APPENDIX
A new species of *Pseudostomella* (Gastrotricha: Macrodasyida: Thaumastodermatidae) from a sandy beach of Kerala, India

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Abstract

During an interstitial faunal survey along the south-west coast of Kerala, India, gastrotrich fauna were found in abundance. Together with species of the genera *Xenorichula*, *Halichaetonotus* and *Terranchyrodernza*, were present several undescribed thaumastodermatid gastrotrichs belonging to the buccal palp bearing genus *Pseudostomella*. Adults of the new species are characterized by the following traits: total body length of about 300 μm; cuticular armature made up of medium sized pentancres covering the entire dorsolateral surface; pre-buccal, grasping palps bearing five, large papillae dorsally and 4-6 smaller papillae ventrally; adhesive apparatus made up of six anterior, 22-24 ventrolateral, two dorsolateral and six posterior adhesive tubes; caudal organ pear-shaped; frontal organ spherical. *Pseudostomella cheraensis* sp. nov. is the fourth taxon of the genus known from India; however, all the previous species reported hitherto from India have tetrancres instead of pentancres.

Key words: interstitial; meiofauna; taxonomy; gastrotrichs; Arabian Sea

Introduction

Gastrotricha constitutes one of the most interesting and taxonomically challenging groups of meiobenthic marine and freshwater invertebrates. Traditionally gastrotrichs are considered, on morphological basis, either to be a separate phylum or to belong to the Aschelminthes, and are believed to be closely related to Rotifera (Brusca & Brusca, 1990) or the Nematoda (Ruppert & Barnes, 1994). More recently, they have been associated on molecular ground with the Platyzoa (Todaro et al., 2006a). In aquatic ecology, gastrotrichs are known as important components of the permanent meiofauna (Todaro et al., 2006b).

Marine gastrotrichs are mainly interstitial, occurring both in the intertidal and subtidal realms. They are more abundant in fine to medium grained sediments in unpolluted and less turbid waters of coastal areas (Todaro & Rocha, 2004). However, submarine caves, dysoxic sand and deep, muddy sediments may also be colonised by gastrotrichs (Leasi et al., 2006; Todaro et al., 2006b; c; Balsamo et al., 2007). In the sandy marine interstices, gastrotrichs rank third in abundance among the meiofaunal taxa following Nematoda and the harpacticoid Copepoda; their numerical abundance may reach a density up to 364 ind./10 cm² (Todaro, 1998).

The phylum is cosmopolitan and includes about 700 species grouped into two orders: Macrodasyida, with 250 strap-shaped species, all but two marine, and Chaetonotida, with 450 tenpin-shaped species, of which only 150 are marine or brackish.

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The gastrotrich fauna of India have been recently reviewed by Naidu & Rao (2004). The present report is on a new species of *Pseudostomella* found during an interstitial faunal survey along the south west coast of Kerala, India. The genus *Pseudostomella* was first created by Swedmark (1956) based on a specimen discovered from Roscoff in France, thirteen species have subsequently been described (Clausen, 2004); of these four are endemic or occur also along the Indian coasts; they are: *P. roscovita* Swedmark, 1956, *P. malayica* Renaud-Mornant, 1967, *P. indica* Rao, 1970, *P. andamanica* Rao, 1993. All these species possess only tetrances whereas the species described here is characterized by the presence of pentancres uniformly distributed dorsally.

**Material and methods**

Sediment sampling employing a corer was done in the Cherai beach (lat.12° 97' N; long. 77° 56' E), Kerala State, located on the south-west coast of India (Fig. 1). The core samples were obtained from the mid tide level at a depth of 17 cm. Temperature (28°C) and salinity (310/0) of the interstitial water were recorded. The animals were narcotized in situ by adding 7% magnesium chloride solution and subsequently fixed in 5% sea water formalin. The fauna was extracted by decantation following the technique adopted by Pfannkuche & Thiel (1988). The specimens of gastrotrichs were dehydrated through graded ethanol series and mounted on slides using glycerol and the slides were sealed with a sealant. Specimens were examined under a Magnus 100× oil immersion objective (India) or with Nomarski differential interference contrast optics using an Eclipse 90i Nikon microscope (Italy). During DIC observation, the specimens were photographed with a DS-5Mc Nikon digital camera. Measurements were taken using an ocular micrometer or derived directly from microphotographs.

**ABBREVIATIONS** (after Ruppert, 1991; Hummon et al., 1993; Clausen, 2000).

Co = caudal organ; CP = caudal pedicle; DP = dorsal papilla; E = egg; eg = Epidermal gland; Fo = frontal organ; Lt = total length from the anterior tip of pre-buccal extension to posterior tip of caudum or pedicles including adhesive tubes; U = percentage unit of total length used for the location (U-) from anterior to posterior; pb = Pre-buccal apparatus; PhIJ = junction between pharynx and intestine; Pp = pharyngeal pore; T = testis; TbA = anterior adhesive tube; TbL = lateral adhesive tube; TbVL = ventro-lateral adhesive tube; TbDL = dorso-lateral adhesive tube; TbP = posterior adhesive tube; VP = ventral papilla.

**Systematics**

Order Macrodasyida Remane, 1925 [Rao & Clausen, 1970]
Family Thaumastodermatidae Remane, 1926
Genus *Pseudostomella* Swedmark, 1956

*Pseudostomella cheraensis* sp. nov.
(Figs 2, 3)

**Type locality.** Cherai beach, (lat.12° 97' N, long. 77° 56' E) Kerala, India. Mid-tide region in clean medium sand, moderately well sorted.

**Materials examined.** Twelve specimens were examined by light microscopy.
Holotype. One specimen of total length (Lt) 295 μm collected on 15-12-2005; glycerol wholemounts on microslide, deposited at Marine Biodiversity Museum, CMFRI (Government of India), Kochi, India; ref. No: MBM – 1.1.1.1

Paratype. Two specimens of length 276 μm and 223 μm respectively collected from the type locality; glycerol wholemounts on microslides, deposited at the same museum as; ref. No: Paratype1: MBM – 1.1.1.1.1; Paratype 2: MBM – 1.1.1.1.2

Etymology. Named after the type locality which is a well known sandy beach frequented by both domestic and foreign tourists.

Diagnosis. Pseudostomella up to 295 μm in total body length, with a distinct anterior pre-buccal apparatus and an elongate bilobed caudum. Buccal palps bearing five dorsal cephalic papillae with sensory hair and four-six minute ventral papillae. Cuticular armature of pentancres extending from the margin of oral cavity to the base of pedicles (caudum) ornaments the entire dorsal surface. Adhesive tubes: pedicles with three distal adhesive tubes (TbP) of unequal length and an adhesive tube at the base. TbA, six in number, in 2+2+2 pattern; TbL, 10-12 per side between U39 and U89. Nine pairs of granular epidermal glands between U25 and U87.5. Sensory hairs on the pre-buccal palps and trunk. Tactile cilia border the margin of the buccal cavity. Caudal organ pear shaped; frontal organ spherical. Oocytes located in the mid body.

Description. The description is based on an adult specimen, 295 μm in total length. Width at oral cavity, neck (slightly swollen), trunk (6th pair of epidermal gland) and caudal base: 39/46/40/15 μm at U12, U21, U67 and U93 respectively. Head with well-developed and extended pre-buccal apparatus (pb) incurving anteromedially, characterizing the genus Pseudostomella. Their dorsal margin project out a little beyond the ventral margin. Pre-buccal apparatus has five fleshy dorsal papillae ranging in length from 6 μm to 12 μm, symmetrically arranged in 2+1+2 pattern. All papillae are with tactile cilia at the tip. Four to six smaller papillae are present along the ventral margin of the buccal palps, arranged in 2+2 or 3+3 pattern. Several sensory hairs (3...
um) present on the outer lateral margins of pre-buccal apparatus among which, a longer one measured 16 μm. Sensory hairs or lateral bristles (10 μm long) of uncertain numbers seen on the lateral margins of the body as well (U22-U91).

Epidermal glands: Eight to nine pairs of granular epidermal glands arranged along the lateral margins of the body originate at about U25 and extent up to U87.5. Their size range between 7.5–10 μm × 7.5–15 μm. The middle glands located at 8 μm apart from each other.

Cuticular armature: The entire dorsal surface from the base of buccal apparatus to the pedicles covered by rows of closely packed pentancres with an average size of 3.5-5 μm. They are arranged in 13-14 longitudinal columns in the mid-trunk region with each column containing around 58 to 60 pentancres antero-posteriorly. The tines of the ancres project out almost masking the posterior border of the body.

Adhesive tubes: Four of the six anterior adhesive tubes (TbA) seen ventrally at the base of the pre-buccal apparatus in 2+2+2 pattern measure 4 μm each. The remaining pair at the farthest end are longer. The number and pattern of TbA seem to vary. In one of the paratypes, an additional pair is seen associated with the distal pair, indicating variability in the number of TbA. Eleven pairs of lateral adhesive tubes (TbL) originate at U39 and extent up to U89, with an average length of about 7-8 μm. Of these, the anterior ten pairs are TbVL, evenly spaced and extent up to U77.6. The last pair, dorso-lateral in position is located at U89. Pedicles (20 μm long) furnished with three distal tubes (TbP), the median one (8 μm) directed slightly dorsally, while the others (5 μm) are directed slightly ventrally. Two posteriorly directed adhesive tubes, 8-9 μm long, are positioned at the base of the pedicles.

Ventral ciliation: Locomotory cilia form a continuous field of transverse rows from behind the margin of mouth and extent up to the caudal base.

Digestive system: The digestive tract begins with a terminal mouth, covered dorsally by a hood like extension and opens into the pharynx, behind the pre-buccal apparatus. The pharyngeal pores could not be located in the holotype but were seen at the base in the paratypes. The entire digestive tract not well discernable in the holotype. The paratype showed Ph1J at U37–U38. The intestine is broad anteriorly and narrows down posteriorly. The anus opens ventrally at U89.

Reproductive system: Simultaneous hermaphrodites. A single elongate testis on the right side (as seen from above) begins behind the pharyngeo-intestinal junction and leads caudally into a narrow elongate vas deferens. The caudal organ located at U78 is pear shaped and is connected to a spherical frontal organ located at U74.8. The paratype showed two oval oocytes in the mid posterior body, of which the upper larger one measured 38×19 μm.

FIGURE 2. *Pseudostomella cheraensis* sp. nov. – Drawing of the habitus as seen from the ventral side. Scale bar: 100 μm.
FIGURE 3. *Pseudostomella cheraensis* sp. nov. – DIC optics - A, habitus, dorsal view; B, anterior end, dorsal view, showing the arrangement of the pentacres and papillae of the pre-buccal palps; C, anterior end, ventral view, showing the arrangement of the anterior adhesive tubes. Scale bars: A, 100 μm; B, C, 25 μm.
Pseudostomella cataphracta can be distinguished from the other pentrancres-bearing species, including the new one from India, principally because it possesses a pair of ventral feet (each foot made up of four adhesive tubes), located in posterior region of the trunk. *P. etrusca* is the only one that bears a pair of dorsal adhesive tubes on the base of the pre-buccal palp, moreover it has a much higher number of anterior adhesive tubes compared to *P. cheraensis* sp. nov. (14 vs 6). *Psudostomella* sp. 1 from Somalia in contrast with the new species from India shows a pair of ventro-lateral adhesive tubes in the anterior region of the pharynx, a higher number of anterior adhesive tubes, (10 vs 6), shorter caudal pedicles and the dorsal tubes at the end of each caudal pedicle that is shorter of the two tubes that flank it.

The pattern of distribution of the representative species belonging to the genus *Pseudostomella* hitherto known clearly indicates cosmopolitanism. However, the species as such appear to have a rather narrow range, on the other hand the general absence of biogeographic records testifying the simultaneous presence of two or more species at a single beach (e.g. as it happens for *Tetranchyroderma*) let to hypothesize that biogeography may be influenced also by interspecific competition. In this general framework the finding of three species of *Pseudostomella* from a North Carolina beach (Ruppert, 1970) and the occurrence of *P. roscovita* in the Atlantic Ocean (and connected seas) and the Indian Ocean appear particularly interesting and certainly call for further investigations.

References


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Note
Sediment transport and bioinvasion - Possible impact of Tsunami - Protodriloides chaetifer an example
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Abstract
The occurrence of Protodriloides chaetifer (Remane, 1926) on the Indian coast is recorded for the first time from the sandy beaches of Fort Kochi (9°48' N and 76°5' E) and Arthungal (9°30' N and 76°23' E). These interstitial polychaetes are characterized by the presence of segmented vermiform body, non-canaliculated tentacles, greenish and colourless epidermal glands, paired, segmentally arranged S-shaped bifid chaetae and bilobed pygidium bearing adhesive glands. Massive transportation of marine sediments brought about by the devastating tsunami might have led to the bioinvasion of this species to this tropical coast. This species was conspicuously absent in the samples collected from the same localities during the pre-monsoon period of 2003-2004.

Protodriloidae (Purschke and Jouin, 1988) is a recently erected family to include the genus Protodriloides under which two species such as Protodriloides chaetifer (Remane, 1926) and Protodriloides symbiorciis (Giard, 1904) described earlier have been assigned by Purschke and Jouin (1988). These were earlier placed in the genus Protodrilus with no specific status. Jouin (1966) felt the necessity to introduce the genus Protodriloides to place these species owing to very clear cut morphological peculiarities not encountered in the group of aberrant psammophilous polychaetes. Species belonging to the family Protodriloidae have been recorded previously from the North Sea, English Channel, Irish Sea, French Atlantic Coast, West Greenland, Mediterranean, Atlantic Coast of North America, Pacific Coast of North America and Indian Ocean (South Africa, Natal). However, no species has ever been recorded from the tropical coast of Indian Ocean. The present record implies cosmopolitanism which is interesting since the species is without a pelagic larval stage. The present finding probably indicates bioinvasion of P. chaetifer to the tropical coast.

Materials and methods
Beach sediment samples collected after the tsunami from Fort Kochi (lat. 9°48' N; long. 76°5' E) and Arthungal (lat. 9°30' N; long. 76°23' E) on the south-west coast of Kerala, revealed the occurrence of several interstitial polychaetes. The fauna in the samples were narcotized in situ by adding 7% MgCl₂ .6H₂O and subsequently fixed in 5% buffered formalin. Rose Bengal stained organisms were extracted by decantation technique (Pfannkuche and Theil, 1988). Semi-permanent slides were made by impregnating the specimens in glycerol. Morphological studies were carried out using 100X oil immersion objective of Magnus microscope. Sediment textural analysis was carried out by Dry Sieving Method (Buchanan, 1984). Sediment organic carbon was measured with CHN analyzer. Hydrographic parameters like temperature, pH, salinity and dissolved oxygen were also recorded.

Results
Of the several interstitial polychaete families hitherto known, Protodriloidae has not been recorded so far from Indian Coast. The present study reveals the occurrence of P. chaetifer in the sediment samples collected along the coast of Kerala (Figs. 1 & 2). Textural analysis indicated that the sediments were constituted of medium sand and a mixture of coarse and medium sand. The organic carbon content of sand measured 0.18% - 0.4%. The interstitial water was typically marine.

Diagnosis: The specimens of P. chaetifer measured 2-3mm with a diameter ranging from 70m to 125m. Body surface characteristically wrinkled. Numerous globular greenish or colourless epidermal glands seen all over the body. Number of segments, 20. A pair of non-canaliculated tentacles, 105m to 115m long, originate from the prostomium anteriorly. Numerous short cilia present on either sides of the head and tentacles. Pharyngeal bulb present. First body segment much shorter than the remaining segments. Two pairs each of S-shaped chaetae approxi-
Sediment transport and bioinvasion - possible impact of Tsunami

1) Fig. 1. Photomicrographs of Protodriloides chaenifer
   A Entire, B Anterior end, C Posterior end

2) Fig. 2. Camera Lucida drawings of Protodriloides chaenifer
   D Anterior end, E Posterior end. Scale bar: 30 μm

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mately 20m long, present from the second segment on­wards. The chaetae are bifid at the tip and originate from the posterior half of the segments. Pygidium bilobed with adhesive gland openings. The adhesive glands concen­trated in the pygidium enable the organisms to remain attached to the substrate even when the sediment is eroded by the wave action. The chaetae are stretched out and form points of attachment of momentary duration. Regu­lar tidal migrations have been observed in P. chaetifer (Meinke and Westheide, 1979).

Discussion

Kerala, with a remarkable straight coastline of 560km, is oriented in NNW – SSE direction. The beaches are generally surf beaten characterized by fine to coarse grained sands. Extensive samplings done during the pre-tsunami period along the beaches of Fort Kochi and Arthungal has not yielded specimens of P. chaetifer. However, collec­tions made on 14.03.05 from these beaches showed a density distribution of 600 and 10 individuals/ 100 cc. sediments respectively. Tsunamis are major geomorphic crisis, since they cause extensive erosion, sediment trans­port and deposition. The occurrence of several individu­als of P.chaetifer from these beaches after the Tsunami probably indicates bioinvasion of a subtle nature due to this bizarre oceanographic phenomenon, which resulted in the massive transport of marine sediments from archibenthal areas to the tidal belts of the affected beaches of various geographic areas. The peculiar morphology of the animal facilitates fast adhesion to sand grains and transport to wider geographical areas by massive sedi­ment transport, that occurred during the recent tsunami. Subsequent collections done during the monsoon and post-monsoon seasons did not reveal the presence of this species.

References


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