



11/2011

**Contribution to the knowledge of the Proseriata (Platyhelminthes, Seriata) from eastern Australia: genera *Necia* Marcus, 1950 and *Pseudomonocelis* Meixner, 1938 (partim)**

1943 (oops...!)

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## ABSTRACT

Two monocelidid species from eastern Australia are described. *Necia boreoceloides* n. sp. is characterized by an extremely elongated, adhesive tail, and further distinguished from the only known congeneric species by details of the reproductive system. A Gondwanian origin of the genus *Necia* is proposed. *Pseudomonocelis hoplites* n. sp. differs from congeneric species by the presence of an accessory organ provided with a stylet. The definition of the genus *Pseudomonocelis* is accordingly modified.

**KEY WORDS:** Platyhelminthes - Systematics - Australia - *Necia* - *Pseudomonocelis*.

## ACKNOWLEDGEMENTS

The author is greatly indebted to Dr Lester Cannon (Queensland Museum, Brisbane) for providing opportunity for research in Australia and stimulating discussions on the systematics and biogeography of Australian flatworms and for his critical reading of the manuscript. Dr Ian Lawn and the staff of the Heron Is. Research Station are gratefully acknowledged for providing hospitality and research facilities. Paul Martens arranged the loan of slides of *Peraclistus oophagus* and *Ectocotyia hirudo* from the I.U.C. collection (Diepenheek, Belgium). Zeinab Khalil is thanked for her skillful technical assistance.

## INTRODUCTION

A study of mesopsammic Proseriata (Platyhelminthes: Seriata) from eastern Australia has yielded numerous new species. Previous contributions dealt with the genera *Monocelis* Ehrenberg, 1831, *Pseudomonocelis* Meixner, 1943, *Minona* Marcus, 1946 and *Acanthopseudomonocelis* Curini-Galletti & Cannon, 1995 (Curini-Galletti & Cannon, 1995, 1996, in press a). All these genera present a copulatory organ of the simplex type (see Karling, 1956), a derived character within the Monocelididae according to Litvaitis *et al.* (1996).

The present paper deals with two further species with a simplex copulatory organ: one species of the genus *Necia* Marcus, 1950, and an additional species of the genus *Pseudomonocelis*.

## MATERIALS AND METHODS

Specimens were collected in sandy habitats by scooping up the superficial layer of sediment. Extraction of the animals from the sediment was with MgCl<sub>2</sub> decantation (Martens, 1984). Preservation techniques routinely adopted for Proseriata were used (see Martens *et al.*, 1989). For microscopical analysis specimens were fixed in Bouin's fluid, embedded in 56° C paraplast and serial sagittal sections were cut at 2-4 µm, stained with Mayer's haematoxylin and eosin and mounted in Depex.

Karyological techniques were as described by Curini-Galletti *et al.* (1989). Relative lengths (r.l. = length of chromosome × 100/total length of haploid genome) and centromeric indices (c.i. = length of short arm × 100/length of entire chromosome) were obtained from measurements of camera lucida drawings of five metaphase plates for each species.

Idiograms are based on karyometrical data presented in the karyotype formula: haploid genome absolute length in µm, fundamental number, relative length and centromeric index of each chromosome; chromosome nomenclature in parentheses (m, metacentric; sm, submetacentric; st, subtelocentric; t, acrocentric). The fundamental number is derived according to Matthey (1949) and chromosome nomenclature follows Levan *et al.* (1964).

Holotypes are stored in the collections of the Queensland Museum (S. Brisbane, Queensland, Australia).

## Abbreviations used in the figures

*ad*, "anterior duct"; *ag*, adhesive glands; *ao*, accessory organ; *aob*, accessory organ bulb; *aop*, accessory organ pore; *aos*, accessory organ stylet; *b*, bursa; *cm*, circular muscle fibre(s); *co*, copulatory organ; *fd*, female duct; *fdg*, female duct glands; *fg*, female glands; *fp*, female pore; *ip*, inverted penis; *ma*, male antrum; *mag*, male antrum glands; *mp*, male pore; *ms*, muscle sheath; *od*, oviduct; *ov*, ovary; *pg*, prostate glands; *ph*, pharynx; *r*, rhabdites; *st*, statocyst; *t*, testis; *vd*, vaginal duct; *vdg*, vaginal duct glands; *vi*, vitellary; *vp*, vaginal pore; *vs*, seminal vesicle.

## SPECIES DESCRIPTIONS

Fam. MONOCELIDIDAE Hofsten, 1907

subfam. Monocelidinae Midelburg, 1908

Genus *Necia* Marcus, 1950

*Necia boreoceloides* n. sp.  
(Fig. 1)

*Material examined*

*Holotype*: sagittally sectioned: G 211737; Queensland, Stradbroke Is., Myora Reef, about 20 cm deep at low tide, mixed sediment: coral rubble with silt (July 1993).

*Paratypes*: three specimens sagittally sectioned: G 211738-40; same data as holotype.

*Other material*: two specimens studied karyologically from the type locality. Queensland, Heron Island, in front of the Research Station, about 30 cm deep in coarse coralline sand (October 1993), two specimens studied alive and prepared as whole mounts on one slide (G 211741); one specimen used for karyology.

*Etymology*

The species is named after the monacelid genus

*Boreocelis* Westblad, 1952, which it resembles in general body shape.

*Description*

Active, agile, and very slender animals, slightly less than 1 mm long in whole mounts. Without pigment or pigmented eye spots. Anterior end obtuse, provided with numerous oily droplets and with a few elongate rhabdites. Posterior end elongated into an extremely long tail. The tail is provided with numerous, elongate adhesive glands and with a few large eosinophilous glands, which have a granular content. The cell bodies of these glands are located at the base of the tail, and their necks run through the whole length of the tail and discharge at the caudal tip. The subepidermal longitudinal musculature is strongly developed all over the ventral surface of the body, and particularly around the tail, where the muscle layer is up to 4  $\mu\text{m}$  thick in sections. In living animals, the

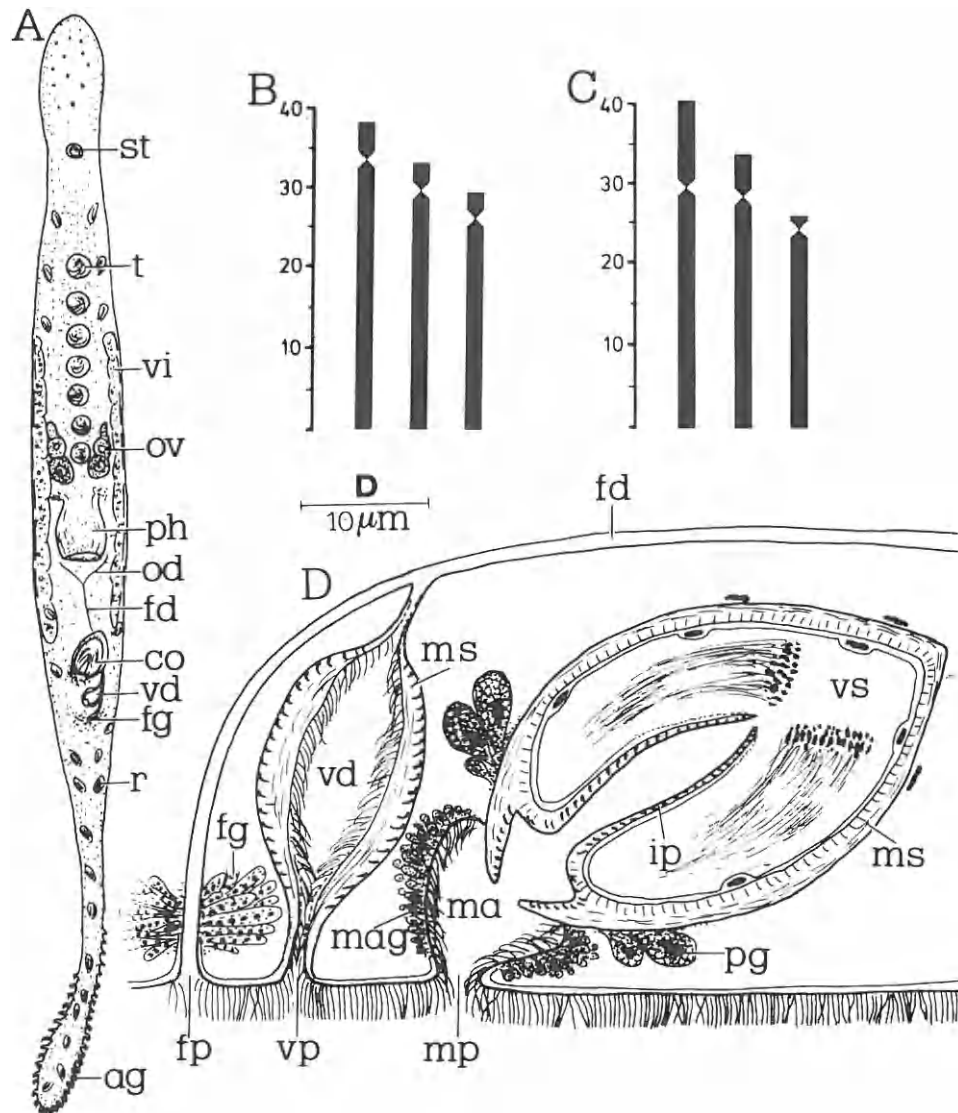


Fig. 1 - *Necia boreoceloides* n. sp. : A, general organization of a living animal; B-C, idiograms of specimens from Myora (B) and Heron Is. (C); D, reconstruction of the copulatory organs from serial sagittal sections.

tail attached to the substrate can be stretched to a considerable extent and suddenly released, with the spring-like effect seen in some long-tailed macrodasyid Gastrotricha. The epidermis, with insunk nuclei, is ciliated, apart from the tail. Cilia are 3–4  $\mu\text{m}$  long. The surface of the whole body is provided with a few very large (up to 13  $\mu\text{m}$  long in sections) ovoid rhabdites. The pharynx, nearly in the middle of the body, is very small (about 40  $\mu\text{m}$  in length), almost as long as broad. It is ciliated (cilia about 2  $\mu\text{m}$  long) apart from its luminal proximal half and its most distal tip, where pharyngeal glands discharge. The oesophagus, with high and nucleated epithelium, is very short, about 1/8 of the total length of the pharynx. Pharynx musculature typical for the subfamily (see for example Curini-Galletti & Cannon, 1995), but with muscle layers very poorly developed.

*Male genital organs:* 6 to 10 testes arranged in one row in front of the pharynx. The copulatory bulb, of the simplex type, is ovoid (30 to 40  $\mu\text{m}$  long and about 25  $\mu\text{m}$  wide in sections). It consists of a seminal vesicle, lined by a nucleated epithelium, surrounded by a thin muscular wall (1–1.5  $\mu\text{m}$  thick), with outer longitudinal and inner circular muscles. The most distal portion of the bulb is inverted, forming a very long (about 20  $\mu\text{m}$ ) inverted penis, with an unciliated and muscular lining, formed mostly by circular muscles. The spermatozoa within the seminal vesicle appear neatly arranged with their nuclei pointing proximally. The male copulatory organ protrudes into the male antrum, forming an obtuse penis papilla. The antrum is large and ciliated. Numerous, tiny eosinophilous glands, easily appreciable in living animals, surround the antrum. The antrum opens to the exterior through a broad male pore.

*Female genital organs:* two ovaries in front of the pharynx. Vitellaria in the middle third of the body. Posterior to the pharynx, the two oviducts fuse into the common female duct. This duct runs posteriorly over the copulatory bulb, where it joins a swollen, ciliated, very muscular (with circular muscle fibres up to 2  $\mu\text{m}$  thick) vaginal duct, which opens to the exterior through a vaginal pore, almost halfway between the male pore and the female pore. The shape of the vaginal duct and the extent of its musculature somehow varied in the specimens studied. In some specimens, the female duct was swollen in front of the vaginal duct to form a sort of postpenial bursa. However, sperm has not been observed in this structure. The female duct opens posteriorly through a female pore. Around the female pore, female glands are present.

#### Karyology

With 3 chromosomes in its haploid set. Karyotype formula of specimens from the type locality:  $8.1 \pm 0.6 \mu\text{m}$ ; NF = 3; Chrom. 1:  $37.80 \pm 1.17$ ;  $13.34 \pm 2.56$  (*st*); Chrom. 2:  $33.22 \pm 1.20$ ;  $12.11 \pm 1.67$  (*t*); Chrom. 3:  $28.98 \pm 0.42$ ;  $11.4 \pm 1.65$  (*t*). The specimen from Heron Is. had a similar karyotype, but with Chrom. 1 less

heterobrachial:  $8.4 \pm 0.3 \mu\text{m}$ ; NF = 4; Chrom. 1:  $40.36 \pm 1.91$ ;  $26.13 \pm 2.06$  (*sm*); Chrom. 2:  $33.76 \pm 1.69$ ;  $15.58 \pm 2.45$  (*st*); Chrom. 3:  $25.87 \pm 1.58$ ;  $6.79 \pm 3.64$  (*t*).

#### Discussion

In the systematics of Monocelididae, great emphasis is placed on the structure of the genital organs and the relative position of the genital pores. Given the relatively few possible combinations, generic attributions based on parallel modifications of the basic body plan might result in non-monophyletic supra-specific taxa. The new species presents a copulatory organ of the simplex type, a postpenial vagina, and is without an accessory organ. The only other species presenting such a combination of features is *Necia sophia* Marcus, 1950 from S. Brazil. The two species markedly differ in habitus. *Necia boreoceloides* n. sp. is a tiny, slender and agile species, with a very long tail. *N. sophia* is a large, stout species, without an elongated tail. Furthermore, in *N. sophia* the vaginal pore is fused with the male pore; its copulatory bulb is much more muscular, with a short penis papilla. The relatively very long pharynx of *N. sophia* is provided with a large oesophagus, about half the length of the pharynx; luminally, it is ciliated only in its distal fourth (Marcus, 1950).

The obvious differences between the two species can raise the question of whether their lumping into a common genus is justified. However, the major differences in habitus are plausibly related to different life-styles: *N. boreoceloides* is a characteristic representative of the interstitial meiofauna; while *N. sophia* lives on sea-weeds (Marcus, 1950). In addition to the postpenial position of the vagina, in both species a prepenial bursa derived from a differentiation of the female duct is absent, and the vaginal duct is provided with an unusually thick and homogeneous coating of circular muscles. Based on character distribution in the Monocelididae, the postpenial vagina, the absence of a prepenial bursa and the very muscular vaginal duct appear as rare derived features, and I consider them as synapomorphies shared by *N. sophia* and the new species. Furthermore, Marcus (1950) reports the existence of large eosinophilous glands, with granular content, in the tail of *N. sophia*, which might be homologous to those found in the tail of *N. boreoceloides*. Based on the above data, the attribution of the new species to the genus *Necia*, and the monophyletic status of the genus itself, seem therefore justified.

*Necia boreoceloides* is relatively common at Myora Reef, a tiny (few hundred square metres), isolated coral patch reef in Moreton Bay, close to the southern edge of distribution of coral reefs on Australia's east coast (Wilson & Allen, 1987). The species has been found nowhere else on the mainland. A few specimens referred to the same species have been found on Heron Is. in similar sediment (coral rubble). Anatomical reconstructions of the latter are not available; their karyotype

significantly differs from specimens from the type locality in the centromeric index of Chrom. 1, which is less acrocentric ( $P \ll 0.01$ ; two tailed  $t$ -test,  $DF = 8$ ). Data are too few for a comparative assessment of the status of the two populations. The Myora population appears anyway extremely isolated, and, given its apparently strict sediment requirements, areas suitable for the species lie at present far from Moreton Bay (basically north of Hervey Bay, about 300 km from Myora). This fact, coupled with the limited dispersal of most unpigmented meiobenthic Platyhelminthes (Armonies, 1989), implies that the number of migrants among the Myora and neighbouring populations may be negligible, if any. There are, therefore, grounds for a divergence in allopatry for the Myora population, as reflected by the karyotype. A comparable process has been observed in other Myora populations and species of Proseriata (Curini-Galletti & Cannon, 1995; our unpubl. data). It cannot thus be excluded that further studies will reveal that the Heron Is.

population deserves a distinct taxonomic position.

The genus *Necia* appears of particular biogeographical interest. Its distribution limited to S. America and Australia is highly suggestive of a Gondwanian origin. While the break-up of Gondwanaland has been already evoked to explain the distributional patterns of several groups of Tricladida (Ball & Fernando, 1969; Ball, 1974, 1975; Sluys, 1989, 1995), this, to my knowledge, is the first Proseriate genus whose Gondwanian ancestry has been proposed.

Genus *Pseudomonocelis* Meixner, 1943

*Pseudomonocelis hoplites* n. sp.

(Fig. 2)

*Material examined*

*Holotype*: sagittally sectioned (G 211742); Australia, Queensland, Caloundra, Shelly Beach, about 15 cm deep

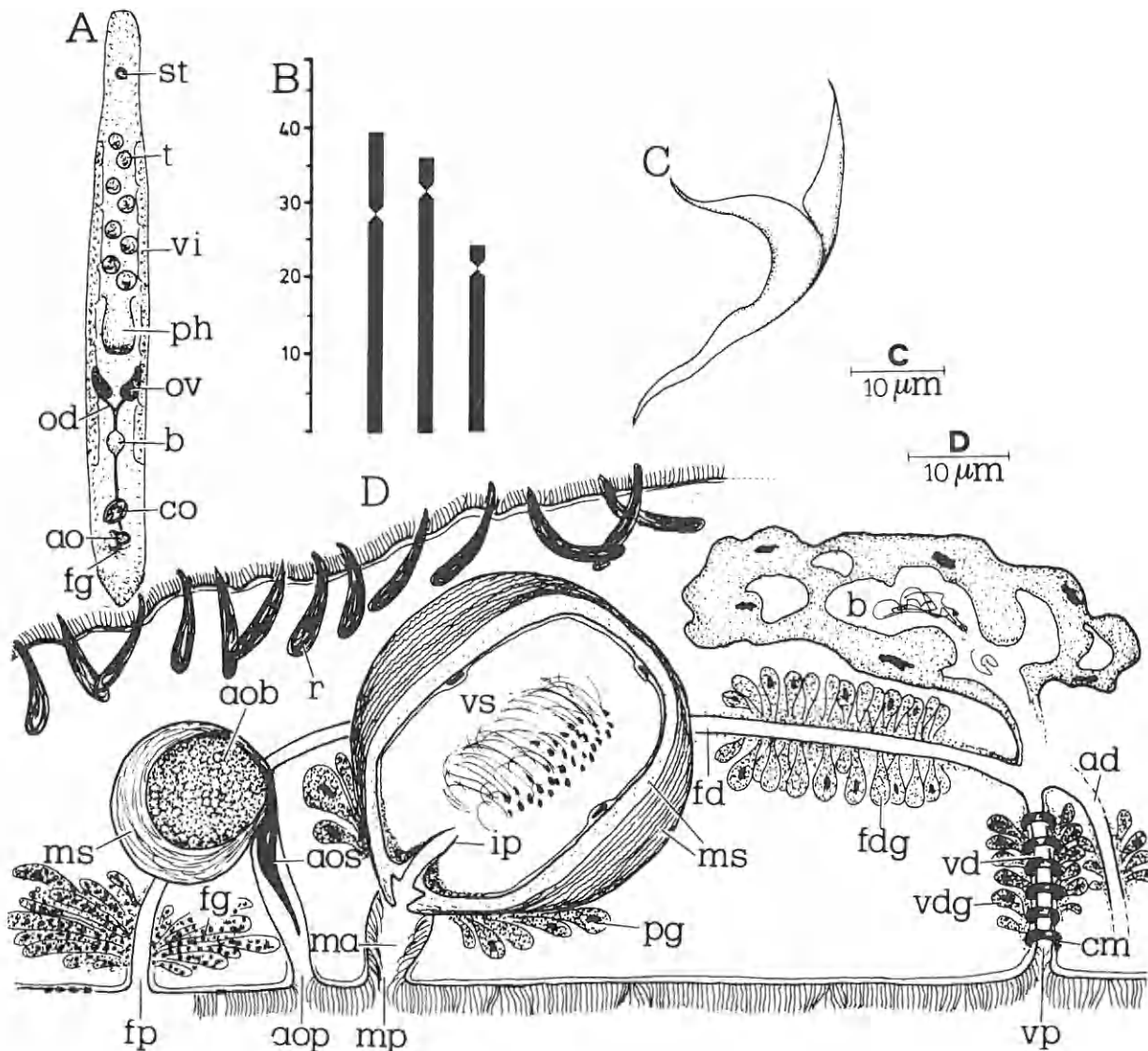


Fig. 2. *Pseudomonocelis hoplites* n. sp.: A, general organization of a living animal; B, idiogram; C, accessory organ stylet from a karyological slide; D, reconstruction of the copulatory organs from serial sagittal sections.

*Chaetonotus (Euchaetonotus) mediterraneus*  
n. sp. (Fig. 3)

*Diagnosis* – A small *Chaetonotus* of the *Euchaetonotus* subgenus, with total length to 112 µm; PhJIn at U30; head slightly five-lobed, bearing a large cephalion, two pairs of pleuria and hypostomion; head, neck and trunk well-defined; furca of medium length, 22.6 µm, indenting to U89; ratio of fleshy:naked portion 1:2. Body enveloped by 17 columns (9 dorsal, 1+1 lateral) each of 19-20 round to elliptical scales with a weak keel extending in a long simple spine; dorsal and lateral spines bear a narrow lamellar expansion. Two pairs of round scales on the dorsal edge of the furca, the medial one with short spines and the lateral one carrying long notched spines. Four small, keeled scales located dorsally just at the base of each adhesive tube. Of the ventrolateral columns, the two more ventral per side only occur in the trunk region and are composed of 10 spined scales each. Interciliary field bare. Ventrally, two pairs of pear-shaped scales with a keel extending in spiny process occur near the anus; four small, elliptical, and spined scales lie on the fleshy base of each furcal branch. Ventral ciliature forms two longitudinal bands that are connected behind the hypostomion.

*Etymology* – The species name alludes to its type locality.

*Description* – The description is based on an adult specimen, 112 µm in total length; pharyngo-intestinal junction (PhJIn) at U30. Head slightly five-lobed, with a cephalion 9.0 µm wide, two pleuria per side and a rectangular hypostomion behind the mouth, 3.0 µm in length × 6.5 in width. Body small, robust, with well-defined head, neck, trunk and caudal base, whose widths are 20.6/15.2/27.0/15 µm at U08/U34/U55/U81, respectively; furca of medium length, 22.6 µm, U-shaped and indenting medially to U89; adhesive tubes attain 15.4 µm in length. On either side of the head are two distinct tufts of five-six cilia each; the anterior tufts include two-three very long cilia, 17.6-18.0 µm. A pair of dorsal tactile bristles, 8-10 µm long, is borne at U78 by two small, subtriangular, and double-keeled scales.

*Cuticular armature*: the body is enveloped by 17 non-overlapping columns (7 dorsal, 1+1 lateral) of 18-20 spined scales each. Dorsal and lateral scales are round on the head, 3.5-4.0 µm in diameter, and elliptical on the trunk, 4.0-6.2 µm in length; they all have a weak keel extending in a simple, thick, and curved spine, which is provided with a narrow lamellar expansion anteriorly along its whole length. The length of the spines increases from the head, 2.4-3.5 µm, to the trunk, 9.2 µm. The last spine of each lateral column, arising at U82, is particularly long, 11.4 µm. At the dorsal posterior end, a series of four keeled and spined scales edge the furcal indentation: the lateral scales are larger, 3.6-3.8 µm, and bear distally notched spines, 5.4 µm long; the medial ones, 2.2-2.5 µm, have simple spines of 2.5 µm. Additionally, a couple of small, keeled scales delimit distally the fleshy part of each furcal branch. The spines of the ventrolateral columns (3+3) have no lamellae and decrease in length from the lateral to ventral side. The ventral interciliary field is bare. At the ventral posterior end, two pairs of pear-shaped, keeled scales, 7.2 µm in length, with short spines, 4 µm, occur near the anus.

Four small, elliptical, and spined scales, 2.5-3.5 µm cover the ventral base of each furcal branch.

*Ventral ciliation*: paired longitudinal bands extend from U5 to U75; each is wider in the head region and narrows from the neck region; the rows are connected behind the hypostomion, but remain separate throughout the rest of their length; cilia are short, ca. 6-7 µm.

*Digestive tract*: the mouth is subterminal and wide, 7.5 µm. The pharynx, 26.3 µm in length, is subcylindrical with a slight anterior swelling where two cuticular rods occur; anus opens ventrally at U75.

*Reproductive tract*: all the specimens observed were in parthenogenetic phase and no spermatozoa were seen.

*Ecology* – Frequency of occurrence: sparse in littoral and shallow sublittoral fine-medium sand samples along the western coast of Italy; sparse in littoral fine sand elsewhere. Abundance: rare to scarce in samples where found.

*Distribution* – Type locality: Liguria - Albissola (44°18' N; 0.8°21' E) (SL) (see Hummon *et al.*, 1996). Other locations: Porto Nuovo (SL), Pozzuoli (SL).

*Remarks* – The only species of the subgenus *Euchaetonotus* with dorsal spines bearing lamellar expansions is *Chaetonotus tempestivus*. However, many morphological features distinguish the latter species, like its peculiar pleuria, the different arrangement of scales at the posterior dorsal and ventral end, and the shape of the lamellar expansions of the spines that are also much shorter (cf. Mock, 1979, Fig. 18). Dorsal lamellar expansions are present also in some species of the genus *Halichaetonotus*, like *H. jucundus* and *H. paradoxus*, but they always coexist with similar expansions of the ventrolateral scales (hydrofoil scales), which have an hydrodynamic function and characterize all the species of this genus.

Genus *Halichaetonotus* Schrom, 1972

*Halichaetonotus italicus* n. sp.  
(Figs 4, 5)

*Diagnosis* – A small *Halichaetonotus*, with total length to 114 µm; PhJIn at U28; head slightly three-lobed, with cephalion, and two pairs of small pleuria; hypostomion not seen; head and trunk well-defined; furca, 20.7 µm, indenting to U84; ratio of fleshy: naked portions 3:5. Body enveloped by 19 columns (9 dorsal, 1+1 lateral) each of 17-19 round to elliptical scales with prominent keels; a pair of hemi-elliptical, keeled scales on the dorsal fleshy furcal base; two ventrolateral columns (1+1) of 16 round hydrofoil scales with spinous lamellae; 6 (3+3) ventral columns of round, small scales with tiny spines. The interciliary field is bare; ventrally, a pair of elliptical keeled scales occur near the anus, and two small keeled scales per side lie on the inner edge of the furcal base. Ventral ciliature in two bands connected behind the mouth. Pharynx 29.7 µm, with two swellings; PhCv present. Hermaphroditic species with a large X-organ and thread-like spermatozoa.

*Etymology* – The species name refers to the geographical location of the type locality.

*Description* – The description is based on an adult,



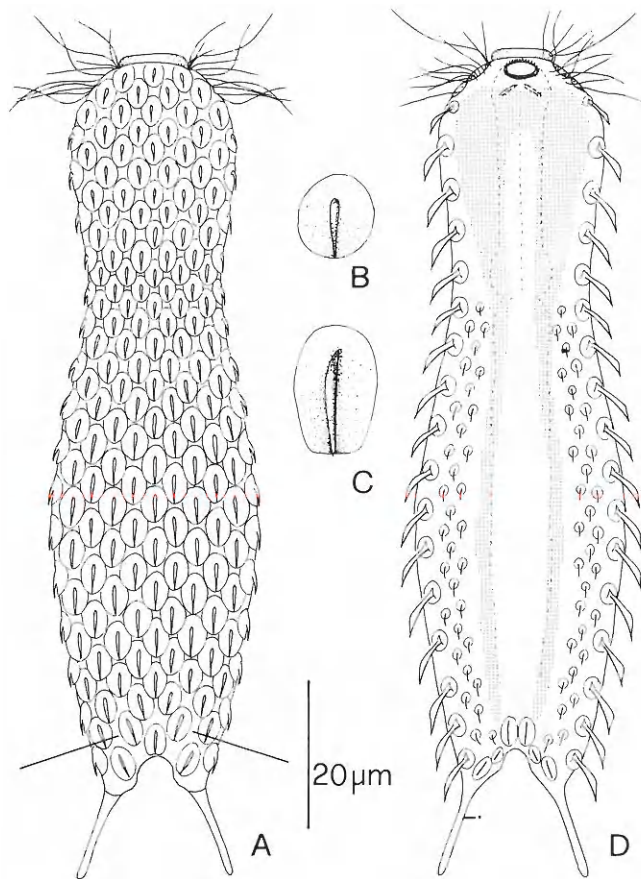


Fig. 4 - *Halichaetonotus italicus* n. sp. A, dorsal view; B and C, dorsal scales; D, ventral view. Dotting mimics the locomotory ciliature.

hermaphroditic specimen, 114  $\mu\text{m}$  in total length; pharyngo-intestinal junction (PhJIn) at U28. Head three-lobed, with a cephalion 9  $\mu\text{m}$  wide, and two very small pleuria per side; a hypostomion was not observed. Body small, slender, with head and trunk well-defined; widths of head/neck/trunk/caudal base are 23/19/29/14  $\mu\text{m}$  at U10/U27/U57/U91, respectively; furca 18  $\mu\text{m}$  long, which indents medially at U84 and has long adhesive tubes, 12.6  $\mu\text{m}$ . On either side of the head are two tufts of cilia connected with one another by some short cilia: the anterior comprises five cilia, 3-15  $\mu\text{m}$  in length, and the posterior five-six cilia, 10-14  $\mu\text{m}$ . One pair of dorsal bristles, 8  $\mu\text{m}$  long, arises at U83.

**Cuticular armature:** the body is enveloped by 19 columns (9 dorsal, 1 + 1 lateral) of 17-19 round to elliptical, keeled scales, 3-5  $\mu\text{m}$  long, and slightly overlapping. Posteriorly, a pair of hemi-elliptical, keeled scales, 4.7  $\mu\text{m}$  in length, cover the dorsal side of the fleshy furcal base. The two (1 + 1) ventrolateral columns are composed of 17 small, round hydrofoil scales, 2.5-3.0  $\mu\text{m}$  in diameter, bearing small spinous lamellae, 5.7-7.0  $\mu\text{m}$  long. The other ventrolateral columns (3 + 3) occur bilaterally throughout the trunk region, between the hydrofoil scales and the ciliary bands: each column is made of 10-12 small, round scales, 1-2  $\mu\text{m}$  in diameter,

with short and thin spines, 1-2  $\mu\text{m}$ . The intercalary field is bare; a pair of elliptical keeled scales, 4.1  $\mu\text{m}$  long, occur near the anus, and two small, keeled scales, 1.5-2.5  $\mu\text{m}$ , lie along each medial edge of the furcal base.

**Ventral ciliation:** paired longitudinal bands extend from U05 to U81; each is broader anteriorly but narrows from the anterior intestinal region; the bands meet medially behind the mouth; cilia are 7-9  $\mu\text{m}$  in length.

**Digestive tract:** the mouth is subterminal and of medium width, 5  $\mu\text{m}$ ; the pharynx, 29  $\mu\text{m}$  in length, is 5.5  $\mu\text{m}$  wide in the middle region, but shows swellings at both ends, 7.5  $\mu\text{m}$  wide the anterior and 9.5  $\mu\text{m}$  the posterior; a well-developed pharyngeal chevron (PhCv) is present anteriorly; the anus opens ventrally at U81.

**Reproductive tract:** one of the specimens observed was in hermaphroditic phase, showing a large, bilobate X-organ surrounding the posterior intestine, and two clews of thread-like spermatozoa lateral to the mid-intestine (Fig. 5); immature oocytes were seen laterally along the posterior half of the intestine.

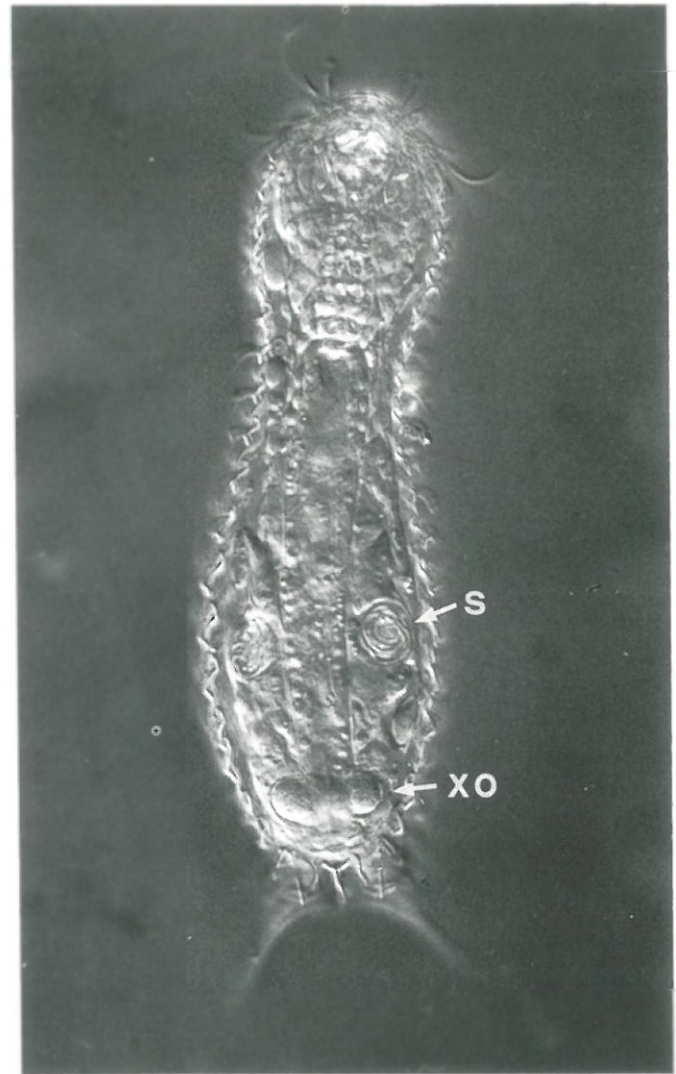


Fig. 5 - *Halichaetonotus italicus* n. sp. Habitus of the hermaphroditic specimen; s, spermatozoa; xo, X-organ (Nomarski optics,  $\times 1100$ ).

*Ecology* – Frequency of occurrence: sparse in littoral fine sand of the central Adriatic Sea and in shallow sublittoral fine sand of the central Tyrrhenian Sea. Abundance: rare to scarce in samples where found.

*Distribution* – Type locality: Apulia - Torre Fortore (41°56' N; 15°21'E), north of Lesina, beyond the lagoon of Lesina (L). Other location: Bagnara (SL).

*Remarks* – The suboval shape and the well-developed keel of the dorsal scales, as well as their regular arrangement approach these specimens to *Halichaetonotus riedli*, *H. decipiens* and *H. thalassopais*. The latter two species have also the same number of columns and of scales per column, and similar main metric parameters. However, all these species differ from the specimens observed in the morphology of the ventral posterior end. Similar hydrofoil scales are described for *H. pleuracan-*

*thus*, which is however a much larger species (150-170 µm total length vs 104-114 µm), and bears also dorsal scales morphologically different.

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