

Pectinaria nuslautensis (Pectinariidae, Annelida): a new polychaete species from Maluku, Indonesia

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Abstract. *Pectinaria nuslautensis*, new species, is described based on a single specimen collected from the intertidal sandy shore of Nuslaut Island, Maluku, Indonesia. This new species is distinguished from all other described species of *Pectinaria* by the presence of 12 pairs of golden stout notopodial paleae with faint transverse lines and blunt distal tips, one pair of ventral lappets on segment 1, one pair of dorsolateral flaps extending ventrally to ventral flaps and one mid-ventral triangular glandular area with faint longitudinal striations on segment 2, two pairs of dorsolateral pads on segments 3 and 4, one prominent mid-ventral trapezoidal glandular area with smooth surface flanked by two small antero-ventral lobes on segment 3, three large and broad antero-ventral lobes on segments 4–6, a strongly translucent abdominal region, golden flattened and bamboo-like notopodial capillaries with smooth margins and pointed tips, and a diamond-shaped scaphe with a triangular anal flap. Indonesian pectinariids appear to be rare especially in intertidal areas. *Pectinaria nuslautensis*, new species, is the seventh pectinariid species identified from the region. A key to all the pectinariid species occurring in the region is given.

Key words. biodiversity, Polychaeta, taxonomy

INTRODUCTION

Taxonomic information on Indonesian pectinariids is limited. Of the 67 pectinariid species that have been described worldwide (WoRMS Editorial Board, 2022), only six species have been recorded from Indonesian waters (Fig. 1). These species are: *Amphictene capensis* (Pallas, 1766) (type locality: South Africa, described from a single specimen; also recorded from the Sunda Strait at 325–362 m depths by Chuar et al. (2021), although this record is doubtful as no species description was given nor was the type specimen examined by the authors, as well as the long distance between South Africa and Sunda Strait); *A. leioscapa* (Caullery, 1944) (type locality: Banda Islands at 9–36 m depths, described from a single specimen); *Pectinaria brevispinis* Grube, 1878 (type locality: the Philippines, described from a single specimen; also recorded close to Nuslaut Island at 46 m depth by Caullery (1944), but again the type specimen was not examined); *P. papillosa* Caullery, 1944 (type locality: Aru Islands at 47 m depth, based on two specimens); *P. profunda* Caullery, 1944 (collected from Banda Sea at 310 m depth, description based on a single specimen); and *Petta*

tenuis Caullery, 1944 (type locality: Sulu Archipelago, the Philippines, collected from 275 m depth, two specimens; also recorded from Sunda Strait at 559–977 m depths by Chuar et al. (2021), yet they do not provide a description, so again this must be a tentative identification; recently Zhang et al. (2019) provided a detailed redescription and expansion of characters of the species based on the syntypes of *P. tenuis* which Chuar et al. (2021) did not refer to).

Since then, no other species of pectinariids have been recorded from Indonesia. This is mainly because few polychaete taxonomic studies have been undertaken in the country; most benthic investigations by local researchers have been ecological in nature (Pamungkas & Glasby, 2019). Also, pectinariids are rarely found in large numbers (Hutchings et al., 2020); four of the above-named species were based only on a single specimen. In the present study, a new pectinariid species is described also based on a single specimen collected from Nuslaut Island, Maluku, Indonesia.

MATERIAL AND METHODS

The specimen of *Pectinaria* was collected on 5 October 2009, from the intertidal sandy shore of Sila Village, which is situated on Nuslaut Island, Central Maluku Regency, Maluku Province, Indonesia (3°38'54.6"S, 128°46'7.7"E). Despite further sampling around the island over the next couple of days, no more individuals were collected. The animal was sampled from the sediment using a hand shovel and directly fixed in 4% formalin for about 24 hours. After being rinsed with tap water, the worm was transferred to 70% alcohol.

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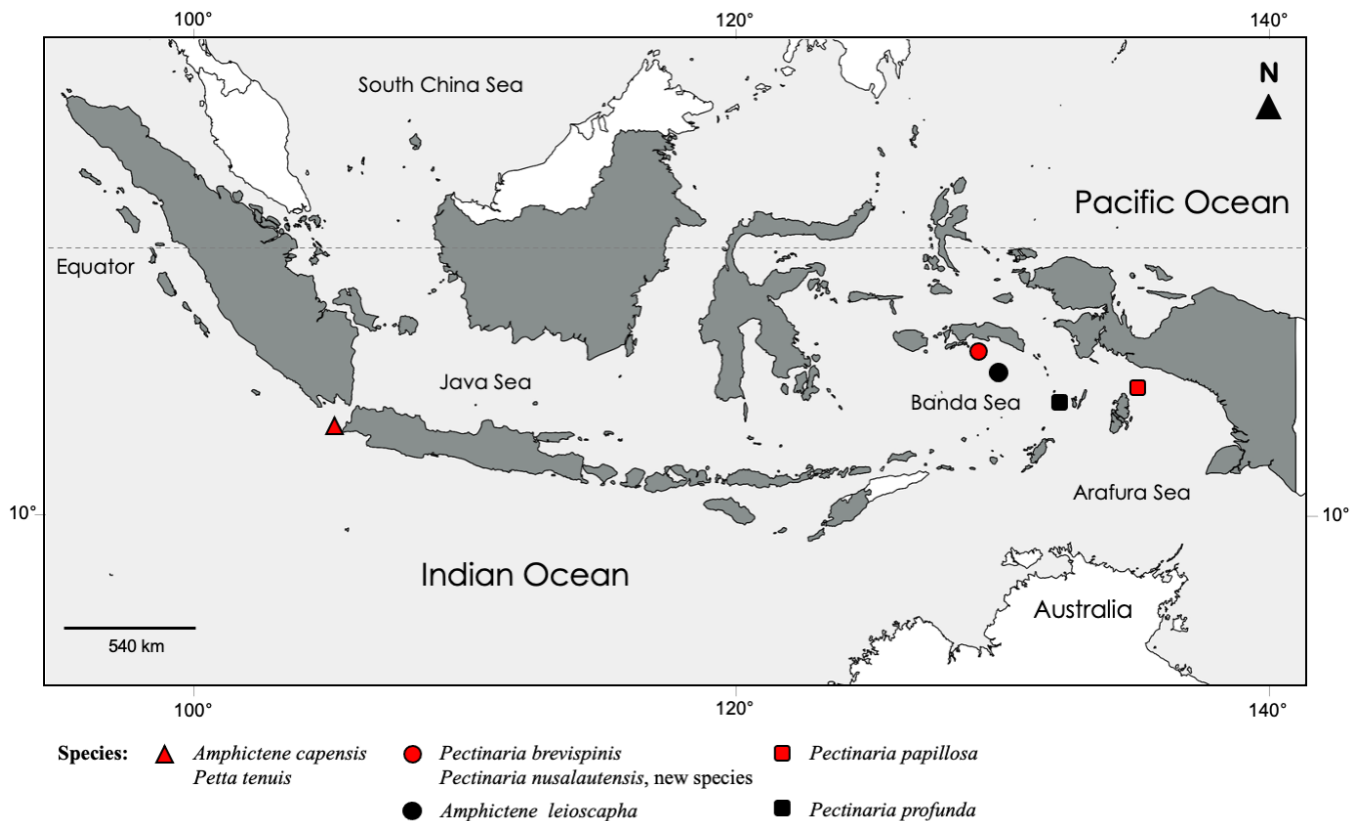


Fig. 1. Distributional map of Indonesian pectinariids. Dark grey and white areas indicate Indonesian islands and nearby regions. *Pectinaria nusalaensis*, new species, and (?)*P. brevispinis* were collected from the same island. The record of *A. capensis* is doubtful due to such a long distance between South Africa and Sunda Strait that may restrict the distribution of the species. *Pectinaria brevispinis* was originally described from the Philippines and was later recorded to occur in Indonesia by Caullery (1944), but this record cannot be verified.

The *Pectinaria* specimen was examined under Leica Z6 APO and OLYMPUS BX53 stereo and compound microscopes, respectively. Photomicrographs were taken using Leica DMC 5400 and OLYMPUS DP22 cameras mounted on their respective microscopes. To examine the chaetae, SEM micrographs were taken using the scanning electron microscope JSM-IT200. The specimen was stained using methylene blue to enhance some morphological features. Due to postal restrictions (the Indonesian post is unreliable in receiving or sending any biological specimens immersed in liquid), no comparative *Pectinaria* material was examined. However, the *Pectinaria* specimen of the present study was morphologically compared to the other *Pectinaria* species mainly through tables 3 and 4 listing major distinguishing characters of *Pectinaria* species in Hutchings & Peart (2002) and Zhang & Hutchings (2019), respectively. Because some species are not included in both papers, the specimen was also compared to the original publications of *P. bifurcata* Blainville, 1828, *P. incerta* (Chenu, 1842), and *P. nonatoi* Nogueira, Ribeiro, Carrerette & Hutchings, 2019. Additionally, the specimen was carefully compared to the original description of *P. brevispinis* by Grube, 1878, as well as the species' descriptions by Nilsson (1928) and Caullery (1944) – Nilsson was the last person who examined the type material of *P. brevispinis* before it was lost, and Caullery recorded the species near Nusalaut Island, i.e., the same island as where the present species was found. A distributional map of Indonesian pectinariids (Fig. 1) was created using SimpleMappr (www.simplemappr.net). The

type specimen is deposited at the Museum Zoologicum Bogoriense (MZB) in Cibinong, Bogor, West Java.

SYSTEMATICS

Order Terebellida Rouse & Fauchald, 1997

Family Pectinariidae Quatrefages, 1866

Genus *Pectinaria* Lamarck, 1818

Pectinaria nusalaensis, new species (Figs. 2–7)

Material examined. Holotype: 1 (MZB. Pol. 00236), intertidal sandy beach of Sila Village, Nusalaut Island, Maluku, 3°38'54.6"S, 128°46'7.7"E, about 30 cm depth, coll. J. Pamungkas, 5 October 2009.

Description. Preserved specimen pale cream in colour, complete, measuring 40 mm long by 10 mm wide at anterior part, slightly tapering posteriorly. Body with 26 segments, divided into three distinct sections, i.e., thorax (segments 1–7), abdomen (segments 8–21) and scaphe (segments 22–26) (Figs. 2, 3). Tube cone-shaped, made of cemented shell-like fragments.



Fig. 2. *Pectinaria nusalaautensis*, new species (MZB. Pol. 00236). A, dorsal view; B, ventral view. Abbreviations: ag = abdominal glandular area; avl = antero-ventral lobe; br1 = first branchia; br2 = second branchia; cvc = cephalic veil cirrus; dlf = dorso-lateral flap; dlp = dorso-lateral pad; lh = lateral hump; no = notopodium; np = notopodial palea; op = opercular plate; or = opercular rim; pp = peristomial palp; savl = small antero-ventral lobe; tra = trapezoidal glandular area; tri = triangular glandular area; vf = ventral flap; vl = ventral lappet. Scale bar = 2 mm.

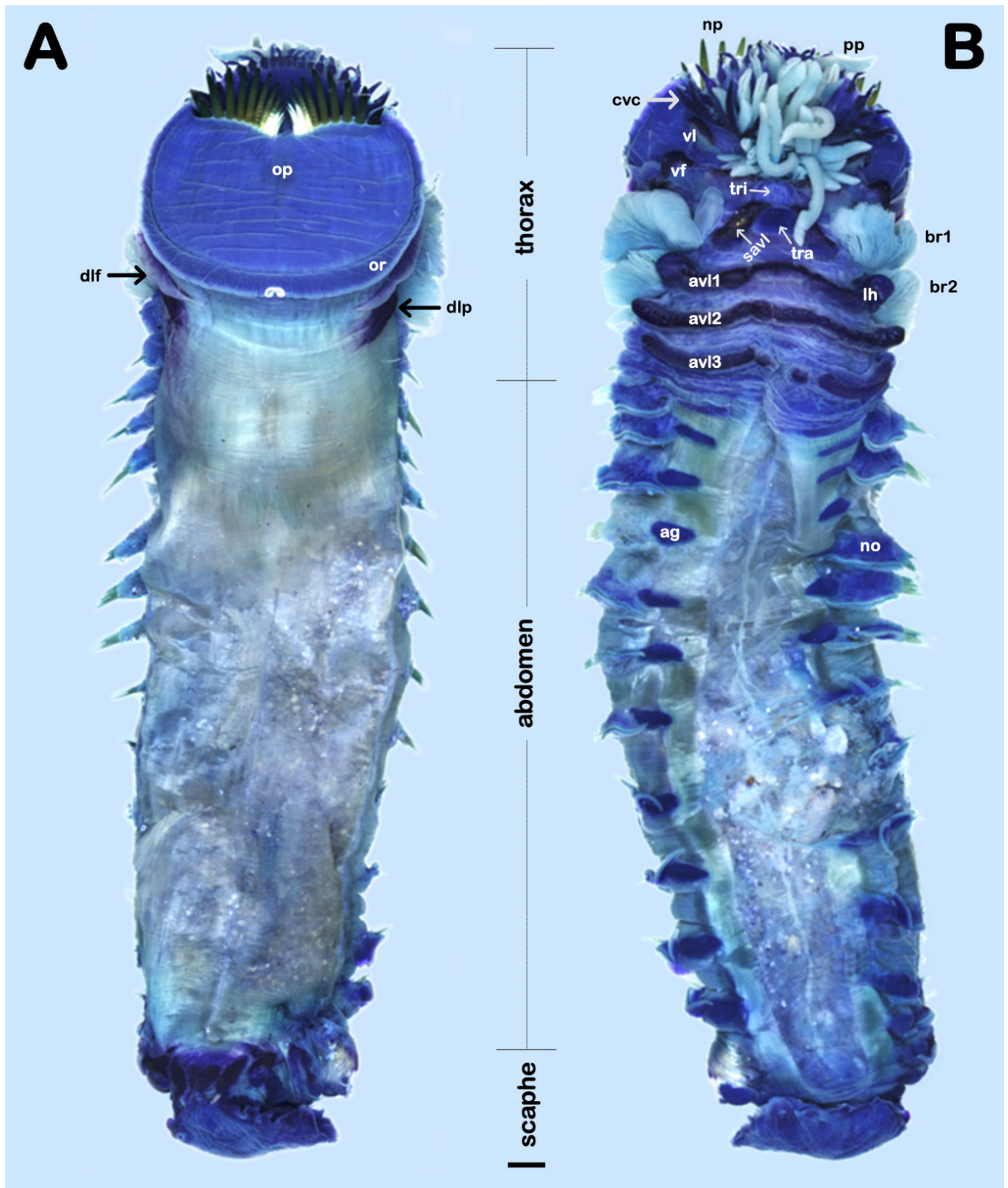


Fig. 3. *Pectinaria nusalaautensis*, new species (MZB. Pol. 00236), stained using methylene blue. A, dorsal view; B, ventral view. Abbreviations: ag = abdominal glandular area; avl = antero-ventral lobe; br = branchia; cvc = cephalic veil cirrus; dlf = dorso-lateral flap; dlp = dorso-lateral pad; lh = lateral hump; no = notopodium; np = notopodial palea; op = opercular plate; or = opercular rim; pp = peristomial palp; savl = small antero-ventral lobe; tra = trapezoidal glandular area; tri = triangular glandular area; vf = ventral flap; vl = ventral lappet. Scale bar = 2 mm.

Thoracic section comprises opercular and cephalic regions along with appendages, and four achaetous segments (1–4) followed posteriorly by three chaetigerous segments (5–7) (Figs. 2, 3). On dorsal side, opercular rim raised, smooth with surface striations (Figs. 2A, 3A). Opercular plate more or less circular, smooth with transverse striations (Figs. 2A, 3A). Two combs of short notopodial paleae present; each comb consists of 12 stout, golden paleae with faint transverse lines and blunt tips. Lateral paleae shortest; length gradually increases towards mid paleae then gradually decreases towards proximal paleae; proximal paleae narrowest (Figs. 2A, 3A, 4A, 5A). On ventral side, rim of cephalic veil cirrate with 25 narrow, elongated, conical cirri (Figs. 2B, 3B, 4A). Cephalic veil broad, thin, and completely free from operculum, forming a dorsal semi-circular lobe covering base of numerous non-retractable peristomial palps (buccal tentacles) (Figs. 2B, 3B, 4A). Peristomial palps finger-like, grooved and varying in size (Figs. 2B, 3B, 4A).

First pair of tentacular cirri small and short, with wide base up to one-third of total length of cirri; cirri arise from anterolateral edge of segment 1, near most lateral notopodial paleae. Second pair of tentacular cirri larger, about three times longer than first pair of cirri; cirri with wide base up to one-third of total length of cirri and present laterally on segment 2 (Fig. 4A). Between two pairs of cirri, one pair of ventral lappets present obliquely on segment 1 (Figs. 2B, 3B, 4A). Two pairs of comb-like, stalked branchiae present on segments 3 and 4. Both pairs similar in size, situated laterally lying against body, and consisting of loose flat lamellae; branchiae of segment 3 inserted more ventrally than those of segment 4 (Figs. 2B, 3B, 4A). Segment 2 without posterodorsal lobe, but with dorsolateral flaps extending ventrally to ventral flaps (Figs. 2B, 3B, 4A) and a mid-ventral triangular glandular area with faint longitudinal striations (Figs. 2B, 3B, 4A). Segments 3 and 4 with dorsolateral pads; pad of segment 3 twice as long as those of segment 4 (Figs. 2A, 3A). A prominent mid-ventral trapezoidal glandular area with smooth surface flanked by two small antero-ventral lobes present on segment 3 (Figs. 2B, 3B, 4A). Three large and broad antero-ventral lobes present on segments 4–6; antero-ventral lobe on segment 4 with lateral humps (Figs. 2B, 3B, 4A, B). Chaetigers 1 to 3 (segments 5–7) uniramous with notopodia bearing golden flattened capillary chaetae (Figs. 4B, 5A).

Abdominal section consists of chaetigers 4 to 17 (segments 8–21), with dorsal and ventral areas strongly translucent, with sand grains visible in gut (Figs. 2, 3). Abdominal glandular areas elliptic, present ventrally on all abdominal segments, adjacent to parapodia (Fig. 3B). Chaetigers 4 to 16 biramous with noto- and neuropodia bearing notochoetae and neurochoetae, respectively (Figs. 2B, 3B, 4B). Chaetiger 17 uniramous with notopodia bearing notochoetae. Holotype has 17 noto- and 13 neuropodia with uncini (17/13). Notochoetae golden flattened capillaries with wide base tapering distally. Chaetae with smooth margins and bamboo-like when seen under a compound microscope; many of which have broken tips, intact chaetae with pointed tips (Figs. 6, 7A). Uncini with major teeth arranged in two longitudinal rows with

about 8–10 teeth per row; basal teeth small and difficult to count (Fig. 7B).

Scaphe distinctly separated from abdomen and consisting of last five posterior segments fused. Six pairs of scaphal hooks observed, situated dorsally at attachment region between base of scaphe and last abdominal segment. Scaphal hooks with a broad shaft and a blunt distal end (Figs. 4C, 5B). Scaphe flattened and diamond-shaped with broad-crenulated margins. A triangular anal flap present posteriorly, smooth with longitudinal striations. Anal cirrus absent (Figs. 4D, 5C).

Methylene blue staining pattern. Darkest blue areas include cephalic veil cirri, ventral lappets on segment 1, ventral flaps on segment 2, dorsolateral pads on segments 3 and 4, trapezoidal gland along with two flanking ventral lobes on segment 3, antero-ventral lobes on segments 4–6, and transitional region between abdomen and scaphe. Medium blue stained areas include operculum, dorsal regions of segments 2–7, abdominal parapodia, elliptic glandular areas on ventral area of abdominal segments and scaphe. Light blue stained areas include peristomial palps, branchiae, dorsal and ventral regions (Fig. 3).

Remarks. *Pectinaria nusalaensis*, new species, can be distinguished from all the other 27 *Pectinaria* species (WoRMS Editorial Board, 2022) by the combination of the following characters: 12 pairs of golden, stout notopodial paleae with faint transverse lines and blunt distal tips, one pair of ventral lappets on segment 1, one pair of dorsolateral flaps extending ventrally to ventral flaps and one mid-ventral triangular glandular area with faint longitudinal striations on segment 2, two pairs of dorsolateral pads on segments 3 and 4, one prominent mid-ventral trapezoidal glandular area with smooth surface flanked by two small antero-ventral lobes on segment 3, three large and broad antero-ventral lobes on segments 4–6, a strongly translucent abdominal region (this is unlikely due to fixation or preservation as to our best knowledge most of the other 27 *Pectinaria* species do not show a similar appearance despite being fixed and preserved in the same way), golden flattened and bamboo-like noto-capillaries with smooth margins and pointed tips, and a diamond-shaped scaphe with a triangular anal flap.

Pectinaria nusalaensis, new species, most closely resembles the Australian species *P. dodeka* Hutchings & Peart, 2002, in terms of the number and the shape of notopodial paleae, the type and the pair number of branchiae as well as their position, and the presence of a mid-ventral triangular glandular area on segment 2 (or according to Zhang & Hutchings, 2019, the glandular area of *P. dodeka* is situated between segments 2 and 3), dorso-lateral pads on segments 3 and 4, lateral humps on segment 4, and relatively large and broad antero-ventral lobes on segments 4–6 (see all these features in the stained specimen of *P. dodeka* in Zhang & Hutchings, 2019: fig. 26). Zhang & Hutchings (2019) re-examined the type material and provided details of additional characters which were not described by Hutchings & Peart (2002). *Pectinaria dodeka* was recorded to occur in the northern area of Australia, adjacent to Indonesian waters,

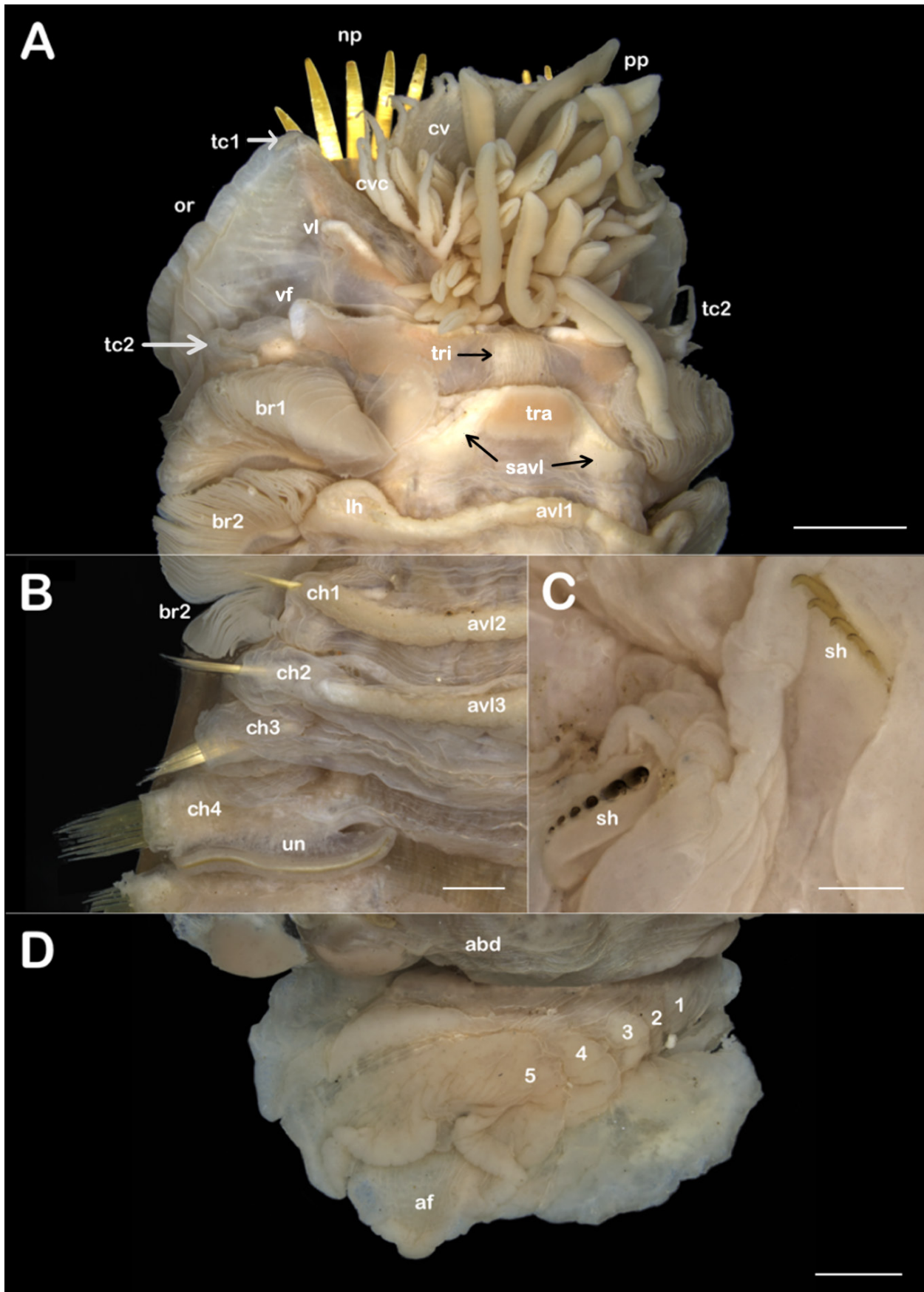


Fig. 4. Close-up of body parts of *Pectinaria nusalautensis*, new species (MZB. Pol. 00236). A, ventral view of the anterior part; B, transitional region from thorax to abdomen; C, scaphal hooks; D, scaphe (ventral view). Abbreviations: abd = abdomen; af = anal flap; avl = antero-ventral lobe; br = branchia; ch = chaetiger; cv = cephalic veil; cvc = cephalic veil cirri; lh = lateral hump; np = notopodial paleae; or = opercular rim; pp = peristomial palp; savl = small antero-ventral lobe; sh = scaphal hooks; tc = tentacular cirrus; tra = trapezoidal glandular area; tri = triangular glandular area; un = uncini; vf = ventral flap; vl = ventral lappet. Numbers 1–5 are the last five posterior segments forming scaphe. Scale bars: A, B = 2 mm; C = 0.25 mm; D = 1 mm.

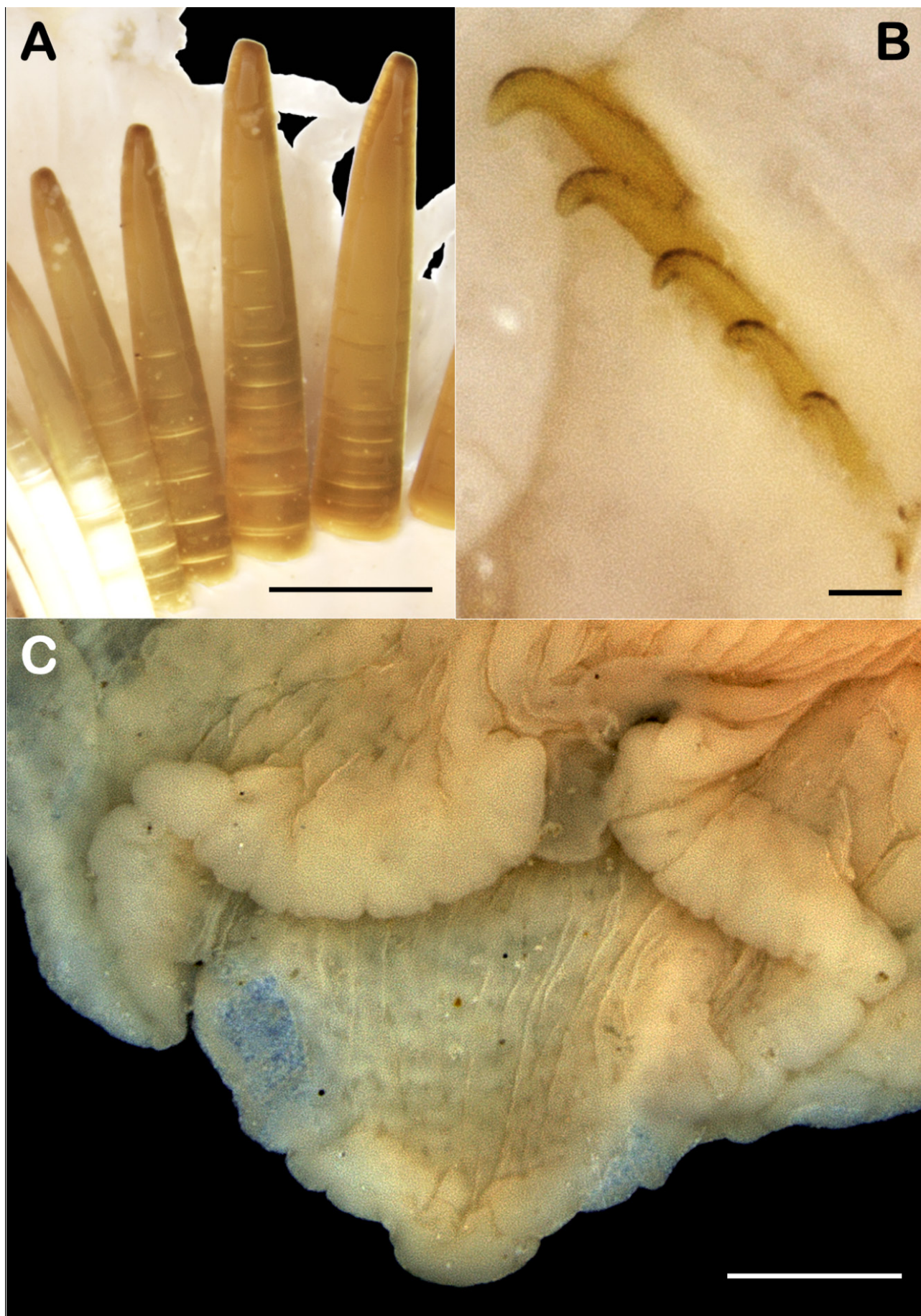


Fig. 5. Close-up of some body parts of *Pectinaria nusalautensis*, new species (MZB. Pol. 00236). A, notopodial paleae showing faint transverse lines; B, scaphal hooks showing blunt tips; C, anal flap (ventral view) showing a triangular shape with longitudinal striations. Scale bars: A = 1 mm; B = 0.05 mm; C = 0.5 mm.

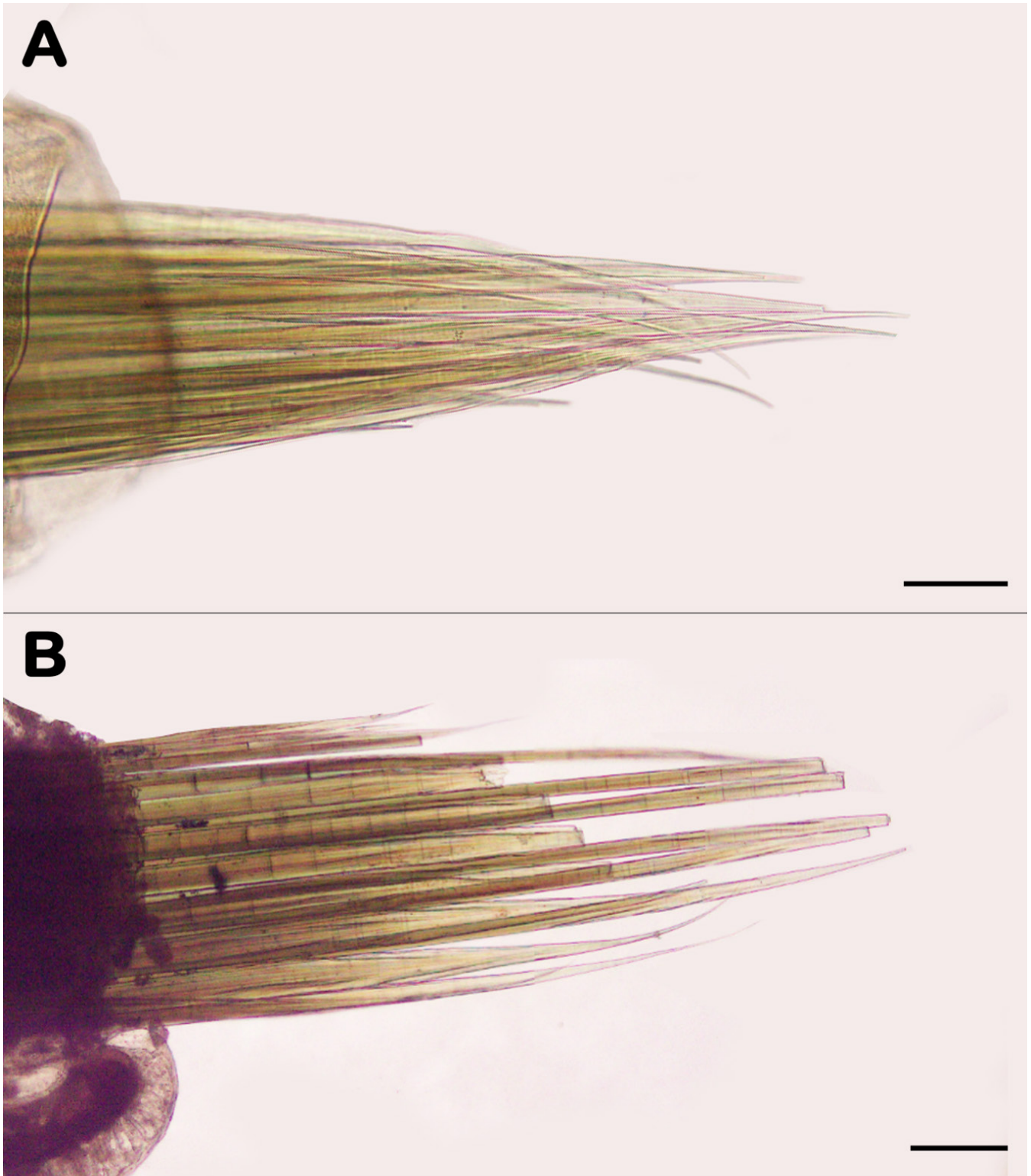


Fig. 6. Chaetae of *Pectinaria nusalautensis*, new species (MZB. Pol. 00236). A, chaetae of chaetiger 3; B, chaetae of chaetiger 5. Scale bars: A = 100 μ m; B = 200 μ m.

i.e., Arafura Sea (Hutchings & Peart, 2002). *Pectinaria nusalautensis*, however, has dorsolateral flaps extending ventrally to ventral flaps on segment 2, which are not present in *P. dodeka* (see Zhang & Hutchings, 2019: fig. 26B, F). While a mid-ventral trapezoidal glandular area flanked by two small antero-ventral lobes is present on segment 3 in *P. nusalautensis*, the feature is absent in *P. dodeka*; instead, a relatively large lobe is present on segment 3 in the latter

species (see Zhang & Hutchings, 2019: fig. 26A, G). The lateral humps of *P. nusalautensis* are semi-circular, whereas those of *P. dodeka* are triangular (see Zhang & Hutchings, 2019: fig. 26F, G). The antero-ventral lobes on segments 3–6 in *P. nusalautensis* are restricted to the anterior side of each segment, whereas in *P. dodeka* the lobes completely cover the entire segments (see Zhang & Hutchings, 2019: fig. 26A, B, F, G). *Pectinaria dodeka* has noto-capillaries

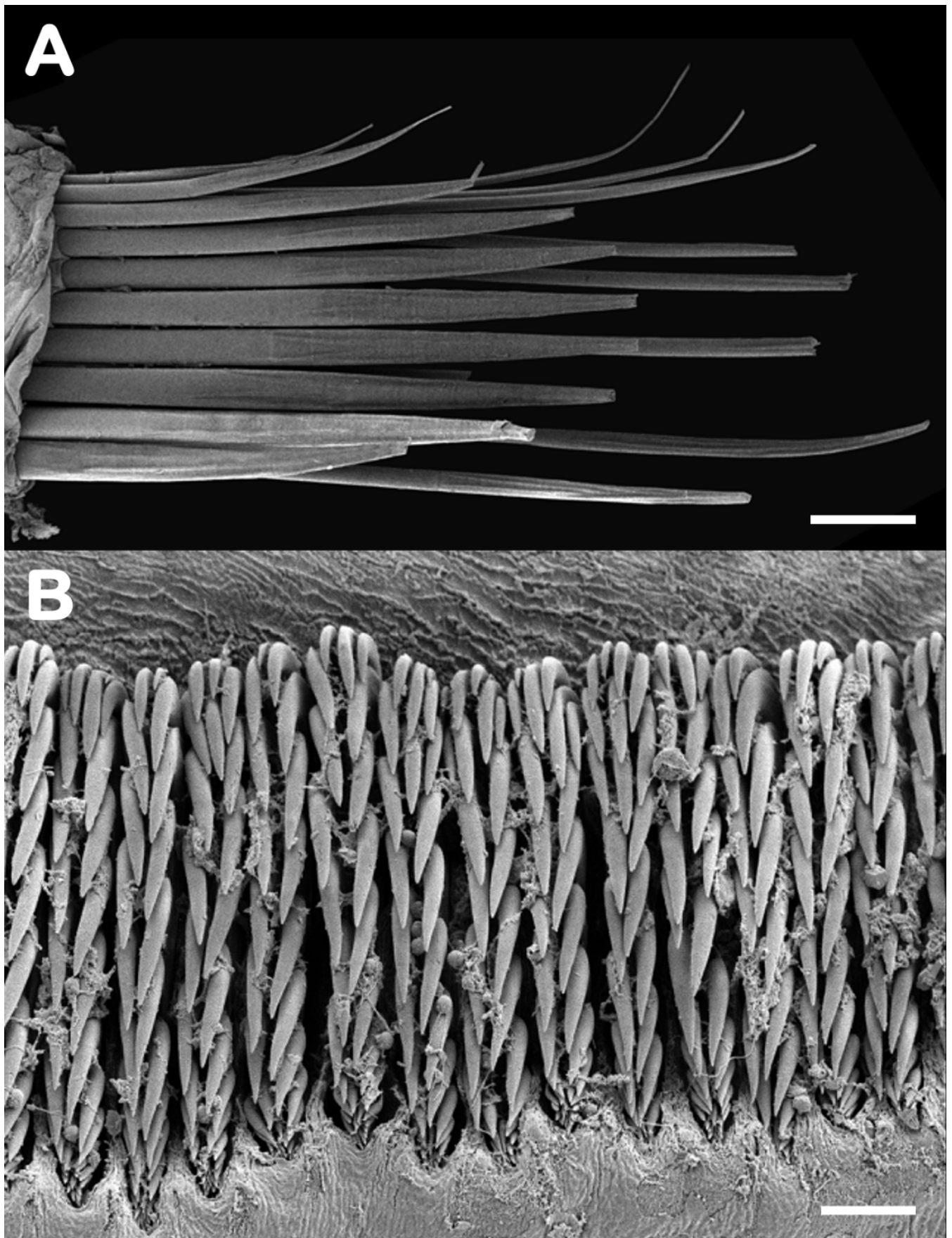


Fig. 7. SEM of chaetae of *Pectinaria nuslautensis*, new species (MZB. Pol. 00236). A, notochaetae of chaetiger 5; B, uncini of chaetiger 5. Scale bars: A = 200 μm ; B = 10 μm .

with one margin strongly pectinated (see Hutchings & Peart, 2002: fig. 11A, B), whereas in *P. brevispinis* both margins are smooth. Lastly, the scaphe of *P. dodeka* is oval and flattened with a triangular tongue-like anal flap bearing a single dorsal cirrus (see Hutchings & Peart, 2002: fig. 14B; Zhang & Hutchings, 2019: fig. 26D, E), whereas that of *P. nusalaautensis* is diamond-shaped with a relatively large triangular anal flap without a cirrus.

Pectinaria nusalaautensis, new species, also shares similar characteristics with *P. brevispinis* which was originally described based on a single specimen collected from the Philippines by Grube (1878), and was later reported to occur in Indonesian waters, i.e., on the same island as *P. nusalaautensis* by Caullery (1944). The type specimen of *P. brevispinis*, which was deposited at the Museum für Naturkunde in Berlin, Germany, has unfortunately been lost (Birger Neuhaus, pers. comm.), making it impossible for the authors to directly compare the morphology of the present specimen with that of the type specimen of the species. Caullery (1944) also did not examine the type specimen of *P. brevispinis*, so his record of the species must also be regarded as tentative. However, based on the descriptions of *P. brevispinis* in four publications, i.e., Grube (1878), Nilsson (1928), Caullery (1944), and Hutchings & Peart (2002), although only Nilsson examined the type, we found that both *P. brevispinis* and *P. nusalaautensis* have a similar number of notopodial paleae, a smooth and slightly wrinkled opercular rim, lateral humps on segment 4, and the same number of rows of major teeth per uncinus. *Pectinaria brevispinis*, nevertheless, has a heart-shaped opercular plate (see Grube, 1878: pl. XI, fig. 2), whereas the feature is more or less circular in *P. nusalaautensis*. Nilsson (1928) furthermore reported the presence of a mid-ventral granular area in *P. brevispinis* (see fig. 20A in his paper), whereas the area is smooth with faint longitudinal striations in *P. nusalaautensis*. The antero-ventral lobe on chaetiger 2 in *P. brevispinis* was not observed by Grube (1878) but is slightly glandular according to Nilsson (1928) and Hutchings & Peart (2002); the lobe is obvious in *P. nusalaautensis* especially when stained. While the dorsum of *P. brevispinis* shows clear segmentation (see Grube, 1878: pl. XI, fig. 2), the region is smooth and translucent in *P. nusalaautensis*. Nilsson (1928) pointed out two types of capillary chaetae in *P. brevispinis* (see fig. 20B–E in his paper), whereas *P. nusalaautensis* only has one type of capillaries. The number of pairs of scaphal hooks of *P. brevispinis* was also reported differently, i.e., 10 pairs according to Grube (1878), 4–6 pairs with blunt tips according to Nilsson (1928) – the author wrote that some hooks have probably fallen out as the cuticle of the type specimen is completely separated and the underlying tissue is very loose – and 8–12 pairs with pointed tips according to Hutchings & Peart (2002). In contrast, *P. nusalaautensis* has six pairs of scaphal hooks with blunt tips. Furthermore, *P. brevispinis* has an oval scaphe with reduced anal flap, whereas *P. nusalaautensis* has a diamond-shaped scaphe with a triangular anal flap. The body length of *P. brevispinis*

species ranges from 60 to 92 mm (Hutchings & Peart, 2002), whereas that of *P. nusalaautensis* is only 40 mm. As there are discrepancies between the original description by Grube and the subsequent redescription by Nilsson of the single type specimen, we suggest that *P. brevispinis* must be considered *species inquirenda* until additional material from the type locality is collected and a neotype is designated.

Etymology. The species was named after the island on which it was discovered.

Distribution. Known only from the type locality.

Habitat. The only known specimen of this species inhabited a sandy beach in the intertidal zone, around the surface of sediment.

DISCUSSION

Pectinaria Lamarck, 1818, is the most speciose genus in the family Pectinariidae Quatrefages, 1866. Including *P. nusalaautensis*, new species, 28 species of *Pectinaria* have been described so far; while the remaining 40 pectinariid species belong to four other genera (Hutchings et al., 2020). More than half of *Pectinaria* species have been recorded from Asian (12 species) and Australian waters (5 species), with the rest occurring in North (3 species) and South America (2 species), Europe (3 species), the Middle East (2 species) and North Atlantic (1 species) (Hutchings & Peart, 2002; Zhang & Hutchings, 2019; WoRMS Editorial Board, 2022). In Indonesia, except *A. capensis*, for which the record is doubtful, all *Pectinaria* species were found in the Coral Triangle (Fig. 1); more sampling effort in this region is likely to reveal additional new species of *Pectinaria*.

These animals are mostly coastal and inhabit both tropical and subtropical regions. Despite having a characteristic ice cream cone-shaped tube, *Pectinaria* species have rarely been recorded in large numbers (Hutchings et al., 2020) partly due to their solitary life habit, except *Pectinaria antipoda* Schmarda, 1861, of which many individuals were collected amongst seagrass beds along the east coast of Australia (Zhang & Hutchings, 2019). Consequently, a number of *Pectinaria* species were described based on a single specimen only, including the Indonesian species *P. nusalaautensis*, new species. In this case, a complete morphological description – involving SEM and photomicrographs of both stained and unstained specimen – and a molecular approach should ideally be carried out (although the latter approach is not possible if the specimen is fixed using formalin). As the descriptions of all Indonesian pectinariid species are relatively brief (the literature in which the species were described typically has few illustrations in the form of line drawings only, and no staining was performed), they require redescrptions using morphology and molecular data.

Key to all pectinariid species recorded from Indonesian waters

1. Opercular rim ciliate 2
- Opercular rim smooth 3
2. Scaphal hooks 12 in number; anal flap tongue-shaped with a small cirrus *Amphictene leioscapa*
- Scaphal hooks 5–8 in number; anal flap small, shield-shaped with a small cirrus *Amphictene capensis**
3. Tip of notopodial paleae blunt *Pectinaria nuslautensis*, new species
- Tip of notopodial paleae fine 4
4. Scaphe smooth; anal flap with small cirrus *Pectinaria profunda*
- Scaphe with papillae; anal flap without cirrus *Pectinaria papillosa*

*The record of this species is considered doubtful.

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