

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*, *Anticomma eberthi*, *Oncholaimellus calvadosicus*, *Viscosia glabra*, *V. langrunensis* and *Eurystomina terricola* under the order Enoplida which happen to be first records 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; Harkantra *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 (33.70-34.20)	7.06 (6.65-7.47)	3.41 (3.28-3.54)

Description

Body length 1 -1.4 mm. Maximum body diameter 39-43 μ m. 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 μ m). 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).

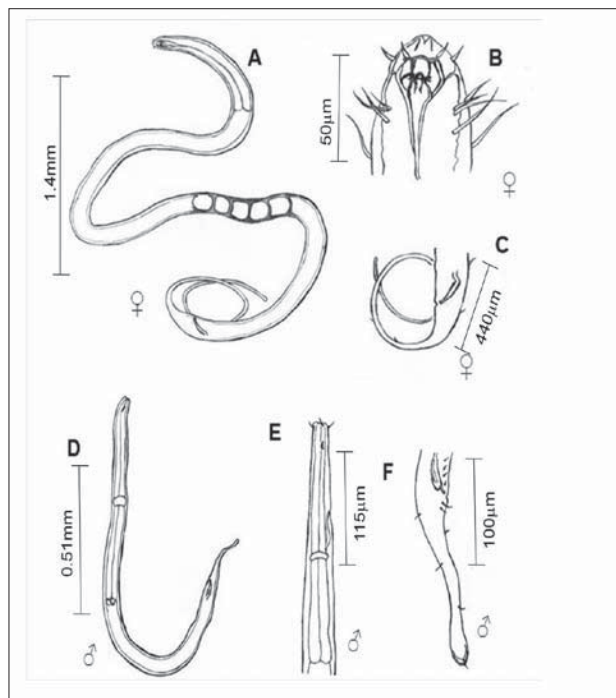


Fig.1. A-C: *Enoplolaimus longicaudatus* A) entire female, B) female head, C) female tail; D-F: *Anticoma eberthi* D) entire male, E) male head, F) male tail

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:	2. <i>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 precloacal 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 0.51mm 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:	3. <i>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).

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

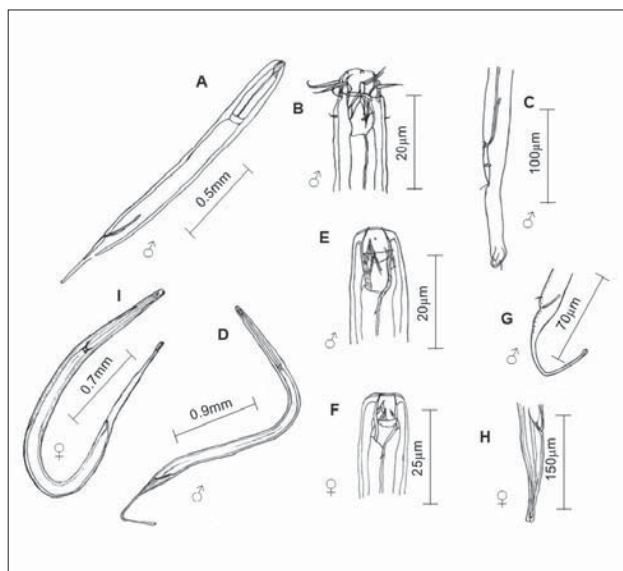


Fig.2.A-C: *Oncholaimellus calvadosicus*; A) entire male, B) male head, C) male tail; D-I: *Viscosia glabra*; D) entire male, E) male head, F) female head, G) male tail, H) female tail I) entire female

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
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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 Man 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).

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

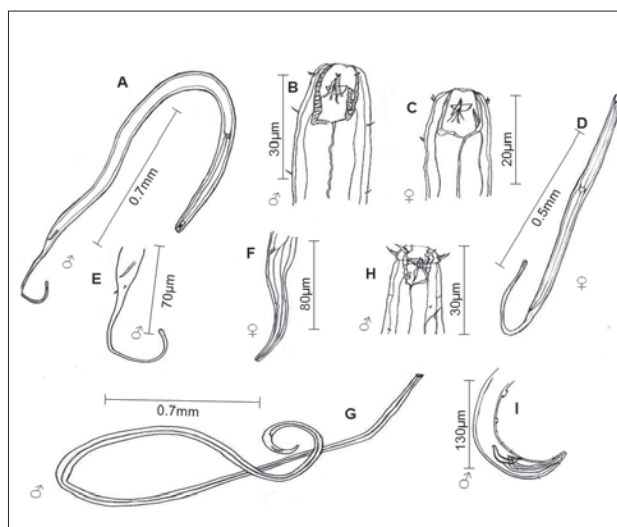


Fig.3.A-F: *Viscosia langrunensis*; A) entire male, B) male head, C) female head, D) female head, E) male tail, F) female tail; G-I: *Eurystomina terricola*; G) entire male H) male head, I) male tail

Distribution

India: Off Karaikkal, Parangipettai, Cuddalore- SIPCOT, Cheyyur, Chennai, Tammenapattanam 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 mail was 2.6 mm and tail length varied between 6.6 a.b.d (Platt and Warwick, 1983) and for female 2.2 mm body length and tail length 5.9 a.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:	6. <i>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 μm . Cuticle smooth. Six labial papillae. Ten cephalic setae in one circle six 10 μm (0.6 h.d.) and four 6 μm (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 μm). Tail conical, 2.1 a.b.d. Caudal glands extend anterior to anus. Spicules 56 μm . Gubernaculum 29 μm . 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*, *Anticomaeberthi*, *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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References

- Allgen, C.A. 1916. On some free-living marine nematodes from Tobago (Br.W.I.). *Reports of Dr.Th.Mortensen's Pacific expedition* (1914-16): p.45-64.
- Allgen, C.A. 1959. Free-living marine nematodes. *Further zoological results of the Swedish Antarctic Expedition 1901-1903*, V. no. 2.
- Allgen, C.A., 1940. Free-living marine nematodes from east Greenland and Jan Mayen. *Reports of the Swedish Greenland Expedition*, 1899: p.1-41.
- Anila Kumary, K.S., 2008. Diversity of meiobenthic nematodes in the Poonthura estuary (Southwest coast of India). *J. Mar. Biol. Ass. India*, 50(1): 23-28.
- Ansari, K.G.M.T., 2010. Diversity of free-living marine nematodes from continental shelf off Parangipettai (Southeast coast of India). *M.Phil. Thesis*, Annamalai University, India, 102 pp.

- Ansari, K.G.M.T., P.S.Lyla and S. Ajmal Khan. 2012. Faunal composition of metazoan meiofauna from the southeast continental shelf of India. *Indian J. Mar. Sci.*, (in press).
- Ansari, Z. A., A. H. Parulekar and T. G. Jagtap. 1980. Distribution of sub-littoral meiobenthos off Goa coast, India. *Hydrobiologia*, 74 (3): 209-214.
- Ansari, Z.A. and M.U. Ganus. 1996. A quantitative analysis of fine scale distribution of intertidal meiofauna in response to food resources. *Indian J. Mar. Sci.*, 25: 259-263.
- Armenteros, M., J.A. Perez-Garcia, A. Perez-Angulo and J.P. Williams. 2008. Efficiency of extraction of meiofauna from sandy and muddy marine sediments. *Rev. Invest. Mar.*, 29:113-118.
- Bastian, H.C.H. 1865. Monograph on the Anguilludidae, or free nematoids, marine, land and freshwater: with descriptions of 100 new species. *Trans. Linn. Soc. London*, 25: 73-184.
- Chinnadurai, G. 2004. Meiofauna of mangroves of southeast and southwest coasts of India, with special reference to nematodes. *Ph.D., Thesis*, Annamalai University, India, 134 pp.
- Chinnadurai, G. and O. J. Fernando. 2006a. New records of free-living marine nematodes from India. *Rec. Zool. Surv. India*, 106 (4): 45-54.
- Chinnadurai, G. and O. J. Fernando. 2006b. New records of free-living marine nematodes from on artificial mangrove of India. *J. Mar. Biol. Ass. India*, 48(1): 105-107.
- Coomans, A. 1989. Overzicht van de vrijlevende nematofauna van België (Nematoda). [The free-living nematofauna of Belgium: a review.] In: Wouters, K. and L. Baert (Eds.), *Proceedings of the Symposium "Invertebrates of Belgium"*. Koninklijk Belgisch Instituut voor Natuurwetenschappen: Brussel, Belgium. p. 43-56.
- De Smet, G., M. Vincx, A. Vanreusel, S. Vanhove, J. Vanaverbeke and M. Steyaert. 2001. Nematoda - free living, In: Costello, M.J. (Ed.). *European register of marine species: a check-list of the marine species in Europe and a bibliography of guides to their identification*. Vol. 50, Collection Patrimoine Naturels. p. 161-174.
- Eldose P. Mani, 2008. Studies on benthic meiofaunal diversity and demersal standing stock prediction of the southeast continental slope (200-1000 m depths) of India (Bay of Bengal). *Ph.D., Thesis*, Annamalai University, India, 212 pp.
- Gerlach, S. A. and F. Riemann. 1974. The Bremerhaven checklist of aquatic nematodes, *Veröff Inst Meeresforsch Bremerhav (Suppl)*, 2 (4): 405-734.
- Gerlach, S.A. 1962. Freilebende Meeresnematoden von den Malediven. *Kieler Meeresforsch*, 18: 81-108.
- Hansson, H.C. 1998. North East Atlantic Taxa (NEAT): *Scandinavian Marine nematoda check-list*, Tjarn Marine Biological laboratory, 1-37 pp.
- Harkantra, S.N., A. Nair, Z.A. Ansari and A.H. Parulekar. 1980. Benthos of the shelf region along the west coast of India, *Indian J. Mar. Sci.*, 9: 106-110.
- Heip C., M. Vincx and G. Vranken. 1985. The ecology of marine nematodes. *Oceanogr. Mar. Biol. Ann. Rev.*, 23: 399-489.
- Heip, C., R. Herman and M. Vincx. 1983. Subtidal meiofauna of the North Sea: a review. *Biol. Jb. Dodonaea*, 51: 116-170.
- Higgins, R. P. and H. Thiel. 1988. Introduction to the study of meiofauna. Smithsonian Institution Press, Washington, DC, 231 pp.
- Krishnamurthy, K., M.A. Sulthan Ali and M.P.J. Jayaseelan, 1984. Structure and dynamics of the aquatic food web community with special reference to nematodes in mangrove ecosystems. In: Soecondmo, E., A.N. Rao and D.J. MacIntosh (Eds.), *Proc. Asia. Symp. Mangrove Res. & Mgmt.* University of Malaya, Kuala Lumpur. p. 429-452.
- Lily Cooper, M.G., 2005. Studies on meiobenthos with special reference to nematodes of Northeast Indian continental slope, Bay of Bengal. *M.Phil., Thesis*, Andhra University, India, 98pp.
- Medin, 2011. UK checklist of marine species derived from the applications Marine Recorder and UNICORN, version 1.0.
- Mondal, N., 2009. Biodiversity of meiobenthos in the inshore waters off Parangipettai coast (southeast coast of India) and its use as a pollution indicator. *Ph.D., Thesis*, Annamalai University, India, 204 pp.
- Muller, Y., 2004. Faune et flore du littoral du Nord, du Pas-de-Calais et de la Belgique: inventaire. [Coastal fauna and flora of the Nord, Pas-de-Calais and Belgium: inventory]. Commission Régionale de Biologie Région Nord Pas-de-Calais: France. 307 pp.
- Nanajkar, M.R. and B.S. Ingole, 2007. Nematode species diversity as indicator of stressed benthic environment along the central west coast of India. In: Desai, P.V. and R. Roy (Eds.), *Diversity and life processes from ocean and land*. Goa University, India. p. 42-52.
- Platt, H.M. and R.M. Warwick, 1980. The significance of nematodes to the littoral ecosystem. In: Prince, J.H., D.E.C. Irvine and W.H. Franham (Eds.), *The shore environment, ecosystems* Vol. 2, Academic Press, London. p. 729-759.
- Platt, H. M., and R.M. Warwick. 1983. Free living marine nematodes. Part I: British Enoplids. *Synopses of the British Fauna (New Series)*. No. 28, Cambridge University Press, Cambridge. 307 pp.
- Rao, G. C. and P.N. Ganapati. 1968. Interstitial fauna inhabiting the beach of sands of Waltair coast. *Proc. Nat. Ins. Sci. India*, 34: 82-125.
- Rao, G. C. 1986. Meiofauna of the mangrove sediments in South Andaman. *J. Andaman Sci. Assoc.*, 2(2): 23-32.
- Sajan, S. and R. Damodaran, 2007. Faunal composition of meiobenthos from the shelf region off west coast of India. *J. Mar. Biol. Ass. India*, 49(1): 19-26.
- Sajan, S., 2002. Meiobenthos of the shelf waters of west coast of India with special reference to free-living marine nematodes. *Ph.D., Thesis*, Cochin University of Science and Technology, India, 248 pp.
- Sajan, S., T.V. Joydas and R. Damodaran. 2010. Meiofauna of the western continental shelf of India, Arabian Sea. *Est. Coast. Shelf Sci.*, 86 (4): 665-674.
- Schratzberger, M., K. Warr and S.I. Rogers. 2006. Patterns of nematode population in the southwestern North Sea and their like to other components of benthic fauna. *J. Sea Res.*, 55: 113-127.
- Sinha, B., A. Choudhury and G.H. Baquiri. 1987. Studies on the nematodes from mangrove swamps of deltaic Sundarbans, West Bengal, India. III. *Anoplostoma macropiculun* n.sp. (Anoplostomatidae: Nematoda). *Curr. Sci.*, 56: 539-540.
- Sivalakshmi, M.V. 2007. Systematics of free living nematodes of northeast Indian continental slope, Bay of Bengal. *M.Phil., Thesis*, Andhra University, India, 101 pp.
- Southern, R. 1914. Nematelmia, Kinorhyncha and Chaetognatha. *Proc. R. Ir. Acad.*, Volume XXXI: 1-80.
- Stekhoven, J.H.S. 1942. Les nématodes libres marins du Bassin de Chasse d'Ostende [The free-living nematodes of the Sluice Dock at Ostend]. *Med. K. Belg. Inst. Nat. Wet.*, 18(12): 1-26.
- Steyaert, M., T. Deprez, M. Raes, T. Bezerra, I. Demesel, S. Derycke, G. Desmet, G. Fonseca, M. de Assunc ao Franco, T. Gheschiere, E. Hoste, J. Ingels, T. Moens, J. Vanaverbeke, S.VanGaever, S. Vanhove, A. Vanreusel, D. Verschelde and M. Vincx. 2005. Electronic Key to the free-living marine Nematodes, <http://nemys.ugent.be/>.
- Sulthan Ali, M.A., 1983. Studies on aquatic nematodes from the mangroves of Pichavaram (Southern India). *Ph.D., Thesis*, Annamalai University, India, 265 pp.
- Sultan Ali, M.A., S. Ajmal Khan and T. Balasubramanian, 1998. Nematodes of the Pichavaram mangroves. *GIS Based Information System for Pichavaram*. Government of India. 47 pp.
- Timm R.W. 1961. The marine nematodes of the Bay of Bengal. *Proc. Pakist. Acad. Sci.*, 1: 1-84.
- Timm, R.W. 1967a. Some estuarine nematodes from the Sunderbans. *Proc. Pakist. Acad. Sci.*, 4: 1-14.
- Timm, R.W. 1967b. New marine nematodes of the family Linhomoeidae from East Pakistan. *Proc. Pakist. Acad. Sci.*, 4: 15-22.
- Travisi, A. and J. Vidakovic. 1997. Nematofauna in the Adriatic Sea: review and check-list of free-living nematode species. *Helgoländer Meeresunters.*, 51: 503-519.
- Vincx, M. 1996. Meiofauna in marine and brackish water sediments, In: Hall, G.S. (Eds.), *Methods for Examination of Organismal Diversity in Soils and Sediments*. CAB International. p. 187-195.
- Vincx, M. 1989. Seasonal fluctuations and production of nematode communities in the Belgian coastal zone of the North Sea, In: Wouters, K. and L. Baert (Eds.), *Proceedings of the Symposium "Invertebrates of Belgium"*, Belgium. p. 57-66.
- Wieser, W. 1953. Die Beziehung zwischen Mundho hengestalt, ernahrungsweise und Vorkommen bei freilebenden marinen Nematoden. *Arkiv. fur Zoologi*, 4: 439-484.