



ORIGINAL ARTICLE

Two new species of Chaetognatha from the Andaman Sea, Indian Ocean

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Abstract

Two new chaetognath species, *Krohmitta balagopali* and *Sagitta meenakshiae*, are described from the Andaman Sea (Indian Ocean). *Krohmitta balagopali* is easily distinguishable from the other two known species of the genus by its unpigmented eye, fully rayed fins and smaller size. *Sagitta meenakshiae* has distinct characters, such as a small size, lower tail percentage, lower meristic counts and a difference in eye pigmentation as compared with three related species. The two new species appear to be endemic to this coral ecosystem.

Key words: Andaman Sea, Chaetognatha, Indian Ocean, new species

Introduction

The Andaman Islands (10°30'–14°N 92–93°E) are the emerged part of a mountain chain and lie as a ridge that extends southwards from the Irrawaddy delta area of Myanmar. The Andaman Islands are known for their fringing coral reefs. The coral ecosystem is very productive and supports a rich and diverse fauna. The waters around the Andaman Islands are considered to be one of the prominent biodiversity hotspots in the Indian Ocean. The chaetognaths of the Andaman Sea have been previously studied by Nair et al. (1981) and a total of 13 species had been recorded. Two new species of chaetognaths belonging to the genera *Krohmitta* and *Sagitta* were found in the zooplankton samples collected by the National Institute of Oceanography from this coral ecosystem during a recent survey in February 2005 as part of the project 'Study on biodiversity of phytoplankton and zooplankton with special emphasis on island ecosystems (Andaman Sea)'. The type specimens are deposited in the reference collection of the National Institute of Oceanography, Regional Centre, Kochi.

Material and methods

Regular zooplankton collections around Andaman waters at 16 oceanic and 16 coastal locations have been taken by the National Institute of Oceanography since 2004. Surface samples were collected using a Bongo net (200 µm, mouth area 60 cm). Stratified samples were taken from three depths, namely 0–top of thermocline (0–TT), top of thermocline–bottom of thermocline (TT–BT) and bottom of thermocline–300 m (BT–300m) using a multiple plankton net (200 µm, mouth area 0.25 m²). During sampling in 2005, the new species of *Krohmitta* was obtained from oceanic as well as coastal stations, whereas the new species of *Sagitta* was found only at the coastal stations of Port Blair. The location of the stations from where the new species were collected are shown in Figure 1. Comparison with related species of *Krohmitta balagopali* sp. nov. and *Sagitta meenakshiae* sp. nov. are shown respectively in Tables I and II. Details of the collections, environmental parameters and population density of chaetognaths are given in Tables III and IV.

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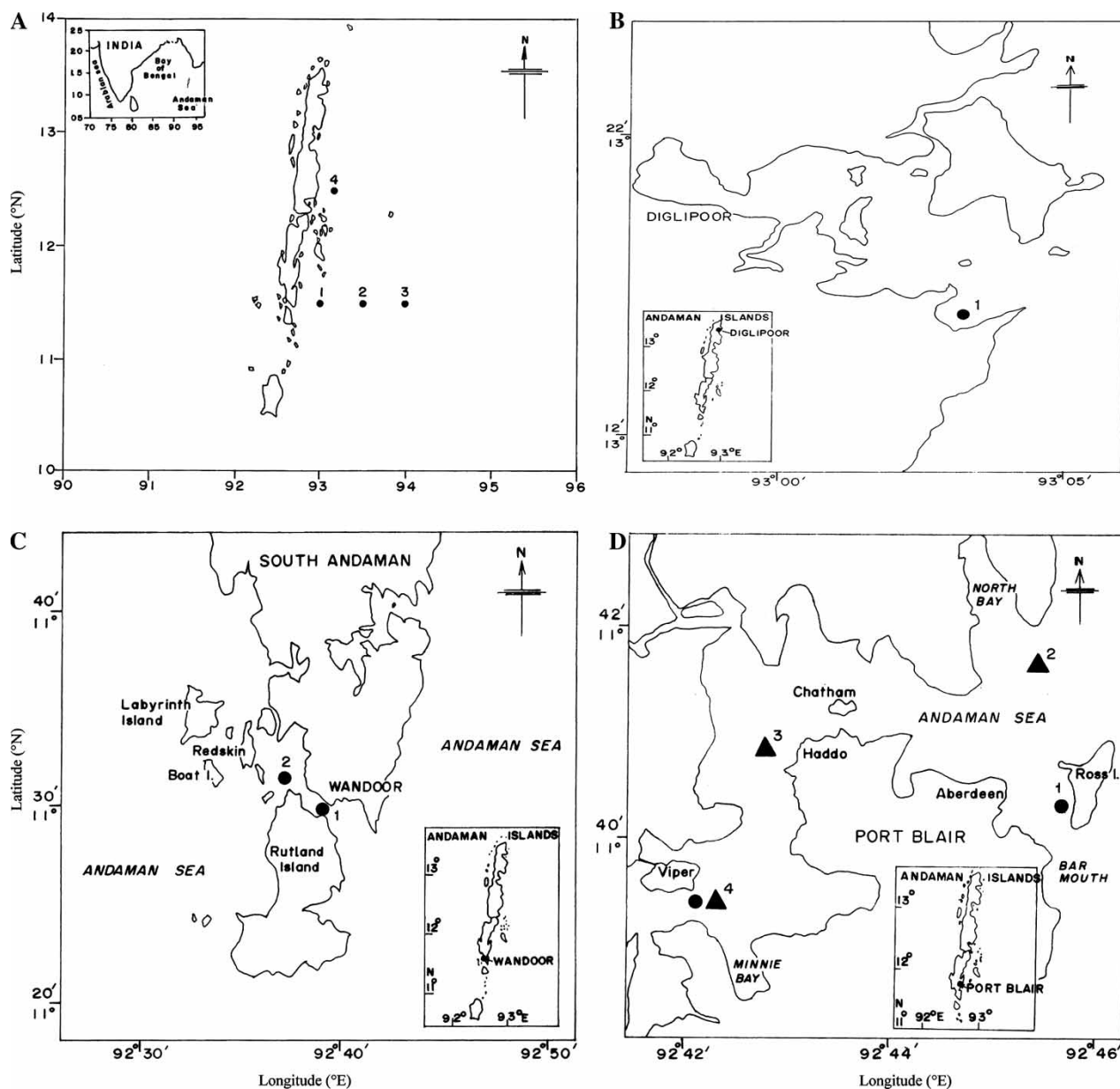


Figure 1. (A) Sampling locations in the Andaman Sea from which *Krohnitta balagopali* sp. nov. was collected; (B) station at Diglipur from which *Krohnitta balagopali* sp. nov. was collected; (C) stations at Wandoor from which *Krohnitta balagopali* sp. nov. was collected; (D) stations at Port Blair from which *Krohnitta balagopali* sp. nov. (closed circles) and *Sagitta meenakshiae* sp. nov. (triangles) were obtained.

Several specimens of the two new species were encountered in the collections. The description and classification of the species are made according to Alvarino (1967).

Krohnitta balagopali sp. nov. (Figure 2A–F)

Description

Body slender, flaccid, transparent, and widest at the level of the ventral ganglion (Figure 2A). Total length from 4.8 to 6.0 mm. Tail segment 29.6–33.3% of the total length without the tail fin.

Head small, neck conspicuous (Figure 2B). Eyes round, small without pigment, covered entirely by cells (Figure 2C). Hooks fine, sharp edged and number eight to nine. One row of teeth on each side, long with sharp ends numbering sixteen to seventeen. Corona ciliata not clearly seen in any of the specimens, but rudiments seen extending to the head. Collarette absent.

One pair of lateral fins narrow at the anterior end, starting about one-third distance between ventral ganglion and caudal septum to the seminal vesicles, extending more on the tail than on the trunk, fully rayed. Caudal fin spatulate in shape and fully rayed.

Table I. Comparison of *Krohmita balagopali* with related species.

Characteristics	<i>K. pacifica</i> (Aida 1897)	<i>K. subtilis</i> (Grassi 1881)	<i>K. balagopali</i> sp. nov.
Total length (mm)	6–8	12–16	4.8–6.0
Tail (%)	27–34	30–40	30–33
Hooks	8–11	6–9	8–9
Teeth	Up to 16	10–13	16–17
Eyes	Round, pigmented region kidney-shaped.	Oval, pigment arranged in isosceles pattern with tips wide and round.	Round, small, without pigment, covered entirely by cells.
Paired fins	Roundish, extending from about half way from level of ventral ganglion to base of tail fin. Fin rays cover only outer half of fin's surface.	Extending from two-thirds to one-half from ventral ganglion to seminal vesicles; wide, semi-circular, almost rayless with short wide-apart rays along edge of lamella.	Narrow at anterior end, starting about one-third distance between ventral ganglion and caudal septum to the seminal vesicles. Fin rays occupy entire fin surface.
Caudal fin	Spatulate in shape and completely rayed.	Spatulate in shape, almost totally covered by rays except for a small part at base of fin close to seminal vesicles.	Spatulate and fully rayed.
Ovaries	When fully mature reaching up to ventral ganglion; ova small, round, ova in one line.	Short, reaching anterior end of paired fins, ova round, distributed in two lines.	Extend up to posterior part of ventral ganglion. Ova small, round and in one row.
Seminal vesicles	Oval, placed dorsally at point where paired fins meet tail fin.	Oval and elongated, touching both paired fins and tail fins.	Large, oval in shape, enclosed by tail fin and paired fins.

Table II. Comparison of *Sagitta meenakshiae* with related species.

Characteristics	<i>S. neglecta</i> Aida 1897	<i>S. regularis</i> Aida 1897	<i>S. oceanica</i> Grey 1930	<i>S. meenakshiae</i> sp. nov.
Total length (mm)	8	5–6	6.5	4.3–4.6
Tail (%)	26–30	33	25–29	24.3–26.4
Hooks	6–7	Up to 11	6–7	5–6
Anterior teeth	7	4	5–8	3
Posterior teeth	Up to 18	6	15–20	5–8
Eyes	Round, pigmented area like five-pointed star with three large and two small arms.	Large, placed apart from each other, pigmented area like an anchor in shape.	Large, pigment in a large spot formed by three branches towards centre and two shorter ones towards sides.	Round and large; pigmented region with five stumpy star-like projections.
Collarette	Filling neck region to anterior fins and as a thin layer to tip of tail.	Well developed, thick, covering body and head; widest from head to anterior fins.	Small or absent.	Thin and visible only at neck region.
Anterior fins	Beginning a short distance behind posterior end of ventral ganglion, shorter than posterior fins, no rayless zone.	Shorter and narrower than posterior fins; beginning close but behind posterior end of ventral ganglion; no rayless zone.	Slightly shorter than posterior fins; beginning a little behind posterior end of ventral ganglion; rayless zone absent.	Smaller than posterior fins, beginning much behind ventral ganglion, fully rayed.
Posterior fins	Beginning at a short distance behind anterior fins; extending to seminal vesicles; elliptical in shape; more on tail (two-thirds of their length) than on trunk; no rayless zone.	Extending to seminal vesicles, located more on tail (three-quarters of their length) than on trunk; no rayless zone.	Roundish – triangular, extending to seminal vesicles with widest part at tail segment; located more on tail (two-thirds of their length); rayless zone absent.	Start slightly after posterior end of anterior fins and extend about 60% on tail region, fully rayed.
Ovaries	Filling trunk cavity and reaching up to midway between neck and ventral ganglion; ova round, large and arranged in one row.	Reaching up to level of ventral ganglion; ova large, oval and arranged in one row.	Reaching up to level of anterior end of ventral ganglion; ova large, elongated, distributed unequally in one line with large spaces in between.	Extending towards ventral ganglion; ova oval in shape, arranged in one row.
Seminal vesicles	Touching end of posterior fins, apart from tail fin; roundish with anterior part more voluminous.	Elongated, oval, anterior part larger; touching posterior fins but apart from tail fin.	Pear-shaped, close to posterior end of posterior fins, separated from tail fin.	Elongated, broader in front, when mature dark brown in colour, not touching posterior or caudal fins.

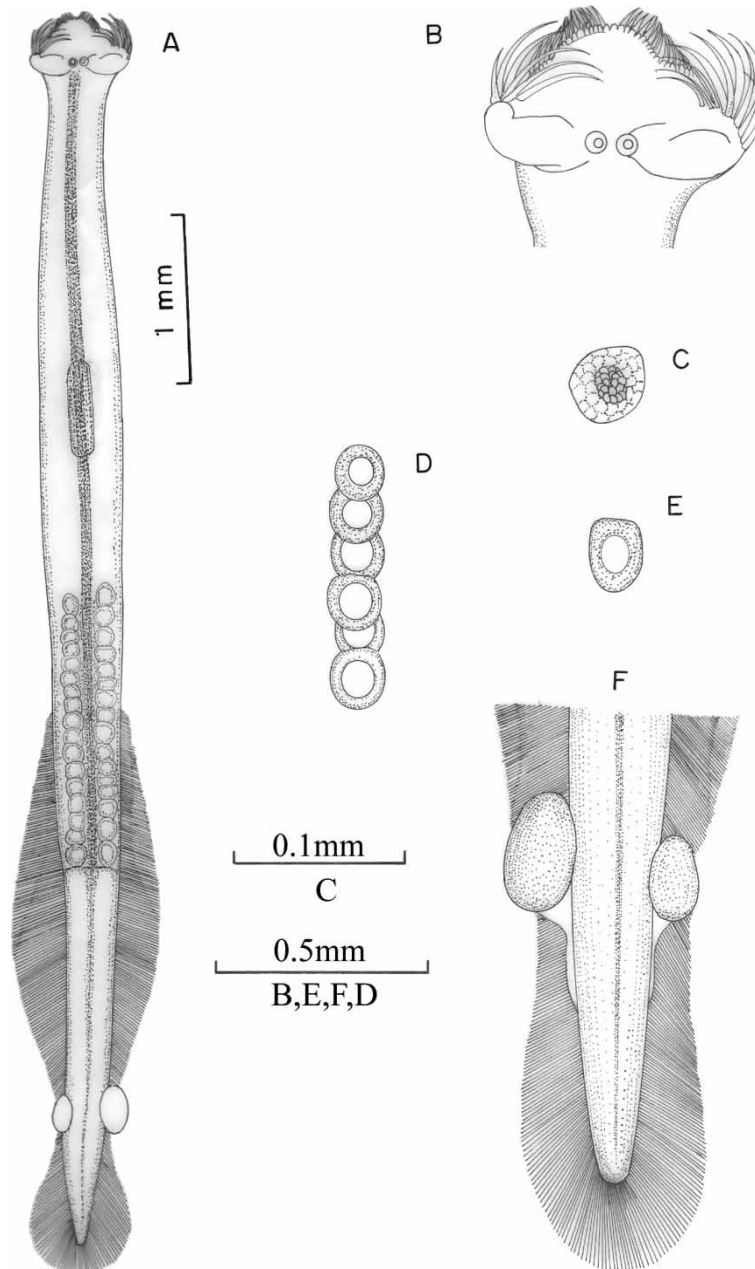


Figure 2. (A) Dorsal view of *Krohnitta balagopalii*. (B) Details of the head depicting teeth, hooks and neck. (C) Enlarged view of the eye. (D) Disposition of ova in the ovary. (E) Single ovum. (F) Posterior part of the tail segment showing details of seminal vesicles.

Ovaries do not reach ventral ganglion. Ova small and round arranged in one row (Figure 2D). There is a space between the shell membrane and the vitelline matter (Figure 2E). Seminal vesicles large, oval in shape and enclosed by tail fin and lateral fins (Figure 2F).

Types

Holotype (IOBC-0510-14-66-2007) mature individual 6.0 mm long and 10 paratypes (IOBC-0510A-14-66-2007).

Etymology

The species is named after the first author's (V. R. Nair) son, Mr Rajappan Balagopal.

A comparison with other related species (Table I) confirms that *Krohnitta balagopalii* is a new species.

Sagitta meenakshiae sp. nov. (Figure 3A–E)

Description

Body firm, thin, fairly opaque and of uniform width from neck to tail septum (Figure 3A). Lateral fields

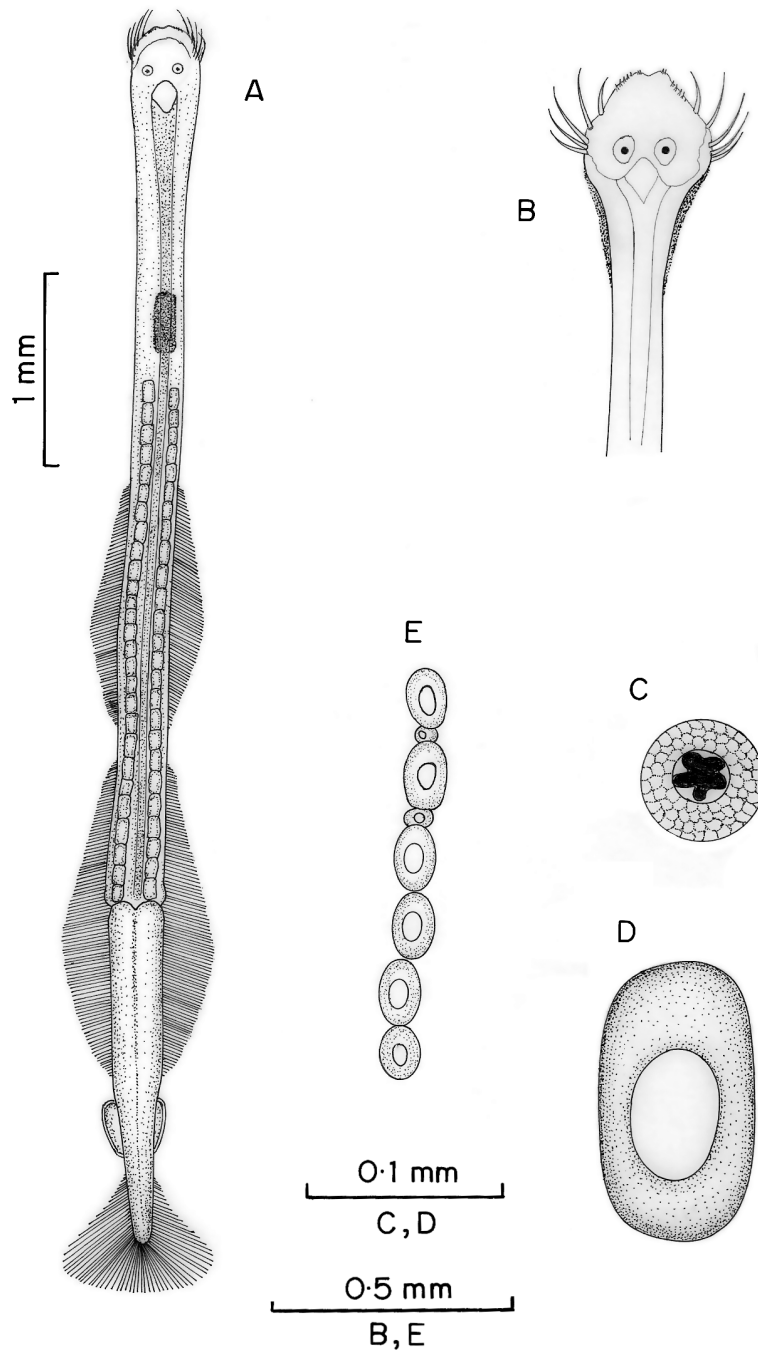


Figure 3. (A) Dorsal view of *Sagitta meenakshiae*. (B) Details of the head depicting teeth, hooks and neck. (C) Enlarged view of the eye. (D) Single ovum. (E) Disposition of ova in the ovary.

thin. Total length from 4.3 to 4.6 mm. Tail segment 24.3–26.4% of the total length. Head big and broad as compared with body (Figure 3B). Neck not well marked, covered by thin collerette. Eyes round and large, pigmented region has five stumpy star-like projections (Figure 3C). Hooks, five to six curved, prominent often pleated together, partially or totally covered by the hood and extension of collerette. Three anterior teeth. Five to eight posterior teeth. Intestinal diverticula present with deep cleft in between. Corona ciliata not clearly visible in any of

the specimens examined, but rudiments extend in a weaving pattern behind the eyes. Anterior fins smaller than posterior fins, starting much behind the ventral ganglion, fully rayed. Posterior fins start slightly after the posterior end of the anterior fins and extend more (about 60%) on the tail region, fully rayed and slightly separated from seminal vesicles. Tail fin fan-shaped and fully rayed.

Seminal vesicles elongated, and broader in front, when mature dark brown and not touching the caudal fin. Ovaries extend towards ventral ganglion.

Table III. Details of the stations, environmental parameters and population density of chaetognaths with percentage contribution of *Krohmitta balagopali* sp. nov. recorded from Andaman waters.

Stations	Latitude	Longitude	Date	Time (h)	Depth (m)	Temperature (°C)	Salinity (‰)	Total chaetognath population (n/1000 m ³)	Percentage contribution
Open ocean									
1 (TT–BT)	11°30′	92°59′	1-2-05	1740	17–156	27.7–15.9	31.3–34.8	9928	4.7
2 (surface)	11°30′	93°30′	1-2-05	1335		27.91	31.6	17,513	1.6
3 (0–TT)	11°30′	94°00′	1-2-05	0845	0–18	27.6	31.5	6667	3.7
3 (BT–300)	11°30′	94°00′	1-2-05	0845	146–300	14.60–11.38	34.8–35.0	8227	4.0
4 (surface)	12°29′	93°04′	30-1-05	1313		27.4	30.9	3138	22.9
Coastal area									
Diglipur									
1	13°16′	93°02′	11-2-05		20	27.5	31	11,108	1.1
Port Blair									
1	11°40′	92°45′	10-2-05	1130	8	29.2	32.38	145,331	0.1
4	11°39′	92°42′	5-2-05	1004	10	28.4	31.6	17,440	1.3
Wandoor									
1	11°34′	92°37′	5-2-05	1050	20	27.7	31.96	7412	8.1
2	11°33′	92°37′	5-2-05	1126	30	29.0	32.06	2457	12.2

TT, top of thermocline; BT, bottom of thermocline.

Ova oval in shape and arranged in one row (Figure 3D, E).

Types

Holotype (IOBC-0511-14-66-2007) mature individual 4.6 mm long and 10 paratypes (IOBC-0511A-14-66-2007).

Etymology

The species is named after the first author's (V. R. Nair) daughter, Dr Meenakshi Venugopal.

A comparison with other related species (Table II) confirms that *Sagitta meenakshiae* is a new species.

Distribution and comments on the phylum

Krohmitta balagopali was obtained from the oceanic stations on the eastern side of the Andaman Islands (0–300 m) and the coastal stations of Diglipur, Port Blair and Wandoor (Table III). A higher proportion of the population was found in the oceanic sector (av. 7.4; 408/1000 m³) as compared with the coastal area (av. 4.6; 279/1000 m³). The maximum number

of 719/1000 m³ was obtained at station 4 from the surface. The temperature and salinity ranges at the stations were 11.38–29.2°C and 30.9–35.0‰, respectively.

Sagitta meenakshiae was only recorded from the shallow coastal area of Port Blair from a depth of 10–20 m (Table IV). Although recorded only from three locations, the population density was high (av. 1466/1000 m³) with a maximum at station 2 (2784/1000 m³). Temperature and salinity in the area showed a fluctuation of 27.4–28.4°C and 31.53–31.60‰, respectively.

Since their discovery, chaetognaths have remained as one of the most isolated phyla in the animal kingdom. The affinities of the phylum have long been debated, and current researchers are far from reaching any consensus of opinion (Telford & Holland 1993). Although molecular techniques can resolve their true affinities, DNA barcoding is still at a formative stage. Studies on the structure and distribution of chaetognaths have not so far provided any reliable base on the evolution of this group. As no evidence exists for the direction of evolution within the group to suggest whether the benthic

Table IV. Details of the stations, environmental parameters and population density of chaetognaths with percentage contribution of *Sagitta meenakshiae* sp. nov. recorded from coastal waters of Andaman.

Stations	Latitude	Longitude	Date	Time (h)	Depth (m)	Temperature (°C)	Salinity (‰)	Total chaetognath population (n/1000 m ³)	Percentage contribution
Port Blair									
2	11°42′	92°44′	4-2-05		20	28.3	31.53	132,598	2.1
3	11°41′	92°43′	4-2-05	1130	20	27.4	31.58	42,257	1.8
4	11°39′	92°42′	5-2-05	1004	10	28.4	31.6	17,440	4.9

chaetognaths are the primitive one from which the pelagic forms were evolved or vice versa, the possibility of recent genera having a parallel rather than successive development cannot be excluded (Bone et al. 1991).

The genus *Sagitta* includes approximately 55 species of chaetognaths (Bieri 1991) and it appears to be the most successful group, as its representatives inhabit a variety of environments and bathymetric levels of the oceans (Alvarino 1965). There are groups of species within the genus *Sagitta* that are more similar to each other than to other species. Some authors divide this genus into separate genera (Tokioka 1965; Bieri 1991), but here this was not adopted. The new species *Sagitta meenakshiae* fits closely to the *neglecta* group. Although members of this group, *S. neglecta* and *S. regularis*, are Indo-Pacific, *S. oceania* has restricted distribution. *Sagitta neglecta*, *S. oceania* and the new species prefer neritic waters. The absence of this new species in open ocean samples suggests that it may be endemic to the coastal belt of Andaman waters.

Krohnitta balagopali occurs both in oceanic as well as coastal waters. The eyes without pigmentation is a unique feature of deep-water species. Unpigmented eyes in epipelagic species is a rare feature among chaetognaths. Future phylogenetic studies may give an answer to this.

The Andaman waters are known for their biodiversity and the area supports a rich and diverse chaetognath fauna (V. R. Nair, unpubl. data). Most of the coral islands and lagoons are unique ecosystems providing shelter and nourishment to a variety of marine life. Such least disturbed reef areas of the Indo-Pacific support new and endemic species. Endemism has already been reported from the Laccadive lagoons (Madhupratap et al. 1991; Casanova & Nair 1999, 2002). Unlike the Lakshadweep lagoons, the coastal sector of the Andaman Islands has a free interchange of water supporting a rich immigrant faunal assemblage. However, the sheltered coral reef ecosystem of the Andaman Sea also promotes speciation and endemism, as evidenced by the occurrence of the two new species not found outside this area of the Bay of Bengal.

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