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Contribution to the study of the Mediterranean meiofauna: Gastrotricha from the Island of Ponza, Italy

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ABSTRACT

Twenty species, 8 Chaetonotida and 12 Macrodasyida, are reported from the Island of Ponza. Among the Chaetonotida, *Chaetonotus mariae* is new to science. It is characterized by peculiar round scales, each with numerous ridges radiating from the base of the spine. Among the Macrodasyida, *Diplodasys minor* is redescribed, and *Platydasys phacellatus* is reported for the second time. The Italian geographic distribution and the species-substratum relationship are also analyzed.

KEY WORDS: Gastrotricha - Taxonomy - Mediterranean meiofauna - Island of Ponza - *Chaetonotus mariae* n. sp.

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INTRODUCTION

The present study is part of a larger programme of biogeographic and faunistic surveys whose goal is the enlargement of our knowledge about the nature, origin and distribution of the Italian fauna. These surveys are within the framework of projects in the national interest, and are made possible by financial support from Consiglio Nazionale delle Ricerche and Ministero dell'Università e della Ricerca Scientifica e Tecnologica. Research carried out during 1988 and 1991 along most of the peninsular coasts increased the total number of marine gastrotrich species known for Italy from 73 to more than 130 (Hummon *et al.*, 1992a, b; Balsamo *et al.*, 1992; Todaro *et al.*, 1992; M. Balsamo, W. D. Hummon, M. A. Todaro and P. Tongiorgi unpublished data).

Investigations in 1990 concentrated on the islands; higher diversity of substrata and favourable environmental conditions are associated with a rich and particularly interesting gastrotrich fauna (Todaro & Balsamo, 1990; Todaro *et al.*, 1990, 1992; Balsamo *et al.*, 1992). The island of Ponza is of special interest due to its volcanic origin and central geographic location with respect to the other islands we have investigated. The results could also contribute to our understanding of the mechanisms and processes of dispersal of marine gastrotrich species. Since these benthic micrometazoa lack larvae or other known planktonic stages, they might be expected to have a restricted geographic range; however, many species seem to have worldwide distribution (Saito, 1937; Wieser, 1957; Ganapati & Rao, 1967; Ruppert, 1977).

MATERIALS AND METHODS

Sampling sites

The sampling was conducted on June 19, 1990 and was confined to the shallow sublittoral area (1.5-8 m depth) of four localities located on different sides of Ponza (40°56'-40°52' N; 13°00-12°56' E; Fig. 1). Cala Feola, Cala la Fonte, Santa Maria and Chiaia di Luna were chosen in order to investigate biotopes with different substrata, and because they were easily accessible. The number of sites was limited to four to allow fast processing of material, thereby avoiding less successful taxonomic analysis on fixed specimens.

Methods

Salinity and water temperature (respectively 35-36‰ and 23°-24° C) were measured at the time of sample collection. The samples (one from each site), consisting of sand or pebble, were placed into two-liter vacuum bottles along with a little water and transported within 24 hours to the laboratory where they were aerated.

The gastrotrichs were extracted daily from the upper layer of substratum during a period of fifteen days after sampling; they were narcotized using a 7% $MgCl_2$ solution. For each sample, a total of ca. 200 cm^3 of sand was processed. The extracted specimens were observed using Nomarski optics on a Leitz Dialux microscope, and were measured by ocular micrometer and photographed *in vivo*. Some specimens were also examined with a Philips 500 scanning electron microscope. For S.E.M., animals were fixed in 10% neutralized formalin, dehydrated through an ethanol series, dried with a critical

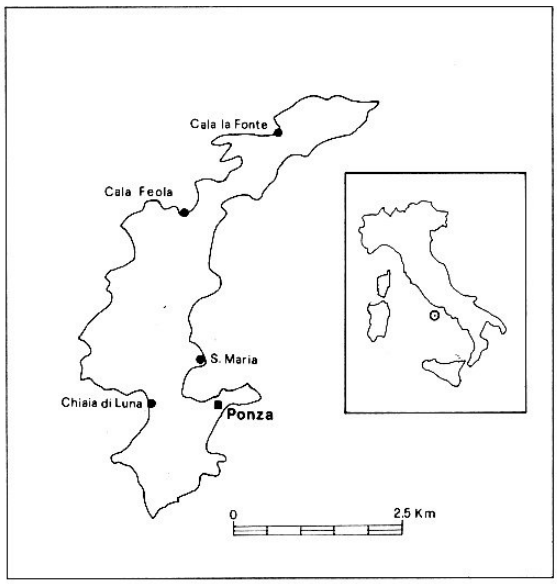

Fig. 1 - Location of sampling sites (circles).

point apparatus (Baltzers CPD 010) using CO_2, mounted on aluminium stubs, and sputter coated with gold-palladium.

For each species found, the Italian geographic distribution and a selected reference is given, while a detailed description accompanied by drawings and/or photographs is provided only for the new species and for those whose previous descriptions are poor and/or ambiguous.

Photographic negatives of *Chaetonotus mariae* n. sp., representing the type species, have been deposited in the Museo Civico di Storia Naturale of Verona (Lungadige Porta Vittoria 9, 37100 Verona, Italy).

The granulometric analysis of the substrata was carried out according to Folk (1968) and Hulings & Gray (1971). The relative parameters were calculated by a computerized programme based on the equations of Seward-Thompson & Hails (1973), while the sorting classes are the same as Gray (1981). The code for the abundance of the species is that suggested by Field (1970).

RESULTS

All specimens found on the island have been identified to the species level. They belonged to 20 species in 14 genera and 5 families in the orders Macrodasyida and Chaetonotida.

Order **MACRODASYIDA**

Family LEPIDODASYIDAE

Genus *Mesodasys* Remane, 1951

Mesodasys laticaudatus Remane, 1951

Localities: Santa Maria, fairly common in angular-subangular, moderately sorted fine sand with detritus, at 1.5 m water depth; Chiaia di Luna, fairly common in angular-subangular, moderately sorted medium sand with little detritus, at 2.5 m water depth.

Mature specimens 720-1620 µm long show from 22 to 26 adhesive tubes along the caudal lobe margins; the anterior adhesive tubes are arranged in two transverse rows.

Previously in Italy, *M. laticaudatus* has been found in Tuscany, Campania and Apulia.

References: Remane, 1951; Wilke, 1954; Schmidt & Teuchert, 1969; Thane-Fenchel, 1970; Kisielewski, 1987.

Family THAUMASTODERMATIDAE

Genus *Acanthodasys* Remane, 1927

Acanthodasys aculeatus Remane, 1927

Localities: Santa Maria, abundant in angular-subangular, moderately sorted medium sand with detritus, at 1.5 m water depth; Chiaia di Luna, abundant in angular-subangular, moderately sorted medium sand with little detritus, at 2.5 m water depth.

This is a common species, sometimes found in large populations along all the Italian coasts. No morphometric differences between the Ponza specimens and those collected in other Italian localities have been found, nor are there differences with the range of data in the literature.

References: Remane, 1927; Wilke, 1954; Forneris, 1961; Boaden, 1963; Rudescu, 1966; Schrom, 1966, 1972; Ganapati & Rao, 1967; Kisielewski, 1987.

Genus *Diplodasys* Remane, 1927

Diplodasys ankeli Wilke, 1954

Locality: Cala la Fonte, fairly common in clean, poorly sorted pebble, at 8 m water depth.

Specimens were observed with S.E.M. as well as with light microscopy, providing additional detail not previously available (Fig. 2A-C).

The mature specimens of Cala la Fonte measured 214-250 µm in total length; this is smaller than values in the literature, but approaches the value for specimens collected on the island of Elba in the Tuscan archipelago (Todaro *et al.* 1990, 1992).

The body is clearly subdivided into head, neck, and trunk, the last of these ending with a small caudal lobe bearing 12-14 adhesive tubes. On each side of the caudal lobe, two adhesive tubes form a caudal foot and protrude from the distal margin. The other adhesive tubes, including two between the feet, do not protrude from the lobe margin. They are ventrally inserted and arranged in two symmetric groups (Fig. 2A). The dorsal side of the body is covered with five longitudinal columns of cuticular plates with lightly sculptured surfaces; each scale has a large central depression, giving a lace-like appearance to the body surface (Fig. 2B). On each lateral

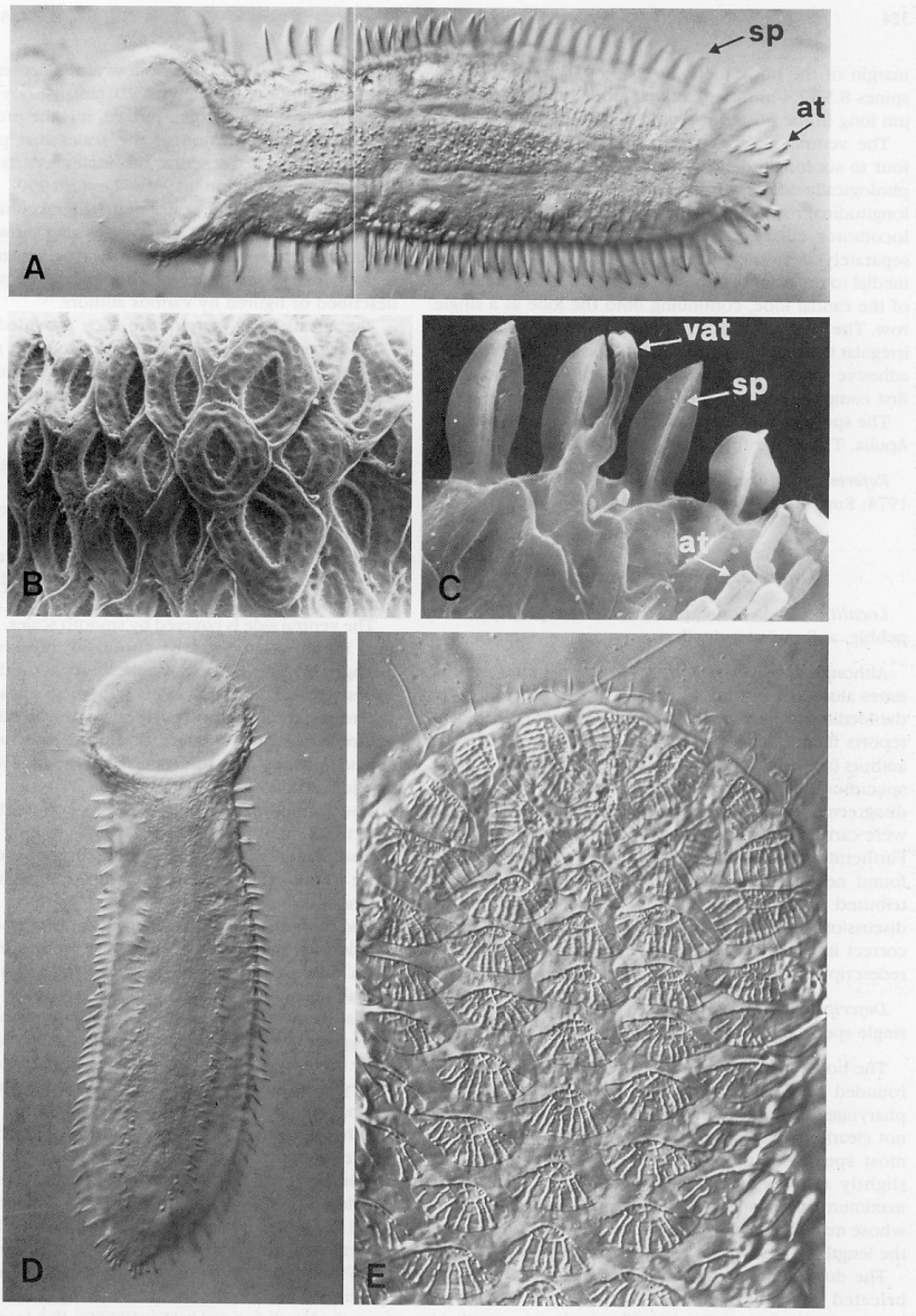

Fig. 2 - **A-C**, *Diplodasys ankeli*. A, general view. Nomarski optics, ×520; B, dorsal scales of the trunk. SEM, ×1650; C, posterior margin of the trunk, ventral view. SEM, ×1650. sp, *Diplodasys* spines; vat, ventrolateral adhesive tube; at, adhesive tubes of caudal lobe. **D-E**, *Diplodasys minor*. D, general view. Nomarski optics, ×400; E, anterior dorsal scales. Nomarski optics, ×1600.

margin of the body there are 34-35 "*Diplodasys*" type spines 8.5-12.4 μm long, as well as an adhesive tube 14 μm long in the posterior region (Fig. 2A, C).

The ventral surface, from margins to center, shows four to six longitudinal rows of imbricated scales, morphologically different from the dorsal ones (Fig. 2C), two longitudinal rows of 34 adhesive tubes, and two narrow locomotor ciliary bands. The last of these originate separately near the retrobuccal region, run rearward medial to the rows of adhesive tubes, and join at the base of the caudal lobe, continuing onto the lobe as a single row. The interciliary field is covered with cuticular plates irregular in shape and arrangement. The anterior (postoral) adhesive tubes are arranged in two transverse rows, the first composed of ten tubes, the second of eight.

The species has been found in Tuscany, Campania and Apulia. This is the first finding for Latium.

References: Wilke, 1954; Swedmark, 1956a; Schmidt, 1974; Ruppert, 1978; Kisielewski, 1987.

Diplodasys minor Remane, 1936

Locality: Cala la Fonte, present in clean, poorly sorted pebble, at 8 m water depth.

Although *Diplodasys minor* has been found several times along the northern coasts of Europe as well as in the Mediterranean Sea, and Renaud-Debyser (1963) even reports it in a paper on the Bahama Islands, only four authors (see below) have given some description of their specimens. Aspects of these descriptions are in disagreement, perhaps because most of the observations were carried out with microscopes with low resolution. Furthermore the creation of a new species for specimens found near Leghorn (Italy) which were previously attributed by Luporini *et al.* (1971) to *D. minor* (for discussion see Todaro *et al.*, 1992) suggests that other incorrect interpretations may have occurred. Therefore a redescription of this species is needed.

Description The following description is based on a single specimen from the Island of Ponza.

The body attains a length of 310 μm. Posterior to the rounded head, which is 80 μm wide, there follows a pharyngeal region 60 μm wide (Fig. 2D). This region is not clearly delimited by the two constrictions typical of most species of the genus *Diplodasys*. The trunk is slightly convex, measuring 72 μm at the point of maximum width, and ends with a small medial lobe from whose margin arise two groups of 4 adhesive tubes each; the length of these tubes ranges from 4 to 8 μm.

The dorsal body surface is entirely covered with imbricated scales organized on the trunk in seven longitudinal columns (Fig. 2E). The median longitudinal column consists of 27-28 scales. A careful microscopic analysis reveals that the scales of the head and those of the median row (at least until mid-trunk) are round in shape with a small circular hollow at the center of each. From the hollow arise about 10 radial grooves which reach the posterior margin. Indeed, it is the prominence of this posterior portion of the scales that persuaded several authors to describe the scales as triangular in shape (i.e., Remane, 1936; Levi, 1950; but see Kisielewski, 1987). The scales of the lateral columns tend to enlarge transversely. Lateral scales also show grooves which run transversely to the major axis, marking out sectors corresponding to the rhombic scales previously described or figured by various authors.

The lateral body margins are each provided with 46 "*Diplodasys*" spines. Four of these occur on the head, the first three being close together and approximately half as long as the fourth. The three originate ventrally and are therefore difficult to view from the dorsal side. The fourth spine, 12.5 μm long, is isolated from the others and occurs on the posterolateral margin of the head. In the pharyngeal region there are 4-5 well-separated spines. Somewhat variable spacing occurs on the trunk region, where the 37 lateral spines are much closer to each other. The last two spines of each trunk margin occur between a posterior ventrolateral adhesive tube, 15 μm in length, and the caudal lobe.

The ventral side is covered by smooth scales. There are two longitudinal rows of about 80 adhesive tubes, arranged in groups of 3-4 tubes each. Another 30-40 adhesive tubes, arranged in 2-3 transverse rows, occur in the retrobuccal region (postoral adhesive tubes). The ventral locomotor cilia are organized into two inconspicuous bands that run medial to the adhesive tubes, and join anteriorly.

The funnel-shaped mouth opens terminally and is directed ventrally. It leads to a 66.3-μm-long pharynx, whose pharyngeal pores are difficult to see and are very close to the pharyngo-intestinal junction. A straight intestine follows.

The reproductive system corresponds very closely to the description given for the genus by Ruppert (1978), and consists of two testes lateral to the intestine and a dorsal unpaired ovary interposed between the posterior caudal organ and the anterior frontal organ system. In this species, the rosette pore (female orifice) opens ventrally on the left side between the longitudinal locomotor ciliary band and the lateral spines in the anterior intestinal region.

Other disagreements in the literature concern the morphology of the posterior end of *D. minor*. In the specimens found at Trezen ar Skoden near Roscoff, Kisielewski (1987) described a posterior lobe bearing two small feet each with two adhesive tubes. This is in agreement with the description of the Naples specimens by Wilke (1954). In contrast, the posterior extremity of specimens collected and observed by Remane (1936) from the North Sea and by Levi (1950), also from Roscoff, was truncated and the 8-10 final adhesive tubes did not form true caudal feet. I suspect that these differences are more apparent than real, and are due primarily to the

degree to which the animals were compressed during observation. An explanation is less obvious for the presence of only 2 (instead of 4) cephalic spines in the specimens examined by Kisielewski.

The Italian geographic range for this species as reported from the literature and from surveys in which I have participated includes the Campanian and Apulian coasts.

References: Remane, 1936; Levi, 1950; Wilke, 1954; Kisielewski, 1987.

Genus *Platydasys* Remane, 1927

Platydasys phacellatus Clausen, 1965

Locality: Cala la Fonte, present in clean, poorly sorted pebble, at 8 m water depth.

The specimen found at Cala la Fonte was in good accordance with those found in the Gulf of Naples by Clausen (1965). Slight differences are probably related to the slightly shorter total body length (315 μm on the Ponza specimen vs. 380-585 μm). The number of adhesive tubes located between the caudal feet is 8 rather than 10-15, and the number of the lateral adhesive tubes is also 8 instead of 10. The Ponza specimen shows four additional adhesive tubes on each side, lateral to the mouth. These tubes are inserted more anteriorly than those described by Clausen. One of these tubes is very well developed and its origin is clearly dorsal with respect to the other three. With regard to the reproductive system, the presence in *P. phacellatus* of two kinds of spermatozoa and the granulated swollen endpiece attached to the vasa deferentia described by Clausen is confirmed.

The species was so far known only for the Posillipo area of Naples, where it was collected at depths and in substrata similar to that of Cala la Fonte. Like *Halichaetonotus atrolosum, Platydasys phacellatus* appears to be typical of this Tyrrhenian area. However, recent, careful survey in the type locality (Villa Rosebery, Naples) as well as in all the Gulf of Naples has yielded no specimens.

Reference: Clausen, 1965.

Genus *Ptychostomella* Remane, 1927

Ptychostomella mediterranea Remane, 1937

Locality: Cala la Fonte, fairly common in clean, poorly sorted pebble, at 8 m water depth.

The posterior end of the specimens examined has two lobes with 7 adhesive tubes inserted on each, rather than the arrangement of feet and accessory tubes described by Remane. The same conformation has been observed by myself in specimens from the island of Elba, as well as by W. D. Hummon A. M. Todaro and P. Tongiorgi (unpublished data) near Leghorn, both in the Tuscany region.

This species is known from the coasts of Tuscany and Campania. This is the first finding from Latium.

References: Remane, 1927.

Ptychostomella tyrrhenica Hummon, Todaro & Tongiorgi, 1992

Locality: Chiaia di Luna, fairly common in angular-subangular, moderately sorted medium sand with little detritus, at 2.5 m water depth.

The metric as well as the meristic characters of the specimens from Ponza are in full accordance with those of specimens previously found.

Ptychostomella tyrrhenica is extensively distributed along the western coast of Italy, and has been repeatedly found in Sicily, Tuscany, and Campania.

References: Todaro & Balsamo, 1990 (as *Ptychostomella* sp.); Hummon *et al.* 1992a.

Genus *Tetranchyroderma* Remane, 1926

Tetranchyroderma megastoma (Remane, 1927)

Locality: Santa Maria, abundant in angular-subangular, moderately sorted fine sand with detritus, at 1.5 m water depth.

The morphometric parameters of the Ponza specimens agreed with those known for the species. It occurs along the Tyrrhenian peninsular coast, with highest abundance on the coast of Campania.

References: Remane, 1927, 1929; Wilke, 1954; Swedmark, 1956b; Ganapati & Rao, 1967; Schmidt & Teuchert, 1969.

Tetranchyroderma thysanophorum Hummon, Todaro & Tongiorgi, 1992

Locality: Chiaia di Luna, fairly common in angular-subangular, moderately sorted medium sand with little detritus, at 2.5 m water depth.

Found for the first time along the Apulian coast where it was relatively common (Hummon *et al.*, 1992a), this species has now also been recorded in Sicily and in Tuscany (Todaro & Balsamo, 1990 as *Tetranchyroderma* sp.; Todaro *et al.*, 1990 as *Tetranchyroderma* sp.). This is the first finding from the central Tyrrhenian Sea. My specimens were in all respects similar to those previously found.

References: Hummon *et al.*, 1992a.

Genus *Thaumastoderma* Remane, 1927

Thaumastoderma ramuliferum Clausen, 1965

Locality: Chiaia di Luna, common in angular-

subangular, moderately sorted medium sand with little detritus, at 2.5 m water depth.

This species, characterized by branched cephalic tentacles, is so far known only from the Italian coastline and for the Roscoff region of France. In Italy it has been collected in Tuscany, Campania and Apulia (Todaro *et al.*, 1990; W. D. Hummon, A. M. Todaro and P. Tongiorgi, unpublished data). Its occurrence on Ponza is the first finding for Latium. There are no apparent differences between specimens of the Ponza population and those collected elsewhere.

References: Clausen, 1965; d'Hondt, 1970.

Family TURBANELLIDAE

Genus *Paraturbanella* Remanem 1927

Paraturbanella teissieri Swedmark, 1954

Locality: Chiaia di Luna, very common in angular-subangular, moderately sorted medium sand with little detritus, at 2.5 m water depth.

Specimens belonging to different populations of this species, which is easily identifiable because of the hexagonal shape of the anterior portion of the head, are characterized by substantial morphological uniformity. The morphometric parameters of Ponza specimens, as well those of the specimens from other Italian localities studied by myself, fall in to the known ranges; therefore the synonymy of *P. microptera* Wilke proposed by Kisielewski (1987) is here accepted.

With this report, the species seems to be present along all the Italian coastline, including the islands.

References: Swedmark, 1954; Wilke, 1954 as *P. microptera*; Schmidt & Teuchert, 1969; Tongiorgi, 1975; Kisielewski, 1987.

Genus *Turbanella* Schultze, 1853

Turbanella thiophila Boaden, 1974

Locality: Santa Maria, fairly common in angular-subangular, moderately sorted fine sand with detritus, at 1.5 m water depth.

The body of mature specimens attains a total length of 1036 μm and a width of 65 μm. The pharynx, provided with pharyngeal pores, is 182 μm long. The typical cephalic appendages are 21.5 μm long. The anterior adhesive tubes are organized into two «hands» each bearing 5-7 tubes, while the posterior ones including the caudal cone, are arranged in the 10 + 1 + 10 fashion.

On each lateral margin there are 29 adhesive tubes, each 8 μm long, and 20 pairs of adhesive tubes occur on the dorsal side of the body. In the posterior region, the tubes of each series tend to alternate.

The species has been collected also from the Tuscany and Apulian coasts (Todaro *et al.*, 1990, 1992; W. D. Hummon, M. A. Todaro and P. Tongiorgi, unpublished data).

References: Boaden, 1974; Tongiorgi, 1975.

Order **CHAETONOTIDA**

Family CHAETONOTIDAE

Genus *Aspidiophorus* Voigt, 1904

Aspidiophorus parameditерraneus Hummon, 1974

Locality: Chiaia di Luna, present in angular-subangular, moderately sorted medium sand with little detritus, at 2.5 m water depth.

The body is 252 μm in length including the furca, which is 26.5 μm long (adhesive tubes 14 μm long). The pharynx, which is 60 μm in length, shows a slight anterior dilation and a strong posterior bulb. It is followed by a straight intestine which ends with a ventral anus. The body is covered dorsally to mid-lateral by about 40 longitudinal alternating columns of stalked scales. Each latero-ventral side covered by about 20 longitudinal alternating columns of scales similar to the dorsal ones. All the scales have a perceptible median keel visible with both light and S.E.M. microscopes.

The apparently higher number of scales which cover the body of Italian specimens compared with that found in specimens of the North American population (Hummon, 1974a) may be due to the different method used for their computation (Hummon, personal communication). All the other morphometric chracteristics match the original description, with the exception of the Y-shaped ventral locomotor ciliary bands on Ponza specimens, which are more similar to those described by Kisielewski (1988). However, I wish to emphasize here that this and the other slight morphological differences described for the specimens of Roscoff and Arcachon (France), and only tentatively affiliated with this taxon by Kisielewski, may be related to the poorer resolution of the brightfield microscope available then to Hummon.

With this report, the first for the Latium coast, the Italian range of *A. parameditерraneus* appears to include the entire coastline with the exception of the northern coasts of the Adriatic Sea.

References: Hummon, 1974a; Kisielewski 1988.

Genus *Chaetonotus* Ehrenberg, 1830

Chaetonotus lacunosus Mock, 1979

Locality: Chiaia di Luna, present in angular-subangular, moderately sorted medium sand with little detritus, at 2.5 m water depth.

Originally described from the North Sea, this species is relatively frequent along the Italian coastline. The

specimens of Chiaia di Luna are in full accordance with those previously found along both the Tyrrhenian and Adriatic coasts.

References: Mock, 1979; Hummon *et al.*, 1992b.

Chaetonotus siciliensis Hummon, Balsamo & Todaro, 1992

Locality: Chiaia di Luna, present in angular-subangular, moderately sorted medium sand with little detritus, at 2.5 m water depth.

The following values refer to a single specimen. Total body lenght 214 µm; furca 35.8 µm long with adhesive tubes of 17.8 µm. Pharynx 37.6 µm in length. Similar values are known for the specimens found elsewhere. The species is present also in the upper Tyrrhenian Sea, in Sicily and along the Ionian coast of Apulia.

References: Todaro & Balsamo, 1990 (as *Chaetonotus* sp.); Balsamo *et al.*, 1992; Hummon *et al.*, 1992b.

Chaetonotus mariae n.sp.

Locality: Cala la Fonte, present in clean poorly sorted pebble, at 8 m water depth.

Diagnosis

Chaetonotus of medium size (131 µm in length). Body covered by 9-11 longitudinal columns of rounded spinate scales strenghthened by numerous radial ridges. Five to seven longitudinal columns of 15-16 scales with short and thick spines on the dorsal side and 4 longitudinal columns of scales with much longer spines on the ventrolateral surface.

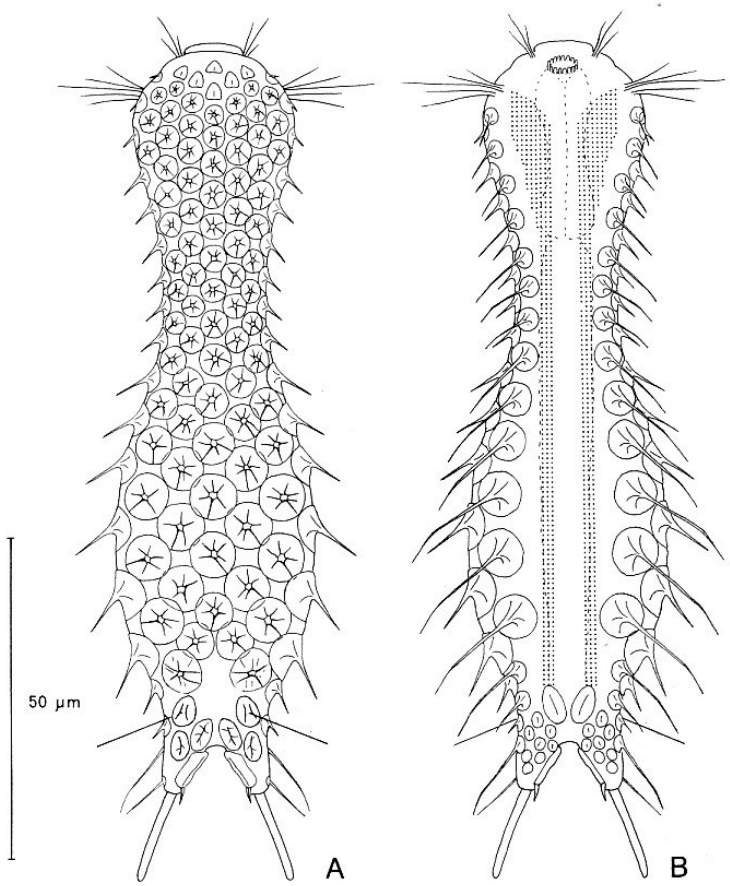

Fig. 3 - *Chaetonotus mariae* n. sp. A, dorsal view (dorsal spines omitted); B, ventral view (dotting mimics the ciliary bands).

Fig. 4 - *Chaetonotus mariae* n. sp. Nomarski optics, × 580.

Description

The body, which is 131 μm is length, is clearly subdivided into head, neck, trunk, and furcal appendages (Figs. 3, 4). The slightly five-lobed head is 25.2 μm wide. It is protected anteriorly by a small cephalion and shows 4 lateral tufts of tactile cilia. The distribution of tactile cilia and the head outline suggest the presence of pleuria, although they were not detected in the present study. The neck region is 16 μm wide, while the trunk measures 31.2 μm at the point of maximum width.

The 24 μm long furca ends with adhesive tubes that are 13.3 μm in length. Dorsally, the body appears to be covered by longitudinal columns of rounded scales, each of which shows numerous radial ridges (Fig. 4). Many of the ridges continue medially onto the central stumpy spine. The scales of the extreme anterior region of the head are smaller and subtriangular in shape, while among those of the rear trunk, four are elliptic and flat, while two are rounded and double keeled. Each of the double-keeled scales bears a tactile bristle 18 μm long. The numbers of longitudinal alternating columns of scales are 9-11 on the head, 7-9 on the neck, and 5-7 in the middle of the trunk region. The scales, which in the medial longitudinal row are 15-16 in number, overlap slightly with one another. The diameter of the scales (4.0-8.5 μm) and the length of the spines (3.0-8.0 μm) increase from head to trunk. Ventrolaterally on each side, there are two longitudinal columns of scales; those of the more medial column carry thin spines which are much longer (10-18 μm) than the dorsal ones.

The interciliary ventral field appears naked with the exception of two elliptic keeled scales (7.6×4.0 μm) under the posterior end. Under the furca, on each side, there are 8-10 small rounded scales (1.5-3.0 μm in diameter) with little or no evident keel. The medial margins of the furca are protected by two strong subrectangular keeled scales each with a short spine directed posteriorly.

The small mouth ring, 5 μm in diameter, is subterminal. It leads into a 25.2-μm-long slightly double-bulbed pharynx. The intestine is straight and becomes narrow posteriorly. The observed specimen was in a parthenogenetic stage.

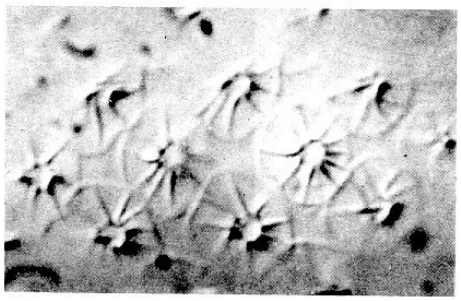

Fig. 5 - *Chaetonotus mariae* n. sp. Dorsal scales of the trunk. Nomarski optics, × 2000.

Taxonomic remarks

No other species of the genus *Chaetonotus* shows a cuticular armature with characteristics like those observed in *C. mariae*. *Chaetonotus apolemmus*, found by our group along the Italian coasts, has some similarity with the new species. However, *C. mariae* clearly differs in the shape of its spines (sharp apex in *C. mariae* vs. truncated apex in *C. apolemmus* sp. K), as well as in the presence of radiating ridges on the scales.

Etimology: The species is dedicated to Dr. Maria Balsamo, who introduced me to the study of these beautiful little creatures.

Genus *Halichaetonotus* (Remane, 1936)

Halichaetonotus aculifer (Gerlach, 1953)

Locality: Chiaia di Luna, present in angular-subangular, moderately sorted medium sand with little detritus, at 2.5 m water depth.

The specimen found is 134 μm long. The body is divided into head (26.3 μm wide), neck (16 μm wide), trunk (21.6 μm wide), and furca (29.2 μm long). Dorsally, there are 9 longitudinal columns of keeled scales; ventrolaterally on each side, there is a longitudinal column of 14-16 scales with lamellae («hydrofoil» scales). Between the bands of ventral locomotor cilia are 5-9 longitudinal alternating columns of small rounded scales, keeled in front and spined to the rear.

Kisielewski (1988) described for the first time a well-defined hypostomion composed of a single plate for the specimens found along the French coasts. In contrast, the specimen from Ponza showed a hypostomion composed of three flanking plates (Fig. 6). This characteristic,

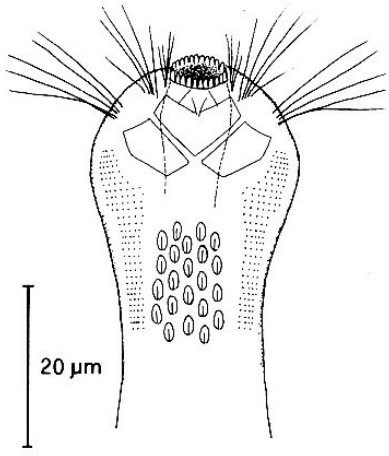

Fig. 6 - *Halichaetonotus aculifer*. Ventral view of head showing the shape of the hypostomion (dotting mimics the ciliary bands).

together with an unusual transparency of the cuticle, which had never been observed among the numerous specimens found in other Italian localities (W. D. Hummon, M. Balsamo and M. A. Todaro, unpublished data), might cast doubt on the specific attribution of this specimen. However, the morphometric parameters and, most importantly, the shape of the hydrofoil scales support its affiliation with *H. aculifer*.

This species has frequently been collected along all Italian coastlines, making it one of the most common species in the region.

References: Gerlach, 1953; d'Hondt, 1966; Luporini & Tongiorgi, 1972; Schrom, 1972; Kisielewski, 1988.

Halichaetonotus etrolomus Hummon, Balsamo & Todaro, 1992

Locality: Cala la Fonte, present in clean, poorly sorted pebble, at 8 m water depth.

Halichaetonotus of minute (92 μm) body size with appendage of 18.2 μm. The pharynx is 22.2 μm in length and shows a bulbous enlargement at each end. The anterior bulb has two cuticular rods similar to those found in other congeneric species. Dorsally, the animal is covered by 7-9 longitudinal columns of keeled scales. There are 15-16 separated scales in the median longitudinal column. Ventrolaterally, 14-15 pairs of hydrofoil scales occur.

As presently known, the distribution of this species is restricted to the island of Ponza and to the nearby coast of Campania. The single previous finding is from the neighboring area of Naples.

References: Hummon *et al.*, 1992b

Genus *Heterolepidoderma* Remane, 1927

Heterolepidoderma loricatum Schrom, 1972

Locality: Santa Maria, present in angular-subangular, moderately sorted fine sand with detritus, at 1.5m water depth.

The total body length reaches 116 μm; the furcal appendages are 18 μm long, including 11.2 μm as adhesive tubes. The pharynx length reaches 27.6 μm. The cuticular armature comprises scales arranged in 13-15 longitudinal alternating columns; of these, 9 longitudinal columns of keeled scales cover the dorsal side. There are 18 scales in the medial longitudinal row.

In the specimens that were examined, the scales of the two more ventrolateral columns bear spines with lamellae (hydrofoil scales), rather than being simply keeled as described by Schrom (1972). Hydrofoil scales are also present in specimens I have observed in other Italian localities. They are difficult to see and may have been overlooked by the first author.

This species is relatively common, and is found along all the peninsula coasts as well as along the coasts of other islands (W. D. Hummon, M. Balsamo and M. A. Todaro, unpublished data).

References: Schrom, 1972.

Family XENOTRICHULIDAE

Genus *Draculiciteria* Hummon, 1974

Draculiciteria tesselata (Renaud-Mornant, 1968)

Locality: Chiaia di Luna, present in angular-subangular, moderately sorted medium sand with little detritus, at 2.5 m water depth.

The measurements of the sexually mature specimens fall in the range of those given for the species. Like the population from the upper Tyrrhenian Sea described by Luporini *et al.* (1971, 1973), the specimens from Chiaia di Luna show two particularly long, lateral spines at the posterior end of the trunk.

Thus far, *D. tesselata* has been found along the Tyrrhenian coasts and along both the Ionian and Adriatic coasts of Apulia.

References: Renaud-Mornant, 1968; Luporini *et al.* 1971, 1973; Hummon, 1974b; Mock, 1979; Ruppert, 1979.

DISCUSSION

Geographic distribution

With Ponza, the total number of the recently studied Italian islands is increased to seven, including Elba, Giglio and Capraia in the Tuscan Archipelago, Ischia and Procida in the Campanian Archipelago, and Sicily more to the south. From the Tuscan Archipelago more than 50 species have been reported with the island of Elba being the richest in species (some 40 spp., Balsamo *et al.*, 1992; Todaro *et al.*, 1992); more than 40 species have also been found in the Campanian Archipelago where Ischia was the richest island (some 30 spp., M. Balsamo, W. D. Hummon, M. A. Todaro, P. Tongiorgi, unpublished data), while the preliminary survey of Sicily reported 26 species (Todaro & Balsamo, 1990) Of the 20 species found in Ponza, 18 are present in at least one of the previously studied islands. In particular, 14 species are in common with the Tuscan islands, 11 species are in common with the ones from Campania, and 10 also occur in Sicily. Six species, *Aspidiophorus parameditерraneus*, *Chaetonotus sicilieusis.*, *Acanthodasys aculeatus*, *Paraturbanella teissieri*, *Ptycostomella tyrrhenica* and *Thaumastoderma ramuliferum*, have been collected in all of the four island areas.

Excluding Ponza from the computation, the other three localities have 14 species in common, which rises

to 22 if Sicily is also excluded (because it is still poorly studied). Thus the composition of the gastrotrich fauna of these islands is surprisingly similar, and the amount of similarity increases with an increase in the number of sampling sites on each island. The number of sites was related to the number of different substrata available from each island. Therefore, the similarity of gastrotrich fauna may reflect the similarity of bottom sediments irrespective of the distances between islands of the region. In others words, it becomes evident to me that at least in this portion of the Mediterranean there are no barriers to dispersal of this meiofaunal group; their occurrence and diversity in a given area depends on the kinds of bottom substrata that are present. The different geological origins, the distance among the islands studied, as well as their distance from the continental coastline suggest, furthermore, that the recruitment of marine gastrotrichs in a given area may occur by more than one process. Local addition of newborn animals within a population to sediment and infaunal immigration of colonists through the sediment from adjacent areas (sediment pathway, McIntyre, 1969) are the usual processes. To them can probably be added transport by water column processes (Palmer, 1988), despite the fact that these animals lack pelagic larvae. To what extent there is an active entry of the gastrotrichs into the water column, and to what extent they are subject to passive erosion from the substratum, remain open questions.

Ecology

Research conducted along most of the Italian coastlines has documented the disappearance of several species of gastrotrichs from their type localities (M. Balsamo, W. D. Hummon, M. A. Todaro and P. Tongiorgi, unpublished data). There is also evidence that both species richness and abundance of individuals can suffer a catastrophic collapse in the presence of heavily polluted waters (Hummon *et al.*, 1990). Thus, performing studies in offshore island environments, where the impact of human activities in less, may provide a better estimate of the regional diversity of the taxonomic group of interest than by studying coastal beaches of the mainland. My finding in Ponza of numerous gastrotrichs with broad taxonomic distribution (20 species, with 8 chaetonotids (C) and 12 macrodasyids (M) belonging to 14 genera and 5 families) supports this concept, and is consistent with results from other islands (Todaro & Balsamo, 1990; Todaro *et al.*, 1990, 1992; Balsamo *et al.*, 1992).

The dissimilar number of species found in the different localities on Ponza (Table I), with a maximum of 11 species (5 C and 6 M) in Cala la Luna, and the absence of

TABLE I - *Species distribution of Gastrotricha at four sublittoral sites of the Island of Ponza.*

	Cala Feola	Cala La Fonte	Santa Maria	Chiaia di Luna
CHAETONOTIDA				
Aspidiophorus paramediterraneus	–	–	–	*
Chaetonotus mariae	–	*	–	–
Chaetonotus lacunosus	–	–	–	*
Chaetonotus siciliensis	–	–	–	*
Draculiciteria tesselata	–	–	–	*
Halichaetonotus aculifer	–	–	–	*
Halichaetonotus etrolomus	–	*	–	–
Heterolepidoderma loricatum	–	–	*	–
MACRODASYIDA				
Acanthodasys aculeatus	–	–	*	*
Diplodasys ankeli	–	*	–	–
Diplodasys minor	–	*	–	–
Mesodasys laticaudatus	–	–	*	*
Platidasys phacellatus	–	*	–	–
Paraturbanella teissieri	–	–	–	*
Ptychostomella mediterranea	–	*	–	–
Ptychostomella tyrrhenica	–	–	–	*
Tetranchyroderma megastoma	–	–	*	–
Tetranchyroderma heterotubulatum	–	–	–	*
Thaumastoderma ramuliferum	–	–	–	*
Turbanella thiophila	–	–	*	–
Total species per site	0	6	5	11

*, species present; –, not present.

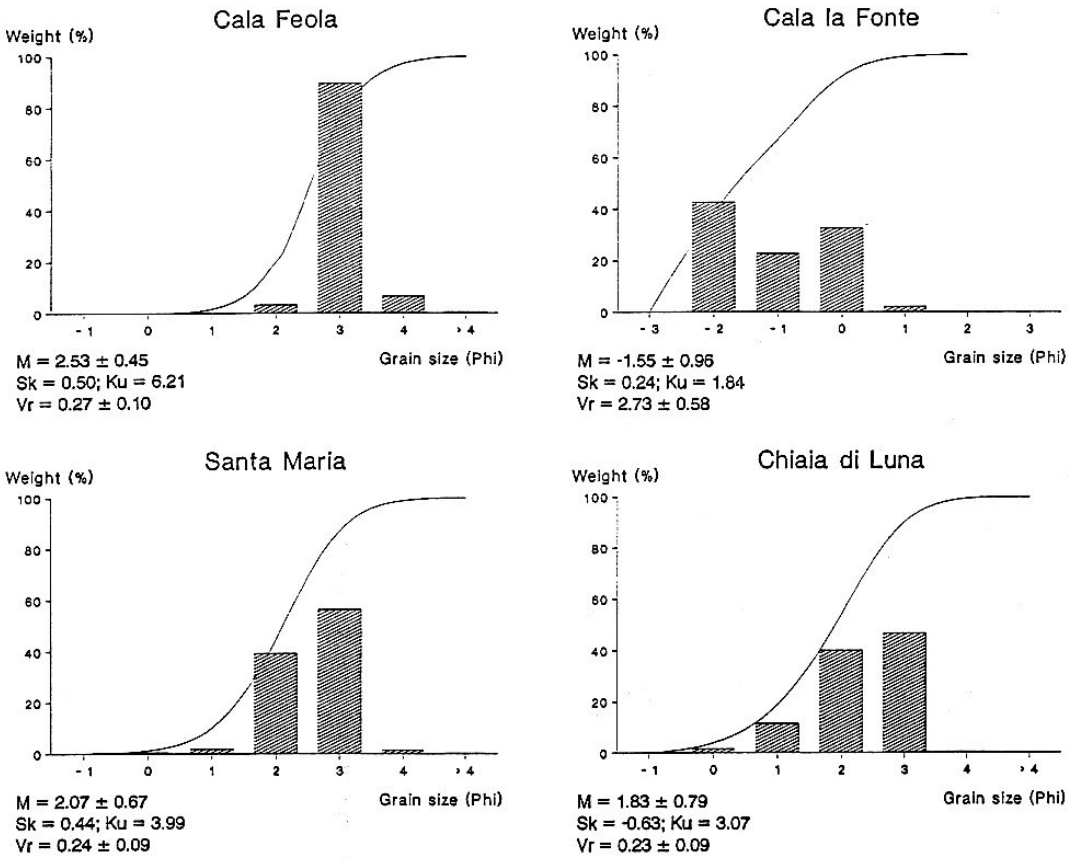

Fig. 7 - Granulometric analysis: histograms by weight and cumulative curves. Ku, kurtosis; M, mean ± SD; Sk, skewness; Vr, Roundess value for quartz grains; Vrc, roundess value for calcium carbonate particles.

gastrotrichs in Cala Feola, shows that differences also exist in areas not subjected to massive pollution.

The colonization of sediment by meiofaunal organisms is influenced by the nature of the sediment itself, in particular its size, sorting, and the angularity of its grains (Wieser, 1959; Renaud-Debyser, 1963; Coull, 1970; Warwick & Buchanan, 1970; Conrad, 1976). These characteristics, as well as the packing arrangement of grains and the amount of detritus, determine porosity and permeability. Pore size, water movement, and gas exchange are important and directly related factors in the meiofaunal environment. A granulometric analysis of the sediments of the four localities (Fig. 7) provides some explanation of the observed species distribution.

At Cala la Fonte, the substratum was poorly sorted, with a high proportion of coarse carbonate grains. Such habitats are typically poor in gastrotrich abundance and species number; yet 30% of the species found on the island occur there. *Diplodays ankeli*, *D. minor* and *Platydasys phacellatus* tend to occur in coarse sediment and may be morphologically adapted to the turbulence which characterizes this microhabitat. *Chaetonotus mariae*, with scales bearing radiating ridges and provided with short, strong spines, may also be adapted to turbulence. However, the other species found at Cala la Fonte are frequently found in sand of medium-fine granulometry (M. Balsamo, W. D. Hummon, M. A. Todaro and P. Tongiorgi, unpublished data). This unusual combination of species may be related to two factors: 1) The time of sampling, following a period of at least 15 days of calm weather, such that recent turbulence would have been at a minimum; 2) the microfissures present in the surface of carbonate grains at this site might serve as a refuge for shelter during the ephemeral period of turbulence. In addition, such sedimentary fissures might also support food reserves since these sites are likely to support a preferential growth of microbial flora, a major dietary component for gastrotrichs. Sediments with similar granulometry, but lacking fissures such as silicious granules that I collected in other parts of Italy under similar weather conditions, usually supported a poorer gastrotrich fauna.

The similar granulometric parameters of Santa Maria and Chiaia di Luna may explain the partial similarity of

the species found. However, the sand from Santa Maria had a larger percentage (54% *vs* 41%) of grains with high sphericity and, above all, a higher amount of detritus compared to the sand of Chiaia di Luna. Detritus reduces the dimensions of the interstitial space, decreases the space available for the infaunal animals, and in large amounts obstructs good oxygenation of the deeper layer of the substratum. Thus a reduction of niches for gastrotrichs and the consequent diminution in the number of species, as in Santa Maria as compared to Chiaia di Luna, might be expected.

At Cala Feola, the substratum consisted of fine sand mixed with a little silt and a conspicuous quantity of organic detritus that was undergoing decomposition. This site fits the definition of the sufide system as described by Fenchel & Riedl (1970), a type of environment unsuitable for colonization by most species of gastrotrichs. However, Boaden (1977) proposed that such an environment, the thiobios, was an important site for the evolution of meiobenthos in general and gastrotrichs in particular; other (Reise & Ax, 1979) have disagreed. From my experience, very few species of gastrotrichs (*Dolichodasys elongatus* and *Megadasys pacificus*) are typical, although not solely restricted, to these environments characterized by low oxygen tension. Furthermore, *Turbanella thiophila*, which Boaden (1974) considered a component of the thiobios, has been found routinely by myself and others in sediments that are highly saturated with oxygen.

Sites subject to low wave energy are easily identified by their substrata, composed of fine or very fine sands (Folk, 1968). In these lentic waters, reduced oxygen tension and poor dispersion of detritus are characteristic. Detritus, sinking and accumulating on the bottom, is involved in processes which deplete the oxygen content of the sediments. The already restricted oxygenation of the deeper sediment layers, which arises from lower substratum permeability, becomes further depleted because of the slow replacement of water from surrounding areas. According to Reise & Ax (1979), these anaerobic sediments, in the absence of large infauna, lack meiofauna of all sorts.

The absence of gastrotrichs at Cala Feola is consistent with Reise & Ax's (1979) predictions. The gastrotrich fauna of Ponza demonstrates the value of examining islands. The diversity of substrata and relatively unpolluted beaches support a rich variety of gastrotrichs, except in substrata with low oxygen tension related to detritus decomposition and slow gas exchange.

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