

First Records of Three *Paraprionospio* Species (Polychaeta: Spionidae) from Indian Waters

Hisashi YOKOYAMA*¹ and Soniya SUKUMARAN²

¹ *National Research Institute of Aquaculture, Fisheries Research Agency, Minami-ise, Mie 516-0193, Japan*

E-mail: hyoko@affrc.go.jp

² *Regional Centre, National Institute of Oceanography, Mumbai 400 053, India*

E-mail: soniya@nio.org

Abstract

The spionid polychaete *Paraprionospio pinnata* (Ehlers, 1901) has been widely reported from Indian waters. We examined 47 *Paraprionospio* specimens collected from the west and northwest coast of India, and identified them as *Paraprionospio cordifolia* Yokoyama, 2007, *Paraprionospio cristata* Zhou, Yokoyama and Li, 2008, and *Paraprionospio patiens* Yokoyama, 2007, which are new to the fauna of India. The present study suggests that *Paraprionospio* species inhabiting Indian waters have been misidentified as *P. pinnata* and that *P. cordifolia*, *P. cristata*, and *P. patiens* are widely distributed in the Far East and south Asia.

Keywords: Paraprionospio, Polychaeta, taxonomy, India.

Introduction

The spionid polychaete, *Paraprionospio pinnata*, which was originally described by Ehlers (1901) based on specimens collected from Chile, has been regarded as a monotypic (Foster 1971) and cosmopolitan (Light 1978; Maciolek 1985) species. This species has been reported also from the east and west coasts of India (Ajmal Khan and Murugesan, 2005). Sukumaran and Sarala Devi (2009) reported the dominance of *Paraprionospio pinnata* along with a reduction in species diversity in the port area of Mumbai, suggesting that this species can be used as an indicator of stressed conditions.

Tamai (1981) and Yokoyama and Tamai (1981) found that the Japanese specimens of *Paraprionospio pinnata* were comprised of four distinct forms of morphological variations based on a series of 11 characters. They suggested that the observed variations might be sufficient to allow the forms to be distinguished at the specific level, but they did not determine species names. Later, Yokoyama (2007) published a revision of the genus *Paraprionospio*, in which 9 valid species including 4 Japanese species, that are *P. coora* Wilson, 1990 and 3 undescribed species (*P. cordifolia*, *P. oceanensis* and *P. patiens*), were validated. Zhou *et al.* (2008) also examined Chinese specimens, which have been previously identified as *P. pinnata*, and found that they belong to the three species, *P. coora*, *P. inaequibranchia* (Caullery, 1914) and an undescribed species *P. cristata*. Yokoyama and Choi (2010) recorded *P. coora*, *P. cordifolia* and *P. patiens* from Korean waters, while Yokoyama *et al.* (2010) reported *P. coora* from the Mediterranean Sea. These studies indicate that the specimens previously reported as *P. pinnata* should be reexamined. Hence we examined some *Paraprionospio* specimens collected from Indian waters, and found that the specimens were not identified as *P. pinnata* but included 3 species, *P. cordifolia*, *P. cristata* and *P. patiens*.

Material and Methods

The specimens were collected during the monitoring studies conducted by the National Institute of Oceanography, Mumbai from the coastal waters of Veraval, Mumbai, Alibag as well as Thane creek on the northwest coast of India, at depths ranging from 2 m to 30 m between the years 2010 and 2011. All specimens were fixed with 5% formaldehyde buffered with sea water and preserved in 70 % ethanol. The specimens examined are deposited in Regional Centre, National Institute of Oceanography, Mumbai.

Taxonomic Account

Paraprionospio cordifolia Yokoyama, 2007

Fig. 1

Specimens: Four specimens collected from the open Arabian Sea, 10 km away from Veraval fishing harbour, 20°50.21'N, 70°18.48'E, silty mud, 30 m, 25 Sep 2010.

Description

All incomplete with up to 23 setigers measuring 5.8 mm long and 0.57 mm wide (setiger 5, excluding parapodia). Specimen of 0.56 mm wide bearing eggs (mean diameter \pm SD = 134.5 \pm 9.0 μ m, n = 10) in coelom. Two pairs of black, small eyes in trapezoidal arrangement. No papilla on posterior margin of peristomium. No pigment patch on peristomium. Three pairs of branchiae on setigers 1–3. First pair longest, third pair shortest (3 specimens), or 3 pairs approximately equal size (1 specimen). Branchiae all with densely packed lamellar plates attached serially on inner to posterior face of shaft except in basal region and distal tip. In proximal region of branchial shaft, lamellae consisting of two triangular plates (Fig. 1a); in middle and distal regions, two plates united completely, showing flabellate-shape (Fig. 1b-d). Notopodial postsetal lamellae lanceolate on setigers 1-2 (Fig. 1e); posterior to setiger 3, lamellae becoming rounded and reducing in size to about setiger 15 (Fig. 1f-i); thereafter elevated posteriorly, becoming triangular to lanceolate (Fig. 1j). Neuropodial postsetal lamellae of setiger 1 lanceolate (Fig. 1e), becoming rounded and reducing to low postsetal ridges posteriorly (Fig. 1f-j). A slender filament at base of third pair of branchiae. Anterior ventral margin on setiger 8 protruding as a bilobed membranous flap to form pocket-like structure (Fig. 1m). Interparapodial pouches not found. Membranous transverse series dorsal crests absent. Neuropodial hooded hooks with 3-4 pairs (variable in a specimen) of apical teeth above main fang (Fig. 1k) from setiger 9, accompanied by alternating nonlimbate slender capillaries (Fig. 1l) and one (usually) to two (occasionally) granulated sabre setae (Fig. 1i).

Fig. 1

Remarks

The Indian 4 specimens have the ventral bilobed flap on setiger 8 that is a characteristic of *Paraprionospio cordifolia* and that is not found in other *Paraprionospio* species (Yokoyama, 2007). These specimens also agree with *P. cordifolia* in having the flabellate lamellae of branchiae and

filament at the base of third branchiae and in the absence of a papilla on the posterior margin of peristomium and transverse dorsal crests, suggesting that these are identical to *P. cordifolia*. Type specimens of *P. cordifolia* collected from Japanese coastal waters have interparapodial pouches, whereas in the Indian specimens such structure was not found. This character was also found in some Japanese specimens of *P. coora*, but not observed in other *P. coora* specimens collected from the same locality (Yokoyama, 2007). It is possible that the observed variability in the Indian specimens is due to the body size and/or maturity (≤ 0.57 mm width of setiger 5 for the Indian specimens vs. ≤ 1.0 mm width for Japanese specimens). A difference in the shape of branchial lamellae in the most proximal region between Japanese *P. cordifolia* (a single plate) (Yokoyama, 2007) and the Indian specimens (2 plates) may be also due to the growth stage. Among the Indian 4 specimens, there was a variability in the relative length of branchiae. In general, branchiae are ready to fall out and to regenerate afterward. These characters (the interparapodial pouches, shape of lamellae in the most proximal region of branchiae and relative length of branchiae) are considered not to be important systematic characters.

P. cordifolia can be differentiated from *P. pinnata* by the possession of the slender filament at the base of third pair of branchiae and the ventral bilobed flap on setiger 8. *P. cordifolia* differs from *P. coora* and *P. patiens* in the absence of small papillae on the peristomium and from *P. inaequibranchia* in the absence of transverse dorsal crests. This is the first record of *P. cordifolia* from Indian waters.

Distribution

Western Japan, more southern than 36°N; Korea; East China Sea; Hong Kong; India.

Paraprionospio cristata Zhou, Yokoyama and Li, 2008

Fig. 2

Specimens

Forty two specimens collected from the following 7 localities on the west and northwest coast of India at depths ranging from 2 m to 30 m: 3 specimens, mouth of the Veraval fishing harbour (northwest coast of India), 20°53.87'N, 70°22.59'E, organically polluted silty mud, 5 m, 8 Jan 2011; 1 specimen, 10 km away from Veraval fishing harbour in the open Arabian Sea, 20°50.21'N, 70°18.48'E, silty mud, 30 m, 25 Sep 2010; 3 specimens, Thane creek (Mumbai), 19°02.62'N,

72°58.63'E, silty mud impacted by oil spill in 2010, 7 m, 18 Feb 2011; 8 specimens, Mahim Bay (semi-enclosed bay where the highly polluted Mithi river empties), 19°02.37'N, 72°49.47'E, silty sand, 2 m, 4 Jan 2011; 13 specimens, mouth of semi-enclosed Mumbai Bay (outer Mumbai Port area, impacted by oil spill in 2010), 18°51.55'N, 72°48.32'E, silty mud, 12 m, 30 Dec 2010; 12 specimens, Mumbai (confluence of Amba & Patalganga estuaries with the coastal waters), 18°50.30'N, 72°56.21'E, silty mud, 8 m, 28 Dec 2010; 2 specimens, open sea off Alibag (impacted by oil spill in 2010), 18°38.08'N, 72°50.65'E, silty mud, 7 m, 3 Jan 2011.

Description

Complete specimen, up to 67 mm long, 1.1 mm wide (excluding parapodia) with 111 setigers. Four specimens of 0.90-1.27 mm wide bearing eggs (mean diameter \pm SD = 129.0 \pm 8.4 μ m, n = 10) in coelom. Prostomium fusiform with bluntly pointed anterior end. Two pairs of black, small eyes in trapezoidal arrangement on prostomium. A pair of yellowish brown pigment patches occasionally (7 specimens) visible between two pairs of eyes. Peristomium well developed, forming conspicuous lateral wings. No papilla on posterior margin of peristomium. No pigment patch on peristomium. Three pairs of branchiae on setigers 1-3. Usually first pair longest, third pair shortest. Branchiae bearing lamellae on branchial shaft except on its base and distal tip. In proximal region of branchial shaft, lamellae consisting of completely separated 2 plates (Fig. 2a) or 1 plate having a deep notch showing bifoliate-shape (Fig. 2b), toward distal region of shaft notch gradually weakened showing lamellae boomerang-like shape (Fig. 2c,d). A slender filament at base of third pair of branchiae. Notopodial postsetal lamellae lanceolate on setigers 1-2 (Fig. 2e), becoming low and round on setiger 3 (Fig. 2f), reduced to low rounded lamellae in subsequent setigers to about setiger 15 (Fig. 2g,h); thereafter elevated posteriorly, becoming triangular to lanceolate (Fig. 2i,j). Neuropodial postsetal lamellae of setigers 1-2 small, lanceolate (Fig. 2e), becoming low and round on setigers 3-7 (Fig. 2f,g), thereafter diminishing progressively in size and reduced to small round lobes posteriorly (Fig. 2h-j). Notopodial postsetal lamellae united across dorsum, forming dorsal crests on setigers 21-25, accompanied by semi-transparent dorsal cuticle bearing circular convexities (Fig. 2k). Interparapodial pouches absent. Neuropodial hooded hooks with 3-4 pairs (variable in a specimen) of apical teeth above main fang (Fig. 2l) from setiger 9, accompanied by Fig. 2 alternating nonlimbate slender capillaries (Fig. 2m) and 1-2 sabre setae. Notopodial hooded hooks with 3 apical teeth (Fig. 2n) appearing between setigers 34 and 40. Pygidium with a long median anal cirrus and two short, lateral cirri.

Variability

Ventral upper margin on setigers 9-10 protruding anteriorly; 8 specimens forming a distinct flap and a pocket-like structure on setigers 9-10 (Fig. 2o) and 27 specimens forming this structure on setiger 10, but other specimens not showing distinct free margin. Usually ventral flaps undeveloped in small size specimens (distinct ventral flap on setiger 10 found in 9 out of 10 large-size specimens (>1.0 mm in width), but not found in 5 out of 6 small-size specimens (<0.7 mm), suggesting that this character develops as the body size increases.

Remarks

Zhou et al. (2008) described a new species, *Paraprionospio cristata*, as having ventral flap on setigers 9 and 10, which was remarkable in material of large body sizes. Present specimens agree with *P. cristata* in having the ventral flap on the same setigers, although small-size specimens did not develop this structure well. Other common characters between the present material and *P. cristata* are bifoliate-shape lamellae in branchiae, a slender filament at the base of 3rd branchia, nonlimbate capillaries in 9th neuropodia and a dorsal crest on setigers 21-25. Yokoyama (2007) redescribed *Paraprionospio inaequibranchia* based on syntypes collected from Banda Sea and Java Sea and additional specimens collected from Malaysia and India. In *P. inaequibranchia*, collected from Kakinada Bay on the east coast of India, the ventral upper margin of setigers 9-10 protrudes anteriorly to form a collar-like process incised midventrally, but not forming a true collar or flap with a free margin. Such structure was found also in the present material, however, these specimens differ from *P. inaequibranchia* in having dorsal crests on setigers 21-25 and the absence of interparapodial pouches. Indian *P. inaequibranchia* has flabellate-shape lamellae in branchiae, dorsal crests on setigers 21-29 and well developed interparapodial pouches. The variability in shapes of the ventral upper margin on setigers 9-10 in the present material should be examined further, but it seems best to refer the present specimens to *P. cristata* till such time that additional material from this area is available for comparisons. *P. cristata* can be differentiated from *P. pinnata* by the possession of the slender filament at the base of third pair of branchiae, developed dorsal crests and ventral flap on setiger 10. This is the first record of *P. cristata* from Indian waters.

Distribution

China, more southern than 34°N, East China Sea, South China Sea, Gulf of Tong King; India.

Paraprionospio patiens Yokoyama, 2007

Fig. 3

Specimen: One specimen collected from the Veraval fishing harbour (northwest coast of India), 20°54.02'N, 70°22.47'E, highly organically polluted silty mud, 5 m, 25 Sep 2010.

Description

Incomplete specimen bearing eggs (diameter: $145.5 \pm 8.8 \mu\text{m}$, $n = 10$) in coelom, 19 mm long, 0.88 mm wide (setiger 5, excluding parapodia) with 37 setigers. Prostomium fusiform with bluntly pointed anterior end extending posteriorly as a faintly raised ridge to setiger 1. Two pairs of black, small eyes in trapezoidal arrangement on prostomium. Small papilla on posterior margin of peristomial wing. No pigment patch on peristomium. Three pairs of branchiae on setigers 1-3. First pair missing. Third pair smaller than second pair, 60% in length. Branchiae bearing lamellae on branchial shaft except on its base and distal tip. All lamellae consisting of 2 plates showing bifoliate-shape; each plate in proximal region lanceolate (Fig. 3a); in middle region, plates increasing their size (Fig. 3b); in distal region, plates becoming rounded, but keeping separate each other (Fig. 3c,d). A slender filament at base of third pair of branchiae. Notopodial lamellae anteriorly lanceolate, distally pointed, longest on setiger 3 (Fig. 3e,f), becoming rounded and reducing in size posteriorly to about setiger 15 (Fig. 3g,h); succeeding lamellae elevated, becoming triangular to lanceolate gradually (Fig. 3i). Neuropodial lamellae lanceolate in setigers 1–2 (Fig. 3e); posterior to setiger 3, lamellae becoming rounded and reduced to a low postsetal ridge in middle and posterior setigers (Fig. 3f-i). Ventral flap absent (Fig. 3j). Interparapodial pouches absent. Notopodial postsetal lamellae united across dorsum, forming dorsal crests on setigers 21–35, accompanied by semi-transparent dorsal cuticle bearing circular convexities. Neuropodial hooded hooks with 3-4 pairs (variable in a specimen) of apical teeth above main fang and secondary hood (Fig. 3k,l) appearing from setiger 9 accompanied by alternating capillaries (Fig. 3m,n) and 1-2 sabre setae (Fig. 3o). Neuropodial capillaries short and limbate on setiger 9 (Fig. 3h,m), replaced by long, fine, nonlimbate capillaries from setiger 10 (Fig. 3i,n). Notopodial hooded hooks with 3 apical teeth (Fig. 3p) appearing from setiger 34.

Fig. 3

Remarks

The present specimen agree with *Paraprionospio patiens* in having the papilla on posterior margin of peristomium, bifoliate lamellae of branchiae, filament at the base of third branchiae, dorsal crests on setigers 21–35 and short and limbate capillaries on 9th neuropodia. Yokoyama (2007) described that lamellae in most proximal region of branchiae in *P. patiens* consist of a single plate, whereas the lamellae of the Indian specimen consist of two plates. The original description by Yokoyama (2007) was based on first branchiae of large-size specimens (>1.0 mm width at setiger 5). In the present examination, the description was based on second and third branchiae of a small sized specimen (0.88 mm wide) due to missing of the first branchia. Such differences may have resulted in the variability of the shape of branchial lamellae.

P. patiens differs from *P. pinnata* in having a papilla on the posterior margin of peristomium, bifoliate lamellae of branchiae, filament at the base of 3rd branchiae, dorsal crests on setigers 21-35 and short and limbate neuropodial capillaries on setiger 9. *P. patiens* is similar to *P. africana* and *P. lamellibranchia* in having the bifoliate lamellae of branchiae and filament on setiger 3, but differs from the former species in having a ridge on setiger 1 only instead of on setigers 1-3 and the latter species in the number of setigers where dorsal crests exist (setigers 21-35 in *P. patiens* vs. setigers 21-30 in *P. lamellibranchia*) and in lacking interparapodial pouches. This is the first record of *P. patiens* from Indian waters.

Distribution

Western Japan, more southern than 37°N; Korea; Indonesia; India.

Concluding Remarks

Paraprionospio pinnata Ehlers (1901) has been regarded as a monotypic (Foster 1971) and cosmopolitan (Light 1978; Maciolek 1985) species. This species has also been reported from India (Ajmal Khan and Murugesan, 2005). We examined the material from the west and northwest coast of India. None of these specimens was identified as *P. pinnata*, and they were identified as *P. cordifolia*, *P. cristata*, and *P. patiens*. Similar taxonomic confusion had been reported from Japan, China and the Mediterranean Sea. Yokoyama (2007) identified Japanese *Paraprionospio* species as *P. coora*, *P. cordifolia*, *P. oceanensis* and *P. patiens*, while Zhou et al. (2008) recorded *P. coora*, *P. inaequibranchia* and *P. cristata* from Chinese waters. On the other hand, Yokoyama et al. (2010) reported the occurrence of *P. coora* instead of *P. pinnata* from the Mediterranean Sea. Simboursa et

al. (2010) also found *P. coora* from Greek coastal waters. These studies and the present examination of Indian specimens suggested that *Paraprionospio* species inhabiting these localities have been misidentified as *P. pinnata* and that *P. cordifolia*, *P. cristata*, and *P. patiens* are widely distributed in the Far East and south Asia.

In the present examination, we did not found *P. inaequibranchia*, however, Yokoyama (2007) reported the occurrence of this species from the east coast of India. The following is an identification key to the 4 Indian and other 6 species of *Paraprionospio*.

KEY TO 10 SPECIES OF *PARAPRIONOSPIO*

- 1a. Ventral bilobed flap on setiger 8 present. Branchial lamellae flabellate. Membranous dorsal crests absent*Paraprionospio cordifolia*
- 1b. Ventral bilobed flap on setiger 8 absent2
- 2a. Filament on dorsum of setiger 33
- 2b. Filament absent8
- 3a. Branchial lamellae bearing distinct notch showing bifoliate or boomerang-like shape ··4
- 3b. Branchial lamellae not bearing distinct notch showing flabellate shape7
- 4a. Transverse ridge between branchial bases on setigers 1–3*Paraprionospio africana*
- 4b. Transverse ridge between branchial bases on setiger 15
- 5a. Neuropodial capillaries on setiger 9 long, nonlimbate. Membranous dorsal crests present on setigers 21-25. Ventral bilobed flap on setiger 10 usually present
.....*Paraprionospio cristata*
- 5b. Neuropodial capillaries on setiger 9 short, limbate6
- 6a. Membranous dorsal crest on setigers 21–30*Paraprionospio lamellibranchia*
- 6b. Membranous dorsal crest on setigers 21–35 (rarely 36)*Paraprionospio patiens*
- 7a. Processes on anterior face of first branchia absent. Membranous dorsal crests present. Pygidium with three anal cirri*Paraprionospio inaequibranchia*

- 7b. Processes on anterior face of first branchia present. Membranous dorsal crests absent. Pygidium with median anal cirrus only *Paraprionospio oceanensis*
- 8a. Membranous dorsal crest on setigers 21–28 *Paraprionospio alata*
- 8b. Membranous dorsal crest absent 9
- 9a. Small papilla on posterior margin of peristomium. Conic processes present in basal region of 1st branchia. Semi-transparent dorsal cuticle absent *Paraprionospio coora*
- 9b. Small papilla absent. Conic processes absent from basal region of 1st branchia. Semi-transparent dorsal cuticle present *Paraprionospio pinnata*

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Figure captions

Figure 1. *Paraprionospio cordifolia*. A, Second lamella from the base of right branchia (number of lamellae = 53) on setiger 1 in cross-section, seen from top; B, 10th lamella of the same branchia in cross-section, seen from top; C, 35th lamella of the same branchia in cross-section, seen from top; D, 48th lamella of the same branchia in cross-section, seen from top; E, 1st parapodium, in anterior view; F, 3rd parapodium, in anterior view; G, 5th parapodium, in anterior view; H, 7th parapodium, in anterior view; I, 9th parapodium, in anterior view; J, 20th parapodium, in anterior view; K, neuropodial hooded hook from setiger 19; L, neuropodial non-limbate capillary from setiger 20; M, setigers 6–10, in ventro-lateral view.

Figure 2. *Paraprionospio cristata*. A, Seventh lamella from the base of right branchia (number of lamellae = 78) on setiger 1 in cross-section, seen from top; B, 25th lamella of the same branchia in cross-section, seen from top; C, 41st lamella of the same branchia in cross-section, seen from top; D, 66th lamella of the same branchia in cross-section, seen from top; E, 1st parapodium, in anterior view; F, 3rd parapodium, in anterior view; G, 5th parapodium, in anterior view; H, 9th parapodium, in anterior view; I, 20th parapodium, in anterior view; J, 50th parapodium, in anterior view; K, semi-transparent dorsal cuticle from setiger 24; L, neuropodial hooded hook from setiger 9; M, neuropodial non-limbate capillary from setiger 9; N, notopodial hooded hook from setiger 48; O, setigers 8–11, in ventro-lateral view;

Figure 3. *Paraprionospio patiens*. A, Forth lamella from the base of right branchia (number of lamellae = 51) on setiger 3 in cross-section, seen from top; B, 21th lamella of the same branchia in cross-section, seen from top; C, 47th lamella of the same branchia in cross-section, seen from top; D, distal end of the same branchia, seen from the side. E, 1st parapodium, in anterior view; F, 3rd parapodium, in anterior view; G, 5th parapodium, in anterior view; H, 9th parapodium, in anterior view; I, ?th parapodium, in anterior view; J, setigers 8–11, in ventro-lateral view; K, neuropodial hooded hook from setiger 9; L, neuropodial hooded hook from setiger 10; M, neuropodial limbate capillary from setiger 9; M, neuropodial non-limbate capillary from setiger 10, N, notopodial hooded hook from setiger 37.

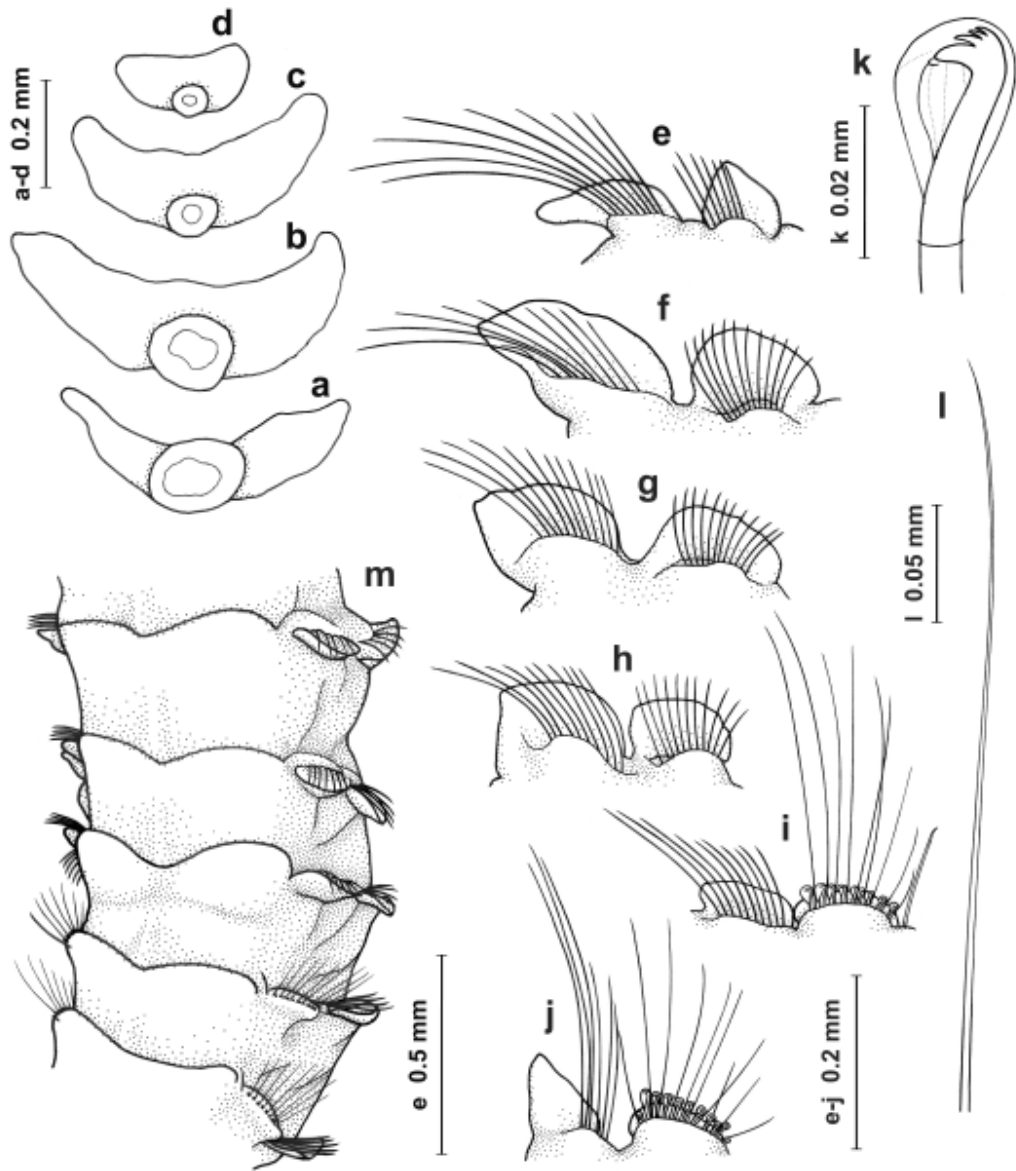


Fig1

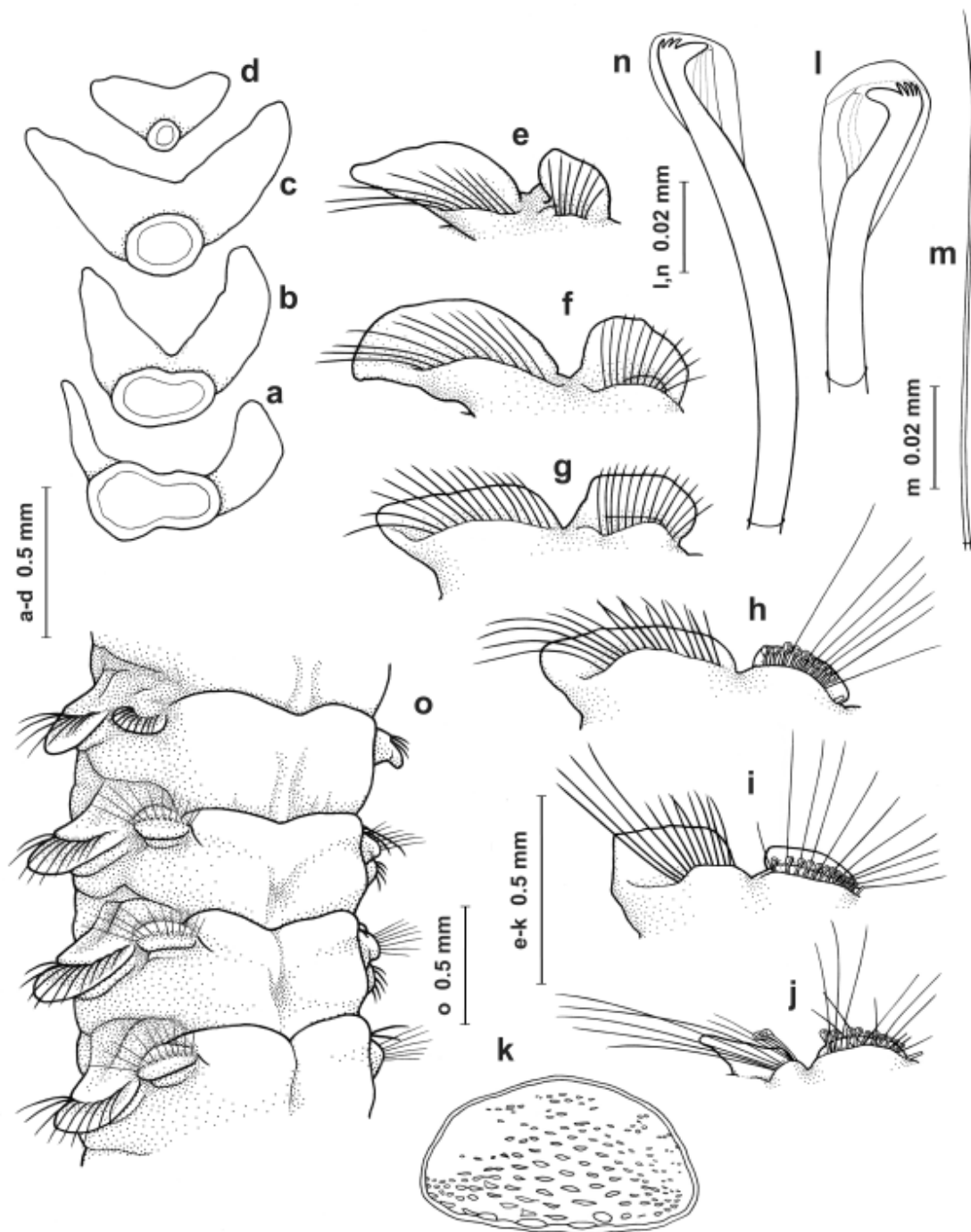


Fig 2

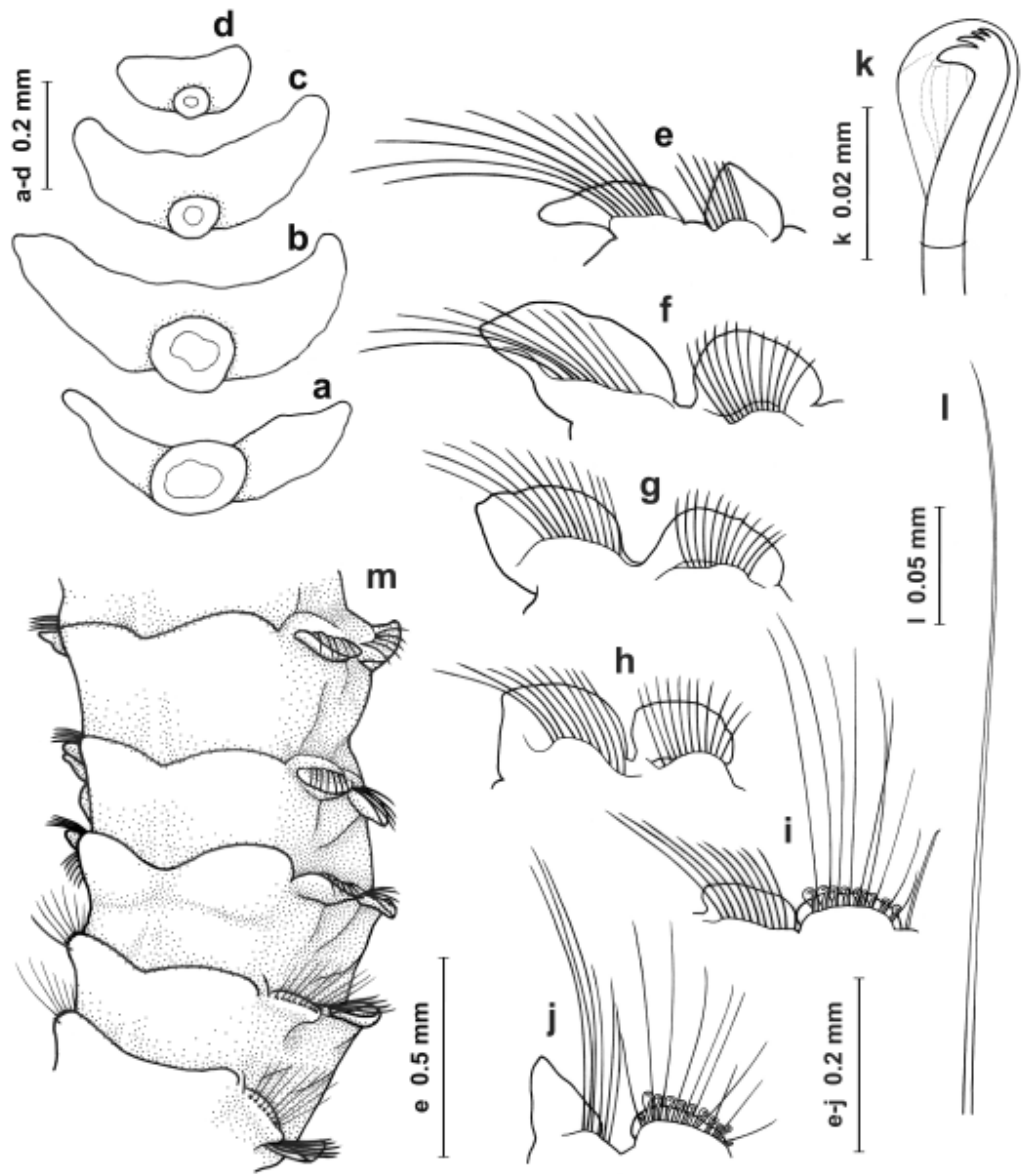


Fig 3