



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

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Original Article

Abstract

One hundred and ninety two species of free-living marine nematodes were collected during Cruise No. 260 of "FORV Sagar Sampada" from the southeast continental shelf of India. Six of these species *Enoplolaimus longicaudatus*, *Anticoma eberthi*, *Oncholaimellus calvadosicus*, *Viscosia glabra*, *V. langrunensis* and *Eurystomina terricola* under the order Enoplida which happen to be first record from Indian waters are described here.

Keywords: Nematodes, Enoplida, continental shelf, India.

Introduction

Free-living marine nematodes are usually the most abundant metazoans inhabiting marine benthic ecosystems, often representing more than 90% of the benthic meiofauna. An important feature of nematode populations is the large number of species present in any one habitat, often an order of magnitude higher than for any other taxon (Platt and Warwick, 1980; Heip *et al.*, 1985; Schratzberger *et al.*, 2006). To date only few studies have been undertaken on the meiobenthos in the Indian waters. However most of them have been on qualitative and quantitative aspects (Ansari *et al.*, 1980; Har-kantra *et al.*, 1980; Ansari and Gauns, 1996; Sulthan Ali *et al.*, 1998; Sajan, 2002; Nanajkar and Ingole, 2007; Sajan and Damodaran, 2007; Anila Kumary, 2008; Ansari, 2010; Sajan *et al.*, 2010; Ansari *et al.*, 2012). Although the nematodes comprise a large fraction of marine benthic communities, only little information is available on their taxonomy in Indian waters

(Timm, 1961, 1967a; Sulthan Ali, 1983; Chinnadurai, 2004; Lily Cooper, 2005; Chinnadurai and Fernando, 2006a, 2006b; Sivalakshmi, 2007). As the free-living marine nematodes are normally only few millimeters long, taxonomic studies are difficult (Heip *et al.*, 1983). In this backdrop the present study was undertaken on the nematode fauna of the southeast continental shelf region and this paper describes six nematode species recorded for the first time from Indian waters.

Material and methods

Study area

The study area extends from 10° 34.03' to 15° 14.48' N lat. and from 79° 52.13' to 80° 53.87'E long in the continental shelf region of the southeast coast of India. Totally 35 sediment samples were collected from the 6 transects covered in the present study (off Karaikkal, Parangipettai, Cheyyur, Chennai, Tammenapatanam and Singarayakonda) at depths of 30-50 m, 51-75 m, 76-100 m, 101-150 m, 151-175 m and above 176 m. In addition, sampling was also done near Cuddalore at the depths of 30-50 m and above 176 m due to the presence of an industrial cluster (SIPCOT -State Industries Promotion Corporation of Tamil Nadu).

Sampling

The samples were collected onboard FORV (Fishery and Oceanographic Research Vessel) "Sagar Sampada" during Cruise No. 260 (from 7th to 28th December 2008). Two sediment samples were collected using a Smith McIntyre grab (having

a bite area of 0.2 m²) at each depth range. Immediately after the grab was hauled to the deck, sub-samples were taken from undisturbed grab samples using a glass corer (having an internal diameter of 2.5 cm and a length of 15 cm) from the middle of grab sample (Platt and Warwick, 1983). The samples were fixed in buffered formalin at a concentration of 4%. Replicate core samples were processed separately in the laboratory and data were pooled for analyses. The samples were washed through a set of 0.5 mm and 0.053 mm sieves. The sediment retained in the 0.053 mm sieve was decanted to extract meiofauna following the method of Higgins and Thiel (1988). Sorting of meiofauna from sediment was done by flotation technique. The efficiency of this technique is around 95% (Armenteros *et al.*, 2008). The meiofaunal organisms were stained with Rose Bengal. Stain sorting and enumeration were done, under a stereomicroscope (Meiji, Japan). The sorted nematodes were mounted onto glass slides, using the formalin-ethanol-glycerol following Vincx (1996). Identification of nematodes was done to the highest taxonomic level possible using the compound microscope (Olympus CX 41 under higher magnification of 1000x) following the standard pictorial keys of Platt and Warwick (1983, 1988), and the NeMys Database by Steyaert *et al.* (2005).

Results

Totally 4,235 nematode specimens were isolated and 192 species were identified. Among these, six species (*Enoplolaimus longicaudatus*, *Anticoma eberthi*, *Oncholaimellus calvadosicus*, *Viscosia glabra*, *Viscosia langrunensis* and *Eurystomina terricola*) belonging to the order Enoplida were found to be new distributional records from the Indian waters. Detailed systematic account, material examined (number of specimens, place, depth and date of collection), brief description, feeding type, habitat and geographical distribution besides remarks of the above six species are given here.

SYSTEMATIC ACCOUNT

Phylum:	Nematoda Rudolphi, 1808
Class:	Adenophorea von Linstow, 1905
Order:	Enoplida Filipjev, 1929
Family:	Thoracostomopsidae Filipjev, 1927
Genus:	<i>Enoplolaimus</i> De Man, 1893
Species:	1. <i>Enoplolaimus longicaudatus</i> (Southern, 1914)
Synonym:	<i>Enoplus longicaudatus</i> Southern, 1914
Material examined:	2 females from Karaikkal at 150m depth (20.12.2008).

Diagnostic characters: Elongated body. Cuticle with transverse striations. Six short cervical setae arranged in a ring. Tail very long.

DeMan ratio:	a	b	c
Female:	33.95	7.06	3.41
	(33.70-34.20)	(6.65-7.47)	(3.28-3.54)

Description

Body length 1 -1.4 mm. Maximum body diameter 39-43 μm. Cuticle with fine transverse striation. Three fairly low flap-like lips with no internal striations. Six long cephalic setae equal, about 0.8 h.d. (head diameter), four shorter subcephalic setae about 0.4 h.d. Six cervical setae shorter than the cephalic setae. Mandibles typical, appearing as two lateral rods united by an anterior curved bar. Buccal cavity narrow and tubular. Oesophagus cylindrical (197 - 206 μm). Ovaries symmetrical paired and reflexed. Tail very long and filiform about 9.1 a.b.d. (anal body diameter). Vulva present at 58-61% of body length (Fig.1.A-C).

Male: Not found

Feeding type: The specimens showed large jaws. According to the classification of buccal cavity by Wieser (1953), this species is a predator (2B).

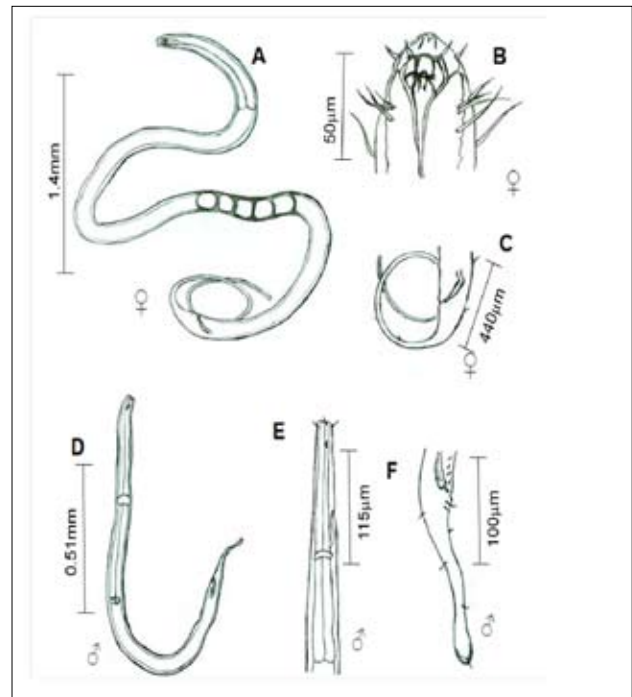


Fig.1. A-C: *Enoplolaimus longicaudatus* A) entire female, B) female head, C) female tail; D-F: *Anticoma eberthi* D) entire male, E) male head, F) male tail

Habitat: Sandy nature of sediments.

Distribution

India: Off Karaikkal.

Global: North Atlantic (Southern, 1914; Platt and Warwick, 1983), Ireland and Portugal (Hansson, 1998), England (Platt and Warwick, 1983), European waters (De Smet *et al.*, 2001; Medin, 2011), North Sea (Gerlach and Riemann, 1974), France (Muller, 2004) and Belgium (Coomans, 1989).

Remarks

The specimens examined agree well with the earlier description, except for the smaller body size. The total body length described was 2.9–3.6 mm and maximum body diameter 50–76 μm . The tail length was between 9.5 and 10.3 a.b.d. (Platt and Warwick, 1983). The body length of the present specimens was found lesser varying between 1.02 and 1.43 mm, maximum body diameter was in the range of 38.8–42.8 μm and the tail length 8.7–9.1 a.b.d. This is the first record of this species from the Indian waters.

Family:	Anticomidae Filipjev, 1918
Genus:	<i>Anticoma</i> Bastian, 1865
Species:	<i>2. Anticoma eberthi</i> Bastian, 1865
Material examined:	Single male specimen from off Chennai at 100 m depth (17.12.2008).

Diagnostic characters: Body elongated. Buccal cavity small and conical. Tubular preloacal supplement. Excretory pore well posterior to cervical setae. Spicules long.

DeMan ratio:	a	b	c
Male:	23.74	4.45	5.36

Description

Body length 0.51 mm. Maximum body diameter 21 μm . Cuticle smooth without any striations. Six rounded lips. Six cephalic setae 18 μm . Cervical setae commence 0.7 h.d. from anterior. Amphid pocket-like. Buccal cavity small conical shaped. Oesophagus narrow tubular. Excretory pore well posterior to cervical setae. Elongated and conico-cylindrical tail with swollen tip. Tail 2.8 a.b.d. long. Spicules 1.3 a.b.d. long. Supplements present in front of cloaca (Fig.1.D-F).

Female: Not found

Feeding type: The specimens showed small narrow buccal cavity. According to the classification of buccal cavity by Wieser (1953), this species is a selective deposit feeder (1A).

Habitat: Sandy sediment.

Distribution

India: Off Chennai.

Global: North Atlantic (Platt and Warwick, 1983), Ireland (Hansson, 1998), England (Platt and Warwick, 1983), European waters (Hansson, 1998; De Smet, *et al.*, 2001; Medin, 2011), North Sea (Gerlach and Riemann, 1974; Hansson, 1998), France (Muller, 2004), Norway (Allgen, 1940), Adriatic Sea (Travisi and Vidakovic, 1997) and Kara Sea (Hansson, 1998).

Remarks

The material examined conforms well to the earlier description, except for the smaller body size. The total body length of the specimen was 6–7 mm and tail length varied between 3 and 4 a.b.d (Platt and Warwick, 1983). The body length of the present specimen studied is lesser being 0.51 mm and the tail length 2.8 a.b.d. This is the first record of the species from the Indian waters.

Family:	Oncholaimidae Filipjev, 1916
Genus:	Oncholaimellus De Man, 1890
Species:	<i>3. Oncholaimellus calvadosicus</i> De Man, 1890
Synonym :	<i>Oncholaimus littoralis</i> Allgen, 1929
Material examined:	Single male from off Karaikkal at 100 m depth (20.12.2008).

Diagnostic characters: Body elongated. Cuticle smooth. Amphid indistinct. Two parts of buccal cavity. A pair of unequal spicules. Gubernaculum absent. Copulatory bursa consisting of two longitudinal wings.

DeMan ratio:	a	b	c
Male:	72.15	1.77	5.94

Description

Body length 1.5 mm. Maximum diameter 20 μm . Cuticle smooth. Six low rounded lips each with a papilliform sensillum. Six long-21 μm (1.3 h.d.) and four short-12 μm (0.7 h.d.) cephalic setae. Cervical and somatic setae absent. Amphid indistinct. Buccal cavity in two parts, separated by cuticularised band: three teeth present in posterior part, the right subventral being the biggest than the left subventral and dorsal. Oesophagus cylindrical. Tail about 4.9 a.b.d., cylindrical with swollen tip. Caudal glands extend well anterior to anus. Spicules unequal: right 120 μm (6.8 a.b.d.), left 69 μm (4 a.b.d.). Gubernaculum absent. Copulatory bursa present consisting of two longitudinal wings of cuticle

occupying anterior third of tail. Paired setae present at both ends of bursa and a pair of supporting rods about one-third of its length from cloaca (Fig.2.A-C).

Female: Not found

Feeding type: The specimens showed large teeth. According to the classification of buccal cavity by Wieser (1953), this species is a predator (2B).

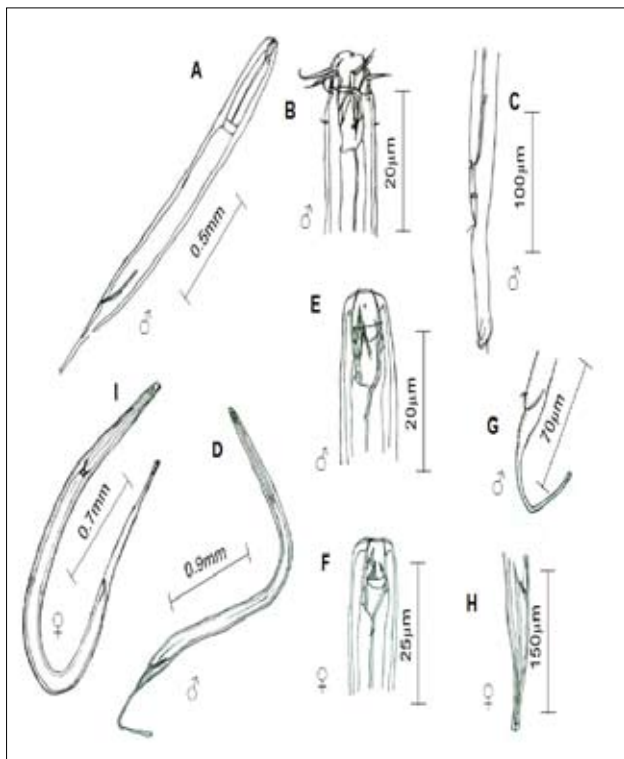


Fig.2.A-C: *Oncholaimellus calvadosicus*; A) entire male, B) male head, C) male tail; D-I: *Viscosia glabra*; D) entire male, E) male head, F) female head, G) male tail, H) female tail I) entire female

Habitat: Mostly sandy sediment and rarely silty nature of sediments.

Distribution

India: Off Karaikkal.

Global: England (Platt and Warwick, 1983), European waters (Hansson, 1998; Medin, 2011), North Sea, Bay of Kiel, Oresund, Kattegatt and Mediterranean (Hansson, 1998).

Remarks

The specimen examined agrees well with the earlier description, except for the smaller body size. The total body length described was 1.9-2.1 mm and tail length 5.5a.b.d (Platt and Warwick, 1983). The body length of the present

specimen is lesser being 1.5 mm and the tail length 4.9 a.b.d. This is the first record of the species from the Indian waters.

Family:	Oncholaimidae Filipjev, 1916
Genus:	Viscosia De Man, 1890
Species:	4. <i>Viscosia glabra</i> (Bastian, 1865)
Synonym:	<i>Oncholaimus glaber</i> Bastian, 1865
:	<i>Viscosia micoletzkyi</i> Chitwood, 1951

Material examined : 16 males and 9 females from off Cheyyur 30 m, 75 m and 150 m depths (18.12.2008); Chennai 75 m depth (17.12.2008) and Tammenapatanam 75 m and 100 m depths (16.12.2008).

Diagnostic characters: Body elongated. Cephalic setae and other setae absent. Large subventral tooth. Pocket-like amphids. Spicules short. Gubernaculum absent.

De M a n a	b	c	
ratio:			
Male:	41.68±0.67 (40.81-42.28)	4.67±0.23 (4.22-5.02)	5.41±0.28 (4.96-5.89)
Female:	43.12±0.44 (42.44-43.66)	4.92±0.14 (4.66-5.04)	5.89±0.21 (5.44-6.10)

Description

Body length 1.9-2.2 mm in male and 1.7-2.1 mm in female. Maximum diameter 35-37 µm in male and 26-28 µm in female. Cuticle smooth without any striation and dots. Six rounded lips. Cephalic sense organs represented by six small papillae only. Pocket-like amphids 6-8 µm wide in male and 6-7 µm wide in female. Right subventral tooth large, other two single tipped, more or less equal. Oesophagus cylindrical, 225-227 µm in male and 208- 216 µm in female. Tail elongate (9.2 a.b.d.). Spicules 19-23 µm (1.1 a.b.d.) and tip slightly bifurcate. No gubernaculum. Few very short circumcloacal setae present. Ovaries paired, equal, opposed and reflexed. Vulva present at 56- 58% of body length. (Fig.2.D-I)

Feeding type: The specimens showed large teeth. According to the classification of buccal cavity by Wieser (1953), this species is a predator (2B).

Habitat: Sandy sediments.

Distribution

India: Off Cheyyur, Chennai and Tammenapatanam.

Global: North Atlantic (Platt and Warwick, 1983), Tobago (Allgen, 1916), Ireland (Hansson, 1998), England (Platt

and Warwick, 1983), European waters (Hansson, 1998; De Smet *et al.*, 2001; Medin, 2011), North Sea (Bastian, 1865; De Man, 1890; Gerlach and Riemann, 1974; Vincx, 1989; Hansson, 1998), France (Muller, 2004), Belgium (Coomans, 1989), Oostende (Stekhoven, 1942), Norway (Hansson, 1998), Adriatic Sea (Travisi and Vidakovic 1997), Skagerrak, Bohuslan, Bay of Kiel, Oresund and Kattegatt (Hansson, 1998), Mediterranean and Black Sea (Allgen, 1916; Gerlach and Riemann, 1974; Hansson, 1998), Sea of Azov (Gerlach and Riemann, 1974) and Kara Sea (Hansson, 1998).

Remarks

The specimens examined conform well to the earlier description, except for the larger body size. The total body length described was 1.9 mm and tail length was 10.5 a.b.d in male (Platt and Warwick, 1983) and in female the body length was 1.6 mm and tail length 9.3 a.b.d. (Gerlach and Riemann, 1974). The body length of the specimen studied at present is larger being 1.9-2.2 mm and the tail length 8.9-11.8 a.b.d. in male and 1.7-2.1 mm body length and tail length 9.1-10.7 a.b.d female. In both sexes, the width of amphid is lesser than the previous description. This is the first record of the species from the Indian waters.

Family:	Oncholaimidae Filipjev, 1916
Genus:	Viscosia De Man, 1890
Species:	<i>5.Viscosia langrunensis</i> (De Man, 1890)
Synonym:	<i>Oncholaimus langrunensis</i> De man, 1980
Material examined:	18 males and 8 females from all the sampling stations.

Diagnosis characters: Body elongated. Pocket-like amphids. Tail conico-cylindrical. Short spicules. Gubernaculum absent.

DeMan ratio:	a	b	c
Male:	43.50 ± 0.51 (42.88-43.98)	4.60 ± 0.24 (4.42-4.89)	13.60 ± 0.15 (13.32-13.96)
Female:	41.80 ± 0.69 (40.96-42.46)	4.10 ± 0.16 (3.88-4.32)	7.10 ± 0.18 (6.92-7.42)

Description

Body length 1.6-2.1 mm in male, 1.2-1.8 mm in female. Maximum diameter 28-34 μm in male and 26-30 μm in female. Cuticle smooth without any striation and dots. Six rounded lips. Cephalic setae 3-4 μm (0.3 h.d.) in male and 2-4 μm (0.2 h.d.) in female. Pocket-like amphids 6-8 μm wide in male and 6-7 μm wide in female. Dorsal tooth and smaller subventral tooth extend anterior to middle of buccal cavity, both single tipped. Oesophagus cylindrical, 276-288 μm in

male and 218-242 μm in female. Tail conico-cylindrical with slightly distended tip, 131-142 μm in male and 122-139 μm in female. Spicules 20-23 μm . No Gubernaculum. Ovaries paired, equal, opposed, reflexed. Vulva present at 60-63% of body length (Fig.3.A-F).

Feeding type: The specimens showed large teeth. According to the classification of buccal cavity by Wieser (1953), this species is a predator (2B).

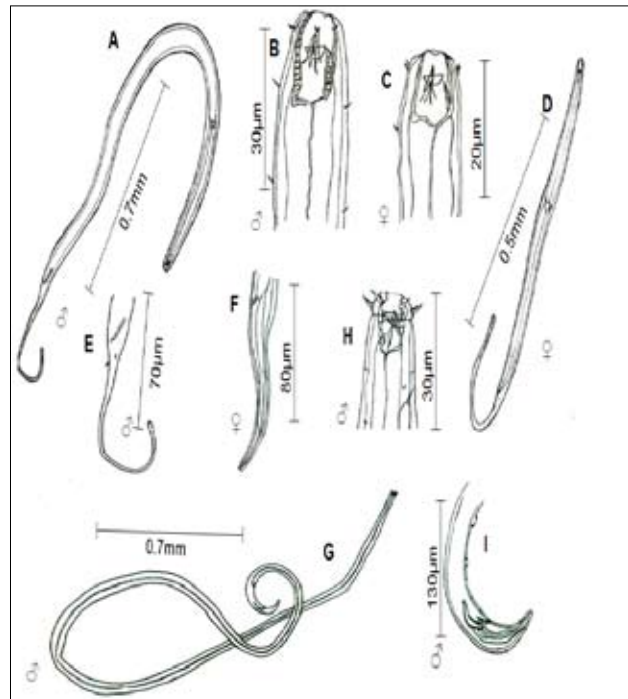


Fig.3.A-F: *Viscosia langrunensis*; A) entire male, B) male head, C) female head, D) female head, E) male tail, F) female tail; G-I: *Eurystomina terricola*; G) entire male H) male head, I) male tail

Habitat: Mostly sandy sediments and rarely silty nature of sediments.

Distribution

India: Off Karaikkal, Parangipettai, Cuddalore- SIPCOT, Cheyyur, Chennai, Tammenapatanam and Singarayakonda

Global: North Atlantic (Platt and Warwick, 1983), Ireland (Hansson, 1998), England (Platt and Warwick, 1983) European waters (Hansson, 1998; De Smet *et al.*, 2001), North Sea (De Man, 1890; Hansson, 1998), Belgium (Coomans, 1989), Norway (Hansson, 1998), Skagerrak, Bohuslan, Oresund and Kattegatt (Hansson, 1998) and Mediterranean, Caribbean Sea and Antarctic ocean (Allgen, 1959).

Remarks

The material examined conforms well with earlier description, except for the smaller body size. The total body length

described for male was 2.6 mm and tail length varied between 6.6a.b.d (Platt and Warwick, 1983) and for female 2.2 mm body length and tail length 5.9a.b.d. (Gerlach and Riemann, 1974). The body length of the present specimen studied is lesser being 1.6-2.1 mm and the tail length 4.9- 5.8 a.b.d in male and female body length 1.2-1.8 mm and the tail length 4.3-4.7 a.b.d in female. This is the first record of the species from the Indian waters.

Family:	Enchelidiidae Filipjev, 1918
Genus:	Eurystomina Filipjev, 1921
Specie:	<i>6. Eurystomina terricola</i> (De Man, 1907)
Synonym:	<i>Marionella terricola</i> Schneider, 1924
Material examined:	Single male from Cuddalore - SIPCOT at 30 m depth (19.12.2008).

Diagnosis characters: Body elongated. Loop-shaped amphids. Large right subventral teeth. Two opposed testis, two supplements - anterior longer than the posterior.

DeMan ratio:	a	b	c
Male:	100.7	4.8	23.9

Description

Body length 2.9 mm. Maximum diameter 33 μ m. Cuticle smooth. Six labial papillae. Ten cephalic setae in one circle six 10 μ m (0.6 h.d.) and four 6 μ m (0.4 h.d.). Loop-shaped amphids dorso-subventral in position and about 0.3 h.d. wide. Buccal cavity divided into chambers by three rows of denticles. Large right subventral and smaller more rounded dorsal and left subventral teeth. Narrow cylindrical oesophagus (608 μ m). Tail conical, 2.1 a.b.d. Caudal glands extend anterior to anus. Spicules 56 μ m. Gubernaculum 29 μ m. Two opposed testis. Two cup-shaped supplements present in front of the cloaca (Fig.3.G-I).

Feeding type: The specimens showed large teeth. According to the classification of buccal cavity by Wieser (1953), this species is a predator (2B).

Habitat: Mostly sandy sediments and rarely silty nature of sediments.

Distribution

India: Off India: Cuddalore - SIPCOT

Global: England (Platt and Warwick, 1983), European waters (Hansson, 1998; De Smet *et al.*, 2001), North Sea (Hansson, 1998), Bay of Kiel, Oresund, Kattegatt and Mediterranean (Hansson, 1998).

Remarks

The material examined conforms well to earlier description, except for the smaller body size. The total body length described was 3.3-4.4 mm and tail length varied between 2.3- 2.5a.b.d (Platt and Warwick, 1983). The body length of the present specimen is less being 2.9 mm and the tail length 2.1a.b.d. This is the first record of the species from the Indian waters.

Discussion

In the present study, the occurrence of six species (*Enoplolaimus longicaudatus*, *Anticoma eberthi*, *Oncholaimellus clavadosicus*, *Viscosia glabra*, *Viscosia langirunensis* and *Eurystomina terricola*) of free-living marine nematodes belonging to four families under order Enoplida is reported for the first time from the continental shelf of southeast coast of India from Indian water. So far, around 125 species of nematodes have been reported from various regions including estuaries, backwaters, lagoons and mangroves on the east and west coasts of India (Timm, 1961, 1967a, 1967b; Gerlach, 1962; Rao and Ganapathi, 1968; Krishnamurthy *et al.*, 1984; Roa, 1986; Sinha *et al.*, 1987; Sultan Ali *et al.*, 1998; Nanajkar and Ingole, 2007; Anila Kumary, 2008). Eldose (2008) recorded 79 species from the continental slope of southeast coast of India and Mondal (2009) 76 species in the inshore waters (up to 25 m depth) of the Parangipettai waters. Sajjan and Damodaran (2007) and Sajjan *et al.* (2010) reported 154 species in the western continental shelf of India. However none of these 6 species have been reported earlier from Indian waters.

The present study concluded that the above six free-living marine nematode species were recorded first time ever in Indian waters. Until now, around 125 free-living marine nematodes were identified in Indian waters and 8921 species were recorded globally (NeMys data base Steyaert *et al.*, 2005). Recently free-living marine nematodes are focused as indicators of aquatic pollution and aquatic toxicological studies worldwide. Therefore, these new recorded species might be useful for future studies in Indian waters.

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