



Italian marine Gastrotricha: I. Six new and one redescribed species of Chaetonotida

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ABSTRACT

The species *Chaetonotus lacunosus* Mock, 1979 is redescribed and refigured from specimens collected in littoral and shallow sublittoral sediments along the entire Italian coastline of the Mediterranean Sea and its adjacent waters. Six species new to science are described and figured: *Chaetonotus apechochaetus*, *C. apolemmus*, *C. siciliensis*, *Halichaetonotus etrolomus*, *H. margaretae*, and *H. thalassopais*. The proper nomenclature for *Halichaetonotus decipiens* (Remane, 1929) is noted, and a new combination is given: *Musellifer delamarei* (Renaud-Mornant, 1968) n. comb.

KEY WORDS: Gastrotricha - Chaetonotida - Italy - Meiofauna - Mediterranean Sea - Taxonomy.

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INTRODUCTION

The present study is part of a larger program of biogeographic and faunistic surveys whose goal is the improvement of our knowledge about the nature, origin and distribution of the Italian fauna. As preparation for two forthcoming volumes of the *Fauna d'Italia* dedicated to gastrotrichs, we began in 1988 to study as extensively as possible the species that live along the entire Italian coastline. Our investigation thus far has discovered numerous species of both chaetonotids and macrodasyids that are new to the Italian fauna or new to science. The first results of this research are presented in the present paper and those of Balsamo *et al.* (1992), Todaro (1992), Todaro *et al.* (1992) and Hummon *et al.* (1993).

The first species of marine Gastrotricha that was reported from Italy was a macrodasyid described by Claparède (1867), the first chaetonotids being described by Grünspan (1908). Subsequently, several workers have studied marine chaetonotid gastrotrichs in the region of Naples and the Tyrrhenian Sea: Wilke (1954), Renaud-Mornant (1968), Todaro *et al.* (1988), Balsamo *et al.* (1992), and Todaro (1992). Some have worked in the Adriatic Sea: De Zio & Grimaldi (1964), Schrom (1966a, 1972, in Riedl, 1970), and Hummon *et al.* (1990). Others have worked in the Ligurian Sea: Gerlach (1953), Luporini *et al.* (1971, 1973), and Luporini & Tongiorgi (1972), and in the Ionian Sea: Balsamo & Todaro (1987).

Prior to our current extensive study, Italy was already the best known country in the Mediterranean region with respect to its marine gastrotrich fauna. There were 92 species known from the Italian Mediterranean based on the study of 42 sites (52 Macrodaysida, representing 17 of the 25 genera then known the world over, plus 40 Chaetonotida, representing all 10 genera that have marine representatives). Following our work during the summer of 1989 these numbers were raised to 144 total species based on 109 sites (74 Macrodaysida; 70 Chaetonotida). By comparison, 117 species are known from the British Isles based on 137 sites (73 Macrodaysida; 44 Chaetonotida), and 146 species from the remainder of Northern Europe based on 222 sites (78 Macrodaysida; 68 Chaetonotida) [WDH, unpublished data].

In this paper we concentrate on seven species of Chaetonotida. Biogeographical data for these species are given in the distribution section under each species; information regarding locations is summarized in Figure 1 and Table I. Data on previously described species that we have amassed, and are continuing to collect, will be published separately. However, they may be made available in tabular form to persons working with marine Gastrotricha who need of cross-referenced information about species and sites.

Here we redescribe and refigure the species *Chaetonotus lacunosus* Mock, 1979 from specimens collected among littoral and shallow sublittoral sediments around the Italian coastline of the Mediterranean Sea and its adjacent waters. Six species new to science are described



Fig. 1 - Location of sampling sites.

and figured: *Chaetonotus apechochaetus*, *C. apolemmus*, *C. siciliensis*, *Halichaetonotus etrolomus*, *H. margaretae*, and *H. thalassopais*. Some have restricted distributions, and others quite broad distributions around Italy. The proper nomenclature for *Halichaetonotus decipiens* (Remane, 1929) is discussed, and a new taxonomic combination is given: *Musellifer delamarei* (Renaud-Mornant, 1968) n. comb., which transfers this species from the genus *Polymerurus* to the genus *Musellifer*.

MATERIALS AND METHODS

Species were obtained from our standard collection scheme at each location (representing a place with a specific set of map coordinates), usually sandy sediments from two sites (representing different habitats) - littoral (L) and shallow sublittoral at 1.5 m depth (S). When other habitats were present, shallow sublittoral samples were extended inward to include nearshore bars at 0.8-1.0 m. Sometimes samples were extended outward to include depths up to 3 m, usually when coarse sands or gravels were encountered in the standard littoral and/or sublittoral sites. Occasionally samples were taken at medium sublittoral depths, 4-10 m (M), typically when a location had no beach. Sediments were placed in 2-liter plastic bags and a small quantity of sea water added, or they were placed in 0.25 liter plastic whirl-top bags and after closing excess water was allowed to drain. They were transferred within 24-48 h to the laboratory where they

TABLE I - Locations in Italy at which new species have been found, along with sites sampled and persons involved in the collections.

Location	Latitude/Longitude	Sites	Collectors
LIGURIA:			
Diano Marina (San Remo)	43° 54'N; 08° 05'E	LS	G # 11
San Remo	43° 48'N; 07° 46'E	S	G # 11
TUSCANY:			
S. Andrea (Isola d'Elba)	42° 48'N; 10° 07'E	LS	G # 5
Torre al Bagno (Isola di Capraia)	43° 47'N; 09° 50'E	SM	G # 6
Campese (Isola del Giglio)	42° 22'N; 10° 52'E	SM	G # 5
Cannelle (Isola del Giglio)	42° 21'N; 10° 54'E	S	G # 5
Cavo (Isola d'Elba)	42° 51'N; 10° 25'E	LS	G # 5
Fetovaia (Isola d'Elba)	42° 43'N; 10° 08'E	LS	G # 5
*Marina di Donoratico (Grosseto)	43° 09'N; 10° 40'E	S	G # 1
Tombolo di Feniglia (Orbetello)	42° 24'N; 11° 14'E	LS	G # 1
Tombolo di Giannella (Orbetello)	42° 27'N; 11° 09'E	LS	G # 1
Secche della Meloria (Livorno)	43° 32'N; 10° 16'E	S	G # 1
*Mortelliccio (Follonica)	42° 56'N; 10° 41'E	LS	G # 1
Cala della Mortola (Isola di Capraia)	43° 49'N; 09° 49'E	S	G # 6
Seno della Perruccia (Isola di Capraia)	43° 47'N; 09° 48'E	M	G # 5
Marina di Pisa (Pisa)	43° 44'N; 10° 16'E	LS	G # 1
Punta del Recisello (Isola di Capraia)	43° 47'N; 09° 48'E	M	G # 6
Porto Vecchio (Isola di Capraia)	43° 48'N; 09° 49'E	M	G # 6
Zuccale (Isola d'Elba)	42° 44'N; 10° 20'E	M	G # 5
LATIIUM:			
Circeo (Terracina)	41° 15'N; 13° 02'E	LS	G # 10
Cala la Fonte (Isola di Ponza)	40° 56'N; 12° 58'E	S	G # 9
Chiaia di Luna (Isola di Ponza)	40° 53'N; 12° 57'E	S	G # 9
Lido dei Pini (Anzio)	41° 31'N; 12° 32'E	LS	G # 10
Torre Scissura (Gaeta)	41° 14'N; 13° 29'E	LS	G # 12
Serapo (Gaeta)	41° 12'N; 13° 33'E	LS	G # 10

(continued)

(continued)

Location	Latitude/Longitude	Sites	Collectors
CAMPANIA:			
Bagnetielli (Isola d'Ischia)	40° 44'N; 13° 55'E	M	G # 12
Marina di Camerota (Sapri)	40° 00'N; 15° 21'E	LS	G # 12
Chiaia (Isola d'Ischia)	40° 44'N; 13° 51'E	LS	G # 3
Citara (Isola d'Ischia)	40° 43'N; 13° 51'E	LS	G # 3
Cuma (Napoli)	40° 52'N; 14° 01'E	LS	G # 3,12
Lido di Fusaro (Napoli)	40° 50'N; 14° 01'E	LS	G # 3,12
Spaggia degli Inglesi (Isola d'Ischia)	40° 44'N; 13° 56'E	M	G # 12
Spaggia Ischia porto (Isola d'Ischia)	40° 44'N; 13° 56'E	LS	G # 12
Paestum (Salerno)	40° 25'N; 14° 58'E	LS	G # 12
Palinuro (Sapri)	40° 00'N; 15° 15'E	LS	G # 12
* Posillipo (Napoli)	40° 49'N; 14° 12'E	LS	G # 3
Pozzuoli (Napoli)	40° 50'N; 14° 06'E	LS	G # 12
Lido di Procida (Isola di Procida)	40° 45'N; 14° 00'E	LS	G # 3
Torregaveta (Napoli)	40° 47'N; 14° 02'E	LS	G # 12
SICILY:			
Cefalù (Messina)	38° 02'N; 14° 00'E	LS	G # 4
* S. Vito Lo Capo (Trapani)	38° 10'N; 12° 45'E	LS	G # 4
APULIA:			
Alimini (Lecce)	40° 12'N; 18° 26'E	LS	G # 2
San Cataldo (Lecce)	40° 22'N; 18° 18'E	LS	G # 2
* Torre Fortore (Foggia)	41° 54'N; 15° 21'E	LS	G # 2
* Marina di Ginosa (Taranto)	40° 25'N; 16° 49'E	LS	G # 2,4
San Isidoro (Lecce)	40° 13'N; 17° 54'E	L	G # 2
Torre Lapillo (Lecce)	40° 16'N; 17° 51'E	LS	G # 2
Santa Maria di Leuca	39° 47'N; 18° 18'E	M	G # 2
Porto Nuovo (Gargano)	41° 51'N; 16° 11'E	LS	G # 2,10
Torre Vado (S. Maria di Leuca)	39° 49'N; 18° 15'E	LS	G # 2
Baia verde (Gallipoli)	40° 00'N; 17° 59'E	S	G # 2
Vieste (Gargano)	41° 52'N; 16° 10'E	LS	G # 10
MOLISE:			
Termoli (Pescara)	42° 00'N; 14° 59'E	LS	G # 2
THE MARCHES:			
San Benedetto del Tronto	42° 47'N; 13° 53'E	LS	G # 2
Numana (Ancona)	43° 25'N; 13° 36'E	L	G # 2
Pesaro (Rimini)	43° 25'N; 13° 36'E	L	G # 2
FRIULI:			
Bibione (Venezia)	45° 37'N; 13° 02'E	LS	G # 11
Foce dell'Isonzo (Trieste)	45° 45'N; 13° 31'E	LS	G # 11
CORSICA, FRANCE:			
Ruppione (Ajaccio)	41° 55'N; 08° 45'E	L	G # 4

For simplicity, the collecting locations are given in the text in abbreviate form by the name the capital letter of which is in bold-face type in the Table.

* = Type locality for one of the new species described herein.

Sites sampled: L = Littoral; S = Shallow sublittoral (usually 1.5 m, sometimes 0.8-3.0 m); M = Medium sublittoral (4-10 m). Collections made by: Groups #1, 2 - VI, VII.1989 (WDH, MAT, MB & Paolo Tongiorgi); Group #3 - VII.1989 (WDH & MAT); Group #4 - IX.1989 (MAT & BM; see also Todaro & Balsamo, In press); Groups #5, 6, 7, 8 - IX.1989, V, VI, IX.1990 (BM, MAT & P. Tongiorgi; see also Balsamo, Todaro & Tongiorgi, 1992); Group #9 - VI.1990 (MAT & P. Tongiorgi see also Todaro, 1992); Groups #10, 11 - VI, VII.1991 (MAT & Wayne A. Evans); Group #12 - VIII.1991 (WDH, MAT & Margaret R. Hummon).

were oxygenated. Bags were routinely insulated from ambient heat during daytime hours and were exposed to cool air at night, during transfer. In the laboratory samples were stored at 14° C.

Gastrotrichs were extracted from the sediments by narcotization and decantation technique using 7% MgCl₂. Specimens were observed *in vivo* with differential interference contrast optics using a Leitz Dialux 20, a Zeiss Photomicroscope one, or a Nikon Labphot-2 microscope. Measurements were taken by ocular micrometer and are reported in μ m. Locations of morphological characters along the

length of the body are given in percentage units (U) measured from anterior to posterior (cf. Hummon, 1974). Specimens were photographed or images of living specimens recorded on high resolution videotape. Photographic negatives of holotypes and paratypes of the new species are deposited at the Museo Civico di Storia Naturale in Verona (Italy). The videotapes form part of the Invertebrates Collection at Ohio University, Athens, Ohio (U.S.A.).

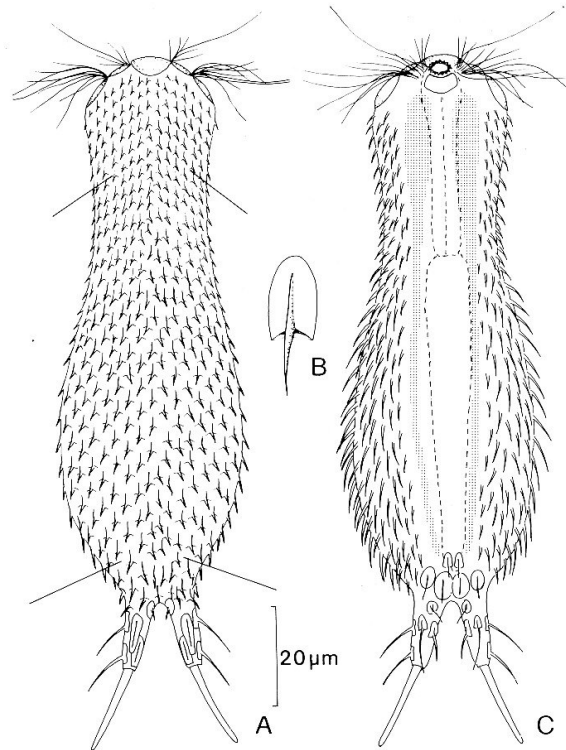
A set of morphological and ecological conventions used in this paper are given in Table IIA, B.

TABLE IIIA - Key to morphological symbols and conventions:

Lt:	Length, total, from anterior tip of head to posterior tip of caudum and its adhesive tubes
U:	Percentage units of Lt from anterior to posterior
PhCv:	Pharyngeal chevron
PhJIn:	Junction between pharynx and intestine
Columns:	longitudinal in orientation
Rows:	transverse in orientation

TABLE IIIB - Key to ecological characteristics:

Frequency of a species from among a sample series:	
Sparse:	less than 10% of samples
Occasional:	10-30% of samples
Common:	30-60% of samples
Usual:	more than 60% of samples
Abundance of a species among other species of a sample:	
Rare:	less than 1% of a sample
Scarce:	3-5% of a sample
Numerous:	10-20% of a sample (often a sub-dominant)
Prevalent:	more than 30% of a sample (usually a co-dominant or dominant)

Fig. 2 - *Chaetonotus apechochaetus* n. sp. A, dorsal view; B, dorsal scale; C, ventral view. Dotting mimics the locomotory ciliature.

TAXONOMIC ACCOUNT

Order **Chaetonotida** Remane, 1925
[Rao & Clausen, 1970]

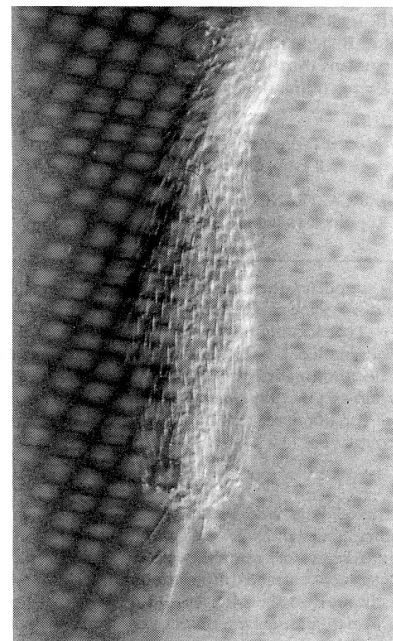
Family CHAETONOTIDAE Zelinka, 1989
sensu Hummon, 1974

Genus *Chaetonotus* Ehrenberg, 1830

Chaetonotus apechochaetus n.sp.
(Figs. 2-4)

Diagnosis - A medium-sized *Chaetonotus* of the «*maximus*» group; total length to 140 µm; PhJIn at U29; head five-lobed, bearing cephalion, two pairs of pleuria and hypostomion; well-defined trunk follows minor neck constriction; furca long, indenting to U79; ratio of fleshy: naked portions 2:3. Body enveloped by 29 columns (17 dorsal, 6+6 ventral), each having 21 small hemi-elliptical scales with keels that extend to form short spines; the 6 columns of ventral scales per side lie outside the ciliary bands and bear spines longer than the dorsal scales, the lateral most being longest; interciliary field is bare; 2 long keeled scales and 2 spined scales lie on the dorsal and lateral surfaces of each caudal branch; 3 pairs of keeled scales with short spines occur ventrally on the caudal base; 3 other spined scales lie on the fleshy part of each furcal branch. Ventral ciliature forms two separate longitudinal bands.

Etymology - The name refers to the dissimilar types of spines that are borne on the furca relative to those borne on the remainder of the body (*apechy*, Gk. discordant; *chaite*, Gk. hair, spine).

Fig. 3 - *Chaetonotus apechochaetus* n. sp. Habitus. Nomarski optics, x700.

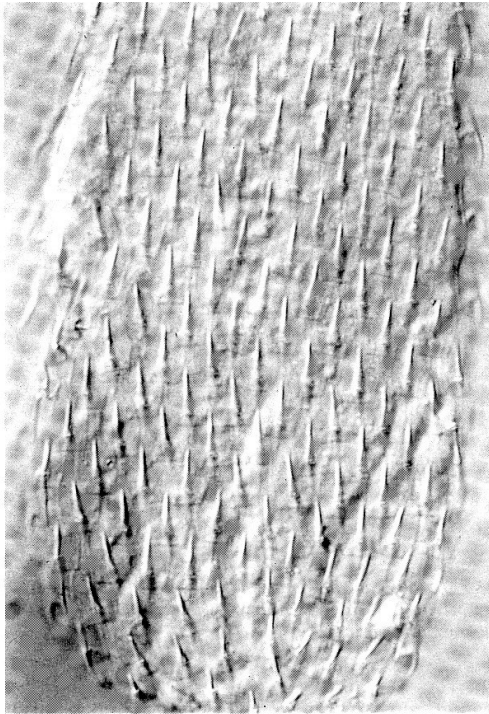


Fig. 4 - *Chaetonotus apechochaetus* n. sp. Dorsal scales of the trunk. Nomarski optics, $\times 2000$.

Description - The description is based on an adult specimen, 140 μm in total length. Pharynx 39 μm in length from the front edge of the mouth to the junction with the intestine; pharyngo-intestinal junction at U29. Head indistinctly five-lobed, with a cephalon that is 9 μm in width, two pleuria per side laterally, the outer broader and more distinct than the inner, and a broadly U-shaped hypostomion behind the mouth that measures 7 μm in breadth and 4 μm in height medially; body of medium length, robust, with neck, and well-defined trunk and caudal base; widths of head/neck/trunk/caudal base are as follows: 26/23/37/14 μm at U08/U21/U58/U79, respectively; caudum relatively long, with a distal furca that indents medially to U79 and has parallel exterior borders over the fleshy two-fifths of its length, but whose naked tubes diverge obliquely to the rear over the remaining three-fifths of its total length. On either side of the head are two tufts of cilia that are connected with one another ventrally by some short cilia; the anterior tuft includes a long tactile cilium 22 μm in length, along with several that are 4-7 μm in length; the posterior tuft has a dozen cilia that range from 8 to 20 μm in length. Two pairs of dorsal tactile bristles, 15 and 20 μm in length, are borne at U17 and U72 respectively.

Cuticular armature: the body is enveloped by 29 columns (17 dorsal and 6+6 ventral) of about 21 spined scales each (Figs 2A, B, 4). Scales are elongate, slightly

overlapping and hemi-elliptical in shape with a truncated posterior edge, up to 3 μm in length and 2 μm in width in the dorsal mid-trunk region; each bears an evident keel which extends to form a short simple spine of similar, 2.5 μm , length; scales, keels and spines of the head and neck regions are only one-third to one-half this size. Ventrally, 6 columns of hemi-elliptical scales per side lie outside the ciliary bands; these bear simple spines 2-3 times the length of the dorsal ones, with the lateral most spines of the trunk region being the longest (Fig. 2C). The ventral interciliary field is bare. Posteriorly, two small rounded scales, each with a short spine, are visible medially on the intrafurcal margin. Each furcal branch bears a pair of elongate keeled scales dorsally, with the proximal one partly overlapping the distal, and two hemielliptical scales externally, each provided with a simple spine, 8-9 μm in length. On the ventral surface, there are 6 pairs of scales that bear both keels and spines, three pairs on the furcal base and the other three on the furcal branches. Of those situated on the furcal base, one pair occurs on either side of the midline and has the size and shape of the dorsal mid-trunk spined scales with keels, while the other two pairs, comprised of larger, ovate scales, lie behind them in a transverse row extending outward from the midline (6 \times 4 and 5 \times 3 μm , with keel/spine lengths of 4/1 and 3/3 μm). Of those situated on the fleshy portions of the furcal branches, the proximal pair has round scales (2 μm diameter) and the distal two pairs hemielliptical scales (3 \times 2 μm); all have keels much shorter than spines (1/3, 2/5, and 2/9 μm).

Ventral ciliation: paired longitudinal rows extend from U08 to U72; each is broad anteriorly (ca. 5 μm), narrowing in the pharyngeal and anterior intestinal region (to ca. 2 μm), following which they bow slightly outward in the mid-intestinal region, and converge again somewhat in the posterior intestinal region; the rows remain separate throughout their length; cilia of the tracts are short (ca. 7 μm in length).

Digestive tract: the mouth is of medium width (3 μm), the buccal cavity tapered toward the rear; the pharynx has a swelling at the fore end (8 μm wide, by contrast to 5-6 μm over the final two-thirds); the intestine is broadest anteriorly (9 μm) and narrows gradually over its length (to 4 μm); the anus opens ventrally at U76.

Reproductive tract: no information regarding testes or ovaries *per se*; well-developed egg (40 \times 22 μm ; germinal vesicle, 6 μm diameter) lies dorsally in the posterior intestinal region.

Distribution - Type locality - APULIA: Marina di Ginosa (Taranto) [lat. 40°, 25' N; long. 16°, 49' E] (L). Other locations: Andrea (S), Bagno (M), Cannelle (S), Casamicciola (S), Cavo (S), Inglesi (S), Mortola (S), Perruccia (M), Pisa (S), Procida (S), and S. Remo (S) [see Table I].

Ecology - Frequency of occurrence - occasional in sublittoral fine sand samples, to water depths of 8 m, along the west coast of Italy, but sparse in samples

elsewhere; Abundance - scarce to rare in samples where found.

Remarks - Specimens have been seen as small as 128 μm , though these were pre-reproductive sub-adults.

Taxonomic affinities - *Chaetonotus apechochaetus* is most similar to *C. aegilonensis* Balsamo *et al.*, 1992, in that they are the only marine species in the genus which have simple spines dorsally whose spines are tiny (length of spinous protrusion in the dorsal mid-trunk region being less than 10% of maximum head width) and lack scales in the ventral intercalary field. They have similar body shapes and very similar spines dorsally, though these spines are borne on elongate hemielliptical scales with truncated posterior ends on *C. apechochaetus*, as opposed to being borne on round scales also with truncated posterior ends in *C. aegilonensis*. *C. apechochaetus* is smaller (Lt to 140 μm) and has an anterior pharyngeal swelling as opposed to the larger size (Lt to 200 μm) of *C. aegilonensis*, with a posterior pharyngeal swelling. A host of other subtle differences are present, which concern: 1) the lengths of ventrolateral spines relative to dorsal spines (especially in the mid-trunk region) and 2) the number, size and placement of scales both dorsally and ventrally on the fleshy parts of the furcal branches. To make matters more difficult, the two species have been found occasionally in the same sample (Balsamo *et al.*, 1992). Good optics with differential interference contrast is essential to distinguish between these two species.

Chaetonotus apolemmus n.sp.
(Figs. 5-6)

Diagnosis - A medium-sized *Chaetonotus* of the «*spinulosus*» group; total length to 140 μm ; PhJIn at U26; head three-lobed, bearing cephalon, two pairs of pleuria and hypostomion; head, neck and trunk all well-defined; furca of medium length, indenting to U82; ratio of fleshy:naked portions 1:1. Body enveloped by 11 columns (5 dorsal, 1+1 lateral, 2+2 ventral), each having 18-19 scales that are, subrectangular (head) or rounded (trunk); spines long, thick, with obliquely notched or blade-like apices, pointed to the rear; lateral spines longer than dorsal; the 2 columns of round ventral scales per side lie outside the ciliary bands and bear simple thin spines, the longest being lateral; the intercalary field is bare; 2 pairs of spined scales continue lateral rows onto the furcal branches; 1 pair of keeled scales with simple heavy spines lie inside the caudal branches; 2 keeled scales lie ventral on the furcal base; 6 small keeled scales lie ventrally on the fleshy half of each furcal branch. Ventral ciliature forms two longitudinal bands that connect behind the hypostomion.

Etymology - The name refers to the generally non-overlapping scales on the dorsal surface of the trunk (*apo* Gk. separate; *lemmus*, Gk. scale).

Description - The description is based on an adult specimen, 140 μm in total length. Pharynx 35 μm in length from the front edge of the mouth to the junction with the intestine; pharyngo-intestinal junction U26. Head indistinctly three-lobed, with a cephalon that is 15 μm in width, two pleuria per side, the outer broader and more distinctly seen than the inner, and a broadly

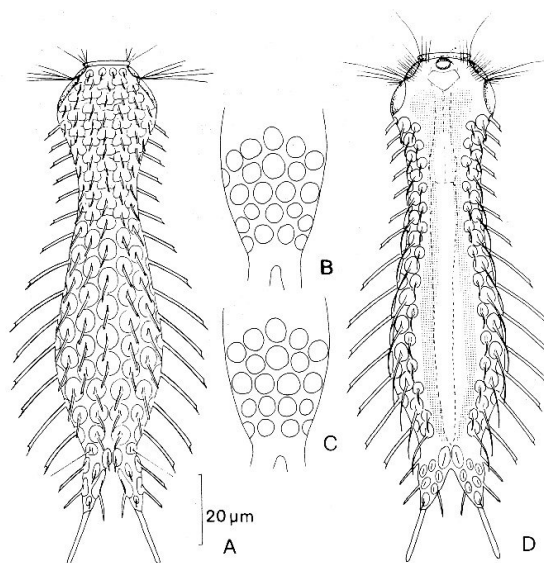


Fig. 5 - *Chaetonotus apolemmus* n. sp. A, dorsal view; B and C, different pattern of the dorsal scaling; D, ventral view. Dotting mimics the locomotory ciliature.

V-shaped, almost pentagonal, hypostomion behind the mouth that measures 10 μm in breadth, 5 μm in height medially and half that in height laterally; body of medium length, robust, with well-defined neck, trunk and caudal base; widths of head/neck/trunk/caudal base are as follows: 26/16/30/14 μm at U10/U20/U57/U78, respectively; caudum of medium length, with a distal furca that indents medially to U82 and has exterior borders that bulge outward over the fleshy half of its length, but whose naked tubes diverge obliquely to the rear over the remaining half of its total length. On either side of the head are two tufts of cilia of varying length, ranging from 12 to 20 μm ; the tufts on each side are connected ventrally by a diagonal patch of short cilia that range in length from 4 to 10 μm . One pair of dorsal tactile bristles, 20 μm in length, is borne at U77, while sometimes a second pair, 15 μm in length, is found at U20.

Cuticular armature: the body is enveloped by 11 columns (5 dorsal, 1+1 lateral and 2+2 ventrolateral) of 18-19 spined scales each (Fig. 5A, B and C). The scales of the first dorsal series are small, round (2 μm diameter) and non-overlapping, like the larger ones of the trunk (5-8 μm diameter), though individual scales often show irregularities from the norm. The scales covering the head and neck are subrectangular, are incised in the rear (measuring ca. 4-6 μm in length by ca. 5-6 μm in width), and overlap quincunxially, but not fore to aft (Fig. 6B). All these scales bear long, thick spines with obliquely notched or blade-like apices on the dorsal surfaces and clearly notched in the lateral rows, and which are all pointed posteriorly. The length of these dorsal spines increases from 2 μm on the head to 8 μm , on the trunk and

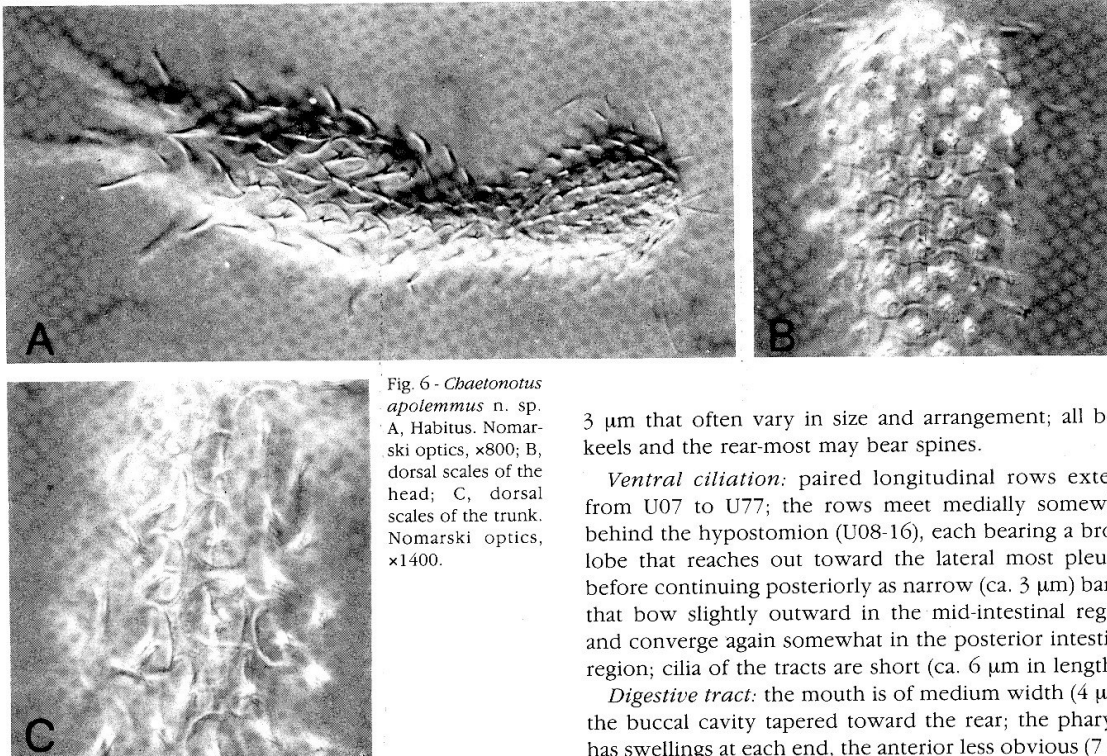


Fig. 6 - *Chaetonotus apolemmus* n. sp. A, Habitus. Nomarski optics, $\times 800$; B, dorsal scales of the head; C, dorsal scales of the trunk. Nomarski optics, $\times 1400$.

then back to $3\ \mu\text{m}$ near the furcal base (Fig. 6C); the lateral spines are longer throughout than the dorsal ones, $5\text{--}8\ \mu\text{m}$ on the head and neck, increasing to a maximum of $18\ \mu\text{m}$ on the trunk, and then decreasing slightly near the furcal base. Ventrally, 2 columns of 14-15 round scales per side lie outside the ciliary bands; these scales bear simple thin, arched spines, those of the inner column being of similar length or shorter than their notched counterparts dorsally, but those of the outer column being of considerable length, especially in the trunk region where they reach $22\ \mu\text{m}$ (Fig. 5D). The ventral interciliary field is bare. Posteriorly, two elliptical scales, each with a short spine, are visible medially on the intrafurcal margins; they are flanked laterally by the two small round scales with twin keels that bear the posterior tactile bristles. Each furcal branch bears five scales; two scales located on the outer furcal margin continue the lateral rows, the proximal having a notched spine $15\ \mu\text{m}$, in length and the distal a simple spine $10\ \mu\text{m}$ in length; the one scale located on the inner furcal margin is large and keeled, and has a thick spine $11\ \mu\text{m}$, in length that arises from its rear end; the remaining two scales lie dorsally on the furcal branch, are smaller, elongate to round and have short spines. On the ventral surface, one pair of large elliptical keeled scales $10 \times 5\ \mu\text{m}$ in size occur medially just behind the terminus of the ventral ciliary rows. Then, extending onto the fleshy portion of each furcal branch, there are six small scales ca. 4 or 5×2 or

$3\ \mu\text{m}$ that often vary in size and arrangement; all bear keels and the rear-most may bear spines.

Ventral ciliation: paired longitudinal rows extend from U07 to U77; the rows meet medially somewhat behind the hypostomion (U08-16), each bearing a broad lobe that reaches out toward the lateral most pleuria, before continuing posteriorly as narrow (ca. $3\ \mu\text{m}$) bands that bow slightly outward in the mid-intestinal region and converge again somewhat in the posterior intestinal region; cilia of the tracts are short (ca. $6\ \mu\text{m}$ in length).

Digestive tract: the mouth is of medium width ($4\ \mu\text{m}$), the buccal cavity tapered toward the rear; the pharynx has swellings at each end, the anterior less obvious ($7\ \mu\text{m}$ in width) than the posterior ($9\ \mu\text{m}$), with the central portion having a fairly constant width ($6\ \mu\text{m}$); the intestine is broadest anteriorly ($4\text{--}5\ \mu\text{m}$) and narrows gradually over its length (to $3\ \mu\text{m}$); the anus opens ventrally at U78.

Reproductive tract: no information regarding testes or ovaries *per se*; large, well-developed egg ($48 \times 25\ \mu\text{m}$; germinal vesicle, $10\ \mu\text{m}$ diameter) may lie dorsal in the intestinal region; bundles of short ($4.5\ \mu\text{m}$) sperm may be seen laterally in the mid-trunk region, but not usually along with a well-developed egg.

Distribution - Type locality - APULIA: Torre Fortore (Foggia) [lat. 41° , $54'$ N; long. 15° , $21'$ E], directly north of Lésina, beyond the Lago di Lésina (L). Other locations: Bagnetielli (M), Bagnara (S), Campese (M), Cataldo (L), Cefalù (L,S), Chiaia (S), Circeo (L), Fetovaia (S), Ischia porto (L), Isidoro (L), Leuca (M), Numana (L), Palinuro (S), Perruccia (M), Pini (L), Pozzuoli (S), Recisello (L), Ruppione (L), Vecchio (M), and Zuccale (M) [see Table I].

Ecology - Frequency of occurrence - occasional in littoral and sub-littoral fine sand samples, the latter to a water depth of $3\ \text{m}$, mostly along the west coast of Italy; sparse elsewhere; Abundance - rare to scarce in samples where found.

Remarks - Specimens have been seen as small as $122\ \mu\text{m}$ though these were pre-reproductive sub-adults. Considerable variation occurs among populations of *Chaetonotus apolemmus*, the population from Bagnara differing from that of the type locality at Torre Fortore in

having round, totally non-overlapping scales on the head and neck. Two different patterns of scale arrangement on the posterior region of the trunk have also been observed, one as in specimens from the type locality and from Bagnara having scales that bilaterally flank the midline (Fig. 5B) and a second continuing the pattern of the mid-trunk region of having yet another scale on the midline (Fig. 5C), one that may be of the same size as the two that flank the midline behind it (populations at Ischia porto and Circeo) or may be decidedly smaller than the enlarged scales that flank the midline behind it (populations at Pini and Pozzuoli). Interestingly, these populations are interspersed with one another in a manner that shows a mosaic, rather than a gradient, pattern of geographic distribution. Even more peculiarly, the six small scales located on the ventral surface of the furcal branches often vary in size and arrangement, even within a population; they may be arranged in a 1 + 2 + 2 + 1 pattern with space between scales (Fig. 5D), a 2 + 2 + 2 pattern with pairs lying adjacent and alternating right and left, or the first may exceed the others in size, being as large as the medial scales of the furcal base, while one is lacking and the other three form a longitudinal column along the outer margin of the furcal branch.

Taxonomic affinities - *Chaetonotus apolemmus* is most similar to *C. woodi* Thane-Fenchel, 1970, in that they are the only marine species in the genus which have notched spines dorsally whose spines are relatively short (length of spinous protrusion in the dorsal mid-trunk region being 11-20% of maximum head width) and lack scales in the ventral interciliary field. They are different in most other respects, the furca of *C. apolemmus* being of normal length, and the dorsal scales being round and bearing thick spines that are notched just under the apices, whereas the furca of *C. woodi* is very long, and the dorsal scales are shield-shaped, bearing three-pronged thickenings, two running diagonally to the rear along the surface of each scale, and the third protruding upward between them and to the rear with a fine denticle just under the apex; in addition *C. woodi* has an elongate pair of «schultzei»-type spines that protrude to the rear between the furcal branches, quite unlike anything present in *C. apolemmus*. *C. apolemmus* is similar in many respects to *C. mariae* Todaro, 1992, except that the spines of the former are notched, while those of the latter are simple.

Chaetonotus lacunosus Mock, 1979
sp. re-description
(Figs. 7-9)

Mock, 1979: p. 42; fig. 19.

Diagnosis - A medium-sized *Chaetonotus* of the «spinulosus» group; total length to 162 μ m; PhJIn at U23; head five-lobed, bearing cephalion, two pairs of pleuria and hypostomion; head, neck and trunk all well-defined; furca of medium length, indenting to U85; ratio of fleshy:naked portions 1:2. Body enveloped by 13 columns (7 dorsal, 1 + 1 lateral, 2 + 2 ventral), each having 17-19 scales, triangularly lobed, odd lobe forward; spines long, thick, with

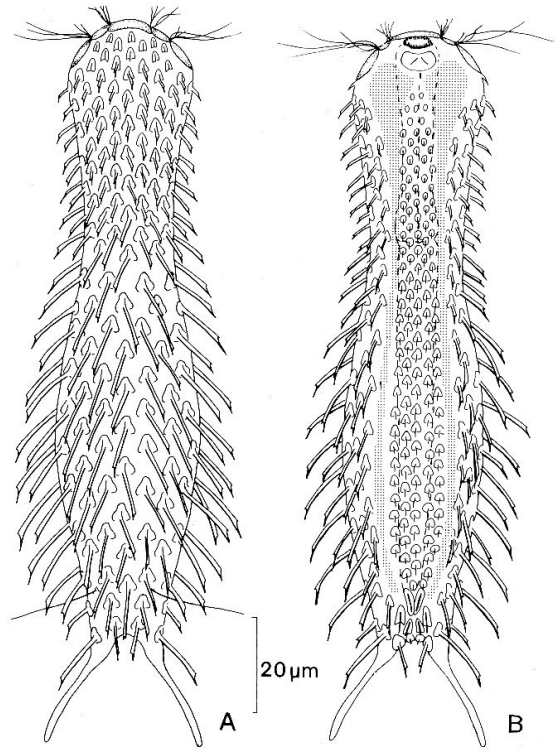


Fig. 7 - *Chaetonotus lacunosus*. A, dorsal view; B, ventral view. Dotted area mimics the locomotory ciliature.

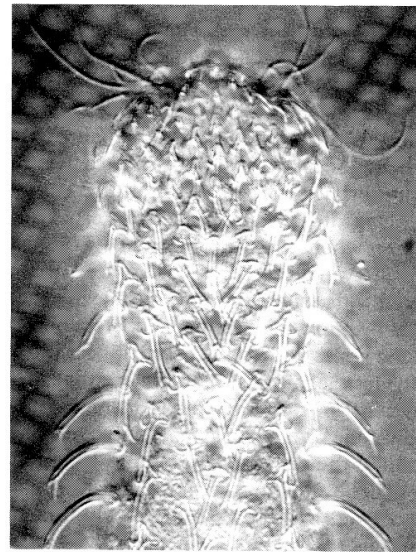


Fig. 8 - *Chaetonotus lacunosus*. Dorsal view of the head. Nomarski optics, $\times 1200$.

obliquely notched apices, pointed to the rear; lateral spines barely longer than dorsal; the 2 columns of ventral scales per side lie outside the ciliary bands and bear shorter notched spines, the longest

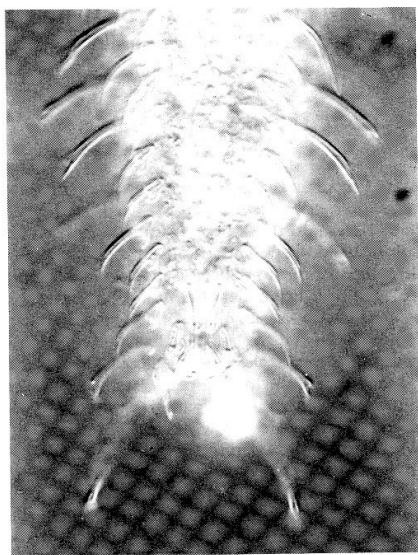


Fig. 9 - *Chaetonotus lacunosus*. Ventral view of the posterior end. Nomarski optics, $\times 1200$.

being lateral; the interciliary field has 5 alternating rows of spined scales; spined scales continue onto the furcal branches both dorsally and ventrally, the last of the spines protruding backward between the furcal branches; dorsally no other scales occur, but ventrally there are 3 other pairs of spined scales that lie behind the anus on the furcal base. Ventral ciliature forms two separate longitudinal bands.

Redescription - The description is based on an adult specimen, 154 μm in total length. Pharynx 34 μm in length from the front edge of the mouth to the junction with the intestine; pharyngo-intestinal junction U23. Head rounded behind a cephalon that is 9 μm in width and projects slightly to the fore, with a narrow and a somewhat broader pleurion per side laterally but not projecting to form a lobe, and a broadly U-shaped hypostomion behind the mouth that measures 8 μm in breadth and 4 μm in height medially; body of medium length, robust, with well-defined neck, trunk and caudal base; widths of head/neck/trunk/caudal base are as follows: 27/19/32/15 μm at U08/U30/U58/U87, respectively; caudum of medium length, with a distal furca that indents medially to U85 and has exterior borders that contract gently inward over the fleshy third of its length, but whose naked tubes diverge obliquely to the rear over the remaining two-thirds of its total length. On either side of the head are two isolated tufts of 5-6 cilia of widely varying length, those of the anterior pair ranging from 4 to 7 μm and those of the posterior pair ranging from 4 to 5 and from 14 to 16 μm . One pair of dorsal tactile bristles, 23 μm in length, is borne at U78.

Cuticular armature: the body is enveloped by 13 columns (7 dorsal, 1 + 1 lateral and 2 + 2 ventrolateral) of 17-19 spined scales each (Fig. 7A, B). The scales are clearly spaced and non-imbricating. With the exception of the scales of the two first cephalic series, which are

hemi-elliptical and keeled, all the scales are triangularly lobed, with the odd lobe forward, and bear long, thick, slightly curved spines, with an obliquely notched apex that points to the rear. Scale size increases slightly from head ($2.5 \times 2.5 \mu\text{m}$) to trunk ($4 \times 3.5 \mu\text{m}$), while spine length increases markedly from head (3 μm) to neck (6 μm) to trunk (11 μm), but decreases onto the furcal base (7 μm), except for the last medial spine (11 μm), with the last pair of spines protruding backward between the furcal branches. Lateral spines in the mid-trunk region are 1.2 to 1.5 times the length and thickness of the dorsal spines: the last spine of each column occurring on the furcal base. Ventrally there are 2 columns of scales per side that lie outside the ciliary bands, with a 3rd being present only in the mid-trunk region; these bear shorter notched spines, the longest being lateral; these spined scales continue onto the furcal branches with the last pair of spines facing outward being clearly longer than the one that protrudes backward between the furcal branches (13 compared with 7 μm) (Figs 7B, 9). The ventral interciliary field is completely covered with 5 alternating columns of 27-28 small scales, the anterior most being ovoid and lacking keels or spines, the others first gaining keels, then spines and then as they become larger gaining an inverted heart shape. Posteriorly, no other scales occur on the dorsal surface, but ventrally there are 3 pairs of scales that lie behind the anus on the furcal base and bear keels or notched spines, the first being elongate-ovoid ($6 \times 2 \mu\text{m}$) and the others being hemi-elliptical and round, respectively, and progressively smaller.

Ventral ciliation: paired longitudinal rows extend from U04 to U83; each is broadly club-shaped anteriorly (ca. 10 μm), narrowing in the pharyngeal and anterior intestinal region (to ca. 2 μm), following which they bow slightly outward in the mid-intestinal region, and converge again somewhat in the posterior intestinal region; the rows approach one another immediately behind the hypostomion, but remain separate there as they do throughout the rest of their length; cilia of the tracts are short (ca. 8 μm in length).

Digestive tract: the mouth is of medium width (4 μm), the buccal cavity goblet-shaped; the pharynx has swellings at each end (8 and 7 μm wide at the anterior and posterior swellings, 5 μm in the reduced middle region) and possesses a pharyngeal chevron anteriorly; the intestine begins and ends with narrower breadths (6 and 4 μm , respectively) than the broadly arched middle section (8-10 μm over most of its length); the anus opens ventrally at U81.

Reproductive tract: all specimens observed were in parthenogenic phase, the largest egg observed being $75 \times 35 \mu\text{m}$ (12 μm diameter).

Distribution - Locations: Bagnetielli (M), Bibione (S), Camerota (S), Cuma (L,S), Fusaro (L,S), Giannella (L), Ginosa (L), Inglesi (M), Isonzo (S), Lapillo (L), Luna (S), Paestum (S), Palinuro (S), Pesaro (L), S. Remo (S), Serapo (S), Torregaveta (S), Vado (S), and S. Vito (S) [see Table 1].

Ecology - Frequency of occurrence - sparse in sublittoral fine to medium coarse sand samples, to a water depth of 8 m, along the coast of Italy; Abundance - rare to scarce in samples where found.

Remarks - Our specimens were slightly larger than those of Mock (1979), and possessed cephalion, pleuria and hypostomion, though these structures were absent in Mock's description. Our specimens had on average one fewer scale per column. The anterior most scales of the head in our animals showed some variability, in some specimens being hemi-elliptical and keeled as in the illustration, but in other specimens being triangularly lobed and with notched spines as in the type material from Germany. In our mature specimens, scales of the ventral intercalary field began beneath the anterior half of the pharynx, but in immature specimens the series appeared to begin nearer the pharyngo-intestinal junction; on close inspection of sub-adults, one could make out the faint outlines of scales in the forward region, leading us to conclude that these scales continue to develop and become better defined as animals reach sexual maturity. Scales in the posterior mid-ventral series also showed some variability in our specimens, with some as described and illustrated above, being distinguished from Mock's specimens by the presence of an additional small round spined scale astride the midline on the furcal base, while we would interpret the lateral most members of Mock's series to be the counterparts of our spined scales that protrude between the furcal branches. In some of our specimens all of the scales had notched spines, comparable to the specimens from Sylt, but some of our specimens also had an additional pair of scales with short notched spines laterally on the fleshy part of the furcal branches, they being difficult to see since they were oriented lengthwise along the furcal branches.

Taxonomic affinities - *Chaetonotus lacunosus* is most similar to *C. variosquamatus* Mock, 1979, in that they are the only marine species in the genus which have notched spines dorsally whose spines are relatively of medium length (length of spinous protrusion in the dorsal mid-trunk region being 21-40% of maximum head width) and bear spined scales in the ventral intercalary field. They are similar sized animals that have similar body shapes and similar spines dorsally, though these spines are borne on triangular scales with apex to the fore on *C. lacunosus*, as opposed to being borne on a variety of scales, which if triangular, as in the neck region, have the apex to the rear, with the apices becoming more and more blunted in the anterior, mid- and posterior trunk regions in *C. variosquamatus*. *C. lacunosus* has heart-shaped scales in the ventral intercalary field and lacks hydrofoil scales ventrolaterally, whereas the *C. variosquamatus* of Mock (1979) has ovoid scales in the ventral intercalary field and bears spinous-lamellar hydrofoil scales ventro-laterally. Thus far, the two species have been found only once at the same location, Marina di Ginosa, but even there *C.*

lacunosus was found at the littoral site, while *C. variosquamatus* occurred at the sublittoral site (1.5 m water depth).

Chaetonotus siciliensis n.sp.

(Figs. 10-12)

Diagnosis - A medium large *Chaetonotus* of the «*maximus*» group, but with «*spinulosus*»-type spines on the head; total length to 214 μm ; PhJIn at U26; head five-lobed, bearing cephalion, pleuria and hypostomion; head, neck and trunk all well-defined; furca of medium length, indenting to U80; ratio of fleshy:naked portions 1:3. Body enveloped by 13 columns (9 dorsal, 2+2 ventral), each with 4-5 hemi-elliptical head scales having thick spines with obliquely notched apices, followed by 14 scales having long, simple spines; the 2 columns of ventral scales per side lie outside the ciliary bands and bear simple spines, the longest being lateral; intercalary field is bare; dorsally, 2 rectangular scales with thick notched spines lie on the furcal base, just behind a row of tiny scales bearing keels or bristles, with a large two-keeled scale on the fleshy part of each furcal branch; ventrally, 4 pairs of small keeled scales with spines form an arc near the anus, with a pair of larger ones on the furcal base, and 3 others on the fleshy part of each furcal branch. Ventral ciliature forms two longitudinal bands that connect behind the hypostomion.

Etymology - Named for the island of Sicily, from which our best material has come and which marks the midpoint of its presently known distribution.

Description - The description is based on an adult specimen, 175 μm in total length. Pharynx 42 μm in length from the front edge of the mouth to the junction with the intestine; pharyngo-intestinal junction at U26. Head indistinctly five-lobed, with a median cephalion that is 12 μm in width, one small pleurion per side immediately lateral to it and a more distinct lobe lying

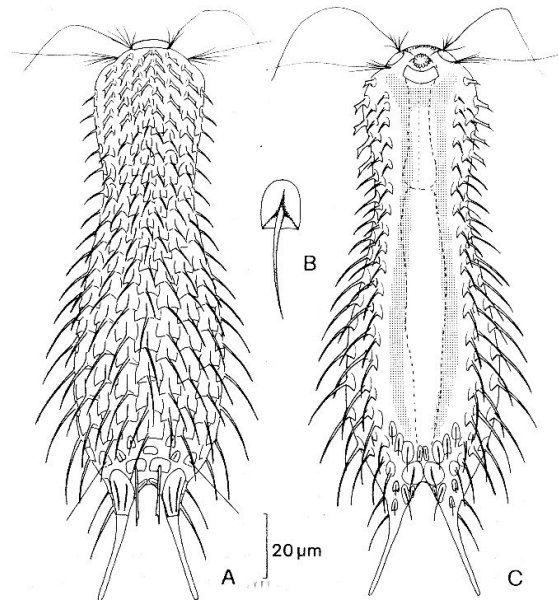


Fig. 10 - *Chaetonotus siciliensis* n. sp. A, dorsal view; B, dorsal scale; C, ventral view. Dotting mimics the locomotory ciliature.

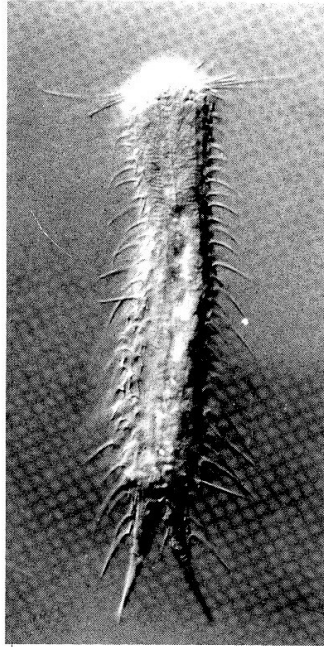


Fig. 11 - *Chaetonotus siciliensis* n. sp. Habitus. Nomarski optics, $\times 500$.

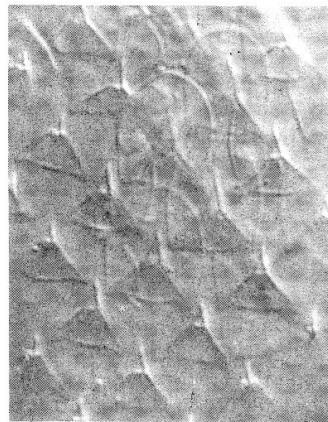


Fig. 12 - *Chaetonotus siciliensis* n. sp. Dorsal scales of the trunk. Nomarski optics, $\times 2400$.

lateral to the pleurion on either side, and a broadly U-shaped hypostomion behind the mouth that measures $11\ \mu\text{m}$ in breadth and $4\ \mu\text{m}$ in height; body of medium length, robust, with well-defined neck, trunk and caudal base; widths of head/neck/trunk/caudal base are as follows: $35/28/48/20\ \mu\text{m}$ at U08/U26/U59/U85, respectively; caudum of medium length, with a distal furca that indents medially to U81 and has exterior borders that

contract inward over the fleshy quarter of its length, but whose naked tubes diverge obliquely to the rear over the remaining three-fourths of its total length. On either side of the head are two isolated tufts of 5-6 cilia of widely varying length, those of the anterior pair ranging from 5 to $8\ \mu\text{m}$, but with one reaching $60\ \mu\text{m}$, and those of the posterior pair ranging from 9 to $17\ \mu\text{m}$, but with one reaching $40\ \mu\text{m}$. One pair of dorsal tactile bristles, $23\ \mu\text{m}$ in length, is borne at U77.

Cuticular armature: the body is enveloped by 13 columns (9 dorsal, 2 + 2 ventral) of 19 spined scales each (Fig. 10A, C). Scales are short, quincunxially overlapping and hemi-elliptical in shape with a truncated posterior edge, up to $7\ \mu\text{m}$ in length and $6\ \mu\text{m}$ in width in the dorsal mid-trunk region; the first 4-5 scales bear short ($4\text{-}5\ \mu\text{m}$), thick spines with obliquely notched apices; these are followed by 14 scales having long (5, gradually increasing posteriorly to $20\ \mu\text{m}$), thin, simple spines (Figs 10B, 12). Ventrally, 2 columns of hemi-elliptical scales per side lie outside the ciliary bands; these all bear simple spines, the longest being lateral (Fig. 10C). The ventral inter-ciliary field is bare. Posteriorly, 2 rectangular scales with thick notched spines lie dorsally on the furcal base; just in front of these there is a row of 7 small scales, an oval median scale that lacks keel or spine, 4 shield-shaped scales that bear keels some of which extend into tiny spines, and 2 shield-shaped scales laterally in the series that bear the posterior tactile bristles; there is also a large two-keeled scale ($16 \times 9\ \mu\text{m}$, with keels 12 and $18\ \mu\text{m}$ in length) located on the fleshy part of each furcal branch. On the ventral surface, 4 pairs of more-or-less elliptical scales of varying shape, the medial pair with keels and the others with spined keels, form an arc behind the ventral ciliary bands, near the anus; a pair of larger rounded scales (ca. $6\ \mu\text{m}$ in diameter) with spined keels occur on the furcal base, on either side of the midline, with 3 others of varying sizes and shapes forming a diagonal row on the fleshy part of each furcal branch, with the largest also bearing the longest spine.

Ventral ciliation: paired longitudinal rows extend from U06 to U70; the rows meet medially behind the hypostomion (U08-11), each bearing a lobe that reaches forward to the side of that structure, before continuing posteriorly as broad ($4\text{-}5\ \mu\text{m}$) bands that bow slightly outward in the mid-intestinal region and converge again somewhat in the posterior intestinal region; cilia of the tracts are short (ca. $8\ \mu\text{m}$ in length).

Digestive tract: the mouth is of medium width ($4\ \mu\text{m}$), the buccal cavity goblet-shaped; the pharynx has swellings at each end (8 and $10\ \mu\text{m}$ wide at the anterior and posterior swellings, $6\ \mu\text{m}$ in the reduced middle region) and possesses a pharyngeal chevron anteriorly; the intestine begins and ends with narrower breadths (9 and $6\ \mu\text{m}$, respectively) than the broadly arched middle section ($10\text{-}13\ \mu\text{m}$ over most of its length); the anus opens ventrally at U76.

Reproductive tract: specimens observed were in parthenogenic phase.

Distribution - Type locality - SICILY: S. Vito Lo Capo (Trapani) [lat. 38°, 10' N; long. 12°, 45' E] (S). Other locations: Bagno (M), Luna (S), Termoli (S), Vado (L,S) [see Table I].

Ecology - Frequency of occurrence - sparse in sublittoral fine to medium coarse sand samples, to a water depth of 8 m, along the coast of Italy; Abundance - rare to scarce in samples where found.

Remarks - The specimen reported from Chiaia di Luna, Island of Ponza, (Todaro, 1992) was reckoned to be 214 μm in total length, somewhat larger than those we have found elsewhere.

Taxonomic affinities - *Chaetonotus siciliensis* is most similar to *C. oceanides* d'Hondt, 1971, in that they are the only marine species in the genus which have simple spines dorsally whose spines are relatively long (length of spinous protrusion in the dorsal mid-trunk region being 41-75% of maximum head width) and lack scales in the ventral intercalary field. They have similar body shapes and similar spines dorsally, though these spines are borne on short hemi-elliptical scales with truncated posterior ends on *C. siciliensis*, as opposed to being borne on ovoid scales that lack truncated posterior ends in *C. oceanides*. *C. siciliensis* is larger (Lt to 175 μm) and has «*spinulosus*»-type spines in the anterior head region, as opposed to the smaller size (Lt to 132 μm) of the *C. oceanides* of d'Hondt (1971), which has simple spines throughout, but in addition bears hydrofoil scales ventrolaterally.

Genus *Halichaetonotus* (Remane, 1936) Schrom 1972

Halichaetonotus etrolomus n.sp.

(Fig. 13)

Diagnosis - A small *Halichaetonotus* with total length to 120 μm ; PhjIn at U30; head five-lobed, bearing cephalion, pleuria and hypostomion; PhCv present; head, neck and trunk all well-defined; furca of medium length, indenting to U80; ratio of fleshy:naked portions 1:1. Body enveloped by 19 columns (13 dorsal, 1+1 ventrolateral hydrofoil, 2+2 ventral), each with 20 hemi-elliptical scales having keels that extend into short spines; hydrofoil scales project laterally as rectangular lamellae; the 2 columns of ventral scales per side lie outside the ciliary bands and form a hem alongside the intestinal tract; intercalary field is bare; dorsally, on the furcal base are 4 small scales, 2 bearing tactile bristles and 2 lying astride the medial margin; a large keeled scale covers the fleshy half of each furcal branch; ventrally, 4 pairs of keeled ovoid scales occur near the anus, the medial-most pair larger than the others, with 2 smaller keeled ovoid scales lying proximally on the fleshy part of each furcal branch. Ventral ciliature forms two longitudinal bands that connect behind the hypostomion.

Etymology - The name refers to the generally non-overlapping scales on the dorsal surface of the trunk (*etron*, Gk. belly; *loma*, Gk. fringe).

Description - The description is based on an adult specimen, 112 μm in total length. Pharynx 33 μm in length from the front edge of the mouth to the junction with the intestine; pharyngo-intestinal junction at U30.

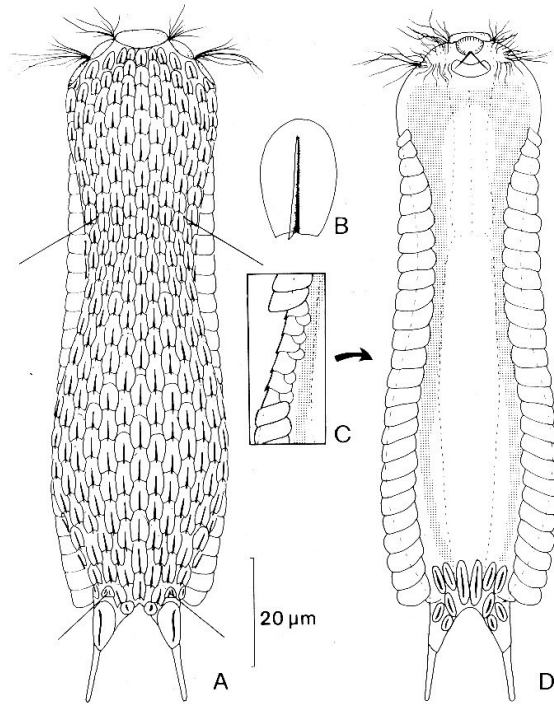


Fig. 13 - *Halichaetonotus etrolomus* n. sp. A, dorsal view; B, dorsal scale; C, detail of a body side to show the arrangement of the ventrolateral scales; D, ventral view. Dotting mimics the locomotory ciliature.

Head five-lobed, with a cephalion that is 9 μm in width and a broadly U-shaped hypostomion behind the mouth that measures 7 μm in breadth and 2 μm in height; body short, robust, with well-defined neck, trunk and caudal base; widths of head/neck/trunk/caudal base are as follows: 25/18/30/15 μm at U11/U35/U62/U84, respectively; caudum short, with a distal furca that indents medially to U86 and has parallel exterior borders, the naked tube of each furcal branch comprising one-half of its total length. On either side of the head are two tufts of cilia, one of about 8 cilia, 8-15 μm in length, to be seen in dorsal view, and the other of more cilia, mostly 3-5 but with some reaching 12 μm in length, that continue ventrally in two transverse rows alongside the mouth, most of them being 3-4 μm in length, but with several reaching 12 μm . Two pairs of dorsal tactile bristles, 16 and 12 μm in length, are borne at U27 and U84 respectively.

Cuticular armature: the body is enveloped by 19 columns (13 dorsal, 2 + 2 ventrolateral, 1 + 1 ventrolateral hydrofoil) of 20 scales each (Fig. 13A, D). Scales are small, but elongate, quincunxially slightly overlapping and hemi-elliptical in shape with a truncated posterior edge, up to 6 μm in length and 3.5 μm in width in the dorsal mid-trunk region, and two-thirds that size at their smallest on the front of the head, on the neck and on the rear of the trunk; each bears an elongate keel

which extends to form a small spiny process that is barely visible (Fig. 13B). Ventrally, hydrofoil scales project laterally as hyaline rectangular lamellae, their outer edges forming nearly parallel lines down both sides of the body, from the lateral head margins, past the lateral trunk margins to the level of the furcal base; 2 columns of ventral scales per side lie between the hydrofoil scales and the ciliary bands, forming a fringe alongside the intestinal tract (Fig. 13C, D). The ventral inter-ciliary field is bare. Posteriorly, on the furcal base are 4 small scales, 2 triangular scales with double-keels lying laterally near the edges of the body that bear the posterior tactile bristles and 2 round scales with single keels that lie astride the medial rear margin; a large keeled scale covers the entire fleshy half of each furcal branch, measuring $8 \times 4 \mu\text{m}$. On the ventral surface, 4 pairs of keeled ovoid scales occur near the anus, the medial-most pair being $8 \times 2 \mu\text{m}$, nearly twice the size of the others, which form a triangular pattern to the side, 2 just behind the rear of the ventral ciliary rows and a third behind and midway between them; 2 smaller keeled oval scales, 3.5 and $3 \mu\text{m}$ in length by $2 \mu\text{m}$ in width, occur in a diagonal row proximally on the fleshy part of each furcal branch.

Ventral ciliation: paired longitudinal rows extend from U07 to U79; each is broad anteriorly (ca. $7 \mu\text{m}$), but narrows in the pharyngeal and anterior intestinal region (to ca. $2 \mu\text{m}$) after which they diverge slightly from one another in the posterior intestinal region; the rows meet medially behind the hypostomion (U08-11); cilia of the tracts are short (ca. $6 \mu\text{m}$ in length).

Digestive tract: the mouth is of medium width ($4 \mu\text{m}$), the buccal cavity goblet-shaped; the pharynx has swellings at each end (8 and $7 \mu\text{m}$ wide at the anterior and posterior swellings; $5 \mu\text{m}$ in the reduced middle region) and possesses a pharyngeal chevron anteriorly; the intestine begins and ends with narrower breadths (6 and $4 \mu\text{m}$, respectively) than the broadly arched middle section ($8-10 \mu\text{m}$); the anus opens ventrally at U85.

Reproductive tract: specimens observed were in parthenogenic phase.

Distribution - Type locality - CAMPANIA: Posillipo (Naples) [lat. $40^\circ, 49' \text{N}$; long. $14^\circ, 12' \text{E}$], at Lido Ideal, located between Mergellina and the Pal. Donn'Anna (L). Other locations: Cuma (L) and Fonte (S) [see Table I].

Ecology - Frequency of occurrence - sparse in littoral to sublittoral, medium to coarse sand and pebble samples, to a water depth of 8 m , thus far only along the Campania and Latium coasts of western Italy; Abundance - scarce to rare in samples where found.

Remarks - This species possesses a chevron-shaped intrusion (Δ) in the anterior swelling of the pharynx that is characteristic of species in *Halichaetonotus* and *Heterolepidoderma*. The elements of the chevron appear to protrude into the buccal cavity and may represent the presence of laterally directed cuticular thickenings or jaw-like structures that probably function in the feeding process.

Taxonomic affinities - *Halichaetonotus etrolomus* is most similar to *H. balticus* Kisielowski, 1975, *H. lamellatus* Kisielowski, 1975 and *H. margaretae* n.sp. in that they are the only described species in the genus which have lamellate hydrofoil scales. *H. etrolomus* differs from all of the others in lacking scales or spines in the ventral inter-ciliary field. The dorsal scales also differ among the four species, *H. etrolomus* being the only one which has truncated hemi-elliptical scales throughout, and in the pattern of scales that occur ventrally on the furcal base.

Halichaetonotus margaretae n.sp.
(Figs. 14-15)

Diagnosis - A medium-sized *Halichaetonotus* with total length to $140 \mu\text{m}$; PhJIn at U24; head five-lobed, bearing cephalon, two pairs of pleuria and hypostomion; head, neck and trunk ill-defined; furca of medium length, indenting to U81; ratio of fleshy:naked portions 2:3. Body enveloped by 11 columns (7 dorsal, 1 + 1 lateral, 1 + 1 ventrolateral hydrofoil), each with 20-21 pyriform to hemielliptical scales having keels that extend into short spines; hydrofoil scales project posteriolaterally as oblong lamellae; no columns of ventral scales lie outside the ciliary bands; inter-ciliary field has 7 alternating rows of 22 spined scales; dorsally, on the fleshy part of the furca are a pair of ovoid spined scales; ventrally, 2 pairs of elongate ovoid keeled scales occur near the anus, with 3 smaller round keeled scales lying laterally on the fleshy part of each furcal branch. Ventral ciliation forms two longitudinal bands that connect behind the hypostomion.

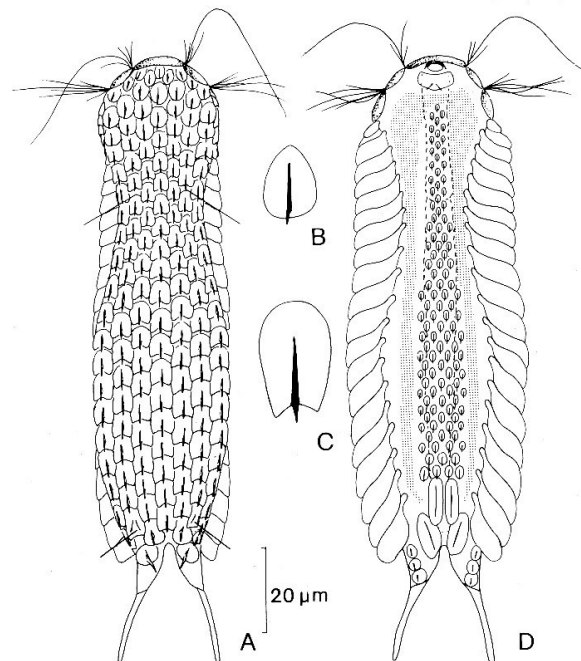


Fig. 14 - *Halichaetonotus margaretae* n. sp. A, dorsal view; B and C, dorsal scales; D, ventral view. Dotted mimics the locomotory ciliation.

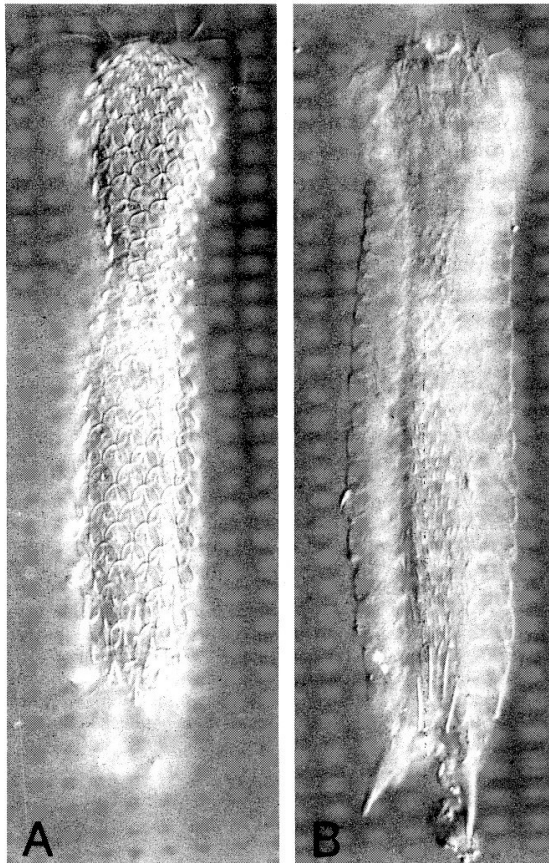


Fig. 15 - *Halichaetonotus margaretae* n. sp. A, dorsal view; B, ventral view. Nomarski optics, $\times 900$.

Etymology - The name is in honor of Margaret Raper Hummon, who consistently gives helpful advice, by virtue of her own excellent background in microscopy and vast experience with these animals.

Description - The description is based on an adult specimen, 140 μm in total length. Pharynx 33 μm in length from the front edge of the mouth to the junction with the intestine; pharyngo-intestinal junction U24. Head indistinctly five-lobed, with a cephalion that is 14 μm in width, two broad pleuria per side laterally; and a broadly U-shaped hypostomion behind the mouth that measures 8.5 μm in breadth and 4 μm in height; body of medium length, robust, with ill-defined neck, trunk and caudal base; widths of head/neck/trunk/caudal base are as follows: 29/20/32-34/15 μm at U11/U25/U46-61/U83, respectively; caudum of medium length, with a distal furca that indents medially to U81 and has parallel exterior borders over the fleshy two-fifths of its length, but whose naked tubes diverge obliquely to the rear over the remaining three-fifths of its total length. On either side of the head are two tufts of cilia, one of about 5 cilia, 5-9 μm in length except one that reaches 48 μm , and the other

tuft of more cilia, 7-20 μm in length. One pair of dorsal tactile bristles, 10 μm in length, is borne at U81, while sometimes a second pair is also found at ca. U20 in the neck region.

Cuticular armature: the body is enveloped by 11 columns (7 dorsal, 1+1 lateral, 1+1 ventrolateral hydrofoil), of 20-21 scales each (Fig. 14A, D). Scales quincunxially overlapping, being pyriform in shape (5 μm in length by 3.5 μm in width) anteriorly, becoming oval (5 \times 4 μm) in the mid-cephalic region and then hemielliptical, with a concave posterior edge, (7 \times 5 μm) in the neck region and thereafter; each bears an elongate keel which extends to form a short spine, one-fourth the length of the keel (Fig. 14B, C). Ventrally, a lateral column of keeled scales with spiny process occurs on each side, the innermost portion which is composed of hydrofoil scales that project posteriolaterally as oblong hyaline lamellae, their outer edges forming nearly parallel lines down both sides of the body, from the lateral head margins, past the lateral trunk margins to the level of the furcal base; no columns of ventral scales lie between the hydrofoil scales and the ciliary bands (Fig. 14D). The ventral interciliary field has 3 increasing to 7 alternating columns of 22 ovoid spined scales that extend from U08 to U70; there are 3 columns throughout the rear two-thirds of the pharyngeal and into the beginning of the intestinal region, increasing to 5 in the remainder of the anterior intestinal region (ca. U27 to U38), and then becoming 7 over the remainder of their coverage; scales increase gradually from 2 \times 1 μm (keel 2, spine 1 μm) in the front to 3.5 \times 2 μm (keel 2, spine 1 μm) in the rear. Posteriorly, on the fleshy part of each furcal branch is a pair of ovoid spined scales, that are oriented diagonally and measure 5.5 \times 4 μm (keel 3, spine 3 μm). On the ventral surface, 2 pairs of elongate ovoid keeled scales occur near the anus, the medial-most pair (11 \times 3 μm in width) being located just inside the rear terminus of the ventral ciliary rows, and the other pair (10 \times 5 μm) being oriented diagonally behind them with their rear ends lying on the furcal base on either side of the midline; 3 smaller round keeled scales (3.5 \times 2.5 to 3 μm) lie in a lateral column on the fleshy part of each furcal branch.

Ventral ciliation: paired longitudinal rows extend from U05 to U74; each is broad anteriorly (ca. 7 μm), bowing outward to follow the lateral head margin and then constricting along with the margin of the neck, while narrowing in the pharyngeal and anterior intestinal region (to ca. 3 μm), following which they bow slightly outward in the mid-intestinal region, and converge again somewhat in the posterior intestinal region; the rows meet medially behind the hypostomion (U06-08); cilia of the tracts are short (ca. 8 μm in length).

Digestive tract: the mouth is narrow (3 μm), the buccal cavity goblet-shaped; the pharynx has weak swellings at each end (7 and 8 μm wide at the anterior and posterior swellings, 5 μm in the reduced middle region) and possesses a faint pharyngeal chevron anteriorly; the intestine begins and ends with narrower breadths (6 and 3

μm , respectively) than the slightly arched middle section (10-11 μm); the anus opens ventrally at U79.

Reproductive tract: most specimens observed were in parthenogenic phase; globular X-organ structures were seen in one larger mature specimen some distance apart laterally (centered at U79, each 8 μm in diameter), along with what can be interpreted to be a residual body from spermatogenesis that was located laterally on one side (centered at U63, 4 μm in diameter), and two eggs (64 \times 12 and 50 \times 12 μm , germinal vesicle 8 μm in diameter) on either side of the intestine, though sperm were not seen.

Distribution - Type locality - TUSCANY: Marina di Donoratico (Grosseto) [lat. 43° 09' N; long. 10° 40' E] (S). Other locations: Alimini (S), Bagnetielli (M), Campese (M), Chiaia (L), Citara (S), Feniglia (S), Fetovaia (S), Fortore (L), Ginosa (L,S), Ischia porto (S), Isonzo (L,S) Lapillo (S), Meloria (S), Mortola (S), Porto Nuovo (S), Perruccia (M), Posillipo (L), Procida (L), S. Remo (S), Serapo (S), Baia verde (S), and Zuccale (M) [see Table I].

Ecology - Frequency of occurrence - sparse to occasional in littoral to sublittoral, fine to coarse sand and shell gravel, to a water depth of 5 m, in all sectors of the Italian coastline; Abundance - usually scarce but sometimes numerous, in samples where found.

Remarks - The ventral view of this specimen, as illustrated, is broader than the dorsal view, owing to it having been compressed in order to better show the pattern of insertion and overlap of the hydrofoil scales. Like *Halichaetonotus etrolomus*, this species possesses a pharyngeal chevron in the anterior swelling, though in this case it is smaller and incomplete medially, which favors interpretation of the elements in this case as being laterally directed cuticular thickenings that probably function in the feeding process.

Taxonomic affinities - *Halichaetonotus margaretae* is most similar to *H. balticus* Kisielowski, 1975, *H. etrolomus* n. sp., *H. lamellatus* Kisielowski, 1975, and *H. paradoxus* Remane, 1927 in that they are the only described species in the genus which have lamellate hydrofoil scales, though only in *H. margaretae*, *H. lamellatus*, and *H. paradoxus* are these directed to the rear all along the length of the body. *H. etrolomus* lacks scales or spines in the ventral intercalary field, *H. lamellatus* has keels but no obvious scales, while both *H. margaretae* and *H. paradoxus* have spines scaled. The dorsal scales also differ among the four species, *H. margaretae* being the only one which has pyriform scales in the anterior head region that gives way to truncated hemielliptical scales in the neck and trunk regions, while those of *H. balticus* are entire, those of *H. lamellatus* are laterally constricted, and those of *H. paradoxus* have very tall keels. The pattern of scales that occur ventrally on the furcal base also differs.

Halichaetonotus thalassopais n. sp.

(Fig. 16)

Diagnosis - A small *Halichaetonotus* with total length to 120 μm ; PhJIn at U29; head three-lobed, bearing cephalion, pleuria and hypostomion; head, neck and trunk well-defined; furca of medium length, indenting to U85; ratio of fleshy:naked portions 1:1. Body enveloped by 15 columns (9 dorsal, 3+3 ventral), each with 18 ovoid scales having keels; the 3 columns of scales per side lying outside the ciliary bands are similar to those of the dorsal surface, but with keels increasing in height as they progress ventrally; hydrofoil scales, occurring mainly in the posterior trunk region, bear spinous lamellae; intercalary field is bare; dorsally, on the furcal base are several scales that are trianguliform or round, including those that bear tactile bristles, though none occur on the furcal branches; ventrally, 7 pairs of ovoid keeled scales occur near the anus, the medial-most being largest and overlapping others, which form a cluster slightly to the side; only the rearmost occur proximally on the fleshy part of the furcal branches. Ventral ciliature forms two longitudinal bands that connect behind the hypostomion.

Etymology - The name means «child of the sea» (*thalassa*, Gk. sea; *pais*, Gk. child).

Description - The description is based on an adult specimen, 120 μm in total length. Pharynx 35 μm in length from the front edge of the mouth to the junction with the intestine; pharyngo-intestinal junction at U29. Head three-lobed, with a cephalion that is 6 μm in width, a small pleurion per side laterally, and a broadly subrectangular hypostomion behind the mouth that measures 9 μm in breadth and 7 μm in height; body small, robust, with well-defined neck, trunk and caudal base; widths of

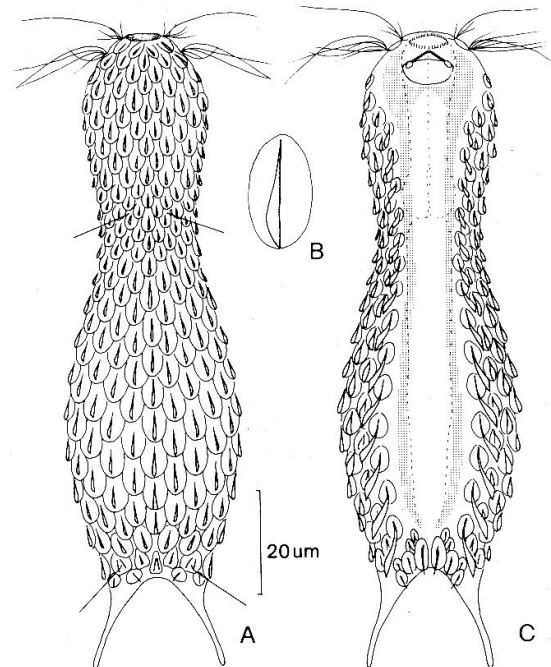


Fig. 16 - *Halichaetonotus thalassopais* n. sp. A, dorsal view; B, dorsal scale; C, ventral view. Dotting mimics the locomotory ciliature.

head/neck/trunk/caudal base are as follows: 25/18/33/17 μm at U12/U29/U61/U90, respectively; caudum of medium length, with a distal furca that indents medially to U85 and has borders that constrict slightly over the fleshy half of its length, but whose naked tubes diverge obliquely to the rear over the remaining half of its total length. On either side of the head are two tufts of cilia, one of about 5 cilia, 3-6 μm in length except one that reaches 22 μm , and the other tuft of more cilia, 8-22 μm in length. Two pairs of dorsal tactile bristles, 10-11 μm in length, are borne at U29 and U84, respectively.

Cuticular armature: the body is enveloped by 15 columns (9 dorsal, 3 + 3 ventral), of 18 scales each dorsally and 15-16 each ventrally (Fig. 16A, C). Scales quincunxially overlapping, being ovoid in shape (4.5 μm in length by 3 μm in width) anteriorly, becoming rounded (4 \times 3 μm) in the neck region and then ovoid once again (to 7.5 \times 5 μm) in the trunk region; each bears an elongate keel that has a height:length ratio throughout the dorsal part of the body of about 1:10 (Fig. 16B). Ventrally, the 3 columns of scales per side that lie outside the ciliary bands are similar to those of the dorsal surface, but have keels that raise in height as the columns progress ventrally, reaching a height:length ratio of 7:10, while bulging upward and backward so that this process protrudes past the posterior end of the scale; hydrofoil scales, occurring mainly in the posterior trunk region, so far as we can determine, bear spinous lamellae (Fig. 16C). The ventral interciliary field is bare. Posteriorly, on the furcal base, are 3 dorsal scales lying medially that are trianguliform and 2 or 3 lying more laterally that are round, including those with double keels that bear the posterior tactile bristles; no scales occur on the furcal branches. On the ventral surface, there are 6 or 7 pairs of ovoid keeled scales that occur near the anus; the largest pair (7.5 \times 4.5 μm) and the only one with keels extending posteriorly to form simple spines, lie astride the midline at the rear of the furcal base; these are flanked by two groups of 5 or 6 smaller scales are often asymmetrically arranged with respect to one another and that may be partially overlapping within each group, but with only the rearmost of each group occurring proximally on the fleshy part of the furcal branches.

Ventral ciliation: paired longitudinal rows extend from U03 to U79; each forming a broad patch anteriorly, then constricting (to ca. 2 μm) along with the margin of the neck, bowing slightly outward in the mid-intestinal region, and converging again somewhat in the posterior intestinal region; the rows meet medially behind the hypostomion (U04-09); cilia of the tracts are short (ca. 6 μm in length).

Digestive tract: the mouth is broad (6 μm), the buccal cavity goblet-shaped; the pharynx has swellings at each end (10 and 9 μm wide at the anterior and posterior swellings, 6 μm in the reduced middle region) and possesses a strong pharyngeal chevron anteriorly; the intestine begins broadly (7-8 μm) and narrows gradually through its length (ending at 3 μm); the anus opens ventrally at U79.

Reproductive tract: all specimens observed were in parthenogenic phase, the largest egg observed being 50 \times 30 μm (15 μm diameter).

Distribution - Type locality - TUSCANY: Mortelliccio (Follonica) [lat. 42° 56' N; long. 10° 41' E] (S). Other locations: Bagnetielli (M), Benedetto (L), Cavo (S), Cefalù (S), Chiaia (S), Cuma (S), Diano (S), Ginosa (S), Inglesi (M), Ischia porto (L,S), Porto Nuovo (S), Paestum (L,S), Palinuro (S), Pini (S), Pozzuoli (S), S. Remo (S), Ruppione (L), Scissura (S), Serapo (L,S), Vado (S), Vieste (S), and Zuccale (M) [see Table I].

Ecology - Frequency of occurrence - sparse in littoral and occasional in sublittoral, fine to medium sand, to a water depth of 3 m, in all sectors of the Italian coastline except the northern Adriatic; Abundance - rare to scarce in samples where found.

Remarks - Juvenile specimens of *Halichaetonotus thalassopais* have been seen that were as small as 97 μm . Like *H. etrolomus*, this species possesses a pharyngeal chevron in the anterior swelling, though in this case the elements are stronger and more robust than usual. The chevron appears to protrude into the buccal cavity and possesses paired orifices at their posteriolateral ends. The elements look like rod- or jaw-like cuticular structures that probably function in the feeding process, but until transmission electron microscopy observation has been done the nature of the chevron will remain unclear.

Taxonomic affinities - *Halichaetonotus thalassopais* is most similar to *H. decipiens* (Remane, 1929) (see below) and *H. riedli* Schrom, 1972, though *H. decipiens* is considerably smaller than the other two. All three have ovoid trunk scales *H. thalassopais* and *H. decipiens* have lateral hydrofoil scales that bear spines with attached lamellae, while *H. riedli* has hydrofoil scales that bear short, blunt spines. *H. thalassopais* and *H. riedli* lack scales in the ventral interciliary field, whereas *H. riedli* has a pharynx with stronger swellings and a broader furcal base with shorter furcal branches than *H. thalassopais*.

Halichaetonotus decipiens (Remane, 1929)

Heterolepidoderma dubium Remane, 1926: p. 250; fig. 5.

Chaetonotus decipiens (Remane, 1926) Remane, 1929: p. 167.

Chaetonotus (*Halichaetonotus*) *decipiens* Remane, 1929 [Remane, 1936-37: p. 190].

Halichaetonotus decipiens (Remane, 1929) Schrom, 1972: p. 326.

Nomenclatural comments - This species was described by Remane in 1926 as *Heterolepidoderma dubium*, but was transferred to the genus *Chaetonotus* by Remane in 1929. Since the specific epithet *dubius* was preoccupied

for the genus *Chaetonotus* by *C. dubius* Daday, 1905, the species in question became a secondary junior homonym (ICZN, 1985: Ch. XII, Art. 53c, 57c), and hence was unavailable for use (Art. 52a). Appropriately (see ICZN, 1985: Ch. IV, Art. 23c), Remane gave the species a new name, *Chaetonotus decipiens* Remane, 1929. Later, this species in question was assigned to the sub-genus *Halichaetonotus*, when this sub-genus was first established by Remane in 1936-37, though this would not have altered the status of its new specific epithet (ICZN, 1985: Ch. XII, Art. 57d). The species in question has been properly referred to in this manner during all of the intervening years (Wilke, 1954: p. 531; Valkanov, 1957: p. 292; Voigt, 1958: p. 24; Rudescu, 1967: p. 137; d'Hondt, 1968a: p. 220; d'Hondt, 1968b: p. 392), up to the time in 1972 when Schrom raised the sub-genus to the status of genus. He referred to the species in question as *Halichaetonotus decipiens* (Remane, 1929), indicating its equivalence to the former *Heterolepidoderma dubium* of Remane, 1926, and was followed in like manner by the single subsequent reference from that time to the present (Mock, 1979: p. 52). We here confirm that this is the proper designation, and indicate the reason why this is so. The International Code of Zoological Nomenclature (ICZN, 1964: Ch. XII, Art. 59b,c) was ambiguous with respect to species in this situation, so that a species whose name had been rejected after 1960, when reassigned to a genus in which its specific epithet is no longer preoccupied, must resume its original specific epithet with its original authorship. But, nothing was said with respect to a species whose name had been rejected prior to 1960, in this case the name *dubius* having been replaced in 1929. The situation has been clarified in the most recent edition of the International Code of Zoological Nomenclature (ICZN, 1985: Ch. XII, Art. 59b), wherein it is stated that «a junior secondary homonym replaced before 1961 is permanently invalid». Hence the proper name and reference for this species is *Halichaetonotus decipiens* (Remane, 1929) Schrom, 1972.

Musellifer delamarei (Renaud-Mornant, 1968) n. comb.

Polymerurus delamarei Renaud-Mornant, 1968: p. 142; figs 1, 2.

Taxonomic comments - This species was described by Renaud-Mornant in 1968 as *Polymerurus delamarei*, a year before the genus *Musellifer* was described by Hummon (1969) for the species *M. sublitoralis*. It became clear following the description of *M. profundus* by Vivier (1974) that *P. delamarei* should be transferred from the genus *Polymerurus*, which has no other marine representatives, to the genus *Musellifer*, but this could not be done until available and additional material had been reviewed. No specimens of this species had subsequently been found until our discovery of a single

specimen in 1989 from Santa Maria di Leuca, in Apulia, at some distance from the type locality. This specimen was studied thoroughly, as was the paratype specimen of Renaud-Mornant that we have had on loan from J. Kisielewski. More recently, specimens have been found on the Isle of Capraia, Tuscany (Balsamo *et al.*, 1992), also at some distance, but in the opposite direction, from the type locality. This species bears a ciliary field that is similar to the one found in *M. profundus*, which along with its body shape, elongate furca and spined scales that continue down onto the furcal branches, render it clearly a member of the genus *Musellifer*.

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