

Research article

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Two new species of *Perinereis* Kinberg, 1865 (Annelida: Nereididae) from the rocky shore of Maharashtra, India, including notes and an identification key to Group 1

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Abstract. Two new species of *Perinereis* with single bar-shaped paragnaths on area VI (Group 1) from the rocky shores of Mumbai, Maharashtra, India, are described with barely (Subgroup 1A) or largely (Subgroup 1B) expanded proximal region of dorsal ligule in posterior parapodia. *Perinereis malabarensis* sp. nov. can be distinguished from the morphologically similar 1B species *P. euiini* Park & Kim, 2017 by the paragnath count in area I, the laterally isolated paragnaths in area III, and the length of the dorsal cirrus and dorsal ligule. Additionally, *P. misrai* sp. nov. is more similar to 1A species *P. falsovariegata* Monro, 1933 and *P. villalobosi* Rioja, 1947, but differs by the paragnath count in areas III–V and VII–VIII, the isolated paragnaths in area III, and the number of rows in the anterior band of areas VII–VIII. The morphological characters of the current 44 species within *Perinereis* G1 are compared, and an identification key to the species belonging to this group is also provided.

Keyword. Polychaetes, West Coast of India, *Perinereis malabarensis* sp. nov., *Perinereis misrai* sp. nov., systematics.

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Introduction

The western coastal plains of India represent about one-fifth of its coastline and stretch north from Gujarat to the south to Kerala, passing through Maharashtra, Goa, and Karnataka along the Arabian and Laccadive seas. Especially the shoreline of Maharashtra, also known as the Konkan region,

encompasses various ecosystems, including mudflats, mangroves, sandy beaches, and rocky shores. The latter are mostly composed of cliffs, platforms, boulder fields, and rock pools that form microhabitats for a broad diversity of algae, lichens, sponges, molluscs, anemones, and particularly annelid polychaetes (Faruque & Ramachandran 2014).

Numerous polychaete species have been recorded so far from the Maharashtra coast (180 species and seven subspecies), with Nereididae de Blainville 1818 as the family with the greatest number of species recorded in the region (28 species; Pati *et al.* 2015). Among them, the heterogeneous and rich genus *Perinereis* Kinberg, 1865 represents about half of all the species currently recorded in India (18 species; Sivadas & Carvalho 2020; Balakrishnan & Tudu 2021; Prajapat *et al.* 2023): *Perinereis aibuhitensis* (Grube, 1878) originally described from Palau, *P. cavifrons* (Ehlers, 1920) from Indonesia, *P. cultrifera* (Grube, 1840) from the Mediterranean Sea, *P. helleri* (Grube, 1878) from the Philippines, *P. nigropunctata* (Horst, 1889) from Malaysia, *P. nuntia* (Savigny in Lamarck, 1818) from the Red Sea, *P. brevicirris* (Grube, 1866) from the St. Paul Island (French Southern and Antarctic Territories), *P. vallata* (Grube & Kröyer in Grube, 1857) from Chile, and *P. vancaurica* (Ehlers, 1868) from the Andaman and Nicobar Islands (off India).

Perinereis has a worldwide marine distribution in all continents (except Antarctica). However, they can also be found near seas in fresh and brackish waters and dwell from shallow to abyssal zones in a wide range of habitats, such as soft sediments, rocky and coral substrates, algae rhizoids, mangrove and seagrass roots, oyster reefs, and among others (Wu *et al.* 1985; Hutchings *et al.* 1991; Wilson & Glasby 1993; de León-González & Solís-Weiss 1998). The species, in the broad sense, are featured by having well-separated and mostly conical paragnaths on both rings of the proboscis, with bar-shaped paragnaths on area VI (Villalobos-Guerrero *et al.* 2021b). They all can be readily separated into three major groups for practical purposes (Hutchings *et al.* 1991), of which the *Perinereis* group 1 (G1) is of concern in the present study.

Perinereis G1 is distinguished by single bar-shaped paragnaths on area VI (Hutchings *et al.* 1991). It includes 42 valid species worldwide, 22 of them with dorsal ligules slightly or not expanded in the posterior parapodia (*Perinereis* subgroup 1A), 17 with greatly expanded dorsal ligules in the same parapodia (*Perinereis* subgroup 1B), and three species with uncertain development due to its epitoke condition (here treated as *Perinereis* subgroup 1U) (Hutchings *et al.* 1991; de León-González & Solís-Weiss 1998; Glasby *et al.* 2013; Park & Kim 2017; Bonyadi-Naeini *et al.* 2018; Conde-Vela 2022; Rezzag Mahcene *et al.* 2023; TFVG pers. obs.). Only six *Perinereis* G1 species have been reported from India (Sivadas & Carvalho 2020; Balakrishnan & Tudu 2021), those records in the coastal region of Maharashtra (Bhatt & Bal 1966; Parulekar 1972; Pati *et al.* 2015) are indicated with (*): *Perinereis cavifrons* (Ehlers, 1920)* originally described from Indonesia, *P. cultrifera* (Grube, 1840)* from the Mediterranean Sea, *P. falsovariegata* (Monro, 1933) from South Africa, *P. floridana* (Ehlers, 1868) from Florida, *P. helleri* (Grube, 1878)* from the Philippines, and *P. nigropunctata* (Horst, 1889)* from Malaysia. All these species belong to the subgroup 1A, except *P. cavifrons* (Ehlers, 1920) which fits into the subgroup 1U.

In the present study, two new species of *Perinereis* with single bar-shaped paragnaths on area VI and different development of dorsal ligules towards the posterior end are described and illustrated from the coastal region of Maharashtra, India. Some comments, an identification key, and a synoptic table of the diagnostic features of the 44 valid species within *Perinereis* G1 are also provided.

Material and methods

Study area

The study area is part of the Mumbai coast in Maharashtra, western India. Sampling sites are located near the outer margin of Back Bay, Malabar Hill region in South Mumbai (Fig. 1A). These consist principally of rocky shores, exposed to around 70–100 m during low tides. Around the initial 20 m of the intertidal area are large exposed rocks laden with a thin layer of silt and clay covered intermittently with a thin, sparse layer of seaweed (Fig. 1B). In the remaining intertidal area beyond the initial 20 m, the rocky substratum is covered with comparatively dense seaweeds (Fig. 1C). In this area, mostly shells of dead oyster are spread over the rocks (Fig. 1D). The oyster shells are sometimes partially covered with seaweed (Fig. 1E). Burrows of polychaetes can be found between the oyster shells and seaweeds (Fig. 1F). These burrows are shallow since the sediment and seaweed layers are comparatively thin.

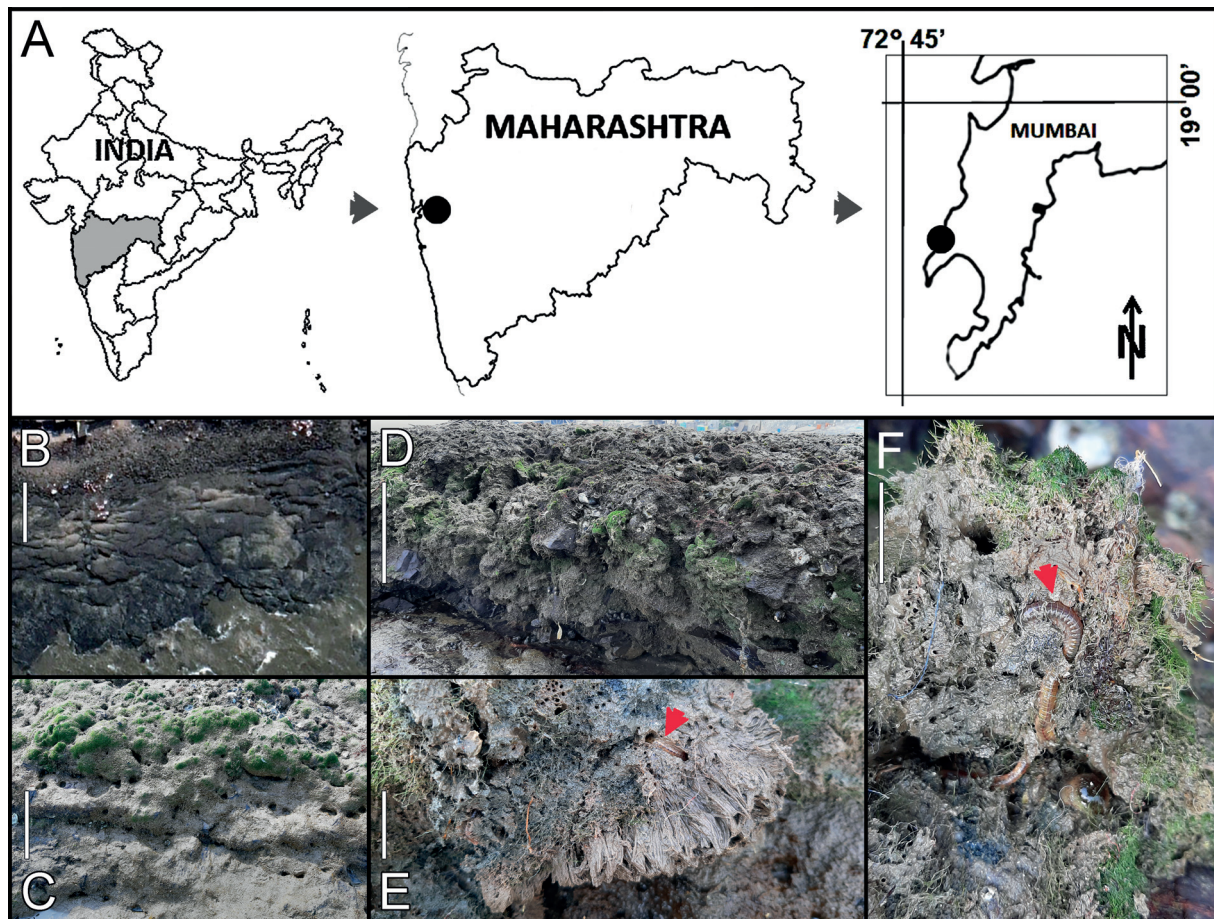


Fig. 1. Study area and surrounding intertidal habitats. **A.** Coastal region of Maharashtra (western India) and collecting localities. **B.** Aerial view of the rocky intertidal habitat of the study area. **C.** Intertidal area with rocks covered with seaweed. **D.** Close-up view of the intertidal area with rocks covered with seaweed and oyster shells. **E.** Scraped-out seabed (oyster shells, algae, and sediment), burrows of polychaetes and other small invertebrates can be seen. **F.** Close-up view of burrowing nereidid dwelling among the seabed. Red arrows point to burrowing worms. Scale bars: B = 20 m; C = 1 m; D = 50 cm; E–F = 3 cm.

Collection of specimens

Burrows of polychaetes belonging to two *Perinereis* species were found. The samples were collected from the rocky shores of Malabar Hill (18°57'21.5" N, 72°47'44.9" E) in Mumbai, Maharashtra (Fig. 1A–C). To collect specimens, layers of seabed (sediment, algae and oyster shells) were scraped off using a forceps and shovel during the low tide from different locations. Specimens were handpicked from these layers of seaweed bed (Fig. 1E–F). Only in rock crevices the burrows were comparatively deeper, and removing deeper layers of sea bedding was required. Live specimens were induced to evert the proboscis using a 1% carvacrol solution diluted in seawater for about 20 minutes. Later, they were fixed with 10% formaldehyde and preserved in 70% ethanol.

Morphological observation

For detailed morphological observations, a stereo microscope (Leica MZ16A) and compound microscope (Lynx LM-52-1601) were used. Photographs were captured using ScopePhoto ver. 3.0 linked to a digital camera (Cat Cam 130-Series) mounted on both microscopes. The figure backgrounds were cleaned and lightened as necessary, and the final figures were assembled in plates using Adobe Photoshop® CS6. Total length (TL), length from the distal end of the prostomium to chaetiger 10 (L10), and body width at chaetiger 10 (W10) were measured. Also, the total number of chaetigers in complete specimens, the number of teeth on jaws, and the paragnaths on all unpaired and paired (left and right sides of proboscis) areas were counted.

The description of the species is based on the morphology of the holotypes, whereas that of paratypes is indicated in parentheses. A section at the end of the descriptions is also included to incorporate the overall variation detected in the species based on all the types and non types. Standardized nereidid terminology for anterior end and parapodial structures (Villalobos-Guerrero & Bakken 2018; Villalobos-Guerrero *et al.* 2021a), type of paragnath of area VI (Conde-Vela 2018; Villalobos-Guerrero *et al.* 2021b), paragnaths arrangement on areas VII–VIII (Conde-Vela 2018), pattern of ridges dorsally on oral ring of proboscis (Villalobos-Guerrero 2019), and type and classification of chaetae (Bakken and Wilson 2005) were here followed.

The holotype and non-type specimens used for the present study are deposited in the Zoology Museum, Department of Zoology, The Maharaja Sayajirao University of Baroda in Vadodara (MSUB), India, while the paratypes are kept at the Zoological Survey of India (ZSI), located in Pune, India.

Results

Taxonomy

Phylum Annelida Lamarck, 1809
Class Polychaeta Grube, 1850
Order Phyllodocida Dales, 1962
Family Nereididae de Blainville, 1818
Subfamily Nereidinae de Blainville, 1818

Genus *Perinereis* Kinberg, 1865

Type species

Perinereis novaehollandiae Kinberg, 1865, by subsequent designation (fide Hartman 1949). It is currently regarded as a junior synonym of *P. amblyodonta* Schmarda, 1861 (Ehlers 1904; Hartman 1959).

Key to all species of *Perinereis* Kinberg, 1865 belonging to Group 1

Perinereis G1 has been pragmatically categorised into two groups depending on the expansion of the dorsal ligule in posterior chaetigers: subgroup 1A (slightly or not expanded) and subgroup 1B (greatly expanded). Considering the division proposal of dorsal ligules into distal and proximal regions (see Villalobos-Guerrero *et al.* 2021a), species of subgroup 1B show a distinct enlargement towards the posterior end. The distal region may also experience slight modifications, although they are much less marked than the proximal one. Hence, the species of the subgroups A and B of *Perinereis* are redefined as follows (after Hutchings *et al.* 1991): (A) the proximal region of dorsal ligule slightly or not expanded in posterior chaetigers; and (B) the proximal region of dorsal ligule greatly expanded in posterior setigers.

The key includes all species now regarded as *Perinereis* G1 sensu Hutchings *et al.* (1991). However, *P. cavifrons* (Ehlers, 1920), *P. curvata* Holly, 1935, and *P. dongalae* (Horst, 1924) are excluded for being known only for their epitokous morphology but without detailed description of the dorsal ligule in posterior parapodia.

Perinereis cavifrons, originally described from Indonesia, resembles *P. rullieri* Pilato, 1974 (subgroup 1A) by having dorsal cirri not projecting beyond the distal region of the dorsal ligule, area V with three paragnaths, neuropodial superior lobe, and by lacking notopodial prechaetal lobe and postchaetal lobes. Nevertheless, *P. cavifrons* has a shorter and more robust median ligule (1.3 × as long as neuroacicular ligule) in anterior chaetigers than in *P. rullieri* (more elongate, 2 × as long as neuroacicular ligule). Also, *P. cavifrons* has 3–4 teeth on its jaws, in contrast to 6–7 in *P. rullieri*.

Perinereis curvata described from Hawaii is similar to *Perinereis falklandica* (Ramsay, 1914) and *P. tobeloana* (Augener, 1933), both belonging to subgroup 1B, by the long dorsal cirrus and the absence of notopodial prechaetal and neuropodial superior and postchaetal lobes. However, *P. curvata* (area I: 2–3; area V: 1; areas VII–VIII: 34–36) can be distinguished from *P. falklandica* (area I: 32–150; areas VII–VIII: 110–300) by having fewer paragnaths on areas I and VII–VIII, and also from *P. tobeloana* (area V: 3; areas VII–VIII: 8) by the number of paragnaths on areas V and VII–VIII.

Perinereis dongalae from Indonesia was briefly described by Horst (1924) with a single illustration (heterogomph falciger). Several diagnostic characters were not considered, although a few included help distinguish it from all the *Perinereis* G1 species, except *P. obfuscata* (Grube, 1878) (subgroup 1A). *Perinereis dongalae* was synonymized with *P. obfuscata* by Hylleberg *et al.* (1986), although this was rejected by Hutchings *et al.* (1991) since the former authors did not examine the type material. Based on the literature, it is here found that both species share dorsal cirri barely or not projecting beyond the distal region of the dorsal ligule, area I with 7 or more paragnaths, area V with one paragnath, tentacular cirri extending to chaetiger 5, and black transverse band on each segment. Nevertheless, no remarkable differences were detected between these two species. A redescription of *P. dongalae* is needed to clarify its valid status.

1. Proximal region of dorsal ligule barely or not enlarged in posterior parapodia (Subgroup 1A) 2
 - Proximal region of dorsal ligule markedly enlarged in posterior parapodia (Subgroup 1B) 25
2. Dorsal cirri short, barely or not projecting beyond distal region of dorsal ligule in mid-body parapodia 3
 - Dorsal cirri long, projecting distinctly beyond distal region of dorsal ligule in mid-body parapodia 18
3. Neuropodial postchaetal lobe present throughout 4
 - Neuropodial postchaetal lobe absent throughout 6

4. Aciculae light yellow; dorsal cirri placed basally on dorsal ligule in posterior parapodia; area V without paragnaths; neurochaetae with homogomph falcigers ... *P. tenuisetis* (Fauvel, 1915) (Italy)
 - Aciculae dark brown or black; dorsal cirri placed medially or subdistally on dorsal ligule in posterior parapodia; area V with paragnaths; neurochaetae with heterogomph falcigers 5
5. Areas VII–VIII with anterior band having two rows of paragnaths (one on furrows and one on ridges); area III without laterally isolated paragnaths; area I with more than 10 paragnaths; subacicular neurochaetae with homogomph spinigers *P. arabica* Mohammad, 1971 (Kuwait)
 - Areas VII–VIII with anterior band having only furrow row of paragnaths; area III with laterally isolated paragnaths; area I with up to 2 paragnaths; subacicular neurochaetae with heterogomph spinigers *P. taorica* Langerhans, 1881 (Madeira)
6. Areas VII–VIII without paragnaths 7
 - Areas VII–VIII with 10 or more paragnaths 8
7. Dorsal surface of chaetigers 1 and 5–7 with well-defined brown bands; tentacular and anal cirri lacking brown stripe *P. pictilis* Glasby, Nu-Wei & Gibb, 2013 (Australia)
 - Dorsal surface from chaetiger 2 with two transverse brown bands, reducing in intensity posteriorly; tentacular and anal cirri with longitudinal brown stripe *P. suluana* (Horst, 1924) (Philippines)¹
8. Notopodial prechaetal lobe present throughout 9
 - Notopodial prechaetal lobe absent throughout 14
9. Neuropodial superior lobe absent throughout 10
 - Neuropodial superior lobe present throughout 11
10. Distal dorsal ligule bluntly conical in anterior parapodia; dorsal cirri located subdistally on dorsal ligule in posterior parapodia; jaws with 4–5 teeth; area III with up to 5–12 paragnaths, with laterally isolated cones; areas VII–VIII with small and delicate paragnaths *P. cultrifera* (Grube, 1840) (Italy)
 - Distal dorsal ligule bluntly rounded in anterior parapodia; dorsal cirri located medially on dorsal ligule in posterior parapodia; jaws with up to 3 teeth; area III with up to 5 paragnaths, without laterally isolated cones; areas VII–VIII with coarse paragnaths *P. louizomarum* Rezzag Mahcene, Villalobos-Guerrero, Kurt, Denis & Daas, 2023 (Algeria)
11. Area V without paragnaths; area III without laterally isolated paragnaths *P. calmani* (Monro, 1926) (Australia and Macclesfield Bank)
 - Area V with paragnaths; area III with laterally isolated paragnaths 12
12. Area V with 3 paragnaths (rarely 1) *P. nigropunctata* (Horst, 1889) (Malaysia)²
 - Area V with 1 paragnath (rarely 2) 13
13. Postero-dorsal tentacular cirri reaching chaetiger 8, 2 × as long as palps; most segments dorsally with 3 short brown transverse lines *P. striolata* (Grube, 1878) (Philippines)²
 - Postero-dorsal tentacular cirri reaching up to chaetiger 5, slightly as long as palps; dorsum of anterior segments with one black transverse line on each side of posterior margin *P. obfuscata* (Grube, 1878) (Philippines)¹
14. Neuropodial superior lobe absent throughout; postero-dorsal tentacular cirri reaching up to chaetiger 2; area IV with 40 or more paragnaths *P. iranica* Bonyadi-Naeini, Rastegar-Pouyani, Rastegar-Pouyani, Glasby & Rahimian, 2018 (Iran)³
 - Neuropodial superior lobe present throughout; postero-dorsal tentacular cirri reaching chaetiger 5 or higher; area IV with up to 25 paragnaths 15

15. Area V with 3 or more paragnaths (rarely 2)	16
– Area V with 1 paragnath	17
16. Tentacular belt with eye-glass-shaped pigmentation pattern; area I with 5 paragnaths; area III with 26 paragnaths; area II with 12 paragnaths	<i>P. perspicillata</i> (Grube, 1878) (Philippines) ²
– Tentacular belt without distinct pigmentation pattern; area I with up to 2 paragnaths; area III with up to 9 paragnaths; area II with 4–10 paragnaths	<i>P. rullieri</i> Pilato, 1974 (Italy)
17. Area III without laterally isolated paragnaths; postero-dorsal tentacular cirri reaching chaetiger 5; jaws with up to 4 teeth	<i>P. atlantica</i> (McIntosh, 1885) (Cape Verde Islands) ⁴
– Area III with laterally isolated paragnaths; postero-dorsal tentacular cirri reaching chaetiger 7–8; jaws with 7–8 teeth	<i>P. floridana</i> (Ehlers, 1868) (Atlantic USA)
18. Neuropodial postchaetal lobe present throughout; area V without paragnaths	<i>P. capensis</i> (Kinberg, 1865) (South Africa)
– Neuropodial postchaetal lobe absent throughout; area V with paragnaths	19
19. Areas VII–VIII with anterior band having two rows of paragnaths (one on furrows and one on ridges); area III without laterally isolated paragnaths	20
– Areas VII–VIII with anterior band having only furrow row of paragnaths; area III with laterally isolated paragnaths	23
21. Notopodial prechaetal lobe present throughout; area IV with smooth bars in addition to cones; area III with up to 8 paragnaths	<i>P. barbara</i> (Monro, 1926) (Australia) ⁶
– Notopodial prechaetal lobe absent throughout; area IV with cones only; area III with 17 or more paragnaths	22
22. Distal region of dorsal ligule bluntly conical (as long as wide) throughout; heterogomph falcigers with serrations present in about half of total blade length; area II with up to 7 paragnaths	<i>P. falsovariegata</i> Monro, 1933 (South Africa)
– Distal region of dorsal ligule bluntly triangular (as long as wide) throughout; heterogomph falcigers with serrations present in about one-sixth of total blade length; area II with 12 or more paragnaths	<i>P. villalobosi</i> Rioja, 1947 (Mexican Pacific)
23. Notopodial prechaetal lobe present throughout; neuropodial superior lobe absent throughout	<i>P. helleri</i> (Grube, 1878) (Philippines)
– Notopodial prechaetal lobe absent throughout; neuropodial superior lobe present throughout	24
24. Ridges of area VI distally separated from each other (areas VI–V–VI ridge pattern π -shaped); area V with three paragnaths (seldom 4); area IV with smooth bars in addition to cones	<i>P. misrai</i> sp. nov. (Western India)
– Ridges of area VI distally and sub-medially coalesced (areas VI–V–VI ridge pattern λ -shaped); area V with one paragnath; area IV with cones only	<i>P. websteri</i> Conde-Vela, 2022 (Bermuda) ⁶
25. Dorsal cirri short, barely or not projecting beyond distal region of dorsal ligule in mid-body parapodia	26
– Dorsal cirri long, projecting distinctly beyond distal region of dorsal ligule in mid-body parapodia	36
26. Neuropodial superior lobe absent throughout	27
– Neuropodial superior lobe present throughout	28
27. Area V with 3 paragnaths; area III with up to 17 paragnaths; area IV with up to 22 paragnaths	<i>P. malayana</i> (Horst, 1889) (Malaysia)
– Area V with 1 paragnath; area III with 24 or more paragnaths; area IV with 28 or more paragnaths	<i>P. oliveirae</i> (Horst, 1889) (Portugal)

28. Ridges of area VI distally separated from each other (areas VI–V–VI ridge pattern π -shaped) 29
– Ridges of area VI distally and sub-medially coalesced (areas VI–V–VI ridge pattern λ -shaped) . 31
29. Area V with many paragnaths; areas VII–VIII with more than 70 paragnaths, minute; area I with 2 paragnaths; area III with 30 or more paragnaths, with laterally isolated cones; area IV with smooth bars in addition to conical paragnaths
..... *P. marionii* (Audouin & Milne-Edwards, 1833) (English Channel)
– Area V with 1 paragnath; areas VII–VIII with up to 40 paragnaths, medium or large; area I with 7 or more paragnaths; area III with up to 18 paragnaths, without laterally isolated cones; area IV with conical paragnaths only 30
30. Area III with 16 or more paragnaths; dorsal ligules $2.3 \times$ as long as median ligules in posterior chaetigers; ventral ligules shorter than neuroacicular ligules in posterior chaetigers
..... *P. ponteni* Kinberg, 1865 (Brazil)
– Area III with up to 6 paragnaths; dorsal ligules $3.3 \times$ as long as median ligules in posterior chaetigers; ventral ligules as long as neuroacicular ligules in posterior chaetigers
..... *P. bairdii* (Webster, 1884) (Bermuda)⁵
31. Areas VII–VIII with anterior band having two rows of paragnaths (one on furrows and one on ridges); areas VII–VIII with up to 7 paragnaths; subacicular neurochaetae with homogomph spinigers
..... *P. bajacalifornica* de León-González & Solís-Weiss, 1998 (Mexican Pacific)⁷
– Areas VII–VIII with anterior band having only furrow row of paragnaths; areas VII–VIII with 18 or more paragnaths; subacicular neurochaetae with heterogomph spinigers 32
32. Area V without paragnaths; areas VII–VIII with up to 24 paragnaths; area IV with up to 11 paragnaths; area II with up to 6 paragnaths *P. pseudocavifrons* Fauvel, 1930 (New Caledonia)
– Area V with 1–3 paragnaths; areas VII–VIII with 32 or more paragnaths; area IV with 14 or more paragnaths; area II with 8 or more paragnaths 33
33. Notopodial prechaetal lobe present throughout 34
– Notopodial prechaetal lobe absent throughout 5
34. Area VI with shield-shaped bars; area III without laterally isolated cones; dorsal ligules thrice as long as median ligules in posterior chaetigers; dorsal cirri extending to half of distal region of dorsal ligule in mid-body parapodia *P. euiini* Park & Kim, 2017 (South Korea)⁸
– Area VI with crescent-shaped bars; area III with laterally isolated cones; dorsal ligules $2 \times$ as long as median ligules in posterior chaetigers; dorsal cirri extending to three-quarters of distal region of dorsal ligule in mid-body parapodia *P. malabarensis* sp. nov. (Western India)
35. Area VI with bar-shaped paragnaths only; area III without laterally isolated cones; area I with 15 or more paragnaths; area IV with up to 20 paragnaths
..... *P. elenacosoae* Rioja, 1947 (Mexican Pacific)
– Area VI with bar-shaped and conical paragnaths; area III with laterally isolated cones; area I with up to 4 paragnaths; area IV with 40 or more paragnaths
..... *P. longidonta* Rozbaczylo & Castilla, 1973 (Chile)
36. Areas VII–VIII with up to 8 paragnaths *P. tobeloana* (Augener, 1933) (Moluccas)⁹
– Areas VII–VIII with 30 or more paragnaths 37
37. Neuropodial superior lobe absent throughout; area I with 30 or more paragnaths; areas VII–VIII with 110–300 paragnaths *P. falklandica* (Ramsay, 1914) (Falkland Islands)
– Neuropodial superior lobe present throughout; area I with up to 7 paragnaths; areas VII–VIII with up to 70 paragnaths 38

38. Notopodial prechaetal lobe present throughout; area V with 1 paragnath; area II with 6 paragnaths *P. monterea* (Chamberlin, 1918) (California)
 – Notopodial prechaetal lobe absent throughout; area V with 3 or more paragnaths; area II with 8–28 paragnaths 39
39. Area III with laterally isolated cones 40
 – Area III without laterally isolated cones 41
40. Dorsal ligule 3 × as long as median ligules in posterior chaetigers; areas VII–VIII with up to 50 paragnaths, in two well-defined bands; areas VII–VIII with distal row of paragnaths on furrows and ridges *P. amblyodonta* (Schmarda, 1861) (Australia)
 – Dorsal ligule 5 × as long as median ligules in posterior chaetigers; areas VII–VIII with 55 or more paragnaths, in one irregular band; areas VII–VIII with distal row of paragnaths on furrows only
 *P. macropus* (Claparède, 1870) (Italy)
41. Dorsal ligule sub-rectangular, 2.5–3 × as long as median ligules in posterior chaetigers; postero-dorsal tentacular cirri extending to chaetigers 2–3; area III with up to 13 paragnaths; area I with up to 2 paragnaths; area IV with smooth bars in addition to cones
 *P. pseudocamiguina* Augener, 1922 (Chile)
 – Dorsal ligule ovoid, 2 × as long as median ligules in posterior chaetigers; postero-dorsal tentacular cirri extending to chaetiger 1; area III with 19 paragnaths; area I with 5 paragnaths; area IV with cones only *P. anderssoni* Kinberg, 1866 (Brazil)

Remarks

- ¹This species is here regarded as a subgroup 1A member based on the original description, contrary to Hutchings *et al.* (1991), who treated it as in the subgroup 1B.
- ²This species is here regarded as a subgroup 1A member based on the original description, contrary to Hutchings *et al.* (1991) which treated the condition of the dorsal notopodial lobe as unknown.
- ³Newly incorporated into subgroup 1B after Bonyadi-Naeini *et al.* (2018).
- ⁴Newly incorporated into subgroup 1B after Darbyshire (2014).
- ⁵This species is here regarded as a subgroup 1A member based on the original description and the redescription by Hutchings *et al.* (1991), who treated it in the subgroup 1B.
- ⁶Newly incorporated into subgroup 1B after Conde-Vela (2022).
- ⁷de León-González & Solís-Weiss (1998) originally included the species in subgroup 1B.
- ⁸Newly incorporated into subgroup 1B after Park & Kim (2017).
- ⁹This species is morphologically similar to *Pseudonereis* Kinberg, 1865, and should probably be transferred after reviewing the type material. Areas II, III and IV are of the *Pseudonereis* type (Augener 1933: 118), which may suggest the presence of both P-bars and comb-like rows of paragnaths, and the elongated proximal region of dorsal ligule with terminal dorsal cirri (Augener 1933: fig. 10b) suits well with those recently redescribed in *P. mancorae* (Berkeley & Berkeley, 1961) and *P. pseudonoodti* (Fauchald, 1977) (see Villalobos-Guerrero & Idris 2020).

Perinereis malabarensis sp. nov.

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Fig. 2, Table 1

Diagnosis

Species of subgroup 1B. Specimens with crescent-shaped bars on area VI; areas VI–V–VI ridge pattern π -shaped; area III with laterally isolated paragnaths; areas VII–VIII with anterior band of paragnaths consisting of two rows; distal region of dorsal ligule anteriorly bluntly conical, more elongated in middle parapodia; dorsal cirri extending anteriorly beyond distal region of dorsal ligule, subequal in following

chaetigers; falcigers with camerated shaft divided into two partitions; postero-dorsal tentacular cirri extending to chaetiger 3–5.

Etymology

The specific epithet refers to the Malabar Hill (Mumbai, India), derived from the type locality where all the specimens were collected.

Material examined

Holotype

INDIA • Mumbai, Malabar Hill; 18°57'18.0" N, 72°47'43.0" E; 29 Jan 2023; V. Prajapat and K. Vachhrajani leg.; rocky shore; MSUB-ZL-AN-PCh-04.

Paratypes

INDIA • 5 specs; same collection data as for holotype; 18°57'21.5" N, 72°47'44.9" E; ZSI-WRC ANN/26.

Additional material

INDIA • 25 specs; Mumbai, Malabar Hill; 18°57'9.4" N, 72°47'43.9" E; 11 May 2023; V. Prajapat and S. Gosavi leg.; rocky shore; MSUB-ZL-AN-PCh-05.

Description (holotype (MSUB-ZL-AN-PCh-04))

COLOURATION AND MEASUREMENTS. Atoke, complete, in good condition, 37 (28–38) mm TL, 7.8 (4.9–7) mm L10, 1.6 (1.5–2) mm W10, and 74 (67–79) chaetigers. Body colour brownish; dorsum of prostomium, palps, cirrophores of tentacular cirri, and first 12 anterior segments with dark brown pigmentation, reducing intensity towards posterior end, with dark brown line on anterior margin; dorsum of chaetigers 13–44 with dark brown, mid-central, cross-shaped pattern (Fig. 2A), remaining chaetigers replaced with triangular shape pointing posteriorly.

PROSTOMIUM. Campanulate (Fig. 2B); anterior region distally entire, sub-rectangular, slightly longer than posterior region; anterolateral gap between antenna and palpophore wide, nearly $2 \times$ as wide as basal diameter of antennae. Nuchal organs deeply embedded, slightly oblique, $1.5 \times$ as wide as posterior pair of eyes.

PALPOPHORES. Sub-conical, thick, $1.5 \times$ as long as wide, as long as $\frac{3}{4} \times$ of entire prostomium; sub-distal transverse groove distinct (Fig. 2B). Palpostyles oval, $\frac{2}{5} \times$ as wide as diameter of palpophore.

ANTENNAE. Tapered, conical, long, $1.3 \times$ as long as prostomial posterior region (Fig. 2B); antennae separated by gap as wide as basal diameter of antennae.

EYES. Paired, in trapezoid arrangement, blackish (Fig. 2B); gap between both pairs $\frac{3}{4} \times$ as wide as diameter of posterior pair. Anterior pair sub-rounded, with eye diameter slightly wider than that of antennae, with gap between eyes $4 \times$ as wide as eye diameter; lenses visible, whitish, oval, placed anterolaterally, covering about 40% of eye. Posterior pair oval, with diameter as wide as that of antennae, not covered by tentacular belt; lenses visible, whitish, rounded, placed centrally, covering about 40% of eye.

TENTACULAR BELT. Nearly $2 \times$ as long as chaetiger 1, with straight anterior margin; dorsum without transverse wrinkle.

TENTACULAR CIRRI. Smooth (Fig. 2B). Antero-dorsal cirri extending posteriorly to chaetiger 3 (2–3). Anteroventral cirri as long as palpophore, slightly thicker than and as long as posteroventral cirri.

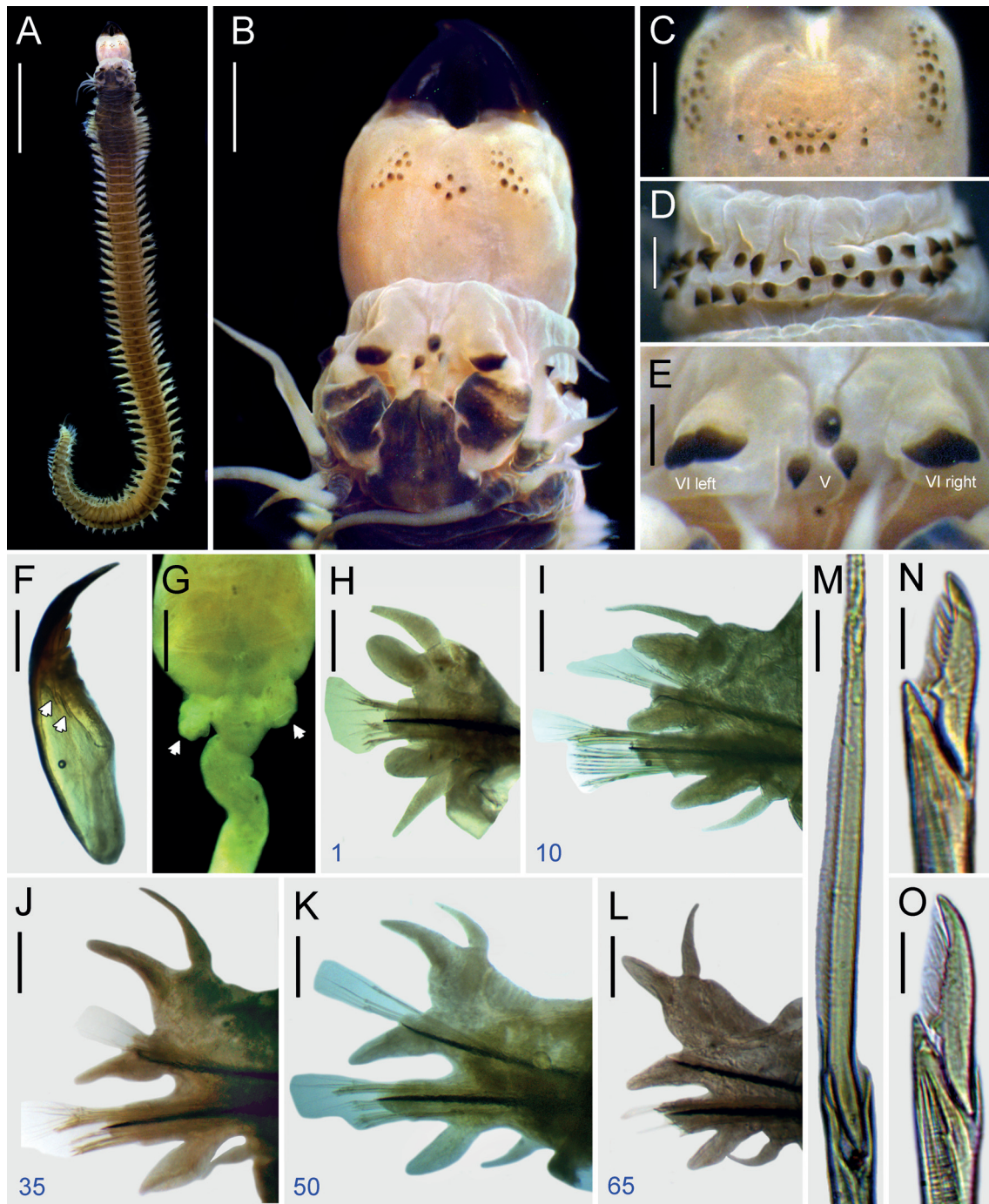


Fig. 2. *Perinereis malabarensis* sp. nov. from Mumbai, Maharashtra, India. A–E, H–O. Holotype (MSUB-ZL-AN-PCh-04), atoke. F–G. Paratype (ZSI-WRC ANN/26), atoke. A. Whole body in dorsal view. B. Anterior end and everted proboscis in dorsal view. C. Maxillary ring of proboscis in ventral view. D. Oral ring of proboscis in ventral view. E. Oral ring of proboscis in dorsal view. F. Left jaw in ventral view, arrow pointing to inner canals. G. Paired oesophageal caeca (arrows) in dorsal view. H–L. Parapodia in anterior view (except I and K, in posterior view), numbers refer to the chaetiger. M. Homogomph spiniger from notopodia (chaetiger 50). N. Heterogomph falciger from neuropodial supracicular fascicle (chaetiger 50). O. Heterogomph falciger from neuropodial subacicular fascicle (chaetiger 50). Scale bars: A = 6 mm; B = 0.7 mm; C–D, F = 0.5 mm; E = 0.4 mm; G = 0.8 mm; H = 0.22 mm; I–L = 0.23 mm; M = 12 μ m; N–O = 16 μ m.

Posterodorsal cirri longest, extending posteriorly to chaetiger 5 (3–5). Posteroventral cirri slenderest, extended over first quarter of prostomial posterior region. Dorsal cirrophores of tentacular cirri cylindrical; posterodorsal cirrophores $1.5 \times$ as long as wide, slightly longer than anterodorsal cirrophores. Ventral cirrophores ring-shaped; posteroventral cirrophores shortest and narrowest, three-quarters as wide as anteroventral cirrophores.

PROBOSCIS. Everted (Fig. 2B–E), with maxillary and oral rings cylindrical, wider than long. Jaws denticulate, dark brown amber, 6 (6–7) short, with blunt tips (Fig. 2F); inner margin of fang curved; 2 canals emerging from pulp cavity (Fig. 2F). Paragnaths brownish on maxillary ring (Fig. 2B–C), dark brown and much coarser on oral ring (Fig. 2B, D–E); consisting of uniform-base cones, except crescent-shaped bars on area VI and some p-bars on areas VII–VIII; plate-like basements absent. Area I: 5 (3–7), cones of similar size in sub-rhomboidal patch, except proximal cone sometimes slightly longer (Fig. 2B). Areas II (left): 11 (10–12), II (right): 10 (10–13), three irregular rows of uneven cones in oblique ovoid patch, inner cones thicker and longer (Fig. 2C). Area III: 16 (13–19), three slightly regular transverse rows of uneven cones in trapezoid patch, distal cones smaller, with 1–2 (0–2) distinct isolated lateral paragnaths (Fig. 2C). Areas IV (left): 22 (14–20), IV (right): 17 (16–23), three irregular rows of uneven cones in slightly crescent patch (Fig. 2C), cones of middle row larger; without merged paragnaths. Area V: 3, triangular patch of even cones, two proximal cones in transverse row and single distal cone placed slightly more distally to paragnaths on area VI (Fig. 2E). Areas VI (left): 1, VI (right): 1, transverse crescent-shaped bar (Fig. 2E). Areas VII–VIII: 38 (33–41), paragnaths in two well-separated anterior and posterior bands; anterior band consisting of two (furrow and ridge) transverse aligned rows, furrow row with one coarse p-bar and ridge row with one cone on each region; posterior band with two (furrow and ridge) transverse rows slightly displaced from each other consisting of even cones, furrow row proximal with one cone slightly displaced from each region, ridge row distal with two cones on region A and one cone in remaining regions (Fig. 2D). Ridges of areas VI–V–VI with π -shaped pattern (Fig. 2B, E). Gap between area VI and areas VII–VIII broad, as wide as three-quarters of palpopore width. Paired oesophageal caeca present (Fig. 2G).

NOTOPODIA. Consisting of dorsal cirrus, dorsal ligule (distal and proximal regions), prechaetal lobe, and median ligule in biramous parapodia.

DORSAL CIRRI. Cirriform (Fig. 2H–L), longer than proximal region of dorsal ligule and extending beyond distal region of dorsal ligule in anterior chaetigers (Fig. 2H–I), nearly as long as distal and proximal region of dorsal ligule in following chaetigers (Fig. 2J–L); attached to one-third of dorsal ligule in anterior chaetigers, medially in following chaetigers.

DORSAL LIGULES. Distal region as long as proximal region in anterior and middle chaetigers (Fig. 2H–J), distal becoming slightly longer than proximal in following chaetigers (Fig. 2K–L). Proximal region compressed in anterior and middle chaetigers (Fig. 2I–J), distended and sub-oval in posterior chaetigers (Fig. 2K), enlarged and sub-rectangular in posteriormost chaetigers (Fig. 2L); one prominent ovoid patch of dark brown glands in anterior and middle chaetigers, two main patches in following chaetigers, covering $\frac{2}{3}$ of ligule area. Distal region subequal in length throughout (Figs 2I, K), except longer in middle chaetigers (Fig. 2J); digitiform in anteriormost and posteriormost chaetigers (Fig. 2H, L), bluntly conical in anterior chaetigers, narrowly fusiform in middle chaetigers (Fig. 2J), subulate in posterior chaetigers (Fig. 2K); slightly shorter than median ligule throughout, except slightly longer in posteriormost chaetigers; projecting beyond notoacacula throughout; one basal oval patch of dark brown gland in anterior chaetigers, one elongate mid-lower patch in following chaetigers, covering half of ligule area (Fig. 2J–K).

NOTOPODIAL PRECHAETAL LOBES. Present in anterior chaetigers (Fig. 2I), digitiform, $\frac{1}{2} \times$ as long as median ligule, reduced to notoacicular process in middle and posterior chaetigers (Figs 2J–K), absent in posteriormost chaetigers (Fig. 2L).

MEDIAN LIGULES. Well developed throughout, short and digitiform in anterior chaetigers (Fig. 2I), becoming longer, narrower and bluntly conical in following chaetigers (Fig. 2J–L).

NEUROPODIA. Consisting of neuroacicular ligule with superior and inferior lobes, ventral ligule, and ventral cirrus; postchaetal lobe reduced throughout (Fig. 2H–L).

NEUROACICULAR LIGULES. Sub-rectangular throughout, truncate in anterior and middle chaetigers, becoming acute in following chaetigers; subequal to ventral ligule in anteriormost chaetigers (Fig. 2H), longer than ligule in following chaetigers, more distinct in anterior ones (Fig. 2I); neuroacicular ligule as wide as ventral ligule in anterior chaetigers, slightly wider than ligule in following chaetigers.

SUPERIOR LOBES. Rounded (Fig. 2H), subequal to inferior lobe throughout.

INFERIOR LOBES. Rounded (Fig. 2H), slightly shorter than neuroacicular ligule throughout, becoming narrower in posterior chaetigers.

VENTRAL LIGULES. Well developed throughout, distinctly shorter than median ligule in all chaetigers (Fig. 2I–L); digitiform and thick in anteriormost chaetigers, becoming narrower in following chaetigers.

VENTRAL CIRRI. Cirriform in anteriormost, anterior and middle chaetigers (Fig. 2H–J), conical and slender in following chaetigers; slightly longer than ventral ligule in anteriormost chaetigers, three-quarters as long as ventral ligule in anterior chaetigers, one-quarter to one-third as long as ligule in following chaetigers.

ACICULAE. Mostly dark brown to black throughout. Notoaciculæ absent in first 2 chaetigers (Fig. 2H). Notoaciculæ distinctly shorter than neuroaciculæ in most chaetigers (Fig. 2I–K), except as long as neuroaciculæ in posteriormost chaetigers (Fig. 2L). Neuroaciculæ as long as median ligule in anteriormost and anterior chaetigers, shorter than median ligule in following chaetigers, two-thirds as long as ligule.

NOTOCHAETAE. All homogomph spinigers throughout; 8–10 spinigers present in anterior chaetigers, 5–6 in middle chaetigers, and 3–4 in posterior chaetigers.

UPPER NEUROCHAETAE. Consisting of homogomph spinigers and heterogomph falcigers throughout; 6–7 spinigers present in anteriormost, anterior and middle chaetigers, 4–5 spinigers in following chaetigers; 2–3 falcigers present in anteriormost and anterior chaetigers, 1–2 falcigers in following chaetigers.

LOWER NEUROCHAETAE. Consisting of heterogomph spinigers and heterogomph falcigers throughout; 1–2 spinigers present in anteriormost chaetigers, 3–4 spinigers in anterior chaetigers, 1–2 spinigers in following chaetigers; 8–10 falcigers present in anteriormost and anterior chaetigers, 6–8 falcigers in middle chaetigers, and 5–6 falcigers in following chaetigers.

BLADES OF CHAETAE. Both homogomph (Fig. 2M) and heterogomph spinigers long, finely serrated, with teeth evenly spaced. Heterogomph falcigers tapering with pointed tip and even teeth; slender and of medium length, straight, entirely serrated (Fig. 2N–O). Shaft of falcigers camerated, with cavity divided sub-distally into two distinct longitudinal partitions.

PYGIDIUM. With short anal cirri, as long as last 3–4 chaetigers.

Variation

Total body length: 31–86 mm. Length to chaetiger 10: 7–11 mm. Body width at chaetiger 10: 1–2.7 mm. Number of total chaetigers: 67–141. Longest tentacular cirri extending to chaetiger 3–6. Jaws with 6–7 teeth. Number and pattern of paragnaths: area I: 3–7 (mean 4–5); area II: 9–18 (mean 11–12); area III: 12–20 in central patch (mean 15–16), 1–2 cones isolated laterally (rarely one side without cones); area IV: 13–27 (mean 19–20); area V: 3 (rarely 2); area VII–VIII: 34–41 (mean 37–38). Total number of paragnaths: 104–141 (mean 123). Anal cirri as long as last 3–4 chaetigers.

Remarks

Perinereis malabarensis sp. nov. is the first species of the subgroup 1B originally described from the Western Indo-Pacific realm (sensu Spalding *et al.* 2007). Among all the 1B members of *Perinereis*, *P. malabarensis* resembles *P. euiini* Park & Kim, 2017 by having dorsal cirri barely or not projecting beyond the distal region of dorsal ligule in mid-body parapodia, notopodial prechaetal and neuropodial superior lobes, and areas VI–V–VI ridge pattern π -shaped. However, *P. malabarensis* is distinguished from *P. euiini* by the paragnath count in area I, the laterally isolated groups of paragnaths in area III, and the length of the dorsal cirrus and dorsal ligule. In *P. malabarensis*, the area I has 3–7 paragnaths, contrary to 1–3 in *P. euiini*. In *P. malabarensis*, the area III has laterally isolated paragnaths, in contrast to their absence in *P. euiini*. In *P. malabarensis*, the dorsal cirrus is slightly longer or as long as the distal region of dorsal ligule throughout, contrary to slightly shorter than that in all chaetigers of *P. euiini*. In *P. malabarensis*, the dorsal ligule is $2 \times$ as long as the median ligule in posterior chaetigers, contrary to $3 \times$ longer than that in *P. euiini*.

Habitat

Worms are found burrowing in the sea bed, formed by oysters, dead shells, algae, and sand clumping on the rocks. This soft sponge-like sea bed provides a habitat for many small invertebrates like crabs, amphipods, isopods, sea anemones, sipunculids, and polychaetes.

Distribution

Species is known only from the type locality.

Perinereis misrai sp. nov.

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Fig. 3, Table 1

Diagnosis

Species of subgroup 1A. Specimens with crescent-shaped bars on area VI; areas VI–V–VI ridge pattern π -shaped; area III with laterally isolated paragnaths; areas VII–VIII with anterior band of paragnaths consisting of one row; distal region of dorsal ligule anteriorly bluntly conical, becoming posteriorly slightly shorter; dorsal cirri longer than distal region of dorsal ligule on all chaetigers; falcigers with camerated shaft divided into two partitions; postero-dorsal tentacular cirri extending to chaetiger 6–11.

Etymology

The new species is named to honour Dr Amalek Misra, a renowned Indian researcher from the Zoological Survey of India (ZSI), who contributed extensively to the taxonomy and ecology of annelids from India, particularly nereidids. The specific epithet is a noun in the genitive case (ICZN 1999, Art. 31.1.2).

Type material

Holotype

INDIA • Mumbai, Malabar Hill; 18°57'18.0" N, 72°47'43.0" E; 11 May 2023; V. Prajapat and K. Vachhrajani leg.; rocky shore; MSUB-ZL-AN-PCh-06.

Paratypes

INDIA • 5 specs; same collection data as for holotype; 18°57'21.5" N, 72°47'44.9" E; ZSI-WRC ANN/27.

Description (holotype (MSUB-ZL-AN-PCh-06))

COLOURATION AND MEASUREMENTS. Atoke, complete, in good condition, 57 (42–79) mm TL, 7 (3.9–7.2) mm L10, 1.5 (1.5–2.2) mm W10, and 122 (85–128) chaetigers. Body color brownish (Fig. 3A–B); dorsum of prostomium, anterior surface of cirrophores of tentacular cirri, and first four anterior segments with brown pigmentation, reducing intensity in next few segments.

PROSTOMIUM. Campanulate (Fig. 3B); anterior region distally entire, sub-quadrangular, slightly longer than posterior region; anterolateral gap between antenna and palpophore wide, $1.3 \times$ as wide as basal diameter of antennae. Nuchal organs deeply embedded, slightly oblique, $1.5 \times$ as wide as posterior pair of eyes.

PALPOPHORES. Sub-conical, thick, $1.3 \times$ as long as wide, as long as entire prostomium; sub-distal transverse groove distinct (Fig. 3B). Palpostyles oval, one-third as wide as diameter of palpophore.

ANTENNAE. Tapered, conical, long as long as anterior region of prostomium (Fig. 3B); antennae nearly joined, gap one-third as wide as basal diameter of antennae.

EYES. Paired, in sub-rectangular arrangement, blackish (Fig. 3B); gap between both pairs three-quarters as wide as diameter of posterior pair. Anterior pair oval, with eye diameter slightly wider than that of antennae, with gap between eyes $4 \times$ as wide as eye diameter; lenses visible, whitish, oval, placed anterolaterally, covering about 40% of eye. Posterior pair oval, with diameter as wide as that of antennae, not covered by tentacular belt; lenses visible, whitish, oval, placed centrally, covering about 40% of eye.

TENTACULAR BELT. Nearly as long as chaetiger 1, with straight anterior margin; dorsum without transverse wrinkle.

TENTACULAR CIRRI. Smooth (Fig. 3B). Antero-dorsal cirri extending posteriorly to chaetiger 4 (3–4). Anteroventral cirri slightly longer than palpophore, as wide and long as posteroventral cirri. Posterodorsal cirri longest, extending posteriorly to chaetiger 6 (5–11). Posteroventral cirri extending over half of prostomial posterior region. Dorsal cirrophores of tentacular cirri cylindrical; posterodorsal cirrophores $1.5 \times$ as long as wide, slightly longer than anterodorsal cirrophores. Ventral cirrophores ring-shaped; posteroventral cirrophores shortest and narrowest, three-quarters as wide as anteroventral cirrophores.

PROBOSCIS. Everted (Fig. 3B–C), with maxillary and oral rings cylindrical, wider than long. Jaws denticulate, dark brown amber, 8 (7–8) short, with blunt tips (Fig. 3D); inner margin of fang curved; 2 canals emerging from pulp cavity (Fig. 3D). Paragnaths dark brown on both maxillary and oral rings (Fig. 3B–C); consisting of uniform-base cones, except crescent-shaped bars on area VI; plate-like basements absent. Area I: 1 (1–2), sole cone or sometimes two in longitudinal line (Fig. 3B). Areas II (left): 6 (4–7), II (right): 8 (4–7), two or three irregular rows of uneven cones in small triangular patch, inner cones thicker and longer (Fig. 3B). Area III: 10 (10–11), two (or three) slightly regular transverse rows of uneven cones in rectangular patch, distal cones smaller, with 2 (1–2) isolated lateral paragnaths, distal one much smaller (Fig. 3C). Areas IV (left): 10 (9–10), IV (right): 10 (9–11), two (or three)

irregular rows of uneven cones in slightly crescent patch (Fig. 3C). Area V: 3 (3–4), triangular patch of even cones, two proximal cones in transverse row and single distal cone (sometimes almost linear patch) (Fig. 3B). Areas VI (left): 1, VI (right): 1, transverse crescent-shaped bar (Fig. 3B). Areas VII–VIII: 26 (22–26), paragnaths in two well-separated anterior and posterior bands of even cones; anterior band consisting of one (furrow) transverse row, one single cone on each furrow; posterior band with two (furrow and ridge) transverse rows slightly displaced from each other, furrow row proximal with one cone on each region, ridge row distal with one or two cones on regions A and B, and one cone in remaining regions (Fig. 3C). Ridges of areas VI–V–VI with π -shaped pattern. Gap between area VI and areas VII–VIII broad, as wide as palpophore width. Paired oesophageal caeca present (Fig. 3E).

NOTOPODIA. Consisting of dorsal cirrus, dorsal ligule (distal and proximal regions), and median ligule in biramous parapodia; notopodial prechaetal lobe absent.

DORSAL CIRRI. Cirriform, longer than proximal region of dorsal ligule and extending beyond distal region of dorsal ligule in all chaetigers (Fig. 3F–H); $1.5 \times$ as long as distal region of dorsal ligule throughout, except $2\text{--}2.5 \times$ longer in posteriormost chaetigers (Fig. 3J); attached to one-third of dorsal ligule in anterior chaetigers (Fig. 3G), medially in middle chaetigers (Fig. 3H), two-thirds in posterior chaetigers (Fig. 3I), three-quarters in posteriormost chaetigers (Fig. 3J).

DORSAL LIGULES. Distal region longer than proximal region in anterior chaetigers (Fig. 3F–G), becoming shorter than proximal one towards posterior end, $\frac{2}{5}$ as long as proximal region in posteriormost chaetigers (Fig. 3J). Proximal region compressed in anterior and middle chaetigers (Fig. 3G–H), distended and sub-oval in following chaetigers (Fig. 3I–J); one prominent ovoid and one irregular patch of dark brown glands in all chaetigers, covering $\frac{3}{4}$ of ligule area (Fig. 3G, I–J). Distal region becoming shorter towards posterior end (Fig. 3F–H); bluntly conical in anteriormost and anterior chaetigers (Fig. 3G), narrowly fusiform in middle chaetigers (Fig. 3H), conical in following chaetigers (Fig. 3I–J); subequal to median ligule in most chaetigers, slightly longer in posteriormost chaetigers.

MEDIAN LIGULES. Well developed and long throughout body, bluntly conical in anterior and middle chaetigers (Fig. 3G–H), becoming slightly narrower and acuminate in following chaetigers (Fig. 3I–J).

NEUROPODIA. Consisting of neuroacicular ligule with superior and inferior lobes, ventral ligule, and ventral cirrus; postchaetal lobe reduced throughout (Fig. 3F–J).

NEUROACICULAR LIGULES. Sub-rectangular throughout, truncate in anterior and middle chaetigers, becoming sub-rounded in following chaetigers; shorter than ventral ligule in most chaetigers (Fig. 3G–I), subequal to ligule in posteriormost chaetigers (Fig. 3J); neuroacicular ligule $1.5\text{--}1.8 \times$ as wide as ventral ligule in all chaetigers.

SUPERIOR LOBES. Rounded (Fig. 3F–G), slightly longer than inferior lobe in anteriormost chaetigers, shorter in following chaetigers.

INFERIOR LOBES. Rounded (Fig. 3F–I), slightly longer than neuroacicular ligule in anteriormost and anterior chaetigers, subequal in following chaetigers.

VENTRAL LIGULES. Well developed throughout, distinctly shorter than median ligule in all chaetigers (Fig. 3G–J); digitiform and thick in anteriormost chaetigers, bluntly conical in anterior chaetigers, becoming narrowly fusiform in following chaetigers.

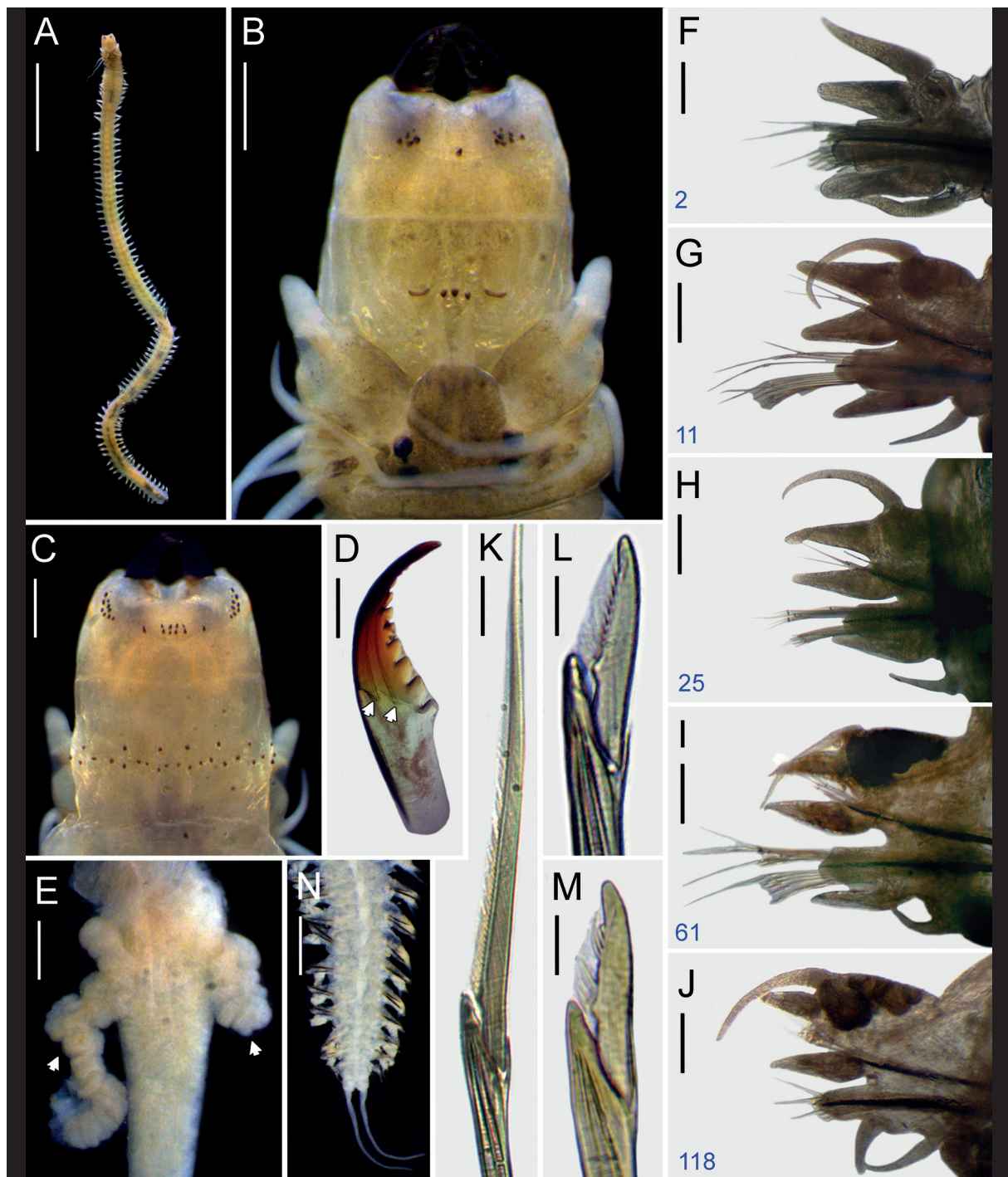


Fig. 3. *Perinereis misrai* sp. nov. from Mumbai, Maharashtra, India. **A–C, F–N.** Holotype (MSUB-ZL-AN-PCh-06), atoke. **D–E.** Paratype (ZSI-WRC ANN/27), atoke. **A.** Whole body in dorsal view. **B.** Anterior end and everted proboscis in dorsal view. **C.** Everted proboscis in ventral view. **D.** Left jaw in ventral view, arrows pointing to inner canals. **E.** Paired oesophageal caeca (arrows) in dorsal view. **F–J.** Parapodia in anterior view; numbers refer to the chaetiger. **K.** Heterogomph spiniger from neuropodial subacicular fascicle (chaetiger 25). **L.** Heterogomph falciger from neuropodial subacicular fascicle (chaetiger 61). **M.** Heterogomph falciger from neuropodial supracicular fascicle (chaetiger 61). Scale bars: A = 9 mm; B = 0.45 mm; C–D, N = 0.5 mm; E = 0.35 mm; F, J = 0.15 mm; G–I = 0.22 mm; K = 18 µm; L–M = 10 µm.

VENTRAL CIRRI. Long and slender throughout; subequal to ventral ligule in anteriormost chaetigers (Fig. 3F), $\frac{2}{3}$ as long as ligule in anterior chaetigers (Fig. 3G), half as long as ligule in following chaetigers (Fig. 3H–J).

ACICULAE. Mostly dark brown to black throughout. Notoaciculae absent in first 2 chaetigers (Fig. 3F). Notoaciculae distinctly shorter than neuroaciculae throughout (Fig. 3G–J). Neuroaciculae nearly as long as median ligule in anteriormost chaetigers, distinctly shorter in following chaetigers, $\frac{2}{3}$ as long as ligule in anterior chaetigers, $\frac{1}{2}$ as long as ligule in following chaetigers.

NOTOCHAETAE. All homogomph spinigers throughout; 8–10 spinigers present in anterior chaetigers, 5–7 in middle chaetigers, and 3–4 in posterior chaetigers.

UPPER NEUROCHAETAE. Consisting of homogomph spinigers and heterogomph falcigers throughout; 3–4 spinigers present in anteriormost, anterior and middle chaetigers, 4–5 spinigers in following chaetigers; 3–4 falcigers present in anteriormost and anterior chaetigers, 5–7 falcigers in following chaetigers.

LOWER NEUROCHAETAE. Consisting of heterogomph spinigers and heterogomph falcigers throughout; 1–2 spinigers present in anteriormost chaetigers, 3–4 spinigers in anterior chaetigers, 1–2 spinigers in following chaetigers; 5–7 falcigers present in all chaetigers.

BLADES OF CHAETAE. Both homogomph and heterogomph spinigers (Fig. 3K) long, finely serrated, with teeth evenly spaced. Heterogomph falcigers tapering with pointed tip and even teeth; slender and medium length, straight, entirely serrated (Fig. 3L–M). Shaft of falcigers camerated, with cavity divided sub-distally into three distinct longitudinal partitions (Fig. 3M).

PYGIDIUM. With long anal cirri, as long as last 6–7 chaetigers.

Variation

Total body length: 42–79 mm. Length to chaetiger 10: 3.9–7.2 mm. Body width at chaetiger 10: 1.2–2.3 mm. Number of total chaetigers: 85–128. Longest tentacular cirri extending to chaetiger 5–11 (mean 8–9). Jaws with 6–8 (mean 7) teeth. Number and pattern of paragnaths: area I: 1–2 (mean 1–2); area II: 4–8 (mean 5–6); area III: 10–11 (mean 10) in central patch, 1–2 cones isolated laterally; area IV: 8–11 (mean 9–10); area V: 3 (rarely 4); area VII–VIII: 22–26 (mean 23–25). Anal cirri as long as last 5–8 chaetigers.

Remarks

Among all the 1A members of *Perinereis*, *P. misrai* sp. nov. resembles *P. falsovariegata* Monro, 1933 from South Africa and *P. villalobosi* Rioja, 1947 from the Mexican Pacific by having dorsal cirri distinctly projecting beyond the distal region of dorsal ligule in mid-body parapodia, neuropodial superior lobes, areas VI–V–VI ridge pattern π -shaped, and by lacking notopodial prechaetal lobes. However, *P. misrai* is distinguished from *P. falsovariegata* and *P. villalobosi* by the paragnath count in areas III, IV, V and VII–VIII, the laterally isolated groups of paragnaths in area III, and the number of rows in the anterior band of areas VII–VIII. *Perinereis misrai* has fewer paragnaths on areas III (10–11), IV (9–11) and VII–VIII (21–26) than *P. falsovariegata* (III: 20–24, IV: 23–27, VII–VIII: approx. 30) and *P. villalobosi* (III: 17–57, IV: 15–54, VII–VIII: 41–45). In *P. misrai*, area V has three paragnaths, contrary to one (rarely two) in *P. falsovariegata* and *P. villalobosi*. In *P. misrai*, area III has laterally isolated paragnaths, in contrast to their absence in *P. falsovariegata* and *P. villalobosi*. Finally, in *P. misrai*, the areas VII–VIII has an anterior band with only a furrow row of paragnaths, contrary to two rows (one on furrows and one on ridges) in *P. falsovariegata* and *P. villalobosi*.

Perinereis misrai sp. nov. is the first species of the subgroup 1A originally described from the West and South Indian Shelf province and the third described from the Western Indo-Pacific realm (sensu Spalding *et al.* 2007), just after *P. arabica* Mohammad, 1971 and *P. iranica* Bonyadi-Naeini *et al.*, 2018, both from the Persian Gulf. *Perinereis misrai* can be distinguished from these two species with biogeographic affinities by the size of dorsal and tentacular cirri, the number of paragnaths in several areas, and the occurrence of isolated groups of paragnaths in area III. In *P. misrai*, the dorsal cirri are $2\text{--}2.5 \times$ as long as the distal region of dorsal ligule in posterior chaetigers, contrary to up to $1.5 \times$ longer in *P. arabica* and *P. iranica*. In *P. misrai*, the tentacular cirri are longer (extending to chaetigers 6–11) than those of the two species (extending to chaetiger 5 in *P. arabica* and chaetiger 2 in *P. iranica*). In *P. misrai*, the areas of the maxillary ring have fewer paragnaths (area I: 1–2, area II: 4–7, area III: 10–11, area IV: 9–11) than in *P. arabica* (area I: 16, area II: 18–20, area III: 16, area IV: 23) and *P. iranica* (area I: 4–6, area II: 12–16, area III: 30–45, area IV: 40–47). Finally, *P. misrai* has area III with laterally isolated paragnaths, in contrast to their absence in *P. arabica* and *P. iranica*.

Habitat

Specimens of this new species were found in the same habitat as the previous species (see above).

Discussion

Perinereis diagnostic features and G1 species

A compilation of species and significant evaluation of many diagnostic characters have already been assessed for the three species groupings of *Perinereis*: G1 (Hutchings *et al.* 1991; Rezzag Mahcene *et al.* 2023; this study), G2 (Hutchings *et al.* 1991; Villalobos-Guerrero *et al.* 2021b; Prajapat *et al.* 2023), and G3 (Hutchings *et al.* 1991; Wilson & Glasby 1993; Glasby & Hsieh 2006; Villalobos-Guerrero 2019). These morphological assessments can eventually facilitate a comprehensive revision of the genus, which is still pending.

Species of *Perinereis* have been historically distinguished mainly by the number of paragnaths in areas I, V and VI, the development of the proximal region of the dorsal ligule in the posterior parapodia, and the size of the dorsal cirri (Kinberg, 1865; Grube, 1878; Horst, 1889). As the studies on the genus became broader by including more species, further diagnostic features were involved, including atokous and reproductive features, such as the length of the tentacular cirri, the number and arrangement of paragnaths of the remaining proboscis' areas, the presence of heterogomph spinigers, and the epitokous body regionalization (Fauvel 1923, 1953; Hartman 1954; Day 1967).

More recently, novel characters were detected after a detailed examination of species groupings sensu Hutchings *et al.* (1991) and aided in the distinction of species, particularly species complexes. These relevant features are the areas VI–V–VI ridge patterns, the gaps between antennae and between areas VI and VII–VIII, the number and arrangement of bands of paragnaths in areas VII–VIII, the occurrence of bars on area IV, isolated lateral groups on area III, p-bars on areas VII–VIII, homogomph spinigers in subacicular neurochaetae, parapodial lobes, the form of proximal teeth in homogomph spinigers, the number of canals in the jaws, the sizes of the neuroacicular ligule and the nuchal organs, and among others (Hutchings *et al.* 1991; Wilson & Glasby 1993; Villalobos-Guerrero 2019; Villalobos-Guerrero *et al.* 2021b; Prajapat *et al.* 2023).

In this study, all these features were also useful in distinguishing among *Perinereis* G1 species – the most speciose group of the genus (44 species) – particularly those characters in Table 1. Most species' comprehensive morphology is based on the literature, chiefly original descriptions, redescrptions or characterizations using near-type-locality material. In several cases, the comprehensive morphology is still unknown, requiring examination of the type material, if available.

Hutchings *et al.* (1991) formerly included *P. barbara* (Monro, 1926), *P. nigropunctata* (Horst, 1889), *P. obfuscata* (Grube, 1878), and *P. suluana* (Horst, 1924) into the subgroup 1B, whereas *P. striolata* (Grube, 1878) and *P. perspicillata* (Grube, 1878) in the group 1 with uncertain subgroup due to the apparently unknown condition of the dorsal ligule. However, they all are relocated here into subgroup 1A, considering the barely expanded proximal region of the dorsal ligule in the posterior chaetigers based on the original descriptions or redescrptions. An additional subgroup is used to include those species for which the shape and size of the proximal region of the dorsal ligule in the posterior chaetigers are unknown. In the present study, three species, *P. cavifrons* (Ehlers, 1920), *P. curvata* Holly, 1935, and *P. dongalae* (Horst, 1924), are included in subgroup 1U because the description is based on the epitokous stage and lacks detailed information about the dorsal ligule in posterior parapodia. *Perinereis dongalae* was considered in subgroup 1A by Hutchings *et al.* (1991).

Current species of *Perinereis* in Indian waters

A total of 103 species of *Perinereis* are known worldwide, including the present study. The number of valid species of *Perinereis* reported from India rose to 20, of which eight belong to *Perinereis* G1. *Perinereis malabarensis* sp. nov. and *P. misrai* sp. nov. are the third and fourth species in the genus originally described from India, just after *P. vancaurica* (Ehlers, 1868) from the Andaman and Nicobar Islands, and *P. khambhatiensis* Prajapat *et al.*, 2023 from Gujarat.

In Maharashtra coasts, Bhatt & Bal (1966), Parulekar (1972), and Pati *et al.* (2015) reported 180 species and seven subspecies of polychaetes. Two varieties of species, *P. vancaurica* var. *indica* and *P. nuntia* var. *bombayensis* (Bhatt & Bal 1966) were recently considered invalid after being published in 1960 (Prajapat *et al.* 2023). Over time, due to the changes in coastal areas and high anthropogenic activities, there is a question mark on the existence of species previously recorded from different localities of the coastal region of Maharashtra. However, taxonomic studies on polychaetes are required, specifically collecting of fresh specimens and redescription of type material.

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Table 1 (continued on next page). Comparison of features of all valid species of *Perinereis* Kinberg, 1865 currently regarded in Group 1. Subgroups (SG) are based on Hutchings *et al.* (1991), with some modifications or updates (1A and 1B), including those with unknown dorsal ligule conditions in posterior parapodia (1U). Species information is taken from original descriptions, redescrptions, specimens featured from (near) type localities, or this study. Features: longest tentacular cirri extending to chaetiger number (TC length); teeth in jaws (jaws); paragnaths of areas I, II, III (presence of laterally isolated groups, Lat.), IV (presence of bars in addition to cones, bars), V, and VII–VIII (presence of paragnaths on ridges of anterior row, ridges); form of bar-shaped paragnaths (type) and presence of conical paragnaths (cones) in area VI; ridge pattern of areas VI–V–VI (RidgeP); size of dorsal ligule in posterior chaetigers (DL–Post); length of dorsal cirrus in comparison with distal region of dorsal ligule in middle parapodia (DC/DDL); occurrence of notopodial prechaetal (PrL), neuropodial postchaetal (PostL) and neuropodial superior (SupL) lobes; presence of homomorph spinigers in subacicular neurochaetae (Sb–HoS). a = absent; HRW = sensu Hutchings *et al.*, 1991; p = present; ? = unknown features or values; No. = total number.

species name	SG	HRW	TC		jaws		I		II		III		IV		V		VI		VII–VIII		notopodia			neuropodia			Ref.
			length	No.	No.	No.	No.	No.	LatL	No.	bars	No.	cones	RidgeP	No.	ridges	DL- Post	DC/ DDL	PrL	PostL	SupL	Sb- HoS					
<i>P. amblyodontia</i> (Schmarda, 1861)	1B	1B	3–4	4–6	2–5	11–28	14–36	p	18–63	p	3–6	creseent	a	π	33–50	p	enlarged	longer	a	a	p	a			24, 27, 46, 48		
<i>P. anderssoni</i> Kinberg, 1865	1B	1B	1	10	5	11–12	19	a	19–33	a	3	smooth	a	π	40	p	enlarged	longer	a	a	p	a			7		
<i>P. arabica</i> Mohammad, 1971	1A	1A	5	?	16	18–20	16	a	23	a	8	smooth	p	?	>60	p	sub- equal	slightly longer	p	p	?	p			31		
<i>P. atlantica</i> (McIntosh, 1885)	1A	–	5	4	1	6–8	8	a	15–16	a	1	creseent	a	?	19	a	slightly enlarged	sub- equal	a	a	p	?			8, 29		
<i>P. bairdii</i> (Webster, 1884)	1B	–	2–3	8–11	7	15–16	6	a	21–24	a	1	smooth	a	λ	39	p	enlarged	sub- equal	a	a	p	a			7		
<i>P. bajacalifornica</i> de León-González & Solís-Weiss, 1998	1B	–	3	?	7	11	15	a	21	a	1	smooth	a	π	7	a	enlarged	sub- equal	a	a	p	p			11		
<i>P. barbara</i> (Monro, 1926)	1A	1B	3	7	0–3	6–14	3–7	a	9–23	p	2–7	creseent	a	π	45–101	p	slightly enlarged	longer	p	a	p	a			24, 32		
<i>P. calmani</i> (Monro, 1926)	1A	1A	3	3–4	2	13–20	12	a	15	a	0	creseent	a	?	10–12	p	slightly enlarged	shorter	p	a	p	a			24, 32		
<i>P. capensis</i> (Kinberg, 1865)	1A	–	3	4	2–3	12–15	8–10	?	8–15	a	0	shield	a	?	>27	?	slightly enlarged	longer	p	p	a	a			9, 10, 26, 34		
<i>P. cavifrons</i> (Ehlers, 1920)	1U	1U	5	3–4	3	8–11	?	?	17+	a	3	creseent	a	?	16	?	?	sub- equal	a	a	p	a			12, 24		
<i>P. cultrifera</i> (Grube, 1840)	1A	1A	4–5	4–5	1–2	3–15	5–11	p	6–20	a	2–5	shield	a	π	20–50	p	slightly enlarged	sub- equal	p	a	a	a			18, 24, 38		
<i>P. curvata</i> Holly, 1935	1U	1U	4–5	7–8	2–3	8–12	16–20	a	14–20	a	1	smooth	a	?	34–36	p	?	longer	a	a	a	?			21		
<i>P. dongalae</i> (Horst, 1924)	1U	1A	5	10	7–8	?	?	?	?	?	1	creseent	a	?	?	?	?	slightly longer	?	?	?	?			23		
<i>P. elenacosae</i> Rioja, 1947	1B	1B	2–3	6–7	20	13–17	18–20	a	15–20	a	1–3	smooth	a	π	32–40	p	enlarged	sub- equal	a	a	p	a			42, 48		
<i>P. euinii</i> Park & Kim, 2017	1B	–	4–8	5–6	1–3	8–16	10–15	a	16–26	a	3	shield	a	π	33–40	p	enlarged	slightly shorter	p	a	p	a			38		
<i>P. falklandica</i> (Ramsay, 1914)	1B	1B	2–4	5–10	32–150	9–28	11–20	a	23–40	a	1	shield	a	π	110–300	p	enlarged	longer	a	a	a	a			8, 40		
<i>P. falsovariegata</i> Monro, 1933	1A	1A	7	?	1	7	20–24	a	23–27	a	1	broad- petite	a	π	30	p	sub- equal	longer	a	a	p	a			10, 34		
<i>P. floridana</i> (Ehlers, 1868)	1A	1A	7–8	7–8	2	6–10	9–14	p	13–19	a	1	smooth	a	λ	18–24	a	slightly enlarged	shorter	a	a	p	a			7		
<i>P. helleri</i> (Grube, 1878)	1A	1A	6–16	5–9	1–2	4–17	8–20	p	10–19	a	3	smooth	a	?	21–40	a	longer	p	a	a	a	a			19, 23, 24		

Table 1 (continued).

species name	SG	HRW	TC	jaws		I		II		III		IV		V		VI		VII-VIII		notopodia				neuropodia				Ref.
				length	No.	No.	No.	No.	LatL	No.	bars	No.	type	cones	RidgeP	No.	ridges	DL- Post	DC/ DDL	PrL	PostL	SupL	Sb- HoS					
<i>P. iranica</i> Bonyadi-Naeini, Rastegar-Pouyani, Rastegar-Pouyani, Glasby & Rahmian, 2018 <i>P. longidonta</i> Rozbaczko & Castilla, 1973 <i>P. louizomarin</i> Rezzag Mahcene, Villalobos-Guerrero, Kurt, Denis & Daas, 2023 <i>P. macropus</i> (Claparède, 1870) <i>P. malabariensis</i> sp. nov. <i>P. malayana</i> (Horst, 1889) <i>P. marionii</i> (Audouin & Milne-Edwards, 1833) <i>P. misrai</i> sp. nov. <i>P. monerea</i> (Chamberlin, 1918) <i>P. nigropunctata</i> (Horst, 1889) <i>P. obfuscata</i> (Grube, 1878) <i>P. oliveirae</i> (Horst, 1889) <i>P. perspicillata</i> (Grube, 1878) <i>P. pictilis</i> Glasby, Nu-Wei & Gibb, 2013 <i>P. ponteni</i> Kinberg, 1865 <i>P. pseudocamiguina</i> Augener, 1922 <i>P. pseudocavifrons</i> Fauvel, 1930 <i>P. rullieri</i> Pilato, 1974 <i>P. striolata</i> (Grube, 1878) <i>P. subana</i> (Horst, 1924) <i>P. taorica</i> Langerhans, 1881 <i>P. tenuis</i> Fauvel, 1915 <i>P. tobelaana</i> (Augener, 1933) <i>P. villalobosi</i> Rioja, 1947 <i>P. websteri</i> Conde-Vela, 2022	1A	–	2	11–12	4–6	12–16	30–45	a	40–47	a	3–5	smooth	a	?	25–31	?	slightly enlarged	slightly longer	a	a	a	a	a	a	4			
	1B	IB	2–3	6–8	2–4	16–25	22–55	p	40–82	a	3	smooth	p	π	39–49	p	enlarged	slightly longer	a	a	p	a	a	a	43, 44			
	1A	–	4–6	0–3	1–2	3–8	1–5	a	6–19	a	0 (1–2)	cresecent	a	π	26–38	p	slightly enlarged	sub-equal	p	a	a	a	a	a	41			
	1B	IB	1–4	>5	2–7	16–25	18–42	p	>25	?	4–12	cresecent	a	π	>53	p	enlarged	longer	a	a	p	a	a	a	6, 30, 36			
	1B	–	3–5	6–7	3–7	10–13	13–19	p	14–23	a	3	cresecent	a	π	33–41	p	enlarged	sub-equal	p	a	p	a	p	a	49			
	1B	IB	4–7	?	2	9–10	16–17	p	22	?	3	cresecent	a	?	?	?	enlarged	slightly longer	a	a	a	a	a	a	22			
	1B	IB	4	15–16	2	14	36	p	21	p	many	shield	a	λ	many	p	enlarged	slightly longer	a	a	p	a	p	a	1, 36			
	1A	–	6–11	7	1–2	4–7	10–11	p	9–11	a/p	3	cresecent	a	π	21–26	a	slightly enlarged	longer	a	a	p	a	p	a	49			
	1B	IB	1–3	?	1	6	26	a	25	p	1	shield	a	?	40	p	enlarged	longer	p	a	p	a	p	a	5, 11			
	1A	IB	3–8	7	4–11	12–39	21–35	p	18–42	a	3 (1, 4)	cresecent	a	?	32–46	?	slightly enlarged	longer	p	a	p	a	p	a	22, 24, 37			
1A	IB	1–5	5–7	2–9	7–27	13–32	p	10–31	a	1 (2)	cresecent	a	?	22–38	p	slightly enlarged	sub-equal	p	a	p	a	p	a	19, 23, 24				
1B	–	3–5	?	1–4	9–25	24–61	p	28–55	a	1	smooth	a	x	30–40	p	enlarged	sub-equal	a	a	a	a	a	a	a	22, 36			
1A	IU	6	7	5	12	26	?	12	?	3	shield	a	?	36	?	sub-equal	equal	a	a	p	a	p	a	19, 33				
1A	–	6	8–9	2	?	?	?	?	?	?	0	shield	a	?	0	a	slightly enlarged	sub-equal	a	a	?	a	?	a	17, 23			
1B	IB	2–3	6	7–12	13–19	16–18	a	18–26	a	1	smooth	a	λ	35	p	enlarged	equal	a	a	p	a	p	a	a	20, 26, 45			
1B	–	2–3	4–5	1–2	8–16	7–13	a	10–30	a/p	3 (4)	cresecent	a	?	39–54	p	enlarged	longer	a	a	p	a	p	a	a	2, 24			
1B	IB	2–3	5–6	0–3	4–6	6–9	a	8–11	a	0	smooth	a	π	18–24	p	enlarged	slightly longer	a	a	p	a	p	a	a	16, 24			
1A	1A	5–10	6–7	0–2	4–10	5–9	a/p	7–24	a	3	smooth	p (rare)	?	16–45	p	slightly enlarged	longer	a	a	p	a	p	a	a	39			
1A	IU	2–7	5–10	4–16	16–18	26–33	p	21–40	?	1–4	cresecent	a	?	36	p	slightly enlarged	sub-equal	p	a	p	a	p	a	a	19, 25			
1A	IB	3–6	6–9	1–4	6–17	7–21	a	9–22	a	0	shield	a	?	0	a	enlarged	slightly enlarged	a	a	p	a	p	a	a	23, 24			
1A	1A	6–7	5	0–2	4–11	4–18	p	14–24	a	1–3	cresecent	a	π	3–6	a	sub-equal	longer	p	p	a	a	p	a	a	28, 35			
1A	1A	?	6	1	>13	?	?	?	?	?	0	broad-petite	a	λ	many	p	sub-equal	slightly longer	p	p	a	p	a	p	13, 14, 15			
1B	IB	5–6	5	4	?	?	?	?	?	?	3	shield	a	?	8	?	enlarged	longer	a	a	a	a	a	a	3			
1A	1A	4–7	7–9	1	12–26	17–57	a	15–54	a	1–2	shield	a	π	41–45	p	slightly enlarged	longer	a	a	p	a	p	a	a	42, 47, 48			
1A	–	7	10	3	10–9	9	p	18–19	a	1	smooth	a	λ	16	a	enlarged	slightly longer	a	a	p	a	p	a	a	7			

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