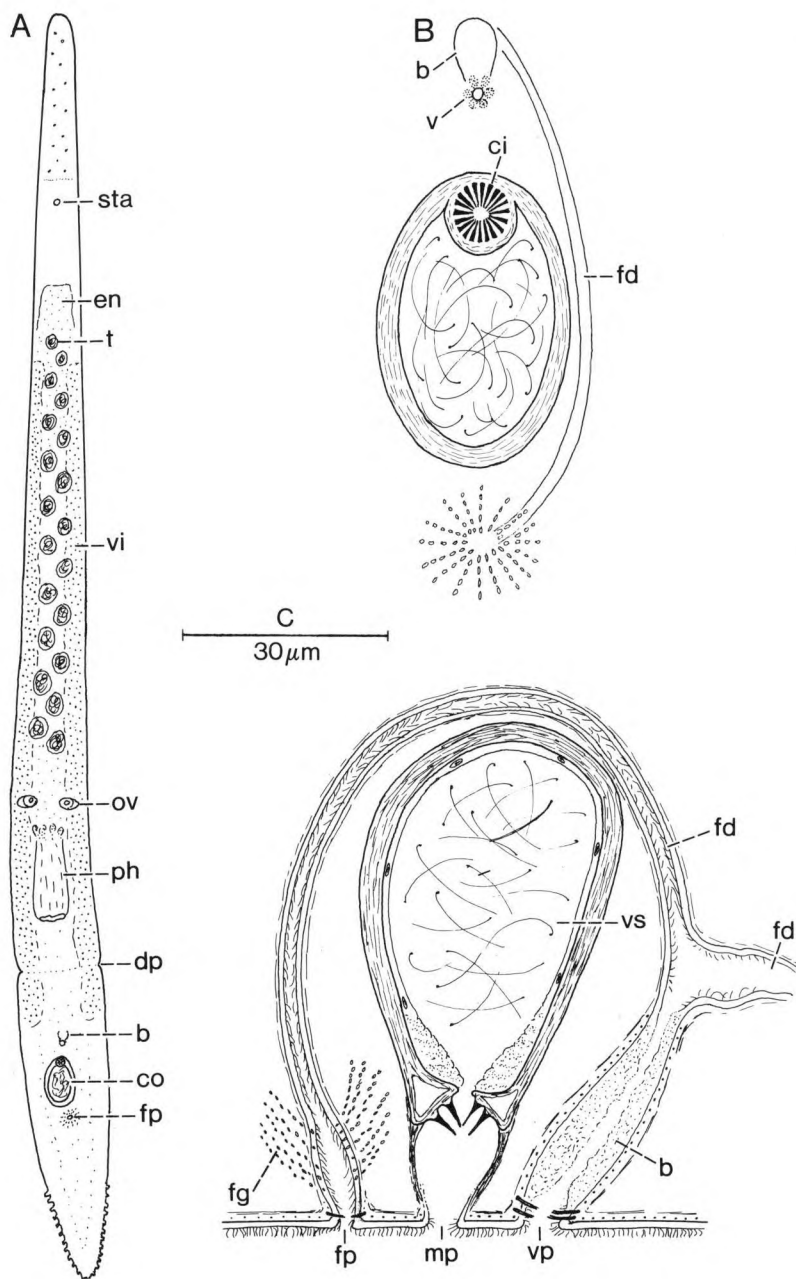


Fig. 2. — *Archiloa vanderlandi* n. sp. A, general organisation from a living animal in dorsal view; B, genital organs in the living animal; C, reconstruction of the genital organs from serial sections (viewed from the right).

diameter) is surrounded by a thick muscular wall and orientated anteriorly in the living animal. In the sections of the strongly contracted specimen the bulb is orientated ventrally. The vesicula granulorum and the vesicula seminalis are not separated. The prostate glands are poorly developed. The cirrus is very short and provided with two girdles of spines, with about 40 spines in each girdle. The spines are needle shaped, about 9 μm long. The male atrium, strongly muscular, is provided with a unciliated epithelium.

The ovaria are located in front of the pharynx; the vitellaria stretch out from the first pair of the testes up to the copulatory organ. The common female duct has a thin muscular wall, and is lined with a ciliated epithelium with in-sunk nuclei. In front of the male copulatory organ the female duct is connected to the outside through a muscular vagina with inner circular and outer longitudinal muscles. The vagina is widened and provided with a well developed secretory unciliated epithelium with in-sunk nuclei; it can be considered as a bursa. The common female duct runs over the copulatory organ to the female pore, which is surrounded by the female glands.

Discussion. This Monocelidinae species clearly belongs to the group of genera with a copulatory bulb of the duplex type and a vagina, which were put all together by KARLING (1966) in the genus *Archiloa* de Beauchamp 1910. This synonymization has not generally been accepted (see SOPOTT 1972). At present one of the authors (P.M. Martens) is undertaking a revision of the whole group. For the time being this species will be considered as an *Archiloa* species. Within this group *A. vanderlandi* can easily be recognised by the presence of a very short cirrus containing only two girdles of spines, whereas in all the other species the cirrus is longer and provided with many more spines.

Genus *Minona* Marcus 1946

Minona hastata n. sp. (Figs 3, 8A)

Locality. Indonesia, South Sulawesi, Kajangan, litoral, coral sand, 22.X.1984 (type locality).

Material. One animal studied alive and conserved as whole mount with lactophenol (holotype, LUC No. 113).

Derivation of name. Refers to the shape of the accessory stylet (lat. *hasta*: spear).

Description. The unpigmented small animals, about 1 mm long, lack eyes. The epidermis is provided with small slender rhabdites, single or grouped (max four together). In front of the statocyst some oily droplets are present. The pharynx lies in the second half of the body.

Eight testes lie in a median row in front of the pharynx. The copulatory bulb is orientated ventrally. It consists of a rather large seminal vesicle, with a diameter of 40 μm and some prostate glands. Both prostate glands and seminal vesicle end together in a small penis papilla. Behind the copulatory bulb an accessory organ is present which bears an extremely elongated accessory stylet. This stylet, about 70 μm long, is orientated anteriorly. The accessory organ is surrounded by a thick muscular wall. Whether the accessory organ has its own pore or not could not be ascertained.

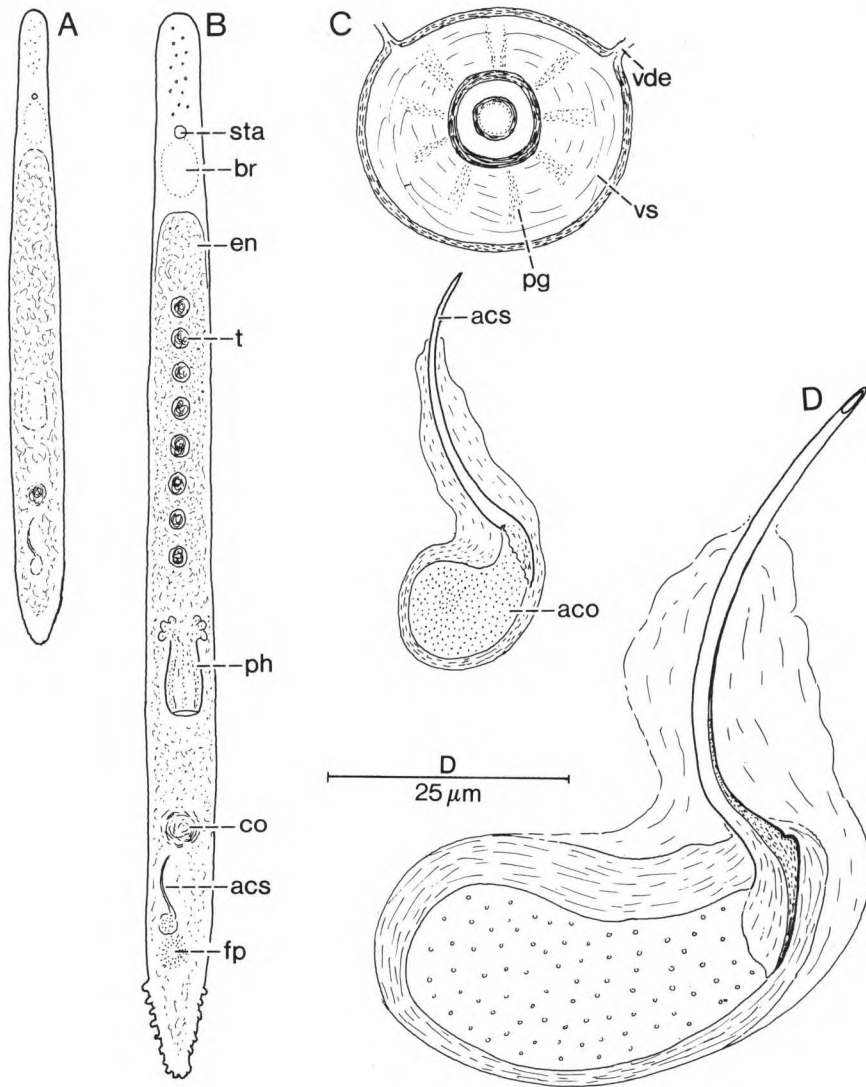


Fig. 3. — *Minona bastata* n. sp. A, habitus; B, general organisation from a living animal in dorsal view; C, genital organs in the living animal; D, accessory organ from a whole mount.

Of the female copulatory organs, only the female pore was observed. It is situated behind the accessory organ and surrounded by female glands.

***Minona indonesiana* n. sp.** (Fig. 4)

Locality. Indonesia, South Sulawesi, Bone Tambung, coral sand, just under the water line, 04.X.1984 (type locality); Galesong, coral sand, litoral, 13.X.1984; Kajan-gan, coral sand, underneath the water line, 22.X.1984.

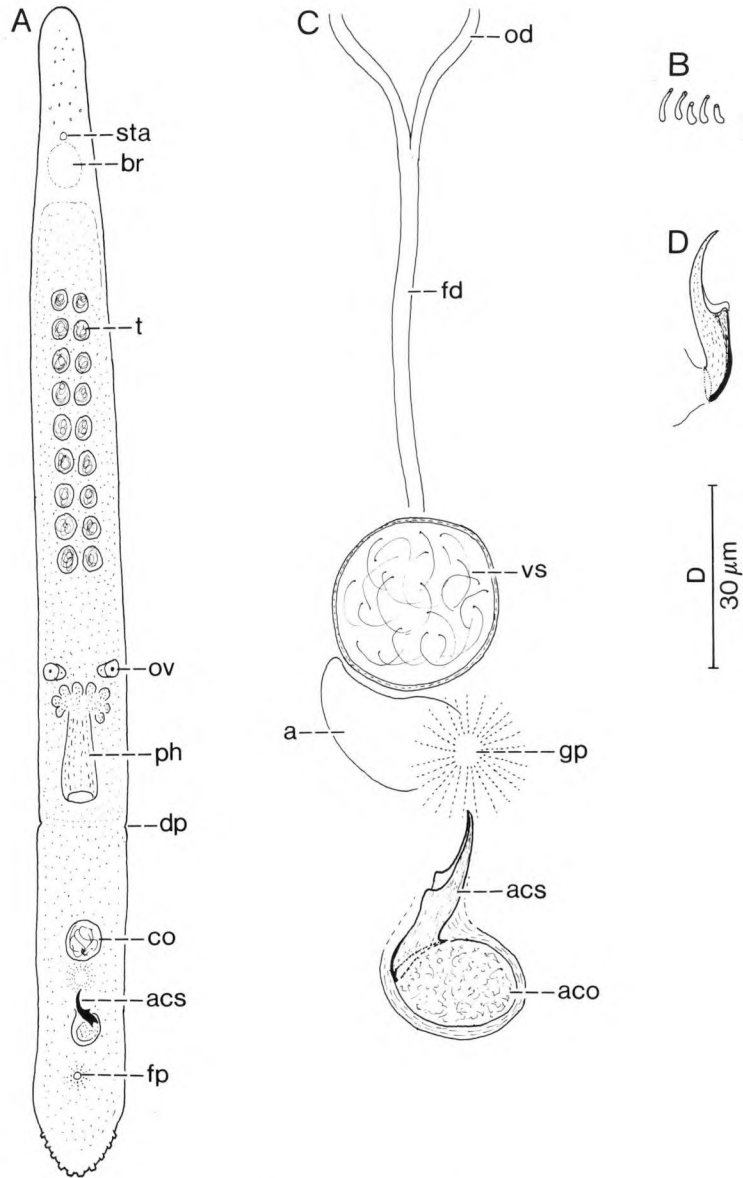


Fig. 4. — *Minona indonesiana* n. sp. A, general organisation from a living animal in dorsal view; B, rhabdites in a living animal; C, genital organs in the living animal; D, stylet from a whole mount.

Material. In each of the localities one animal was found; they were studied alive and conserved as whole mounts with lactophenol (holotype, LUC No. 114).

Derivation of name. Named after the geographical area of finding.

Description. Rather small animals, about 1-1.5 mm long without pigment or eyespot. The epidermis is provided with densely packed banana-shaped rhabdites (Fig. 4B). These are extremely dense at both ends of the body. A diaphragm is present behind the pharynx.

Vitellaria were not observed; the ovaries are located in front of the pharynx. The two oviducts come together in the common oviduct (female duct) just behind the pharynx. At this level there is no specialization into a bursa or a vagina. The female duct runs over the male organs to the female pore which is surrounded by female glands.

About nine pairs of testes lie in two rows in front of the pharynx. The copulatory bulb is of the simplex type. Only a large seminal vesicle was observed. The accessory organ bears a stylet, 30-32 μm long. The proximal part of the stylet is curved, so that its orifice is parallel to the axis of the stylet itself. The accessory organ opens into a wide atrium through a pore surrounded by numerous glands lying just behind the copulatory bulb. Whether this atrium also forms the male atrium or not could not be ascertained. No connection was seen between the female duct and this large atrium.

***Minona beaglei* n. sp.** (Fig. 5)

Locality. Northern Australia, Darwin N.T., Fannie Bay, medium to coarse sand, in brackish waters at the mouth of a small creek close to the Northern Territory Museum of Arts and Sciences (type locality). North-East Australia, Fitzroy Is., N.E.Q., coral rubble with mud among mangroves, brackish, October 1987.

Material. Numerous specimens studied alive and conserved as whole mounts in polyvinyl-lactophenol (one of which chosen as the holotype, LUC No. 116) and as squashed mounts in lactic-aceto orcein.

Derivation of name. It honours the vessel «Beagle», which touched both the localities (named after two eminent crew members) where the species was found.

Description. Unpigmented animal without eyes about, 2 mm long. The anterior tip is rounded, slightly set off from the rest of the body. Oily droplets are present in front of the statocyst. The posterior end is provided with eight to 10 adhesive glands at both sides and is very variable in shape. In the posterior part of the body numerous large rhabdoid glands are present; smaller rhabdoid glands are spread over the whole body containing rhabdites shorter and thicker than the previous ones (Fig. 5C, D). The pharynx lies in the second half of the body.

Numerous testes, varying in number from 30 to 70, lie irregularly in front of the pharynx. The large male copulatory bulb, with a diameter of 60 μm , is of the simplex type and consists of a large seminal vesicle, some prostate glands and a short fine penis papilla. The bulb is orientated ventrally; behind it, an accessory glandular organ with stylet is present. This organ has its own pore, and the stylet is 25 μm long.

The ovaries lie in front of the pharynx; the vitellaria extend from the front of the testes to the copulatory organ. Both oviducts fuse behind the pharynx and form the common female duct. This duct opens through the female pore which is surrounded

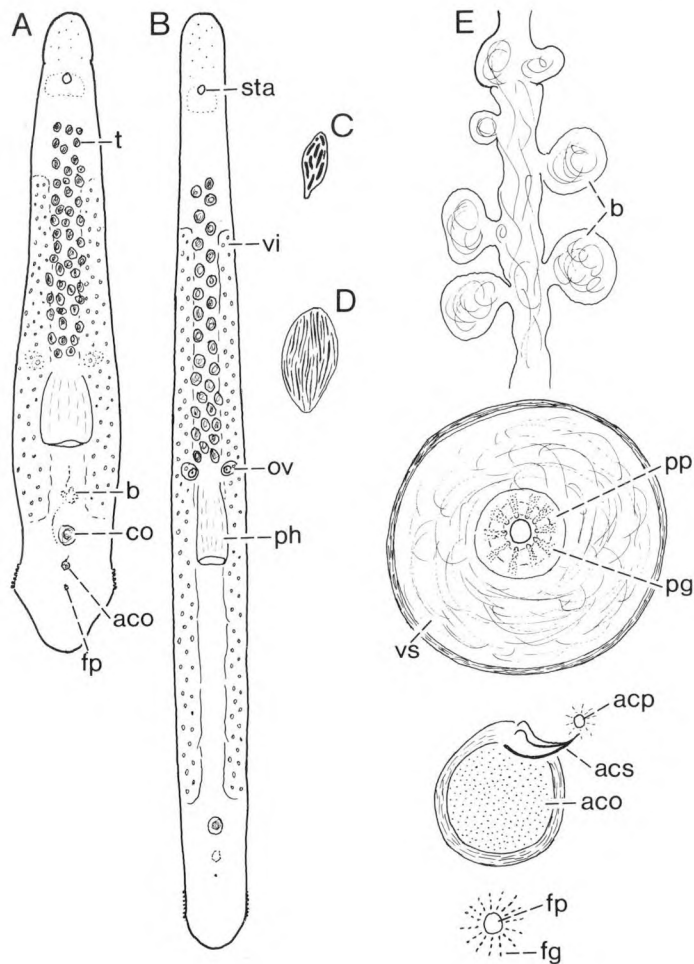


Fig. 5. — *Minona beaglei* n. sp. A-B, general organisation from a living animal in dorsal view, (A) contracted animal, (B) elongated animal; C-D, rhabdoid glands, (C) detail of the glands which are spread over the whole body, (D) detail of the glands from the posterior part of the body; E, genital organs in a living animal.

by numerous glands. In front of the copulatory bulb, the female duct forms a bursa of the resorbiens type without a vagina; in living specimens different spherical parts with spermatozoa could be observed.

Discussion. *M. hastata* n. sp. is easily recognizable from the congeneric species by the length and shape of the accessory organ. Both *M. indonesiana* n. sp. and *M. beaglei* n. sp. belong to the group of species which lack a permanent vagina (a possible autapomorphic feature of a species group within the taxon *Minona* according to Ax &

SOPOTT-EHLERS 1985). Within this group *M. obscura* Karling 1966 is immediately recognizable by the parenchymal pigment and the presence of one pair of eyes, while *M. bistylifera* Karling et al. 1972 has an intrapenial stylet. Of the remaining species, *M. baltica* Karling & Kinnander 1953 is characterized by the large dimension of the copulatory organ (diameter: 145 μm) and the size of the stylet of the accessory organ (42 μm); both *M. fernandinensis* Ax & Ax 1977 and *M. bermudensis* Ax & Sopott-Ehlers 1985 have a wide and broad bursa in front of the copulatory organ. In *M. indonesiana* n. sp. a prepenial bursa seems to be totally absent, whereas in *M. beaglei* n. sp. the bursa, of the resorbiens type, extends over a long section of the female duct and consists of several more or less distinct vesiculae. Furthermore *M. indonesiana* is characterized by the presence of a large atrium between the copulatory and the prostatoid organs.

Genus *Duplominona* Karling 1966

Duplominona muslimini n. sp. (Fig. 6)

Locality. Indonesia, Southern Sulawesi, Bone Tambung, coral sand, sublitoral (20 m deep), 04.X.1984 (type locality).

Material. One animal studied alive and conserved as a whole mount with lactophenol (holotype, LUC No. 117).

Derivation of name. Named after Dr M. Muslimin head of the Environmental Study Centre of the University of Hasanuddin.

Description. *Duplominona muslimini* is a species with 10 testes in one median row in front of the pharynx and four clearly separated genital pores, each of them seemingly surrounded by some glands. Within the bursa a granulated structure was observed; whether this is the place where both the oviducts enter the bursa or where the common female duct leaves could not be ascertained. The copulatory bulb bears a small cirrus with 12 spines (2 to 3 μm long) lying in one plane. In comparison with the copulatory bulb, the accessory organ is rather large, as it is nearly of the same size. The accessory stylet is about 20 μm long.

Duplominona samaloniae n. sp. (Figs 7, 8B)

Locality. Indonesia, Southern Sulawesi, Samalona Is., coral sand, sublitoral (12 m deep), 30.X.1984 (type locality).

Material. One animal studied alive and conserved as whole mount with lactophenol (holotype, LUC No. 118).

Derivation of name. Named after the type locality.

Description. *Duplominona samaloniae* is about 3 mm long, without eyes or epidermal pigment. The gut appeared light-pink to green due to its contents. Some oily droplets are present in front of the statocyst. In the living animal the epidermis appeared to contain small amorphous platelike structures which may be rhabdites.

The pharynx lies in the second half of the body. Four pairs of testes lie in front

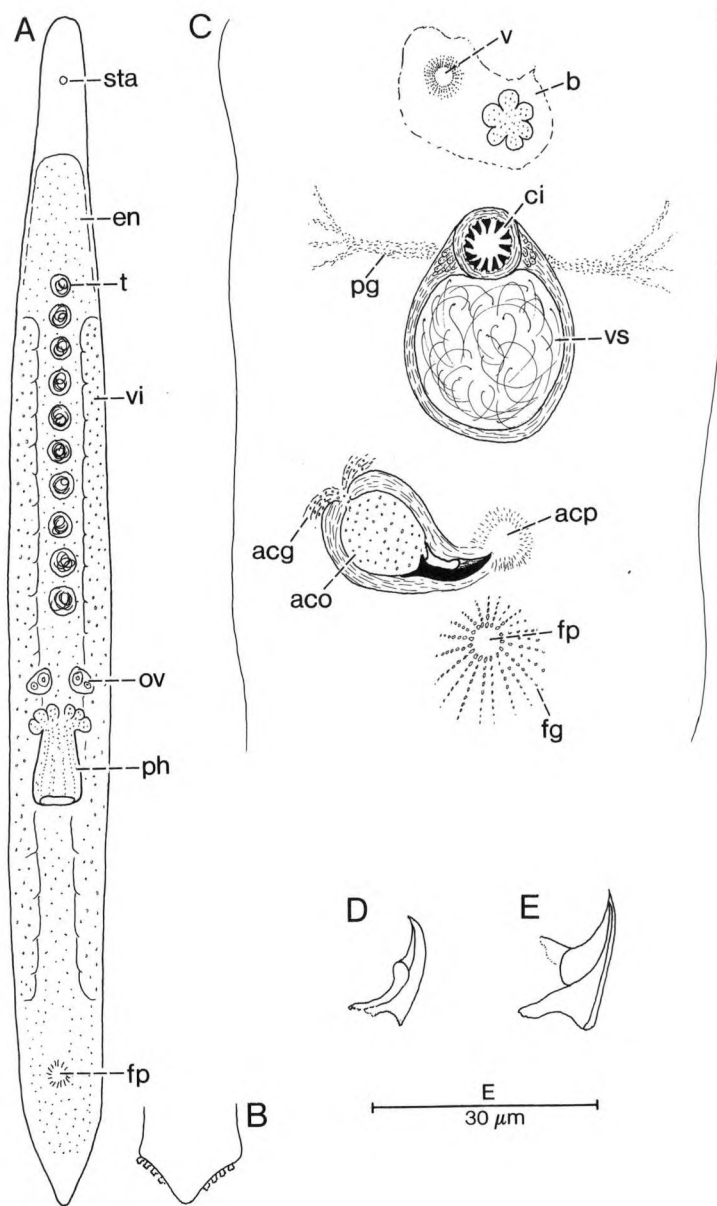


Fig. 6. — *Duplominona muslimini* n. sp. A, general organisation from the living animal in dorsal view; B, detail of the posterior part of the body which is provided with adhesive glands; C, genital organs in the living animal; D-E, accessory stylet, (D) in the living animal, (E) in the whole mount.

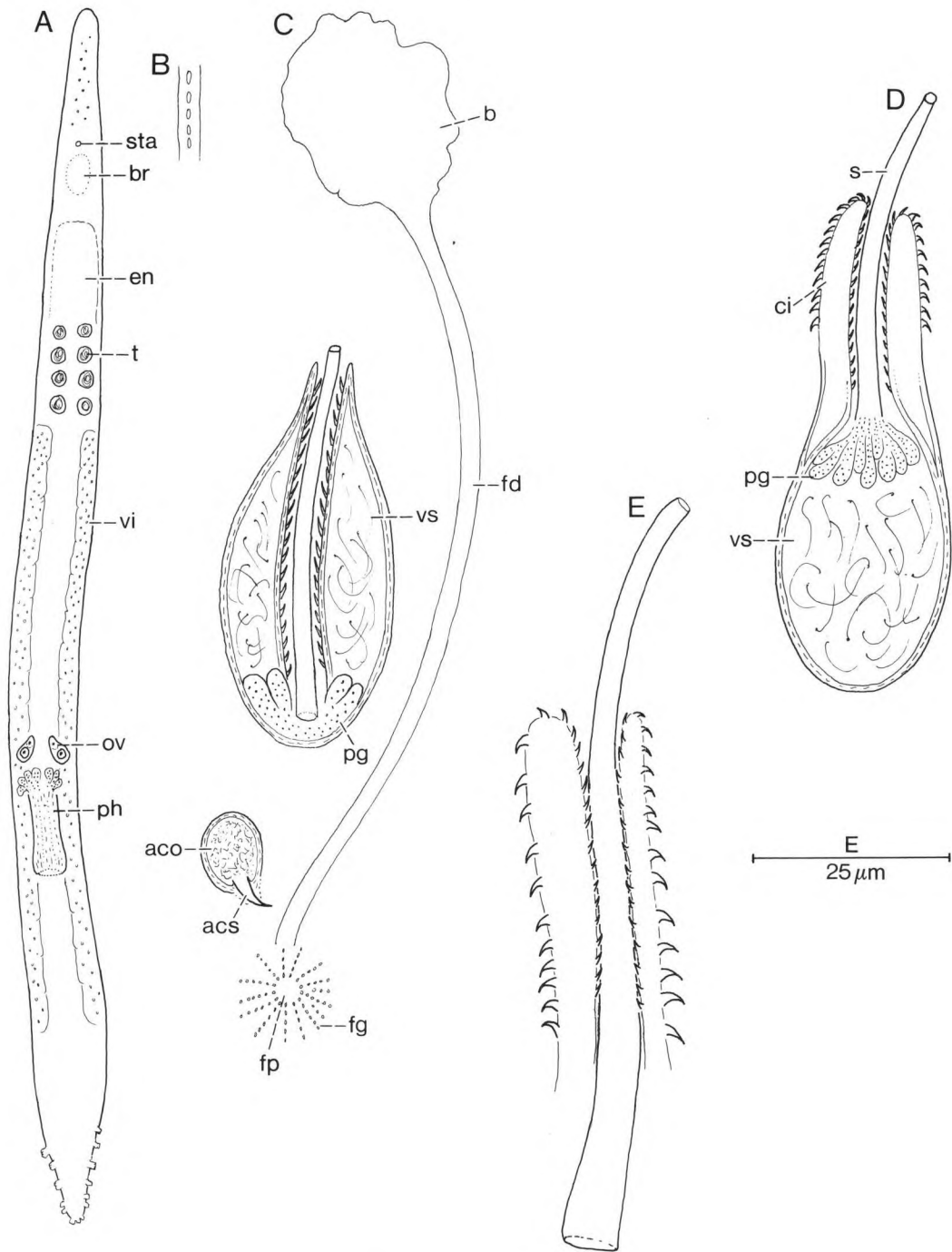


Fig. 7. — *Duplominona samalonae* n. sp. A, general organisation from the living animal in dorsal view; B, detail of the epidermis in the living animal; C, genital organs in the living animal; D, partly everted copulatory organ in the living animal; E, stylet and cirrus in the whole mount.

of the pharynx; the vitellaria extend from behind the last testes to the copulatory organs. Ovaries are located in front of the pharynx. The common female duct forms a bursa in front of the copulatory organ; no vagina could be observed. The female duct ends at the female pore, surrounded by some glands.

The copulatory bulb consists of a seminal vesicle, prostatic glands and a cirrus with central stylet. When the cirrus is inverted, the prostatic gland lies caudally in the bulb together with the proximal part of the cirrus. Meanwhile the stylet is, over nearly all of its total length, surrounded by the cirrus itself. The length of stylet is about 100 μm . Cirrus spines vary from 1 μm (proximally) up to 3 μm in the distal part of the cirrus.

The accessory organ is rather small and has its own pore. The stylet is about 10-12 μm long.

Duplominona axi n. sp. (Fig. 10)

Locality. Indonesia, Southern Sulawesi, Ujung Pandang, fine volcanic sand, under the water line (0.25-0.5 m deep), 12.X.1984 (type locality).

Material. Several specimens studied alive; three of them imbedded as whole mounts (one designated as the holotype, LUC No. 118). Two specimens were serially sectioned (paraffin) and one specimen was semi-thin sectioned (epon); however, they were of poor quality and were used only to clarify the observations on living specimens.

Derivation of name. Named after Prof. Dr P. Ax, for his contribution to the study of the genus *Duplominona*.

Description. Animals are about 1-1.2 mm long, without eyes or pigment. The epidermis is provided with very small rhabdoids which are particularly abundant in the caudal region. The tail is provided with large adhesive glands.

The pharynx lies in the last third of the body. About 14 testes are arranged alternately in front of the pharynx; a pair of ovaries is present behind the testes.

Neither vagina nor bursa were found in living animals or in sectioned specimens. Only two genital pores are present: the male genital pore through which the accessory organ also opens, and the female pore, around which many strongly developed female glands are located.

The copulatory organ has a large prostate part which is orientated backwards and so is the stylet (26-27 μm long). The wall of the cirrus is smooth without spines, however, the copulatory organ is clearly of the duplex type.

The accessory organ has a stylet about 20 μm long.

Duplominona makassarensis n. sp. (Figs 8C, D; 11)

Locality. Indonesia, South Sulawesi, Kudingareng Lompo, coral sand, 0.35 m below the low water line, 24.X.1984 (type locality).

Material. Three animals studied alive, two of which were embedded as whole mounts (one of them is designated as holotype, LUC No. 120); the third animal was fixed for serial sections. The sections were however of poor quality and could only be used to check some characters seen on living animals.

Derivation of name. Named after the sampling area (Makassar being the ancient name of Ujung Pandang).

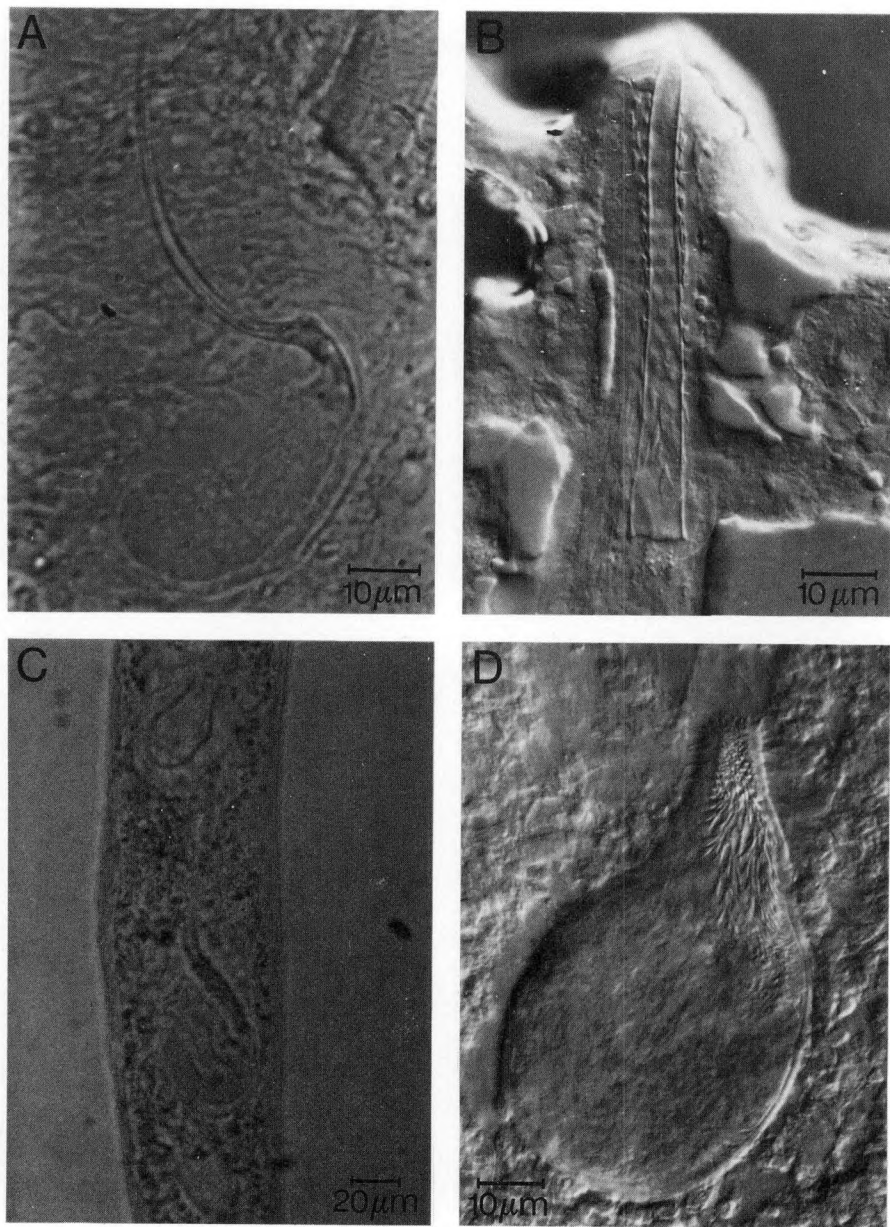


Fig. 8. — A, *Minona hastata* n. sp., accessory organ. B, *Duplominona samaloniae* n. sp., stylet and cirrus. C-D, *Duplominona makassarensis* n. sp. C, genital organs in a living animal; D, copulatory organ in a living animal.

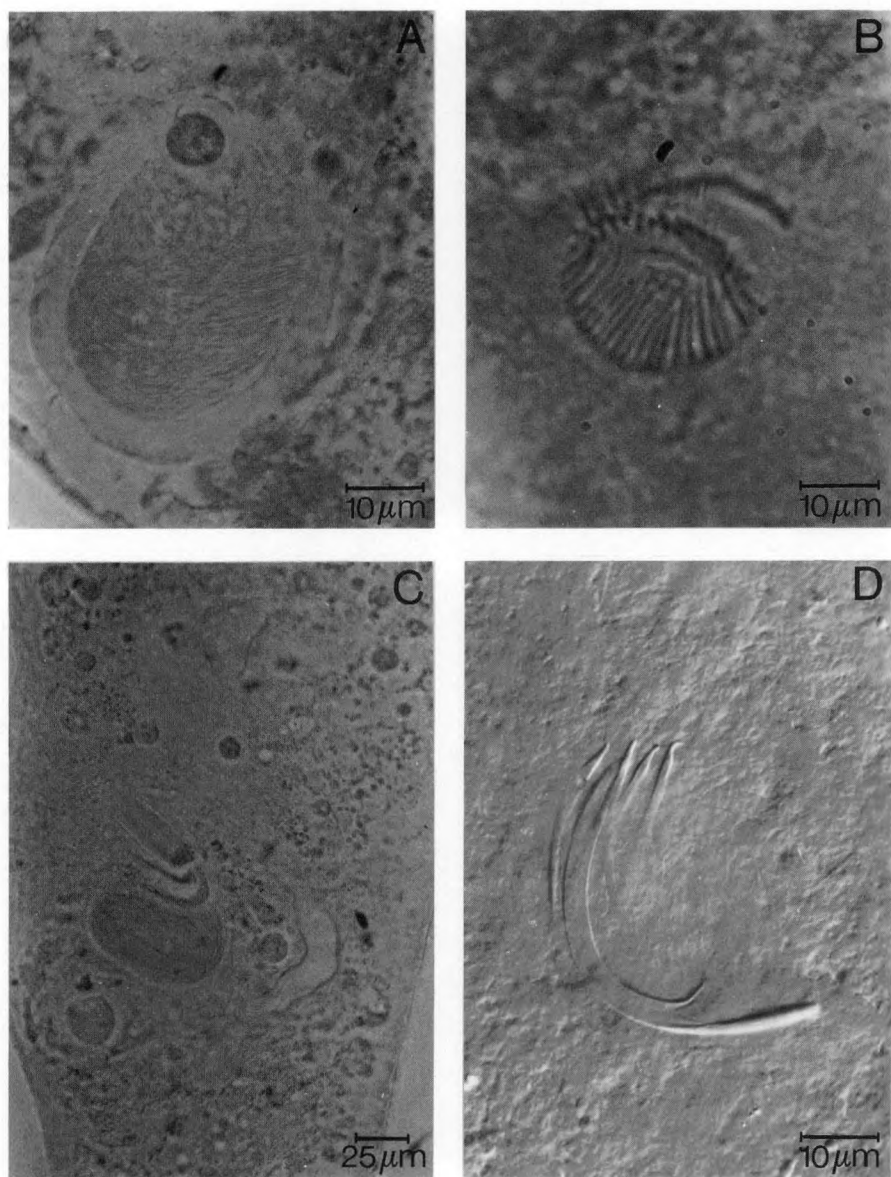


Fig. 9. — A-B, *Archiloa vanderlandi* n. sp. A, copulatory organ in a living animal; B, cirrus in the whole mount. C, *Duplominona sulawesiensis* n. sp., genital organs in a living animal. E, *Archimonocelis basanuddin* n. sp., stylet and accessory spines in the whole mount.

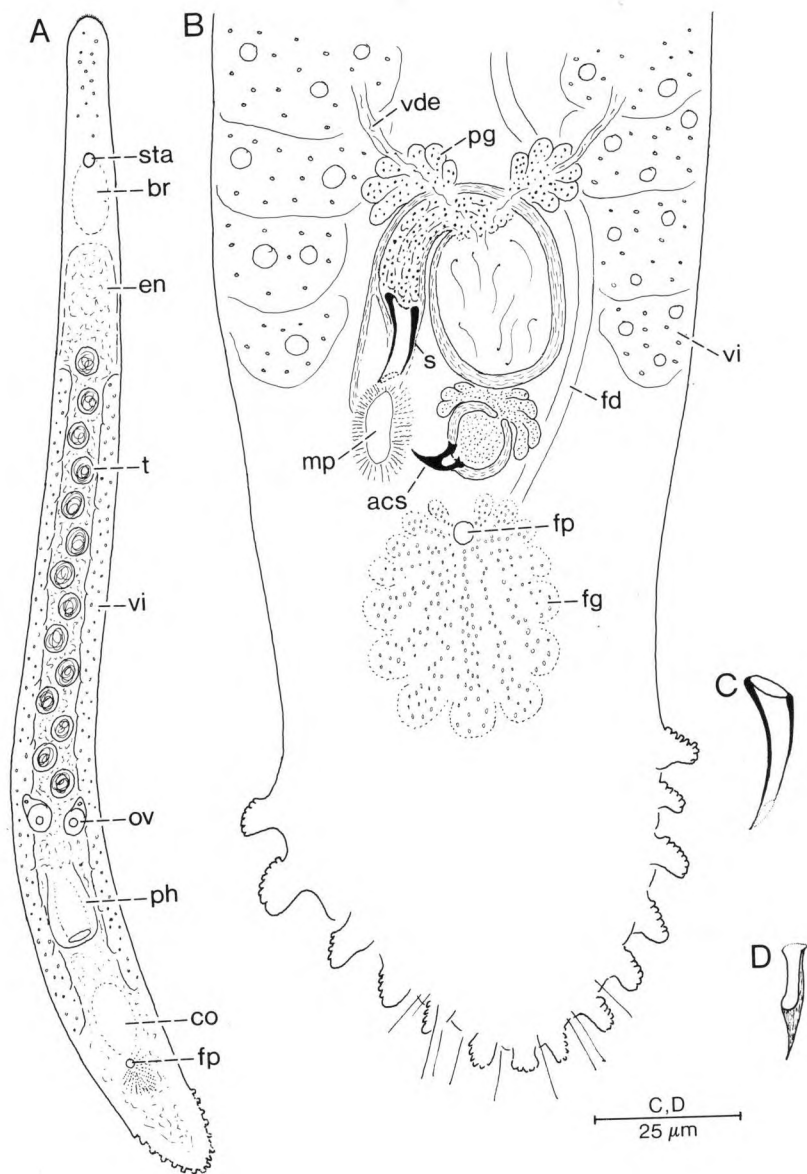


Fig. 10. — *Duplominona axi* n. sp. A, genital organisation from a living animal in dorsal view; B, genital organs in a living animal; C, stylet from a whole mount; D, accessory stylet from a whole mount.

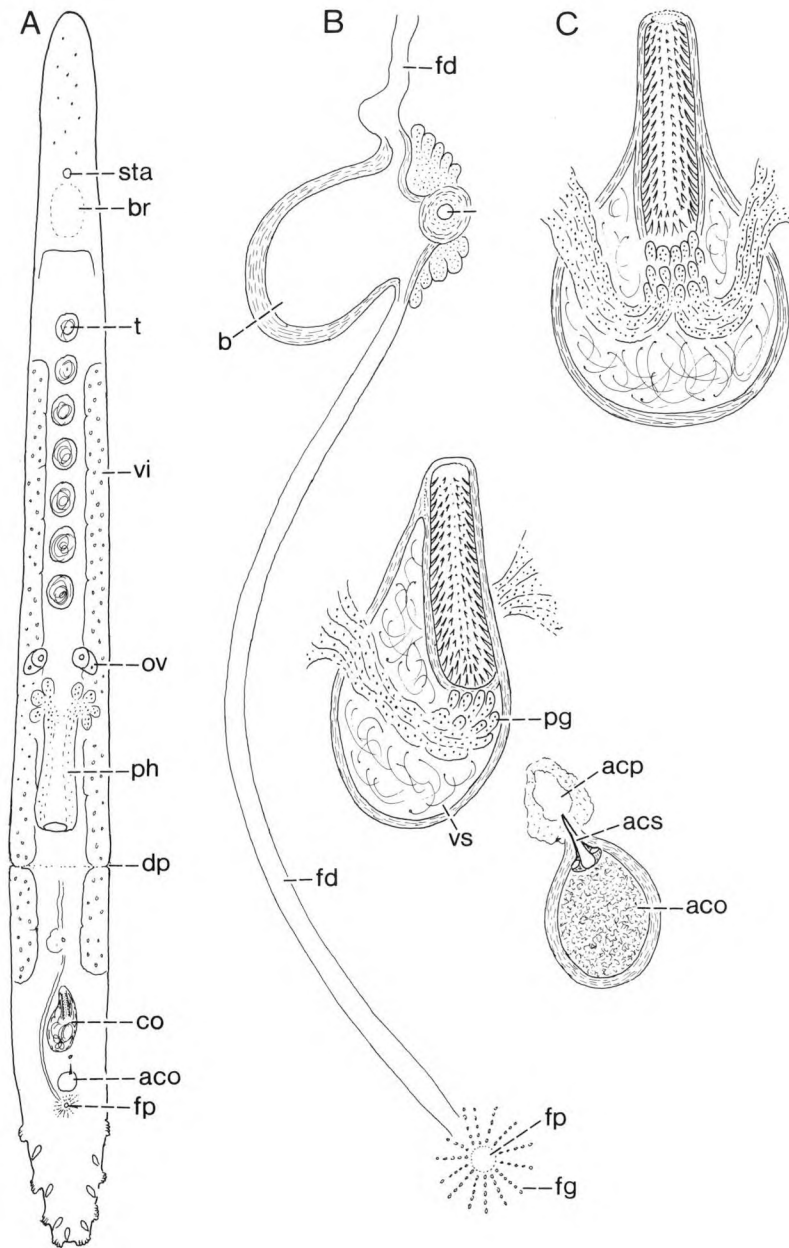


Fig. 11. — *Duplominona makassarensis* n. sp. A, general organisation from a living animal in dorsal view; B, genital organs in a living animal, more or less from a lateral view; C, copulatory organ from a living animal in dorsal view.

Description. The living animals are about 1.5 mm long and 0.1 mm broad, without pigment or eyespot. Oily droplets occur in front of the statocyst. The posterior end, with large adhesive papillae, is provided with a few large rhabdoid glands. The pharynx, long and slender, lies just behind the middle of the body; behind it a diaphragm is present.

Seven testes lie medially in one row in front of the pharynx. The male copulatory organ is ovoid with a total length of about 75 to 80 μm . A large vesicula seminalis fills most of the bulb. Two groups of prostatic glands enter the bulb dorsolaterally. The cirrus is about 58 to 60 μm long, proximally its spines are a little longer (4 to 5 μm) than in the distal part (3 to 4 μm). The spines are arranged in regular evenly spaced rows. The postpenial accessory organ has a stylet about 12 μm long. The copulatory organ and the accessory organ both have their own pore.

The ovaries are in front of the pharynx. Both oviducts fuse behind the pharynx and form a common female duct. In front of the copulatory organ this duct widens and forms a spherical bursa lined with a thick muscular wall and connected to the outside through a muscular vagina, surrounded by glands. The common female duct runs over the copulatory bulb and opens into the female pore, surrounded by the female glands. Behind the female glands some «kittdrusen» are present (observations on sectioned material).

Duplominona sulawesiensis n. sp. (Figs 9C, 12)

Locality. Indonesia, South Sulawesi, Samalona Is., coral sand, sublitoral (6-12 m deep), 30.X.1984 (type locality) and Kudingareng Keke, coral sand, sublitoral, 04.X.1984 (20 m deep).

Material. Four specimens studied alive and mounted (one of them designated as holotype, LUC No. 121).

Derivation of name. Refers to the island Sulawesi.

Description. The long slender animals are about 2 mm long and 0.1 mm broad, without pigment or eyespots. The anterior tip is slightly set off in front of the statocyst and is provided with many oily droplets. The epidermis contains small rhabdites all over the body. The posterior end is provided with numerous large rhabdoid glands (about 10 μm long) and with many large adhesive glands. The pharynx lies in the second half of the body and is highly variable in shape.

In front of the pharynx five or six testes lie in one median row; behind them, a pair of ovaries is present. The copulatory bulb is orientated anteriorly and about 65 μm long. The cirrus, about 35 μm long, bears spines 4 μm long which are neatly organized in girdles. The accessory organ, with a small hook-shaped stylet, 12-15 μm long, has its own pore. The female duct widens in front of the copulatory bulb and forms a bursa with external vagina. The last part of the female duct is strongly muscular and discernible. It opens into the female pore, which is surrounded by numerous glands.

Duplominona cynaroides n. sp. (Figs 13; 15A, B)

Locality. N Australia, Darwin N.T., Fannie Bay, fine to medium sand, intertidal, September 1987 (type locality).

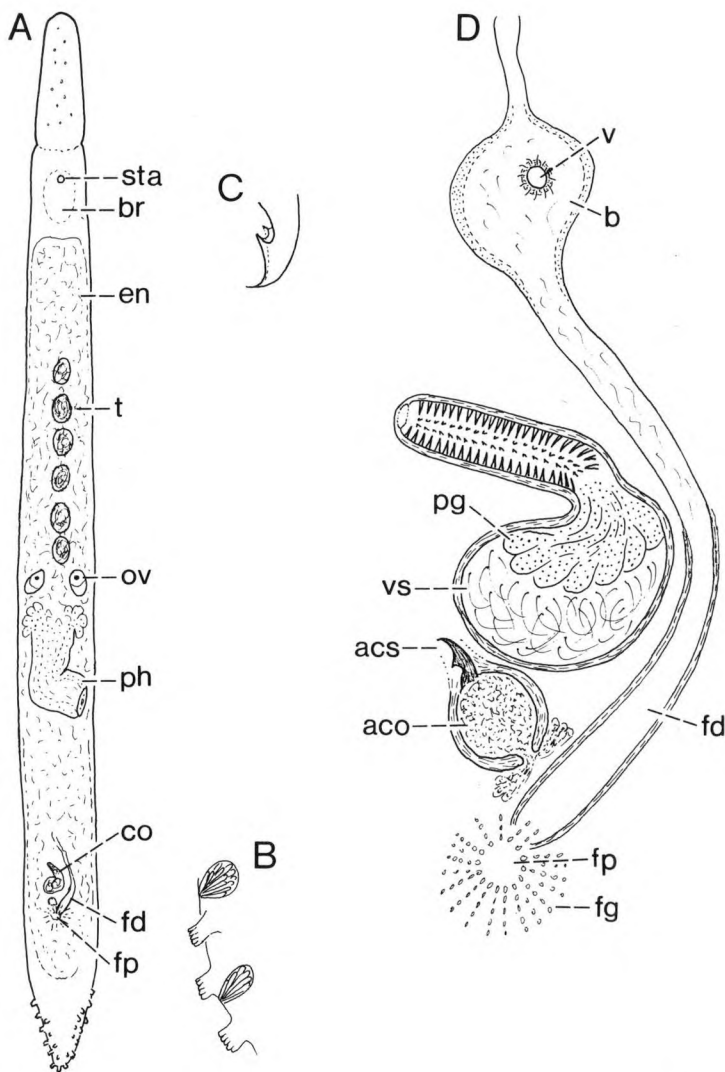


Fig. 12. — *Duplominona sulawesiensis* n. sp. A, general organisation from a living animal in dorsal view; B, detail of the posterior end with rhabdoid glands; C, accessory stylet in a whole mount; D, genital organs in a living animal.

Material. Two specimens studied alive and processed for karyological purposes; conserved as squashed mount in lactic-acetic orcein (one of them is the holotype, LUC No. 122).

Derivation of name. The species name refers to the shape of the cirrus, somewhat resembling an artichoke (lat. *cynara*).

Description. *Duplominona cynaroides* has nine to 13 testes arranged in one row in front of the pharynx. The male, female and accessory pore are separated. The

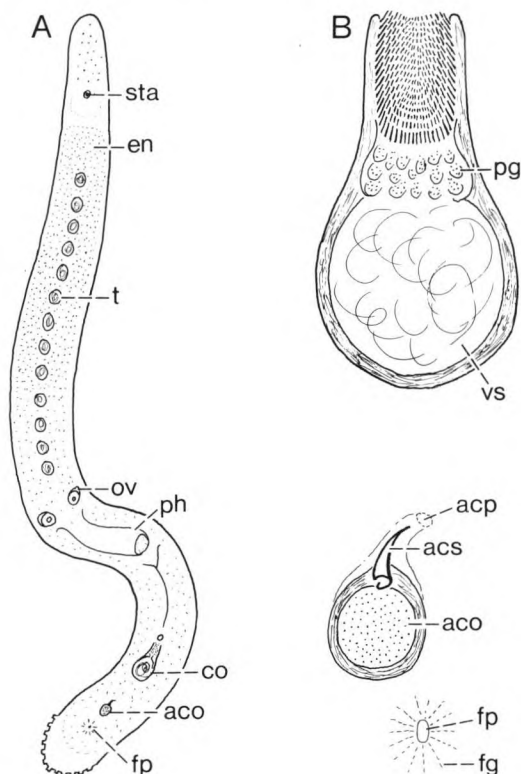


Fig. 13. — *Duplominona cynaroides* n. sp. A, general organisation from a living animal in dorsal view; B, genital organs in a living animal.

presence of vagina was not observed. The copulatory bulb, orientated anteriorly, is about 100 μm long and clearly divided into three parts: a large seminal vesicle, a group of prostatoid glands and a large cirrus, 40 to 50 μm long. The cirrus has some 38 girdles of needle-shaped spines, about 30 to 40 in each girdle. Proximally the spines are longer (up to 5-6 μm) and more loosely packed than in the median and distal part, where they attain 3-4 μm in length (see Fig. 15A with the everted cirrus). Due to the needle like shape of the spines and their number, they are hardly distinguishable individually in the cirrus of the living animals. The cirrus appears finely dotted. Behind the copulatory organ is an accessory organ, with a stylet 20-21 μm long.

***Duplominona darwinensis* n. sp.** (Figs 14; 15C, D, E)

Locality. N Australia, Darwin N.T., Fannie Bay, fine to medium sand, intertidal (type locality); Casuarina Beach, fine to medium sand, intertidal; Alexandra Bay, fine sand with mud, intertidal among mangroves; all September 1987.

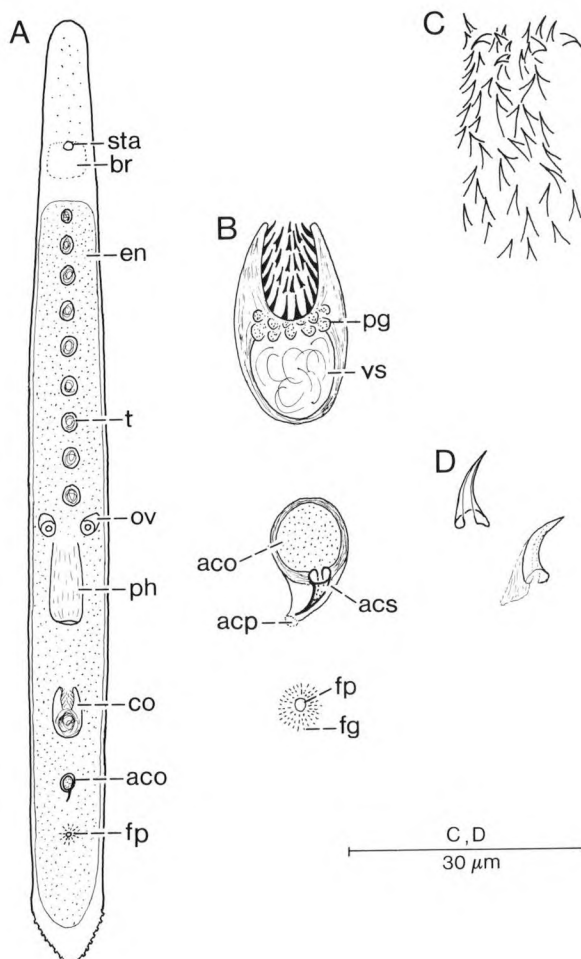


Fig. 14. — *Duplominona darwinensis* n. sp. A, general organisation from a living animal in dorsal view; B, genital organs in a living animal; C, cirrus in a whole mount; D, accessory organs from whole mounts.

Material. Numerous specimens for each site, studied alive and processed for karyological purposes; conserved as squash mounts in lacti-acetic orcein. One specimen from Fannie Bay has designed as holotype (LUC No. 123).

Derivation of name. It refers to the type locality.

Description. This *Duplominona* species has nine testes before the pharynx and separated male, female and accessory pores. Whether a vagina or bursa are present could not be stated. The copulatory bulb is of the duplex type, bearing a rather straight and short cirrus, about 20-25 μm long, in unsqueezed animals. The cirrus

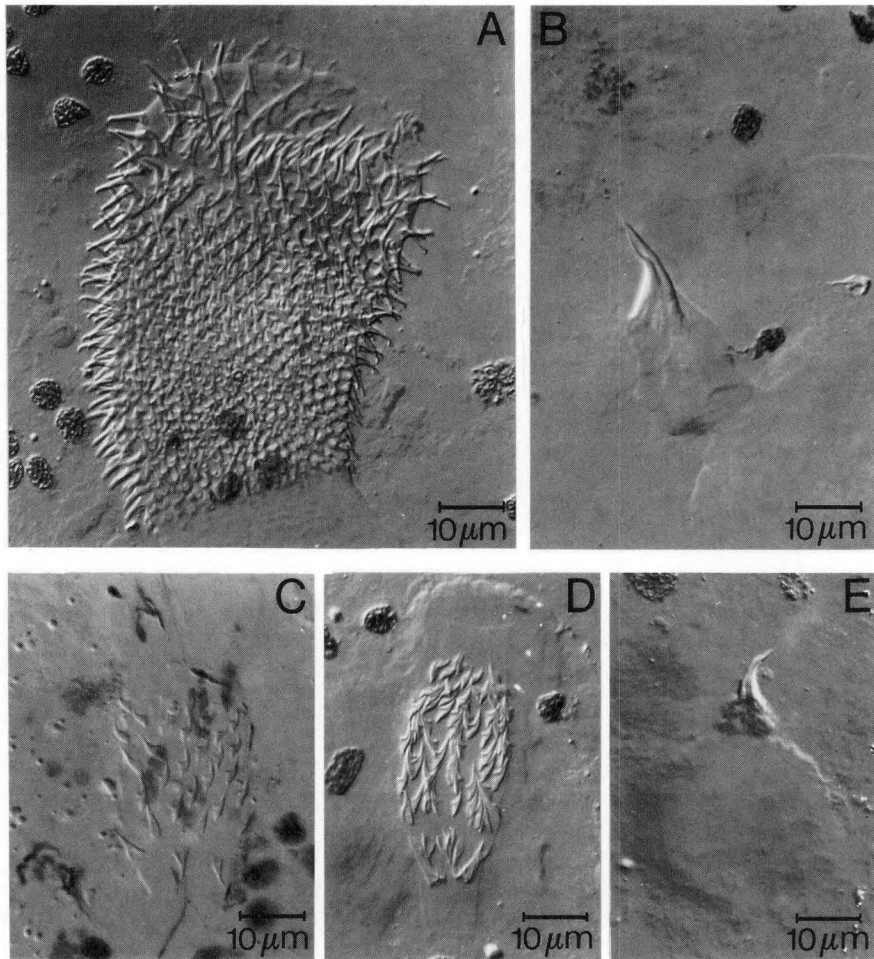


Fig. 15. — A-B, *Duplominona cynaroides* n. sp. A, everted cirrus; B, accessory stylet. C-E, *Duplominona darwinensis* n. sp. C, everted cirrus; D, non-everted cirrus; E, accessory stylet.

bears rather few spines (between 60 and 80). Proximally the spines are longer (5 to 7 μm) and less densely packed than in the distal part, where they attain only 3 μm in length. The accessory organ is orientated posteriorly and bears a small stylet of 11 to 14 μm .

Discussion. Two of the species described above bear a stylet within the cirrus, i.e. *D. samaloniae* n. sp. (with a spiny cirrus) and *D. axi* n. sp. (with a naked cirrus). Up to now, only *D. sieversi* Ax & Ax 1977 from Galapagos was known to possess a stylet within a naked cirrus, but it differs from *D. axi* in other features: the presence of only two genital pores (vaginal pore + male pore; accessory pore + female pore) and the presence of an anteriorly orientated stylet about 32 to 36 μm long. In *D. axi* the male

pore is combined with the accessory pore while the stylet is only 26 to 27 μm long and posteriorly orientated.

D. samalonae is characterized by the length of its stylet (100 μm) and by the fact that the stylet runs through the full length of the bulb. In comparison the length of the stylet in the species of the Galapagos group with a spiny cirrus (*D. galapagoensis*, *D. karlingi*, *D. krameri* all Ax & Ax 1977), *D. septentrionalis* Martens 1983 and *D. stilifera* Sopott-Ehlers & Ax 1985 is much shorter and varies between 22 and 62 μm .

Three of the new species have four separated genital pores and a spiny cirrus without a stylet, i.e. *D. muslimini* n. sp., *D. sulawesiensis* n. sp., *D. makassarensis* n. sp. The known species with these characters are *D. istanbulensis* Ax 1959, *D. paucispina* Martens 1984, *D. corsicana* Martens 1984, *D. longicirrus* Martens 1984, *D. amnica* (Ball & Hay 1977) and *D. mica* (Marcus 1951). Due to its very short cirrus, *D. muslimini*, with 12 spines (2 to 3 μm long) arranged in one girdle, looks similar only to *D. paucispina*, but the latter has a cirrus with nine spines to 5.6 μm long.

The other two species, *D. makassarensis* and *D. sulawesiensis*, differ clearly one from the other. In *D. sulawesiensis* the cirrus is distinctly set off from the other parts of the copulatory bulb, only 35 μm long and provided with spines of 4 μm . The spherical bursa is weakly muscular, while the posterior part of the female duct has a thick muscular sheath and is well visible in living animals. In *D. makassarensis* the cirrus, 58 to 60 μm long with spines 4 to 5 μm in length, is partly surrounded by the vesicula seminalis. The bursa has a thick muscular wall, while the posterior part of the female duct is not more specialized than the other parts. Both species can be distinguished from *D. longicirrus* and *D. corsicana* because these latter have very small cirrus spines (0.5 to 1.5 μm) and from *D. amnica* and *D. mica* whose spines are much larger (about 6 to 7 μm). The exact length of the spines in *D. istanbulensis* is not known, but they seem to be much finer than those in *D. sulawesiensis* and *D. makassarensis*.

The new species *D. cynaroides* n. sp. in view of its slender and fine spines, more closely recalls *D. istanbulensis*. However, in *D. istanbulensis* the cirrus is 3.5 times longer than broad and the accessory organ is orientated posteriorly, while in *D. cynaroides* the cirrus is twice as long as broad and the accessory organ is orientated anteriorly.

D. darwinensis n. sp. is characterized by relatively few spines (between 60 and 80) in a small cirrus (length of the cirrus: 22 to 25 μm , length of the spines: 5 to 7 μm). The only species with a cirrus without a stylet of comparable length are *D. kaneobei* Karling et al. 1972, *D. corsicana*, and the *D. canariensis* Ehlers & Ehlers 1980 group. *D. kaneobei* seems to be very similar to *D. darwinensis*, but differs from it in the following features: the accessory organ is orientated anteriorly, clearly visible vagina and bursa are present and the spines are much broader at the base and hook-shaped at the top (compare the figs 20, 21, in KARLING et al. 1972: 258, with Figs 15C, D of *D. darwinensis*). In *D. corsicana* and in the *D. canariensis* group the spines of the cirrus are much smaller (attaining 2 μm at maximum) than in *D. darwinensis*.

We refrain from giving any interpretation of the phylogenetical relationships within the genus *Duplominona*. In our opinion the features upon which these kinds of kinship diagrams have largely been based (presence/absence of a stylet within the cirrus, relationships between the genital pores and their number) can be homoplasous. SOPOTT-EHLERS & AX (1985) discuss the convergence of the stylet within the genus *Duplominona* and *Archilina*. Stylets within the cirrus are furthermore present in

species of the genera *Duploperaclistus* and *Archilopsis*. From light microscope sections we have observed that in all those genera the stylet has the same basic morphology and is the result of an eversion of the ejaculatory duct within the cirrus, forming a papilla within the cirrus. The outer basal lamina of the papilla becomes thickened and forms the stylet (see also MARTENS et al. 1989). This process might have originated independently and caused a parallelism. In none of these cases it is the result of the fusion of long cirrus spines, as suggested by MARTENS (1986) and reported by SOPOTT-EHLERS & AX (1985).

Genus *Duploperaclistus* Martens 1983

Duploperaclistus garudae n. sp. (Fig. 16)

Locality. Indonesia, South Sulawesi, Ujung Pandang, fine volcanic sand, 0.25 to 0.50 m under the low water level, 12.X.1984 (type locality).

Material. Four animals studied alive, from which one preserved as a whole mount (holotype, LUC No. 124) and one fixed for serial sections.

Derivation of name. It refers to the «garuda», the bird which is the symbol of the independence day of Indonesia.

Description and discussion. Living animals are long and slender, about 2 mm long, 0.1 mm broad. At the tip of the body frontal glands and some oily droplets were observed. Small rhabdoids are present in the epidermis, especially in the anterior part of the body. The posterior end narrows into a point and is provided with adhesive glands, long sensory bristles and rhabdoid glands.

Eight testes lie in a row in front of the pharynx. The copulatory organ is orientated anteriorly and is about 70 μm long. The cirrus, about 23 to 25 μm long, is provided with few spines, varying from 2 to 3 μm in length; the ventral side of the cirrus is seemingly provided with more spines than the dorsal part. Numerous prostatoid glands are present between the cirrus and vesicula seminalis. Internally, the cirrus is provided with a poorly sclerified stylet 17 to 20 μm long. In living animals this stylet is difficult to see and appears flexible. The accessory organ is orientated posteriorly and bears an accessory stylet of 12 μm in length; the pore of this organ is close to the female pore.

The ovaria are located between testes and pharynx; the vitellaria reach from the first testes up to the copulatory organ. The common female duct widens into a bursa with vagina between the copulatory bulb and the accessory organ; vagina and bursa are muscular and do not appear to be of the resorbiens type on sectioned material.

The presence of the muscular vagina and the bursa between the copulatory organ and the accessory organ places this species within the genus *Duploperaclistus* Martens 1983. The main diagnostic feature of the new species consists in the presence of the tubular structure within the cirrus and in the distribution of the spines. In *D. circocirrus* Martens 1983 two groups of spines occur, the largest of which (between 7 and 9 μm in length) are distinctly longer than in *D. garudae* n. sp.

D. westbladi (Karling 1966) probably has very fine spines within a rather long cirrus (see discussion in MARTENS 1983: 157).

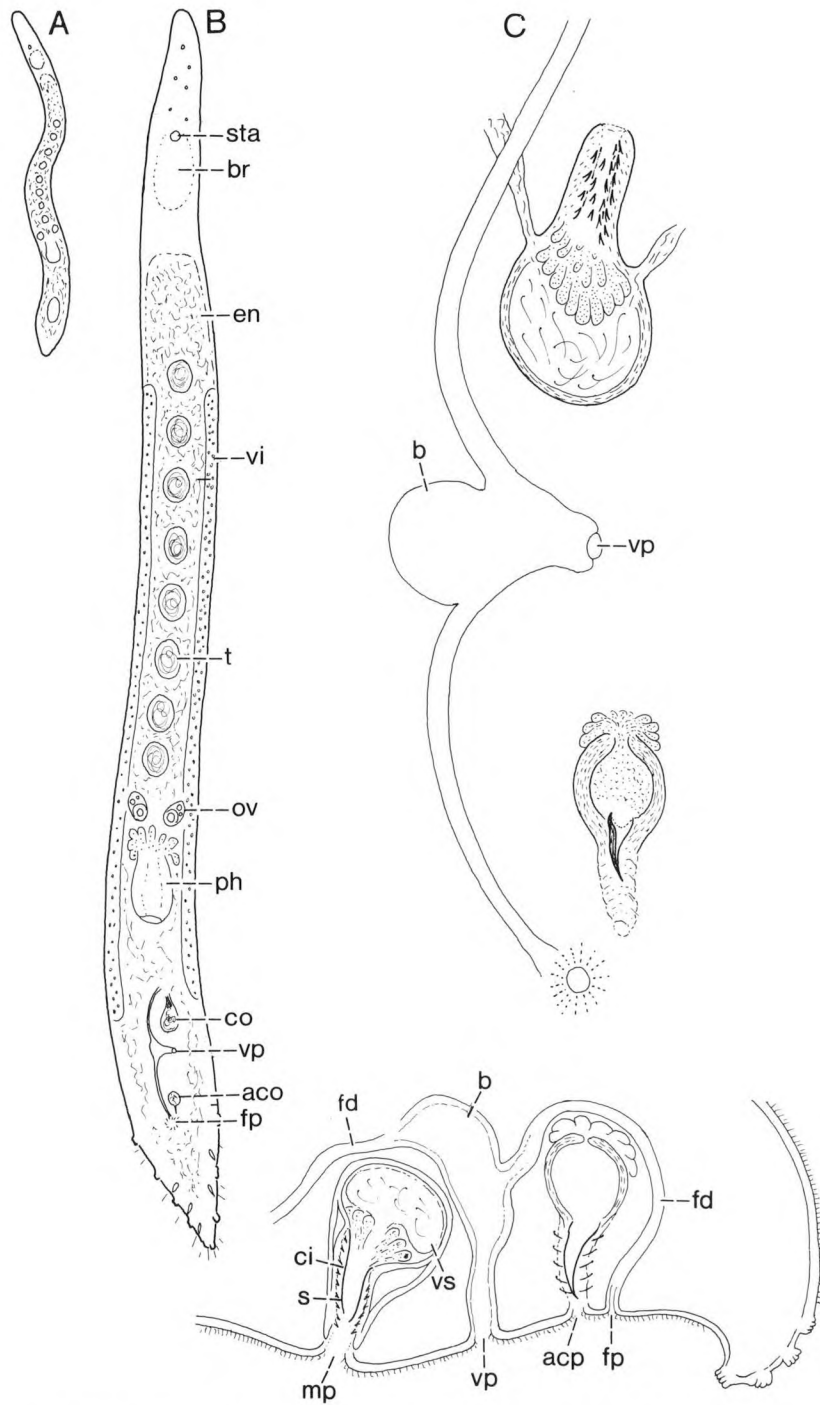


Fig. 16. — *Duploperaclistus garudae* n. sp. A, habitus; B, general organisation from a living animal in dorsal view; C, genital organs in the living animal; D, reconstruction of the genital organs from serial sections (viewed from the left).

Family Archimonocelididae

Genus *Archimonocelis* Meixner 1938***Archimonocelis hasanuddin*** n. sp. (Figs 9D, 17A-C)

Locality. Indonesia, South-West Sulawesi, Soreang, fine volcanic sand, just below the water line (0.25 m deep), 27.IX.1984 (type locality).

Material. One specimen studied alive. Observations came to an early stop due to an electricity breakdown. The specimen was then fixed with lactophenol as whole mount (holotype, LUC No. 124).

Derivation of name. Named after the University were the first author (P.M. Martens) had working facilities: Hasanuddin University, Ujung Pandang, Sulawesi.

Description. This rather small *Archimonocelis* species, about 1.5 to 2 mm long, is colourless and without an eyespot. Dorsally over the whole body length a row of cnidoblasts is present, each containing 7-15 kleptocnids, of different types and varying between 5-25 μm in length. No female organs could be observed.

About 10 testes are situated in front of the pharynx. A slender pharynx, about 1/10 of the body length, lies behind the middle of the body. Behind it a transverse septum is present, easily seen in the living specimen. The male copulatory organ is provided with two vesiculae seminales and a rather small vesicula granulorum with the cell bodies of the prostate glands lying outside the bulb. A strong curved stylet (about 180°) is present, about 65 μm long. Its proximal opening has a diameter of 15 μm . Distally the stylet is pointed with an oblique opening with a diameter of 11 μm . Four bristles, 20-22 μm long, surround the stylet.

Archimonocelis keke n. sp. (Fig. 17D, E)

Locality. Indonesia, South Sulawesi, Kudingareng Keke, coral sand, litoral, 17.X.1984 (type locality).

Material. Observations on one living specimen, imbedded as a whole mount (holotype, LUC No. 126).

Derivation of name. Named after the type locality.

Description. *Archimonocelis keke* n. sp. is rather large, without pigment or an eyespot. Observations on the living specimen were forcedly reduced due to the thickness and opaque nature of the body. Furthermore, during the examination the animal was lying on its side and did not move.

The pharynx lies in the last third of the body; behind it a diaphragm can be seen. From the beginning of the gut up to the posterior end of the animal a medio-dorsal row of cnidoblasts was present.

Elements of the female reproductive system could not be observed. A row of 13 testes lies medially in front of the pharynx. On the fixed animal, with interference contrast, it was possible to see that the male copulatory organ consists of a vesicula

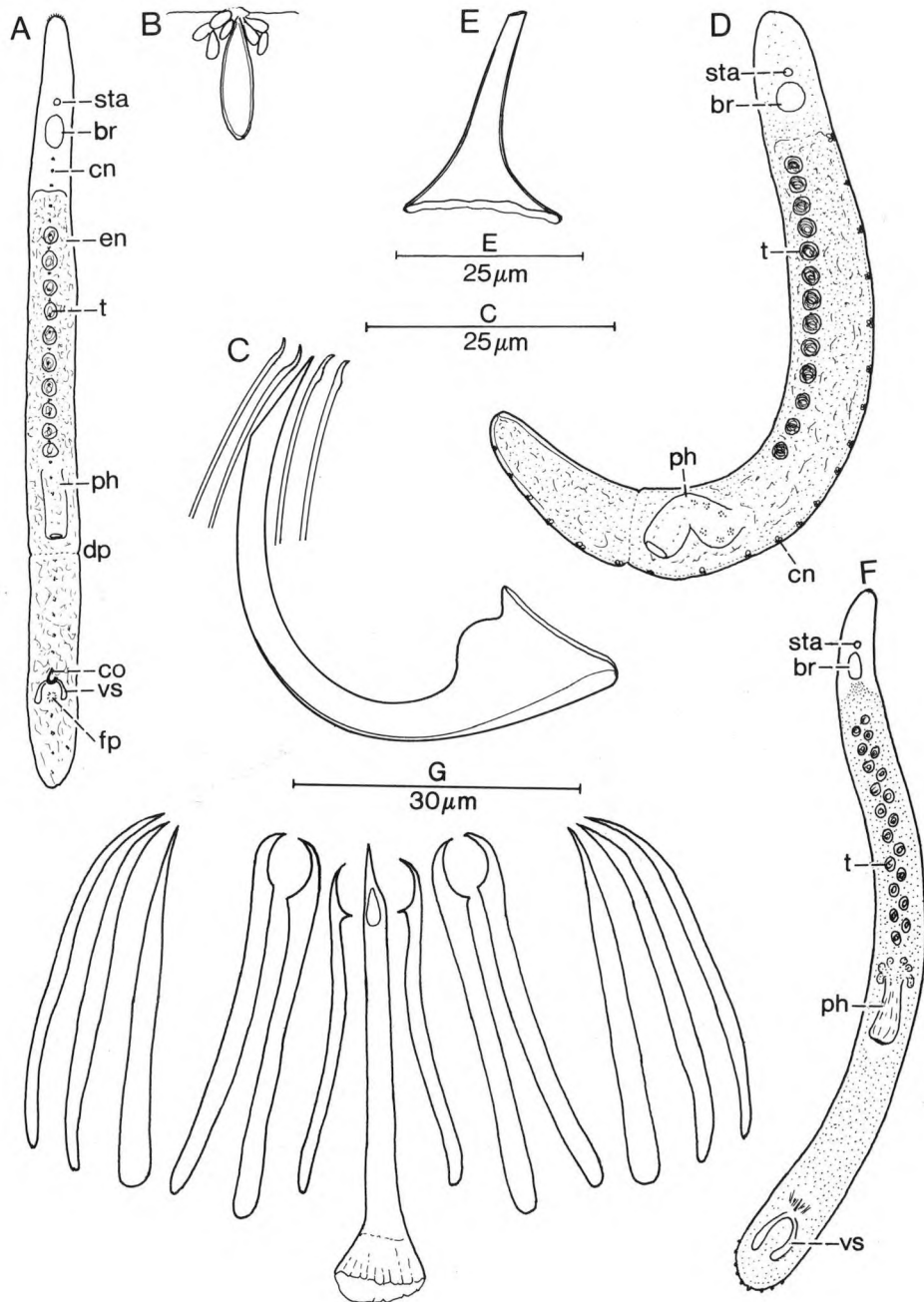


Fig. 17. — A-C, *Archimonocelis basanuddin* n. sp. A, general organisation from a living animal in dorsal view; B, cnidosac; C, hard structures of the copulatory organ. D-E, *Archimonocelis keke* n. sp. D, general organisation from a living animal in lateral view; E, stylet. F-G, *Archimonocelis rhizophoralis* n. sp. F, general organisation from a living animal in dorsal view; G, hard structures of the copulatory organ.

seminalis, a vesicula granulorum and a stylet. The stylet, nearly straight, is not surrounded by spines and is 28 μm long and 21 μm broad at the basis.

Archimonocelis rhizophoralis n. sp. (Fig. 17F, G)

Locality. N Australia, Darwin N.T., Lutmilla Bay, fine sand with mud, intertidal in mangroves, September 1987 (type locality).

Material. Six specimens studied alive and processed for karyological purposes, preserved as squash mounts in lactic-acetic orcein. One mature specimen selected as holotype (LUC No. 127).

Derivation of name. It refers to the environment where the species was found, in sediment among the roots of mangroves (genus *Rhizophora*).

Description. Archimonocelid with about 20 testes, a long tubular pharynx in the second half of the body and a copulatory organ with two separated vesiculae seminales. The copulatory organ is provided with a stylet about 65 μm long, with a broad basis and narrowing into a long tube ending into a point. The opening of the stylet is subterminal and ovoid. The stylet is surrounded by 12 spines, which can be divided into three different groups. Two slender spines about 45 μm long, with hooked tips, constitute the first group, they are lying close to the stylet. Laterally to these, two groups of two spines are situated, they are hooked, 53 μm long and broader than the previous ones. Even more laterally to both groups, on each side a group of three needle-like spines, 45 μm long, with slightly curved tip is present. Between the second and the third group of spines some glands seem to open into the male atrium. In the squeezed animals cnidoblasts were found.

Discussion. All three of the new species described above are considered as belonging to the genus *Archimonocelis* Meixner 1938, due to the presence of cnidoblasts, an apomorphy for the genus (see MARTENS & SCHOCKAERT 1988). All the three species are characterized by the absence of an accessory glandular organ and by the presence of few if any spines around the stylet. *A. keke* n. sp. and *A. itoi* Tajika 1981 are the only species in the genus without spines and are easily distinguishable from each other by the shape of the stylet which is curved and 68 μm long in *A. itoi* and nearly straight and 28 μm long in *A. keke*.

A. hasanuddin n. sp. shares strong similarities with *A. helfrichi* Karling et al. 1972. The stylet of *A. helfrichi* is however less curved and the four accessory bristles consist of rather strong hooks (11-15 μm) with base plates and 29-35 μm long non-cuticular supports (see KARLING et al. 1972: 257, figs 15 and 35). The accessory bristles of *A. hasanuddin* are all of the same kind, are 22 μm long and the distal tip is less hook shaped and 2-3 μm long.

A. rhizophoralis n. sp. can easily be recognized from all the other species by the presence of three different kind of spines, which are arranged symmetrically on both sides of the straight stylet.

BIOGEOGRAPHICAL CONSIDERATIONS

All the species found in South Sulawesi and Northern Australia belong to genera with a wide distribution, in some cases cosmopolitan. On the other hand, all the species found were new. Also in other tropical areas where data on Proseriata fauna

became available recently, Pacific: Hawaii (KARLING et al. 1972), Galapagos (AX & AX 1977); Indian Ocean: Somaliland (SCHOCKAERT & MARTENS 1987, SCHOCKAERT unpubl. data), Kenya (JOUK, unpubl. data); Atlantic Ocean: Bermuda (KARLING 1978, AX & SOPOTT-EHLERS 1985); Canaries (EHLERS & EHLERS 1980) a large portion if not all Proseriata were new to science. Although data are still scanty with regard to the extension into the tropical areas of the world, and some findings could merely reflect the diversity of the habitats sampled by the different authors, the data at our disposal seem to suggest that the tropical Proseriate fauna is highly heterogeneous and probably rich in endemisms.

As far as the distribution of the genera is concerned, a few of them, namely *Monocelis*, *Minona*, *Duplominona*, are cosmopolitan, occurring in all the major biogeographical provinces. Other genera are limited to just a few areas. We are well aware that most investigators have dealt with the North Atlantic area, and that consequently the Proseriate fauna of other regions could be underestimated (but this does not hold for the Galapagos, Bermuda and Brazil). Nonetheless, it is remarkable that the genera basically characterizing the Proseriate fauna of North-West Europe (viz. *Archilopsis* Meixner 1938, *Monocelopsis* Ax 1951, *Borocelis* Westblad 1952, *Paramonotus* Meixner 1938) seem to be completely absent from strictly tropical areas. On the other hand, in Europe genera like *Minona* and *Duplominona* mainly occur in subtidal environments and are limited in the number of species. In the tropical Proseriate fauna, and possibly those of the southern hemisphere as a whole, they are the dominant genera. Here they occur in a much wider range of habitats than in Europe, including fresh-water (*D. amnica*, BALL & HAY 1977), brackish habitats (*M. beaglei*, this study) and intertidally in areas of strong tides (up to 7 m high) as in Darwin, N.T. (*D. cynaroides* and *D. darwinensis*, this study). In general, they are found on open unprotected oceanic beaches (most of the other reports).

These differences in species composition in the different geographical areas support the hypothesis that the dispersal of meiofauna is limited to a small scale (GERLACH 1977). On the other hand, STERRER's theory of dispersal through plate tectonics could account for the occurrence of the cosmopolitan genera (STERRER 1973). Whether or not those genera are older than those with less widespread distribution (a criterium generally accepted in biogeography, WESTHEIDE 1977) can not be ascertained on basis of the data presented here. This can only be clarified by through phylogenetical reconstructions.

ABBREVIATIONS USED IN THE FIGURES

a: atrium; *acg*: accessory glands; *aco*: accessory organ; *acp*: accessory pore; *acs*: accessory stylet; *b*: bursa; *br*: brain; *ci*: cirrus; *cn*: cnidoblasts; *co*: copulatory organ; *dp*: diaphragm; *en*: enteron; *fd*: female duct; *fg*: female glands; *fp*: female pore; *gp*: genital pore; *mp*: male pore; *od*: oviduct; *ov*: ovary; *pg*: prostate glands; *pb*: pharynx; *pp*: penisapilla; *s*: stylet; *sta*: statocyst; *t*: testes; *v*: vagina; *vde*: vas deferens; *vi*: vitellary; *vp*: vaginal pore; *vs*: seminal vesicle.

ACKNOWLEDGEMENTS

Part of this research was conducted during the Snellius II expedition. The first author thanks the organisers of this expedition: the Indonesian Institute of Science (LIPI) and the Netherlands Council for Oceanic Research (NRZ).

We thank Prof. E. Schockaert and A. De Vocht for critical reading the manuscript, Mr and Mrs Withofs-Ievens for technical assistance.

REFERENCES

- AX P. & AX R. 1977. Interstitielle Fauna von Galapagos XIX. Monocelididae (Turbellaria, Proseriata). *Mikrofauna Meeresboden* 64: 1-44.
- AX P. & SOPOTT-EHLERS B. 1985. Monocelididae (Plathelminthes, Proseriata) von Bermuda. *Microfauna Marina* 2: 371-382.
- BALL I.R. & HAY D.A. 1977. The taxonomy and ecology of a new monocelid flatworm from Macquarie Island (Platyhelminthes, Turbellaria). *Bijdragen tot de Dierkunde* 47: 205-214.
- EHLERS B. & EHLERS U. 1980. Zur Systematik und geographischen Verbreitung interstitieller Turbellarien der Kanarischen Inseln. *Mikrofauna Meeresboden* 80: 1-23.
- GERLACH S.A. 1977. Means of meiofauna dispersal. *Mikrofauna Meeresboden* 61: 89-103.
- KARLING T.G. 1966. Marine Turbellaria from the Pacific coast of North America IV. Coelognoporidae and Monocelididae. *Arkiv för Zoologi* 18: 493-528.
- KARLING T.G. 1978. Anatomy and systematics of marine Turbellaria from Bermuda. *Zoologica Scripta* 7: 225-248.
- KARLING T.G., MACK-FIRA V. & DÖRJES J. 1972. First report on marine Microturbellaria from Hawaii. *Zoologica Scripta* 1: 251-269.
- MARCUS E. 1946. Sobre Turbellaria brasileiros. *Boletim da Faculdade de Filosofia, Ciências e Letras, Universidade São Paulo (Zoologia)* 11: 5-254.
- MARCUS E. 1949. Turbellaria Brasileiros (7). *Boletim da Faculdade de Filosofia, Ciências e Letras, Universidade São Paulo (Zoologia)* 14: 7-156.
- MARCUS E. 1950. Turbellaria Brasileiros (8). *Boletim da Faculdade de Filosofia, Ciências e Letras, Universidade São Paulo (Zoologia)* 15: 5-192.
- MARCUS E. 1951. Turbellaria Brasileiros (9). *Boletim da Faculdade de Filosofia, Ciências e Letras, Universidade São Paulo (Zoologia)* 16: 5-216.
- MARCUS E. 1954a. Turbellaria Brasileiros (11). *Papéis Avulsos, Departamento de Zoologia, São Paulo* 11: 419-489.
- MARCUS E. 1954b. Reports of the Lund University Chile Expedition 1948-49. 11. Turbellaria. *Kungliga Fysiografiska sällskapets, Handlingar* 64 (13): 1-115.
- MARTENS E.E. 1986. Comparative ultrastructure of copulatory organs having a stylet in the Proseriata (Turbellaria). *Hydrobiologia* 132: 165-173.
- MARTENS P.M. 1983. Three new species of Minoninae (Turbellaria, Proseriata, Monocelididae) from the North Sea, with remarks on the taxonomy of the subfamily. *Zoologica Scripta* 12 (3): 153-160.
- MARTENS P.M. 1984. Comparison of three different extraction methods for Turbellaria. *Marine Ecology Progress Series* 14: 229-234.
- MARTENS P.M., CURINI-GALLETI M.C. & PUCCINELLI I. 1989. On the morphology and karyology of the genus *Archilopsis* (Meixner) (Platyhelminthes, Proseriata). *Hydrobiologia* 175: 237-256.
- MARTENS P.M. & SCHOCKAERT E.R. 1988. Phylogeny of the digonporid Proseriata. *Fortschritte der Zoologie* 36: 399-403.
- SCHOCKAERT E.R. & MARTENS P.M. 1987. Turbellaria from Somalia. IV. The genus *Pseudomonocelis* Meixner, 1943. *Monitore Zoologico Italiano (Nova Serie) Supplemento* 22: 101-115.
- SOPOTT B. 1972. Systematik und Ökologie von Proseriaten (Turbellaria) der deutschen Nordseeküste. *Mikrofauna Meeresboden* 13: 1-72.
- SOPOTT-EHLERS B. & AX P. 1985. Proseriata (Plathelminthes) von der Pazifikküste der USA (Washington). III Monocelididae. *Microfauna Marina* 2: 331-346.
- STERRER W. 1973. Plate tectonics as a mechanism for dispersal and speciation in interstitial sand fauna. *Netherlands Journal of Sea Research* 7: 200-222.
- WESTHEIDE W. 1977. The geographical distribution of interstitial polychaetes. *Microfauna des Meeresbodens* 61: 287-302.