

Five new records of free-living marine nematodes (Nematoda: Enoplida) from Indian waters

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The present study provides information about the systematics of nematodes along the continental shelf region of the Visakhapatnam, Bay of Bengal during the period from March 2009 to February 2010. Monthly samples were collected from six GPS selected locations i.e., 10, 20, 30, 50, 75 and 100m. 4996 specimens were enumerated belong to 125 nematode species, 78 genera and 31 families. Among these five species were found which proved to be new records from India. Species are described below as *Enoploides longispiculosus* and *Enoplolaimus subterraneus* (Thoracostomopsidae), *Phanoderma albidum* (Phanodermatidae), *Leptosomatium elongatum* (Leptosomatidae) and *Rhabdodemanina major* (Rhabdodemaniidae).

[Key words: Nematodes, continental shelf, Visakhapatnam]

Introduction

Nematodes, which occur in every habitat that can support life, are the most numerous of all metazoans and one of the most diverse metazoan taxa in marine waters²³. Free-living nematodes play an important functional role in aquatic ecosystems^{23 & 9}. For example, they are of major energetic importance in benthic environments as they represent a significant part of the diet of many aquatic organisms^{12 & 8} and facilitate the mineralization of organic matter^{9 & 24}. Furthermore, as nematodes are highly habitat specific^{11 & 16}, changes in the composition of their assemblages are good indicators of environmental changes, either naturally^{19, 14 & 20} or as a result of anthropogenic activities^{10, 17 & 3}.

Preliminary investigations on nematodes were carried out by Timm^{29, 30 & 31} from the Bay of Bengal region and Gerlach¹³ from the Maldives Islands. Although the nematodes comprise a large fraction of marine benthic communities, only little information is available on their taxonomy in Indian waters^{29, 30, 28, 6, 18, 4, 5, 26, 1 & 2}. The present study was undertaken on the free-living marine nematodes of the Visakhapatnam continental shelf region and this paper describes five nematode species from the order Enoplida recorded for the first time in Indian waters.

Material and Methods

The study area is the continental shelf region off Visakhapatnam extending from 17° 44' 41" N to 17° 28' 16" N latitude and from 83° 21' 40" E to 83° 33' 32" E longitude. Sampling stations are at a distance of 2.37 km from the coast in one transect, starting from the harbour. They are at 10, 20, 30, 50, 75 and 100 m isobaths as shown in figure 1. Totally 153 sediment samples were collected from the nine transects in the present study during the period from March 2009 to February 2010.

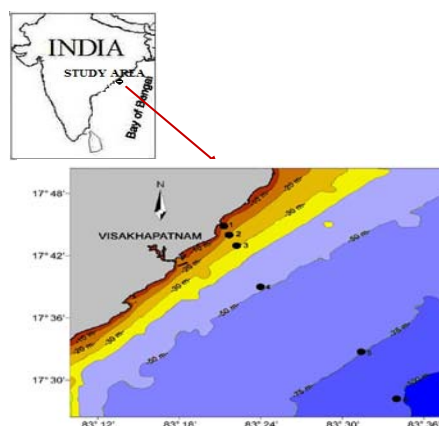


Figure.1. Schematic map of the sampling stations Visakhapatnam shelf

Samples were taken from the depths of 10, 20, 30, 50, 75 and 100m using a Van veen grab having an area of 0.1m². From these, sub samples were collected at each location using a 10 cm long glass corer (3.6cm dia.). The samples were anaesthetized with MgCl₂ and preserved in 4% buffered formalin. Triplicate core samples were processed separately in the laboratory and data were pooled for analyses. About 50 g of sediment was sub-sampled from each grab sample for the analysis of sediment texture and organic matter. Sediment samples were oven-dried (at 60 °C) and stored for further analysis. At each sampling location, bottom water temperature, dissolved oxygen, salinity, pH, sediment texture and organic matter were measured according to standard protocols¹⁵. In the lab, nematode specimens were picked out by hand using a fine needle and transferred into pure glycerin²⁵ and mounted on Cobb slides⁷. Taxonomic identifications were made based on the pictorial key of Platt and Warwick^{21, 22, 34} and the NeMys online identification key²⁷. Drawings were made with the camera lucida. All measurements were carried out with the software ProgResR Capture Pro. The curved structures such as spicule length were measured along the arch.

The following measurements were taken

- L : Total body length
- a : Body length divided by maximum body diameter
- b : Body length divided by oesophagus length
- c : Body length divided by tail length
- (a: b: c is deMan ratios)
- a.b.d : anal body diameter

Results and Discussion

In the study area, the temperature varied with depth and ranged between 23.92 °C (100m) and 31 °C (10m), salinity ranged from 24.01PSU (20m) to 35.2 PSU (75 and 100m), dissolved oxygen ranged from 1.14 ml.l⁻¹ (100m) to 6.58 ml.l⁻¹ (20m) and pH ranged from 7.68 (100m) to 8.28 (20m). Sediment organic matter (%) ranged from 0.53 (10 and 20m) to 3.84 (75m), sediment chlorophyll ranged from a minimum of 0.002 µg.g⁻¹ (20m) to maximum of 1.063 µg.g⁻¹ (50m) and most of the study sites were characterized by clayey-silt and sand with a mean particle diameter of 229.58µm (Table.1).

In the present study, altogether 125 nematode species belonging to 3 orders, 31 families and 78 genera were identified. The members of the orders Enoplida (*Enoploides longispiculosus*, *Enoplolaimus subterraneus*, *Phanoderma albidum*, *Leptosomatum elongatum* and *Rhabdodemanina major*) were found to be new records for Indian waters. The characteristics of these species are described below.

1. Enoploides longispiculosus

Phylum: Nematoda Rudolphi, 1808

Class: Adenophorea von Linstow, 1905

Order: Enoplida Filipjev, 1929

Family: Thoracostomopsidae Filipjev, 1929

Genus: *Enoploides* De Man, 1983

Enoploides longispiculosus Gerlach, 1952 (Fig. 2a)

1988. *Enoploides longispiculosus* Platt and Warwick, synopses of British Fauna (New series) Part. 1

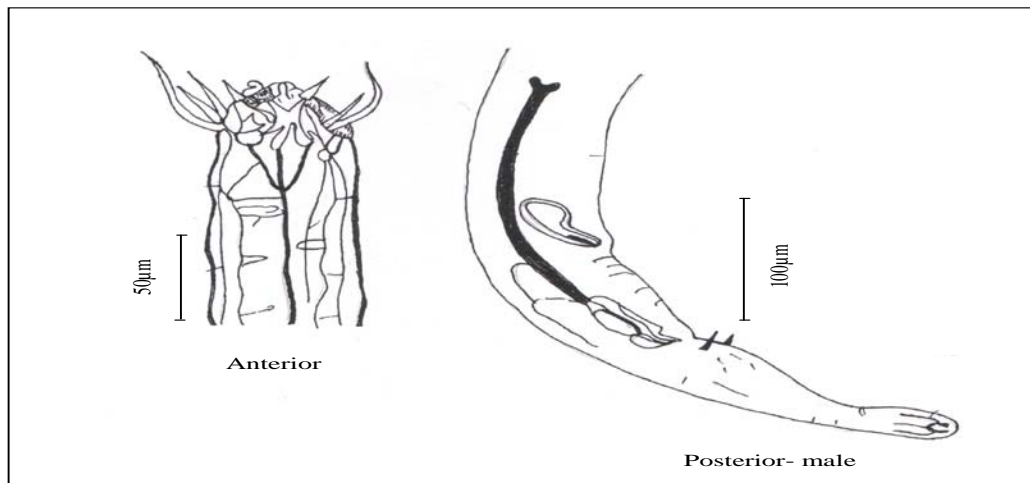
Material examined: Two males

Diagnosis: Buccal cavity is cup shaped with solid mandibles. Cuticle smooth. Six long cephalic setae present. Male with one large supplement. Tail is cylindrical with swollen tip.

Measurements:

L=2322.8-2567.3µm a=24.68-26.69; b=9.3-10.2; c=12.3-11.6

Description: Cuticle smooth. Three solid mandibles, Lips as in *E. brunettii*. Six longer cephalic setae. Mandibles and mandibular processes as *E. brunettii*. No subcephalic setae, but six short cervical setae just posterior to cephalic capsule. Tail 2.1-2.4 a.b.d. Spicule 282-294 µm (4.8-5.7 a.b.d.), transversely striated. Gubernaculum in three parts: paired S-shaped parts 40-48 µm, dilated and knobbed distally, with an unpaired curved plate dorsal to these. Supplement large and spatulate, about half the spicule length in front of the cloaca. Testes paired outstretched. Paired postcloacal papillae swollen in middle. Body length 2322.8-2567.3 µm. Maximum diameter 87-104 µm (a=24.68-26.69) (Figure 2).

Figure.2. *Enoploides longispiculosus*Table 1. Sea water temperature, salinity, dissolved oxygen (DO), pH, chlorophyll (Chl) and organic matter (OM) content of Visakhapatnam continental shelf. The values represent the range, mean \pm S.D; n=sample size.

Depth (m)	Temperature ($^{\circ}$ C)	Salinity (PSU)	DO (ml.l $^{-1}$)	pH	Chl (μ g.g $^{-1}$)	Org (%)
10m (n=21)	26.0-31.0 (28.84 \pm 0.73)	30.3-35.0 (32.50 \pm 0.80)	2.2-5.4 (3.75 \pm 0.60)	7.92-8.27 (8.11 \pm 0.04)	0.003-0.007 (0.01 \pm 0.001)	0.53-1.96 (1.02 \pm 0.19)
20m (n=27)	25.92-30.5 (27.99 \pm 0.50)	24.01-35.0 (30.96 \pm 1.38)	2.22-6.58 (4.79 \pm 0.40)	7.88-8.28 (8.11 \pm 0.04)	0.002-0.032 (0.01 \pm 0.004)	0.53-2.41 (1.06 \pm 0.19)
30m (n=27)	25.83-30.3 (28.01 \pm 0.43)	24.41-35.01 (31.58 \pm 1.44)	2.66-6.58 (4.41 \pm 0.39)	7.9-8.26 (8.10 \pm 0.04)	0.031-0.103 (0.06 \pm 0.01)	1.43-3.09 (2.23 \pm 0.21)
50m (n=27)	26.0-29.6 (27.77 \pm 0.43)	30.05-35.02 (32.76 \pm 0.76)	1.55-6.26 (3.98 \pm 0.59)	7.96-8.24 (8.07 \pm 0.03)	0.054-1.063 (0.48 \pm 0.12)	2.26-3.16 (2.49 \pm 0.10)
75m (n=27)	24-28.9 (26.76 \pm 0.55)	32.69-35.2 (34.01 \pm 0.34)	1.40-5.77 (3.30 \pm 0.55)	7.84-8.22 (7.97 \pm 0.05)	0.095-0.956 (0.55 \pm 0.12)	2.03-3.84 (2.84 \pm 0.22)
100m (n=27)	23.92-29.0 (25.97 \pm 0.58)	32.91-35.2 (34.39 \pm 0.29)	1.14-4.72 (2.74 \pm 0.64)	7.68-8.23 (7.94 \pm 0.06)	0.082-0.863 (0.46 \pm 0.11)	2.56-3.76 (3.27 \pm 0.14)

Remarks: The material examined conforms well to the earlier description, except for minor variation in the relative measurements of the body. The total body length varied between 2.4-2.9 mm, the maximum diameter 92-112 μm and tail 2.5-3.0 a.b.d., spicule 320-345 (Platt and Warwick, 1988). The aforesaid details are taken in to account for placing the present specimen as *Enoploides longispiculosus* Gerlach, 1952.

2. *Enoplolaimus subterraneus*

Family: Thoracostomopsidae Filipjev, 1929

Genus: *Enoplolaimus* De Man, 1893

Enoplolaimus subterraneus Gerlach, 1952 (Fig. 2b)

1988. *Enoplolaimus subterraneus* Platt and Warwick, synopses of British Fauna (New series) Part. 1

Material examined: One male and three females.

Diagnosis: Cuticle smooth. Mandibles short and broader. Six large cephalic setae present. One precloacal supplement is present in male. Spicule straight. Tail cylindrical.

Measurements:

Male: L=2134 μm ; a=32.8; b=7.2; c=11.6

Female: L=2189.2 μm ; a=33.6; b=7.5; c=13.1

Description: Three hollow mandibles, lips extended, labial setae well developed. Six longer cephalic setae, four shorter ones are only one-quarter as long. Male with six short cervical setae, none in female. Cuticle smooth. Lips with semi-lunar striations. Labial setae very short and stout. Mandibles shorter and broader than in other members of the genus. Tail 1.9-2.3 a.b.d., strongly constricted behind the anus. Spicules 24-36 μm , straight. Supplement 2.1 a.b.d. in front of cloaca. Body length 2134-2189 μm . Maximum breadth 65-89 μm (a=24.59-32.8) (Figure 3).

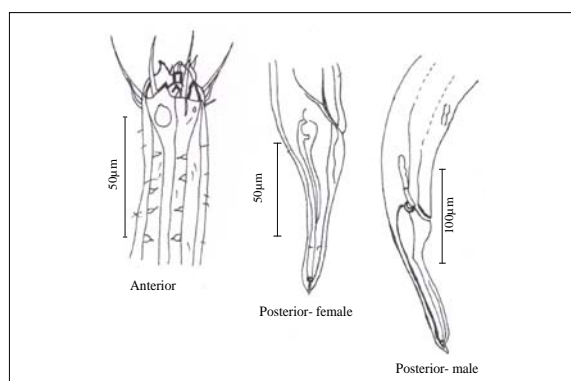


Figure.3. *Enoplolaimus subterraneus*

Distribution: India: Visakhapatnam shelf (10 and 20m).

Elsewhere: Exe estuary (intertidal sand).

Remarks: The material examined conforms well to the earlier description, except for minor variation in the relative measurements of the body. The total body length varied between 2.4-3.3 mm, the maximum diameter 62-110 μm and tail 2.7-3.8 a.b.d., spicule 38-45 μm (Platt and Warwick, 1988). The aforesaid details are taken in to account for placing the present specimen as *Enoplolaimus subterraneus* Gerlach, 1952.

3. *Phanoderma albidum*

Family: Phanodermatidae

Genus: *Phanoderma* Bastian, 1865

Phanoderma albidum Bastian, 1865 (Fig. 2c)

1988. *Phanoderma albidum* Platt and Warwick, synopses of British Fauna (New series) Part. 1

Material examined: Two females

Diagnosis: Cuticle smooth, Anterior gradually attenuated, presence of ocellus, long oesophagus and widened posteriorly. Tail short and conico cylindrical.

Measurements: L=3597.9 μm , a=24.98; b=2.17; c=9.78; a.b.d. =17.3

Description: Cuticle smooth with a few scattered very short somatic setae. Anterior gradually attenuated; head diameter about 15% of the body diameter at the posterior end of the oesophagus. Six labial papillae. Ten cephalic setae. Amphids situated just posterior to lateral cephalic setae. Buccal cavity small. Cephalic capsule present but not strongly cuticularised and extending anteriorly as three lobes. Excretory pore conspicuous, situated anterior to nerve ring. Oesophagus widens posteriorly. Tail short and conico-cylindrical, 17.3 a.b.d. caudal glands extend only a short distance anterior to anus. Ovaries paired, opposed and reflexed. Body length 3597.9 μm . Maximum diameter 124 μm (a=29.01) (Figure 4).

Distribution: India: Visakhapatnam shelf (10m).

Elsewhere: Falmouth (on weed in tide-pool); Plymouth (on seaweed); Northumberland (kelp holdfast); Isles of Scilly (seaweed and kelp holdfast).

Remarks: The material examined conforms well

to the earlier description, except for minor variation in the relative measurements of the body. The total body length 4.5 mm, the maximum diameter 165 μ m (Platt and Warwick, 1988). The aforesaid details are taken in to account for placing the present specimen as *Phanoderma albidum* Bastian, 1865.

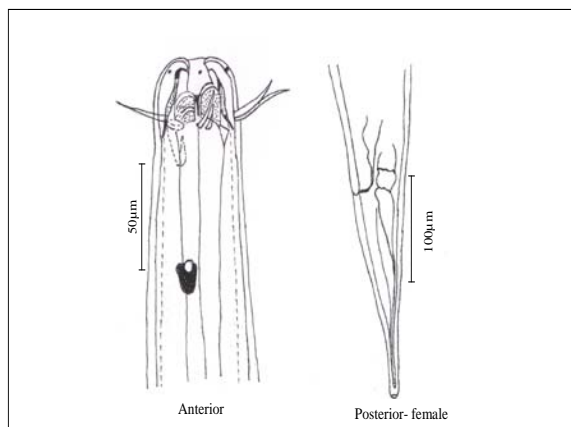


Figure.4. *Phanoderma albidum*

4. *Leptosomatum elongatum*

Family: Leptosomatidae Filipjev, 1916

Genus: *Leptosomatum* Bastian, 1865

Leptosomatum elongatum Bastian, 1865 (Fig. 2d)

1988. *Leptosomatum elongatum* Bastian, 1865 Platt and Warwick, synopses of British Fauna (New series) Part. 1

Material examined: One male

Diagnosis: Cuticle smooth, buccal cavity absent, presence of ocellus, tail short and round.

Measurements: L=5256.4 μ m; a=59.06; b=0.11; c=25.02

Description: Twelve short papillate cephalic setae. Amphids situated a short distance posterior to lateral cephalic setae. Ocelli situated about 3 h.d. from anterior. Buccal cavity absent, but dorsal segment of anterior oesophageal lumen lining is more heavily cuticularised. Cephalic capsule present, resembling a shield beside the anterior part of the oesophagus and most easily seen in optical cross-section. Nerve ring situated at about 25% of the oesophagus length. Oesophagus 37 μ m. Tail short and rounded, 21.3 a.b.d. Spicule 86 μ m. Gubernaculum lies parallel to distal end of spicules. Supplementary

copulatory structures absent. Two ovaries, opposed. Body length 5256.4 μ m, maximum diameter 91 μ m (a=57.76) (Figure 5).

Distribution: India: Visakhapatnam shelf (30m).

Elsewhere: England (Bastian 1865), Russia: Black sea (Filipjev 1918), Falmouth (in sponge); Plymouth (among hydroids); Northumberland

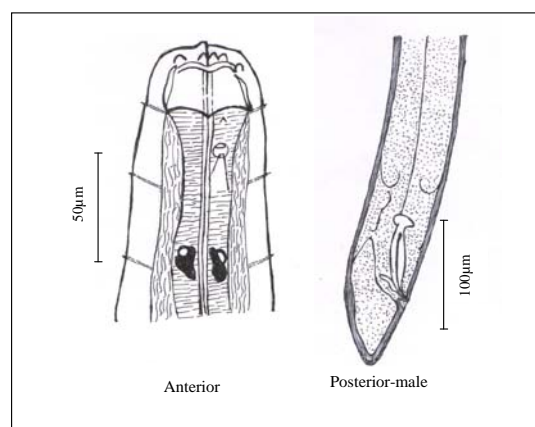


Figure.5. *Leptosomatum elongatum*

(kelp holdfasts); Isles of Scilly (sublittoral among sponges and hydroids), United States of America: California and Bay of Panama (Allgen 1947), Australia: Port Jackson (Allgen 1951).

Remarks: The material examined conforms well to the earlier description, except for minor variation in the relative measurements of the body length. The total body length 8.3-12.7 mm, the maximum diameter 127-191 μ m, spicule 75-100 μ m (Platt and Warwick, 1988). The aforesaid details are taken in to account for placing the present specimen as *Leptosomatum elongatum* Bastian, 1865.

5. *Rhabdodemaniamajor*

Family: Rhabdodemaniidae Filipjev, 1934

Genus: *Rhabdodemaniamajor* Baylis and Daubney, 1926

Rhabdodemaniamajor Southern, 1914 (Fig. 2e)

1988. *Rhabdodemaniamajor* Southern, 1914 Platt and Warwick, synopses of British Fauna (New series) Part. 1

Material examined: One male

Diagnosis: The body is long and cylindrical, tapering only slightly towards each extremity. The cuticle is thick and smooth with a few hairs on

neck and tail. The buccal cavity is large, deep and cup shaped. The oesophagus is expanded a little in front and then gradually expanded towards the posterior end. The tail tapers to a rounded tip. The spicules are slightly curved, pointed distally and swollen in the middle.

Measurements: L=4142.2 μ m; a=50.51; b=8.77; c=14.7; a.b.d. =1.3

Description: Cuticle smooth, devoid of body setae except for fine sublateral setae in oesophageal region and tail. Head sharply narrows level with cephalic setae. Six minute papillae at anterior end. The amphid is most tightly looped in the anterior part and gradually begins to straighten out further back. Buccal cavity conical, bearing anteriorly two pairs of subdorsal cuticularised teeth and posteriorly a large dorsal and two subventral teeth. Oesophagus tissue surrounds the posterior half of the buccal cavity. The oesophagus has no bulb, but widens posterior to the nerve ring. Tail cylindrical with complex spinneret and four stout terminal setae; 1.3 a.b.d. Two caudal glands. Spicule 72 μ m long. Large species; body length 4142.2 μ m. Maximum diameter 82 μ m (a=50.51) (Figure 6).

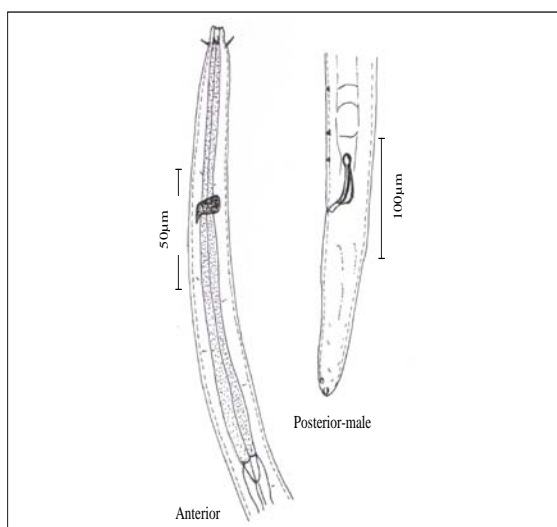


Figure.6. *Rhabdodemanía major*

Distribution: India: Visakhapatnam shelf (30m).

Elsewhere: West Ireland (sand and shells at 44m); Isles of Scilly (intertidal coarse sand).

Remarks: The material examined conforms well to the earlier description, except for minor variation in the relative measurements of the body. The total body length 7.5-8.2mm. Maximum diameter 97-110 μ m, tail 2.1-2.5 a.b.d., spicule 80 μ m (Platt and Warwick, 1988). The aforesaid details are taken in to account for

placing the present specimen as *Rhabdodemanía major* Southern, 1914.

Conclusions

This is the first report of species *Enoploides longispiculosus*, *Enoplolaimus subterraneus*, *Phanoderma albidum*, *Leptosomatium elongatum* and *Rhabdodemanía major* in Indian waters and contributes to the knowledge about the morphological and ecological features of this species.

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