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First description of two *Paraprionospio* species (Polychaeta: Spionidae) from tropical estuarine and coastal waters of India

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Abstract
The spionid polychaete, *Paraprionospio pinnata* (Ehlers, 1901), has been widely reported from many estuarine coastal waters of India. The occurrence of *Paraprionospio cordifolia* (Yokoyama, 2007), *Paraprionospio cristata* (Zhou, Yokoyama & Li, 2008), and *Paraprionospio patiens* (Yokoyama, 2007) have also been reported earlier from the East and Southeast Asian coastal waters. We now examined 93 specimens that were collected from the tropical Godavari estuarine system, situated in the Bay of Bengal, on the east coast of India, and the coastal waters of the Arabian Sea, identified them as *Paraprionospio cristata* and *Paraprionospio patiens*. These are new records being found in the estuarine and the coastal waters of India. The present study suggests that *Paraprionospio* species inhabiting Indian estuarine waters are often misidentified as *P. pinnata* and that, in fact, *P. cristata* and *P. patiens* are widely distributed in the estuarine and coastal waters of India. Therefore, further studies are targeting extensive and intensive sampling improve the regional biodiversity studies.

Keywords: East coast of India, *Paraprionospio cristata*, *Paraprionospio patiens*, Polychaete taxonomy

Introduction
In both marine and estuarine benthic habitats, polychaetes are the most prevalent fauna, and they considerably contribute to overall macrofaunal biodiversity, frequently making up 60 to 80 percent of it (Hutchings, 1998) [11]. In addition to recycling nutrients and organic matter, polychaetes are crucial biological markers for determining the ecological condition of an area (Naidu *et al*., 2018a) [15], and more recently, they have also gained recognition as prospective species for microplastics research (Naidu *et al*., 2018b) [16]. Spionidae family polychaetes are significant taxa in marine benthic assemblages because they can thrive in a variety of environments, including muddy and sandy substrates (Abdul Jaleel *et al*., 2021; Sivadas *et al*., 2021) [1, 27]. Additionally, they frequently make up the dominant species in the intertidal to deeper marine environments (Blake, 1996) [4].
The subgenus *Paraprionospio* was established for *Prionospio pinnata*, mainly based on the presence of the first pair of branchiae on chaetiger 1, instead of on chaetiger 2 as in other *Prionospio* species (Caullery, 1914) [5]. However, the difference in homology between chaetiger 1 in *Paraprionospio* and chaetiger 2 in *Prionospio* did not allow for it to be adequately recognized as a separate genus (Söderström, 1920) [28]. Subsequently, based on the well-developed parapodia of chaetiger 1, a hood formed by the fusion of the peristomium and an achaetous first segment, as well as three pairs of branchiae on chaetigers 1-3, the status of a separate genus was assigned to *Paraprionospio* (Foster, 1971; Fauchald, 1972; Maciolek, 1981) [8, 7, 14], and *Paraprionospio* was recognized as a monotypic, cosmopolitan genus (Foster, 1971; Delgado-Blas and Carrera-Parra, 2018) [8, 6]. Subsequently, *Paraprionospio cristata* was reported as a new species from Chinese waters (Zhou *et al*., 2008) [26]. These studies, as well as an investigation by Yokoyama and Choi (2010) [24] in Korean waters suggest that *Paraprionospio* species are widely distributed in East and Southeast Asia.
Paraprionospio pinnata has been widely reported from the marine environment around India (Ajmal Khan and Murugesan, 2005; Sukumaran and Sarala Devi, 2009; Sivadas *et al*., 2020; 2021) [2, 22, 20, 27], whilst more recently, Yokoyama and Sukumaran (2012) [25] reported on the occurrence of *P. cristata*, *P. patiens*, and *P. cordifolia* from the northwest coast of India.

They suggested that earlier records of *P. pinnata* found in Indian waters may well also be cases of misidentification. The coastal waters of eastern Arabian Sea is well experiencing seasonal upwelling and regulated the biological production and biogeochemical processes in the pelagic-sea floor system (Gupta *et al*., 2016) [9]. On the other hand, high biological production and sinking organic matter enhances the benthic abundance and diversity (Joydas and Damodaran, 2009; Naidu *et al*., 2018a) [12, 15].

The recent checklist by Sivadas and Carvalho (2020) [21] has indicated the marine annelids from the coastal waters of Indian subcontinent that 25% of the records are questionable and there is need for rigorous sampling and reexamination to discover new species for biodiversity studies. The Godavari estuary, which is located on the southeast coast of India, is one of the world's largest tropical monsoonal estuaries. The first comprehensive study on the abundance and distribution of benthic polychaetes in this estuary reported 42 species (Rao and Sarma, 1983), as well as the subsequent ones (Raut *et al*., 2005; Rao *et al*., 2009; Appalanaidu, 2015) [19, 18, 3], did not provide taxonomic descriptions. In case of coastal waters of Arabian sea, mostly studies focused on traditional taxonomic patterns (abundance, biomass, and diversity; Joydas and Damodaran, 2009; Naidu *et al*., 2018a; Sivadas *et al*., 2016; Abdul Jaleel *et al*., 2021) [12, 1, 15, 20], and further accurate taxonomic studies greatly needed for the benefit of ecological and conservation aspects along the Indian coast (Sivadas and Carvalho, 2020) [21]. Therefore, the present study carried out is the first detailed study on *Paraprionospio* species descriptive research work from the Godavari estuary, southeast coast of India, and the coastal waters of Arabian sea.

Material and Methods

Study area with sampling stations and sample collection

The Godavari estuarine system (16°30–16°45'N; 82°15–82°25'E - Bay of Bengal, Indian Ocean) extends over an area of 330 km^2 (Fig. 1). Among the sixty largest estuaries in the world, it ranks 34th in terms of catchment area and 32nd in terms of water discharge. The Godavari River bifurcates into two estuarine systems -the Vasishta Godavari and the Gautami Godavari - before joining the sea. Sampling was conducted at three stations (VE (16°71.22'N, 82°23.05'E), V3 (16°64.50'N, 82°25.94'E) and BE (16°71.47'N, 82°32.83'E)) at downstream positions of Gautami Godavari in Godavari estuary (Fig. 1). Depths over the sampling stations ranged from 3 m (VE and V3) to 8 m (BE). The sediment at VE and V3 was silty mud, while it was silty sand at BE. The sediment organic carbon from the study area ranges from 0.91 to 1.30% (mean 1.12%) and is of allochthonous origin (Krishna *et al*., 2015) [13]. The salinity at these sampling stations varied from 20 to 30‰. Further, the observations were conducted along the eastern Arabian Sea during Jan-Feb-2018 and Sep-Oct-2018, onboard Sagar Sampada (FORV) and Sagar Kanya (SK) covering four coastal transects (Kochi (76°11.8'E - 75°95.5'E; 9°94.0'N - 9°88.5'N), Mangalore (75°62.1'E - 75°46.0'E; 11°18.5'N -11°18.'N), Goa (73°70.7'E - 15°39.9'E) and Mumbai (72°60.2'E -72°45.7'E; 19°04.9'N - 19°05.1'N)). Smith-McIntyre grab (0.1m^{-2}) was used for coastal sediment sampling, at each transect, 1-3 stations were covered with depths ranging between 13-50 m. The sediment was then sieved through a 0.5 mm mesh sieve, before being fixed with 5% formaldehyde buffered with seawater on-board ship. The fauna were washed to remove the formaldehyde, polychaetes sorted out in the laboratory, before being preserved in 70% ethanol.

Microscopic and SEM analysis

Using a binocular microscope, the *Paraprionospio* species were identified based mainly on specific diagnostic characters such as the papilla on the peristomium, the shape of the branchial lamellae, type of capillary in the 9th neuropodium, ventral flap, and membranous dorsal crest (Yokoyama, 2007; Zhou *et al*., 2008; Yokoyama, and Choi, 2010; Yokoyama and Sukumaran, 2012) [23, 26, 24, 25]. The specimens observed using the scanning electron microscope (SEM). The sample preparation for SEM were done through an ethanol series (25%, 50%, 75%, 100%), critical point dried, coated with gold-palladium, and examined using the JSM-IT500 model, JEOL in Touch Scope^{TM} with a voltage of 10kV. A total of 93 specimens collected (from estuarine VE, V3, and BE) and coastal transects (Kochi, Manglore, Goa and Mumbai) were identified as species belonging to the genus *Paraprionospio* (Table 1). These were sorted into 37 specimens of *P. cristata*, 44 specimens of *P. patiens*, and 12 specimens of *Paraprionospio* sp. (Table 1). The latter 12 specimens of *Paraprionospio* sp. could be either *P. cristata* or *P. patiens* or others, but this could not be resolved further due to the missing or undeveloped stages of diagnostic characters.

Taxonomic Account

Paraprionospio cristata Zhou, Yokoyama and Li, 2008 [26]
Yokoyama and Sukumaran, 2012 [25] (Fig. 2)

Material examination and description of the specimens

Thirty-two specimens were examined (Table 1). Length of the specimens broadly varied between 8.7 and 29 mm long, with a total of between 57 and 85 chaetigers, and a width of between 0.4 and 1.1 mm for chaetiger 5 (Table 1). The prostomium id fusiform with round/ pointed/ bilobed anterior end (Fig. 2A & B). Two pairs of small, black eyes in trapezoidal arrangement are seen on the prostomium. A pair of yellowish-brown pigment patches are occasionally visible between the two pairs of eyes. The peristomium is well-developed, forming conspicuous lateral wings. No papillae were observed on the posterior margin of the peristomium and there was no pigment patch seen on the peristomium. Three pairs of branchiae were found on chaetiger 1–3. Usually, the first pair of branchiae were the longest, whilst the third pair were the shortest. Branchiae bearing lamellae on branchial shaft except on its base and a distal tip. In the proximal region of the branchial shaft, lamellae consisted of having either completely separated plates i.e., 2 plates (Fig. 2C) or 1 plate that had a deep notch showing a bifoliate-shape (Fig. 2D. Towards the distal region of the shaft, the notch gradually weakened, and the lamellae became more boomerang-like in shape (Fig. 2E). A slender filament is observed at the base of the third pair of branchiae. The notopodial postsetal lamellae are lanceolate on chaetiger 1–2 (Fig. 2F), becoming low and round on chaetiger 3 (Fig. 2G). Thereafter the lamella become further reduced and rounded in subsequent chaetigers to approximately chaetiger 15 (Fig. 2H); thereafter they become elevated posteriorly and more triangular to lanceolate (Fig. 2 H & I). Neuropodial postsetal lamellae of chaetigers 1–2 are small and lanceolate, becoming low and round on chaetigers 3–7, thereafter diminishing progressively in size and reduced to small round lobes posteriorly. The notopodial postsetal lamellae unite across the dorsum, forming dorsal crests on

chaetigers 21–25 (Yokoyama and Sukumaran, 2012) [25] and are accompanied by a semi-transparent dorsal cuticle bearing circular convexities (Fig. 2J). Inter-parapodial pouches are absent. Neuropodial hooded hooks with 3-4 pairs of apical teeth above the main fang (Fig. 2K) from chaetiger 9 are accompanied by alternating Neuropodial non-limbate slender capillaries (Fig. 2L) and 1–2 sabre chaetae from setiger 10 (Fig. 2M) (Yokoyama and Sukumaran, 2012) [25]. Notopodial hooded hooks with 3 apical teeth appear in the posterior chaetigers (Fig. 2N). The pygidium has a long median anal cirrus and 2 short, lateral cirri.

Variability

The ventral upper margin on chaetigers 8–11 protrudei anteriorly; in three specimens i.e., Specimen No.s. 3, 8 and 15 shown in Table 1 form a conspicuous pocket-like structure on chaetiger 9-10 (Fig. 2O), however, most specimens do not show this distinct free margin. Ventral flaps are usually undeveloped in small-sized specimens. A similar phenomenon was observed in specimens in the coastal waters of India by Yokoyama and Sukumaran (2012) [25]. A variation in the number of anal cirri was obseved, probably due to the missing or undeveloped stage of this character in some juveniles, or individuals having regenerated posterior parts of bodies.

Remarks

Zhou *et al*. (2008) [26] described a new species, *Paraprionospio cristata*, from Chinese coastal waters which was observed as having a ventral flap on chaetigers 9-10 in specimens with large body sizes. In this study the ventral flap in these specimens examined, was unclear, especially in the small-sized specimens, suggesting that this character develops as the body size increases. Other common characters between the current specimens and *P. cristata* are the non-limbate capillary in the 9th neuropodium and a membranous dorsal crest on chaetigers 21-25. These characters aided in the identification of the present specimens as *P. cristata*. The shape of the branchial lamellar plates in the present specimens is boomerang-like, whereas the shape in the Chinese specimens examined by Zhou *et al*. (2008) [26] was 'bifoliate'. However, Yokoyama and Sukumaran (2012) [25] described branchial lamellae of specimens collected from the west and northwest coast of India as being 'bifoliate' in the proximal region of the branchial shaft or boomerang-like in the middle and distal regions. There is no conspicuous difference in the shape of the branchial lamellae between the specimens from China and the ones in this study. In addition, no clear morphological differences were observed between the present specimens and those collected from the west coast of India by Yokoyama and Sukumaran (2012) [25].

Yokoyama (2007) [23] re-examined specimens collected from Kakinada Bay, India, which had been reported as *Paraprionospio lamellibranchia* by Hartman (1975) [10]. He identified these specimens as being *P. inaequibranchia* and pointed out that the ventral upper margin of chaetigers 9–10 protruded anteriorly but did not form a true collar or flap with a free margin. A similar structure was found also in some of the present specimens. However, the present specimens differ from *P. inaequibranchia* in having dorsal crests on chaetigers 21–25 and also the absence of interparapodial pouches. The Indian *P. inaequibranchia* is characterized by dorsal crests on chaetigers 21-29, well developed interparapodial pouches and flabellate-shaped branchial lamellae (Yokoyama *et al*., 2007) [23]. The present specimens of *P. cristata* differs from *P. pinnata* in having dorsal crests as well as a slender filament at the base of the third pair of branchiae, whereas these characters are not found in *P. pinnata*.

Paraprionospio patiens Yokoyama, 2007 [23]

Yokoyama and Choi, 2010 [24]

Yokoyama and Sukumaran, 2012 [25]

(Fig. 3)

Material examination and description of the specimen

In total forty-one specimens were examined (Table 1). The length of the specimen broadly varied between 7 and 48 mm as did the total number of chaetigers (between 43 and 98) and the width of chaetiger 5 varied between 0.3 and 1.4 mm (Table 1). The prostomium is fusiform, and either bluntly pointed, round or truncate anteriorly and extends posteriorly as a faintly raised ridge to chaetiger 1 (Fig. 3A & B). Two pairs of small, black, eyes are arranged in a trapezoid on the prostomium. Small papilla are found on the posterior margin of the peristomial wing and no pigment patch is observed on the peristomium. Three pairs of branchiae are found on chaetigers 1–3 (Fig. 3B) with usually the first pair being the longest and the third pair the shortest. Branchiae bear lamellae on the branchial shaft except on their base and distal tip. All lamellae consist of two plates showing a bifoliate shape (Fig. 3C); each plate in the proximal region is lanceolate; in the middle region, plates increase in size (Fig. 3D), whilst in the distal region, plates become more rounded, but still remain separate from each other (Fig. 3E). A slender filament is observed at the base of the third pair of branchiae. The notopodial lamellae anteriorly are lanceolate, distally pointed, longest on chaetiger 3 (Fig. 3F) and become rounded and reduced in size posteriorly to about chaetiger 15 (Fig. 3G); subsequent lamellae are elevated and gradually become triangular to lanceolate (Fig. 3H & I). Neuropodial lamellae are lanceolate in chaetigers 1–2; posterior to chaetiger 3, lamellae become rounded and reduced forming a low postsetal ridge in the middle and posterior chaetigers (Fig. 3F-I). Both the ventral flap and is interparapodial pouches are absent (Fig. 3J). Notopodial postsetal lamellae unite across the dorsum forming dorsal crests on chaetigers 21–35 and are accompanied by semi-transparent dorsal cuticle bearing circular convexities. Neuropodial hooded hooks with three pairs of apical teeth above the main fang and secondary hood hooks (Fig. 3K) appear from chaetiger 9 accompanied by alternating capillaries (Fig. 3 L & M) and 1–2 sabre setae (Fig. 3N). Neuropodial capillaries are short and limbate on chaetiger 9 (Fig. 3L), replaced by long, fine, non-limbate capillaries from chaetiger 10 (Fig. 3M). Notopodial hooded hooks (Fig. 3O) with three apical teeth appear from about chaetiger 35. The pygidium has a long median anal cirrus and 2 short, lateral cirri.

Variability

Most specimens had bifoliate-shaped branchial lamellae, while three specimens had boomerang-shaped lamellae (Table 1), suggesting that there is variability in the shape of the branchial lamellae between individuals. There is variability in the number of anal cirri found which is similar to the present specimens of *P. cristata* (Table 1). This variability seems to result from the missing or undeveloped stage of the character.

Remarks

Usually, the shape of branchial lamellae in *Paraprionospio* species change along the branchial shaft; in the proximal region of the branchial shaft, lamellae consist of two completely separated plates; towards the distal region of the shaft, each plate becomes broader, but still remains separate from each other (bifoliate-shape); eventually this fuses to a single plate with a distinct notch (boomerang-shaped); the notch gradually weakens and completely fuses into one plate (flabellate-shape). Branchial lamellae in most of the present specimens showed a bifoliate-shape, indicating that the notch in the branchial lamellae in the specimens is deeper than in other *Paraprionospio* species including *P. cristata* which has a boomerang-shaped branchial lamellae (Yokoyama and Sukumaran, 2012) [25]. In addition to the shape of the branchial lamellae, small papilla are observed on the posterior margin of the peristomial wing, neuropodial capillaries are short and limbate on chaetiger 9, notopodial postsetal lamellae unite across the dorsum forming dorsal crests on chaetigers 21–35, which has led us to conclude that the present specimens are identifiable as *Paraprionospio patiens*.

The current specimens of *P. patiens* are similar to *P. africana* and *P. pinnata* in having bifoliate-shaped branchial lamellae. However, *P. patiens* differs from *P. africana* in having small papilla on the peristomium and ridge between branchial bases on chaetiger 1 instead of on chaetigers 1-3, while *P. patiens* differs from *P. pinnata* in having small papilla on the peristomium, limbate capillaries in the 9th neuropodium, and dorsal crests on chaetigers 21–35 instead of no dorsal crest. *P. patiens* differs from *P. inaequibranchia* collected from Kakinada Bay (Yokoyama, 2007) [23] in having small papilla on the peristomium, bifoliate-shaped branchial lamellae instead of flabellate-shaped branchial lamellae, dorsal crests on chaetigers 21-35 instead of on chaetigers 21-29, limbate capillaries in the 9th neuropodium instead of non-limbate capillaries, and no interparapodial pouches.

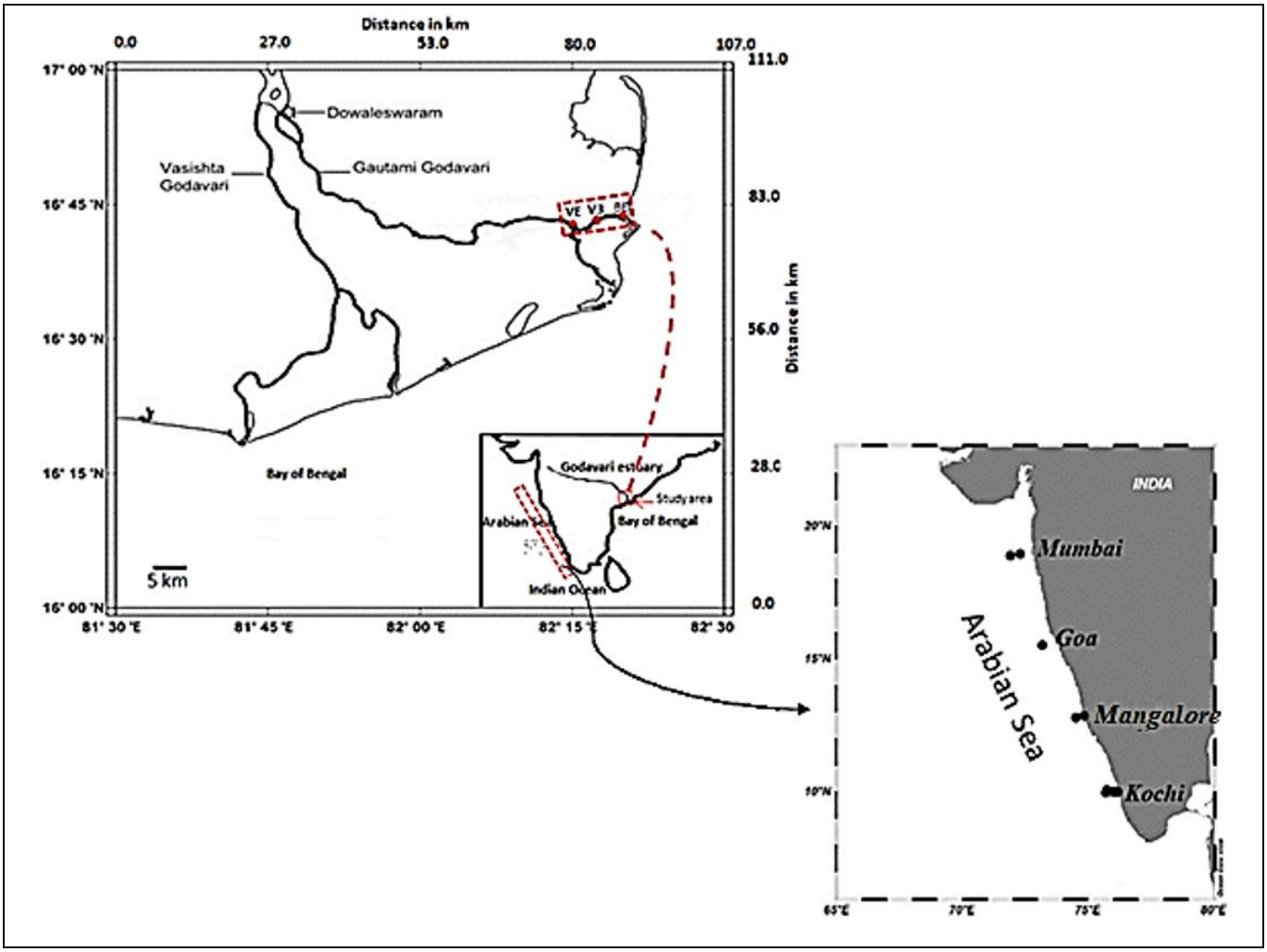

Fig 1: Map of Godavari estuary and coastal waters of Arabian Sea showing the study area and stations (VE, V3, and BE), and Kochi-Mumbai transects, where the *Paraprionospio* species were collect.

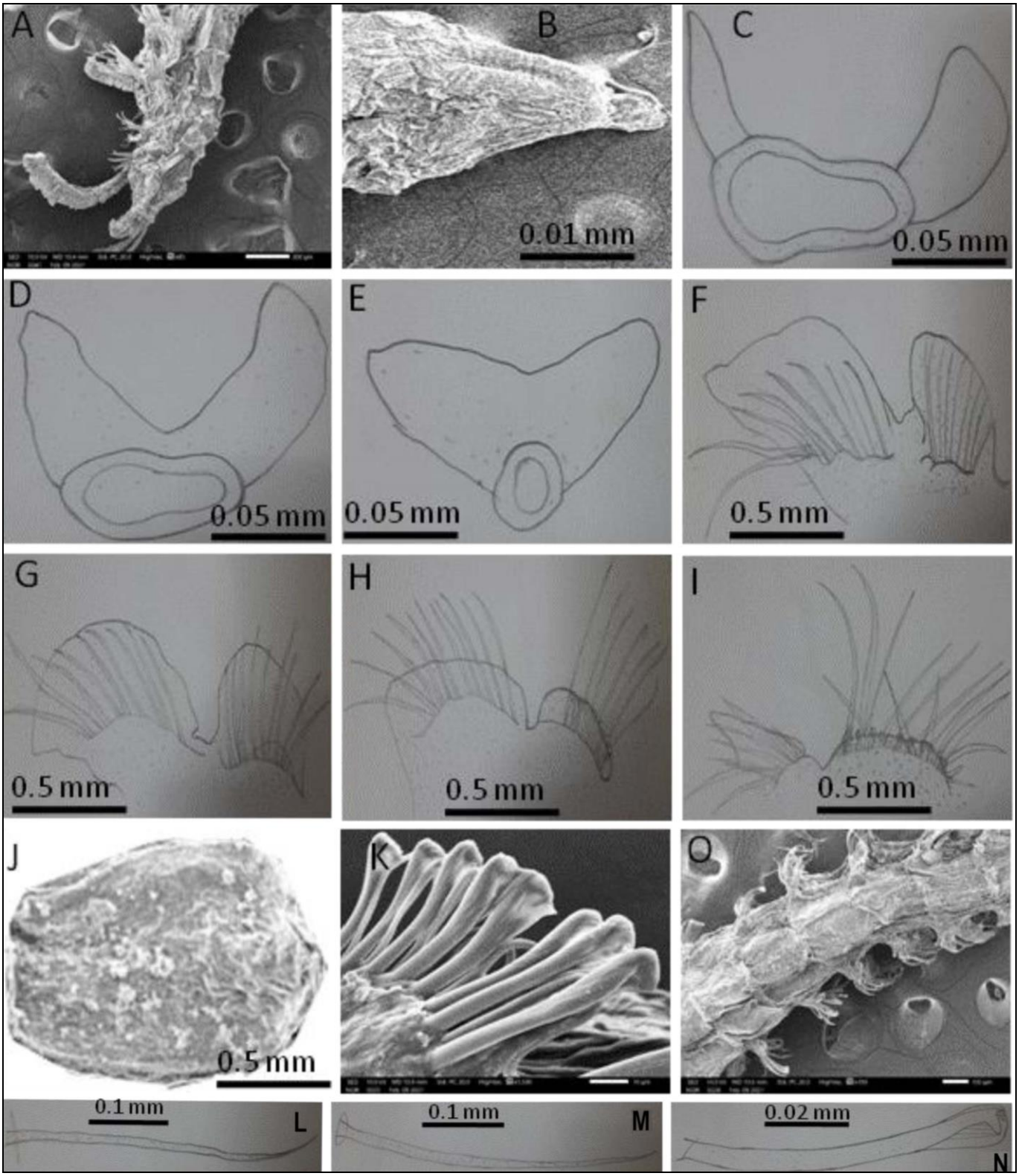

Fig 2: *Paraprionospio cristata*. A. anterior region, lateral view; B. Prostomium; C. Seventh lamella from the base of right branchia on setiger 1 in cross-section, seen from the top. D. 25th lamella of the same branchia in cross-section, seen from the top. E. 66th lamella of the same branchia in cross-section, seen from the top. F.1st parapodium, in anterior view. G. 3rd parapodium, in anterior view. H. 9th parapodium, in anterior view. I. 50th parapodium, in anterior view. J. Semi-transparent dorsal cuticle from setiger 24. K. Neuropodial hooded hook from setiger 9. L. Neuropodial non-limbate capillary from setiger 10. M. Sabre seta from setiger 10. N. Notopodial hooded hook from setiger 48. O. Setigers 8-12, in ventro-lateral view.

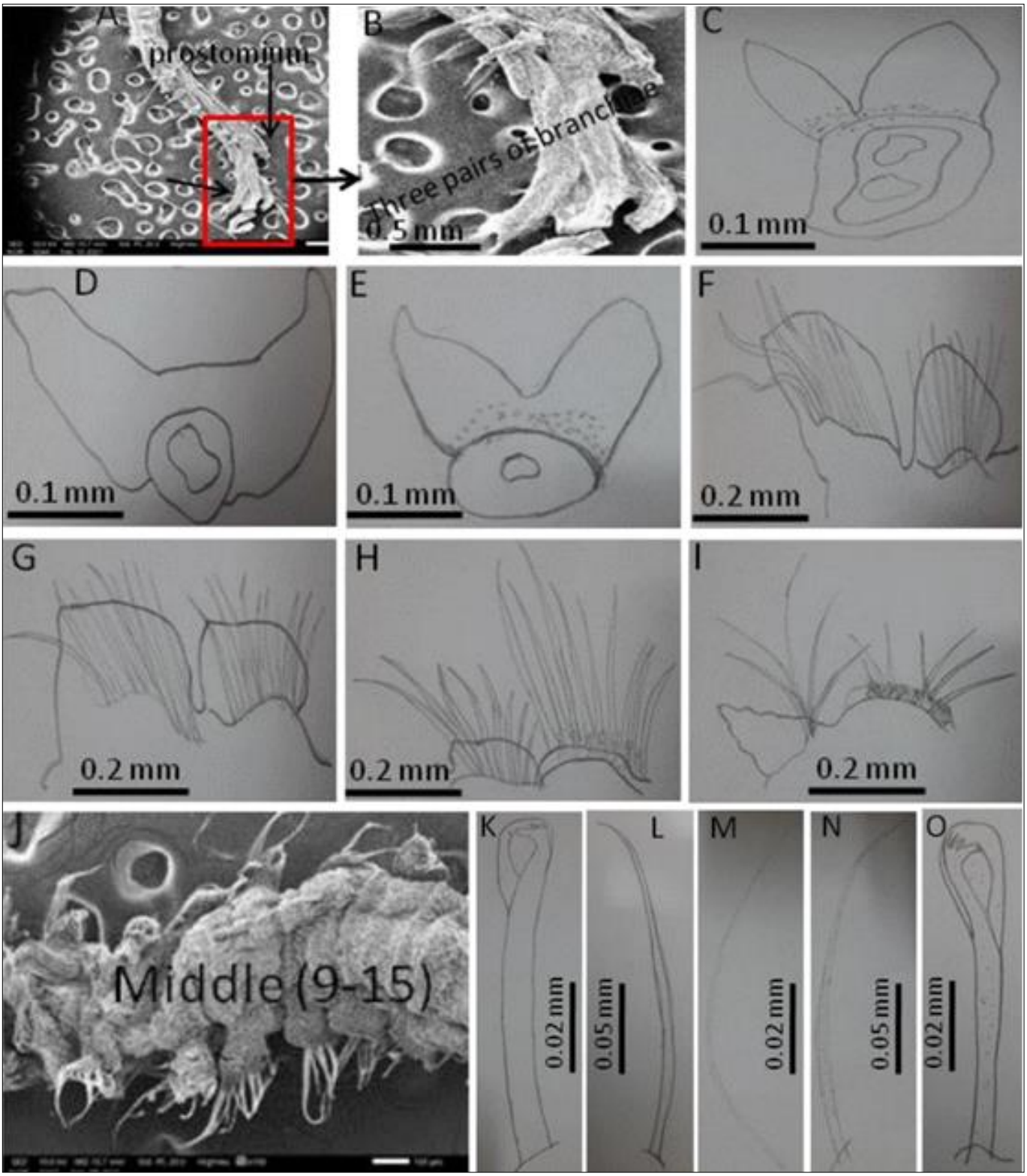

Fig 3: *Paraprionospio patiens*. A & B. anterior region, lateral view. C. Forth lamella from the base of right branchia on setiger 3 in cross-section, seen from top. D. 25th lamella of the same branchia in cross-section, seen from the top. E. 47th lamella of the same branchia in cross-section, seen from the top. F. 3rd parapodium, in anterior view. G. 3rd parapodium, in anterior view. H. 9th parapodium, in anterior view. I. 37th parapodium, in anterior view. J. Setigers 9-15, in ventro-lateral view. K. Neuropodial hooded hook from setiger 9. L. Neuropodial limbate capillary from setiger 9. M. Neuropodial non-limbate capillary from setiger 10. N. Sabre seta from setiger 10. O. Notopodial hooded hook from setiger 37.

Table 1: Characters and status in the 83 *Paraprionospio* specimens collected from Godavari estuary. "+" denotes presence of the character; "−" absence of the character; "?" missing data or unclear; bi, bifoliate-shaped branchial lamellae; bo, boomerang-shaped branchial lamellae in branchiae. "S" means chaetigers, for example, "S21-35" means the presence of the character on chaetigers 21-35. "ND" denotes no data

S. No	Species	Total length (mm)	Width of S5 (mm)	No. chaetigers	Shape of prostomium	Papilla on peristomium	Lamellae of branchiae	Limbate capillary in 9th neuropodium	Ventral flap	Membranous dorsal crest	Number of anal cirri	Other comments
1	*Paraprionospio cristata*	ND	1.05	ND	round	−	bo	?	S10?	S21-25	?	
2	*P. cristata*	29	0.78	85	pointed	−	bo	−	S9,10	S21-25	3	Ventral flat in S10 is pocket like
3	*P. cristata*	ND	0.84	ND	pointed	−	?	−	S8-10?	S21-25	0	
4	*P. cristata*	ND	0.36	ND	round	−	bo	−	S8-10?	S21-	?	
5	*P. cristata*	ND	0.39	ND	round	−	bo	−	S8-9?	S21-	?	
6	*P. cristata*	ND	0.8	ND	round	−	bo	−	S9-10?	S21-	?	
7	*P. cristata*	ND	0.89	ND	round	−	bo	−	S8-10?	S21-	?	
8	*P. cristata*	18.5	0.61	74	round	−	bo	−	S8-10?	S21-25	1	Posterior part regenerated?
9	*P. cristata*	18	0.59	69	round	−	bo	−	S8-10?	S21-	3	
10	*P. cristata*	12	0.52	68	round	−	bo	?	S8-10	S21-	0	
11	*P. cristata*	ND	0.42	ND	round	−	bo	?	S8-10?	S21-	?	
12	*P. cristata*	ND	0.73	ND	round	−	bo	−	S8-10	S21-25	?	
13	*P. cristata*	ND	0.63	ND	round	−	bo	−	S8-10?	?	?	
14	*P. cristata*	ND	0.52	ND	round	−	bo	−	S8-10?	?	?	
15	*P. cristata*	ND	0.72	ND	bilobed	−	bo	−	S9-11?	S21-	?	Anterior part regenerated?
16	*P. cristata*	ND	0.42	ND	round	−	bo	?	S8-10	?	?	
17	*P. cristata*	ND	0.59	ND	round	−	?	?	S10-11?	+	?	
18	*P. cristata*	ND	0.88	ND	round	−	?	−	S8-11?	+	?	
19	*P. cristata*	ND	0.7	ND	round	−	?	−	S9-11?	+	?	
20	*P. cristata*	ND	0.64	ND	round	−	?	−	S10-11?	?	?	
21	*P. cristata*	ND	0.58	ND	round	−	?	−	S9-10?	+	?	
22	*P. cristata*	ND	0.47	ND	round	−	?	−	S8-9?	S21-	?	
23	*P. cristata*	ND	0.5	ND	round	−	?	?	S8-9?	+	?	
24	*P. cristata*	ND	0.39	ND	round	−	?	?	S8-10?	+	?	
25	*P. cristata*	ND	0.3	ND	round	−	?	−	S8-10?	S21-25	?	
26	*P. cristata*	ND	0.53	ND	round	−	?	−	S9-10?	?	?	
27	*P. cristata*	ND	0.77	ND	round	−	bo	−	S8-10?	?	?	
28	*P. cristata*	ND	0.48	ND	round	−	bo	−	S10?	?	?	
29	*P. cristata*	ND	0.55	ND	round	−	bo	?	S9-10?	S21-25	?	
30	*P. cristata*	8.7	0.41	57	round	−	bo	−	S8-9?	+	0	
31	*P. cristata*	ND	0.52	ND	round	−	bo	?	−	S21-	?	
32	*P. cristata*	ND	0.48	ND	pointed	−	bo	−	−	S21-	?	
33	*Paraprionospio patiens*	48	1.41	98	pointed	+	bi	+	−	S21-35	1	
34	*P. patiens*	37	1.17	91	pointed	+	bi	+	−	S21-35	1	
35	*P. patiens*	38	1.02	88	pointed	+	bi	+	−	S21-35	1	
36	*P. patiens*	39	1.19	90	pointed	+	bi	+	−	S21-35	1	
37	*P. patiens*	17.5	0.63	75	pointed	+	bi	+	−	S21-35	1	
38	*P. patiens*	25	0.83	78	pointed	+	bi	+	−	S21-35	1	
39	*P. patiens*	24	0.84	79	pointed	+	bi	+	−	S21-35	1	Posterior part regenerated?
40	*P. patiens*	34	0.92	85	pointed	+	bi	+	−	S21-35	1	

41	*P. patiens*	27	1.08	82	pointed	+	bi	?	–	S21-35	3	
42	*P. patiens*	30	1.02	79	pointed	+	bi	+	–	S21-35	2	
43	*P. patiens*	ND	1.09	ND	round	+	bi	+	–	S21-35	0	
44	*P. patiens*	26	1.05	74	pointed	+	bi	+	–	S21-35	3	
45	*P. patiens*		0.92		pointed	+	bi	+	–	S21-35	0	
46	*P. patiens*	34	1.02	82	pointed	+	bi	+	–	S21-	1	Posterior part regenerated?
47	*P. patiens*	26	0.95	75	pointed	+	bi	+	–	S21-35	1	
48	*P. patiens*	19	0.69	74	pointed	+	bi	+	–	S21-35	1	Posterior part regenerated?
49	*P. patiens*	15.5	0.66	76	truncate	+	bi	+	–	S21-35	1	
50	*P. patiens*	19.5	0.64	75	pointed	+	bi	+	–	S21-35	1	
51	*P. patiens*	13	0.55	63	pointed	+	bi	+	–	S21-	?	
52	*P. patiens*	ND	0.8	ND	pointed	+	bi	+	–	S21-35	?	
53	*P. patiens*	10	0.42	54	pointed	+	bi	+	–	S21-35?	1	
54	*P. patiens*	ND	0.73	ND	pointed	+	bi	+	–	S21-35	?	
55	*P. patiens*	12	0.48	58	pointed	+	bi	+	–	S21-	1	
56	*P. patiens*	12	0.48	57	pointed	+	bi	+	–	S21-	1	
57	*P. patiens*	13.5	0.59	65	pointed	+	bi	?	–	S21-35	1	
58	*P. patiens*	8	0.36	44	pointed	+	bi	?	–	S21-	1	
59	*P. patiens*	8.5	0.39	47	pointed	+	bi	?	–	S21-	1	
60	*P. patiens*	13.5	0.52	63	pointed	+	bi	?	–	S21-	1	
61	*P. patiens*	7.5	0.34	45	pointed	+	bi	?	–	S21-	1	
62	*P. patiens*	13.5	0.59	64	pointed	+	bi	?	–	S21-	1	
63	*P. patiens*	ND	0.42	ND	pointed	+	bi	?	–	S21-	?	
64	*P. patiens*	7.5	0.39	46	pointed	+	bi	?	–	S21-	1	
65	*P. patiens*	7	0.33	43	pointed	+	bi	?	–	S21-	1	
66	*P. patiens*	7.2	0.3	44	pointed	+	?	?	–	S21-	1	
67	*P. patiens*	12	0.47	57	pointed	+	bi	?	–	S21-	1	
68	*P. patiens*	9	0.38	48	pointed	+	bi	?	–	S21-	1	
69	*P. patiens*	ND	0.44	ND	pointed	+	bi	?	–	S21-	?	
70	*P. patiens*	ND	0.47	ND	pointed	+	bi	?	–	S21-	?	
71	*P. patiens*	ND	0.48	ND	pointed	+	bo	?	–	S21-	?	
72	*P. patiens*	7.5	0.39	46	round	+	bo	?	–	+	0	
73	*P. patiens*	ND	0.39	ND	round	+	bo	?	–	S21-	?	
74	*Paraprionospio* sp.	7	0.36	44	round	?	bo	–	–	S21-	1	
75	*Paraprionospio* sp.	7	0.38	39	pointed	?	bi	?	–	?	1	
76	*Paraprionospio* sp.	7	0.34	42	pointed	?	bi	?	–	?	1	
77	*Paraprionospio* sp.	11	0.41	52	pointed	?	bi	?	–	S21-	1	
78	*Paraprionospio* sp.	8.8	0.44	48	pointed	?	bi	?	–	S21-	1	
79	*Paraprionospio* sp.	4.8	0.3	40	pointed	?	bi	–	–	S21-	1	
80	*Paraprionospio* sp.	6.3	0.36	44	pointed	+	bi	–	–	S21-	1	
81	*Paraprionospio* sp.	5.8	0.33	41	pointed	?	bi	?	–	S21-	1	
82	*Paraprionospio* sp.	6.8	0.38	40	pointed	+	bi	–	–	S21-	1	
83	*Paraprionospio* sp.	5	0.33	37	pointed	?	bi	–	–	S21-	1	
84	*P. cristata*	22.1	0.73	73	round	–	bo	?	S8-10?	?	?	

85	*P. cristata*	15.2	0.65	59	round	−	bo	−	S9-10?	?	?	
86	*P. cristata*	9	0.55	ND	round	−	?	−	S8-10?	?	?	
87	*P. cristata*	8.9	0.45	ND	pointed	−	?	?	S9-10?	S22-25	?	
88	*P. cristata*	ND	0.58	ND	round	−	bo	?	S9-10?	S21-25	?	
89	*P. patiens*	19.1	0.60	75	pointed	+	bi	+	−	S21-	1	
90	*P. patiens*	13	0.55	63	pointed	+	bi	+	−	S21-	?	
91	*P. patiens*	ND	0.8	ND	pointed	+	bi	+	−	S21-35	?	
92	*Paraprionospio* sp.	15	0.61	55	pointed	−	bi	?	−	?	1	
93	*Paraprionospio* sp.	5.8	0.45	51	pointed	?	bi	?	−	S21-	1	

Concluding remarks

Paraprionospio pinnata Ehlers (1901) has been reported from Indian waters (e.g., Ajmal Khan and Murugesan, 2005; Sukumaran and Sarala Devi, 2009; Sivadas *et al*., 2016; Naidu *et al*., 2018a; Abdul Jaleel *et al*., 2021) [1, 23, 15, 20]. However, Yokoyama and Sukumaran (2012) [25] suggested that these *Paraprionospio* species reported from India have been misidentified. The present study we identified two *Paraprionospio* species collected from the Godavari estuary and the coastal waters of the Arabian sea as being *P. cristata* and *P. patiens*, which are the first records of being found in the Godavari estuary. Zhou *et al*. (2008) [26] observed that *P. cristata* has a distribution from the Changjiang River estuary to the South China Sea. Yokoyama (2007) [23], however, observed that *P. patiens* has a distribution ranging from western Japan south of 37°N to Indonesia. Yokoyama and Sukumaran (2012) [25] reported the occurrence of *P. cristata* and *P. patiens* on the west and northwest coasts of India. The present study shows the occurrence of these two species between these two localities, i.e., the Godavari River and the eastern Arabian Sea. Yet, none of the specimens collected from Godavari estuary, east coast of India, could be identified as *P. cristata* or *P. patiens*.

P. cristata and *P. patiens* have a wide distribution from East Asia to South Asia. The only difference in the morphology of *P. cristata* between the specimens in our study and those in Zhou *et al*. (2008) [26] study have a large body size and a sizeable ventral flap on chaetigers 9–10, whereas, in our study, the ventral flaps are usually found between chaetiger 8–11. However, this character was inconspicuous in some specimens, especially in juveniles. Such variations may be a result of growth stages, and further studies are needed to clarify whether the observed morphological variations are determined genetically or not. Genetic diversity is important for a healthy benthic population in an ecosystem because it gives rise to different individual species capacities to adapt to stress and unfavourable environmental conditions, to improving the regional biodiversity. Therefore, there is a need for extensive and intensive sampling to discover new species, and from tropical ecosystems require our further attention.

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Authors contribution

SA. Naidu: Sample collection, analysis of sample, taxonomic identification, and writing the manuscript
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Declaration of competing interest

The authors declare that there are no conflicts of interest.

Ethical Approval

This article does not contain any experimental studies with animals performed by any of the authors.

Data Availability

The data used to support the findings of this study are included within the article

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