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Description of a new species of *Spinosphaera* (Polychaeta: Terebellidae) from the eastern Mediterranean

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Research Article

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Abstract

The present study describes a new Mediterranean terebellid, *Spinosphaera latachaeta* sp. nov., found along the Aegean coast of Türkiye and the Sea of Marmara, between 27 and 80 m depth in soft substrata. It can be morphologically distinguished from all other species of *Spinosphaera* having 18 pairs of notopodia, double rows of uncini present until the last notopodia, and 11 pairs of *Spinosphaera*-chaetae. A dichotomous taxonomic key and a table summarizing the morphological characters that distinguish all species of *Spinosphaera* are provided. This study also reports, for the first time, the transformations of *Spinosphaera*-chaetae and saw-like chaetae from the anterior to posterior segments of body.

ZooBank: urn:lsid:zoobank.org:pub:628B1F01-166A-4E26-9C42-39D0CBFDE998.

Introduction

Terebellidae are a diverse family of tubiculous polychaete annelids commonly found in shallow and deep waters in the world's oceans (Nogueira and Hutchings, 2007; Hutchings *et al.*, 2021). The definition and coverage of the family is still under debate (Grube, 1851; Malmgren, 1866; Hessle, 1917; Holthe, 1986; McHugh, 1995; Nogueira *et al.*, 2013; Stiller *et al.*, 2020). The traditional subfamilies used by Day (1967), Fauchald (1977), and Holthe (1986) were later raised to the family level (Nogueira *et al.*, 2013) and, together with the Trichobranchidae, constituted the Terebellidae *sensu lato* (Hutchings *et al.*, 2021; Lavesque *et al.*, 2021). More recently, however, they have been replaced as subfamilies or tribes within Terebellidae (Stiller *et al.*, 2020).

Within Terebellinae, the genera, *Baffinia* Wesenberg-Lund, 1950, *Hutchingsiella* Londoño-Mesa, 2003, *Lanassa* Malmgren, 1866, *Laphania* Malmgren, 1866, *Leaena* Malmgren, 1866, *Phisidia* Saint-Joseph, 1894, *Proclea* Saint-Joseph, 1894, *Pseudoproclea* Hutchings & Glasby, 1990, *Spinosphaera* Hessle, 1917, and *Stschapovella* Levenstein, 1957 include species lacking branchiae and having double rows of uncini on some chaetigers. *Spinosphaera*, first described for *Spinosphaera pacifica* Hessle, 1917, lacks branchiae as well as lateral lappets, has short-handled avicular uncini in double rows and bears the so-called *Spinosphaera*-chaetae (Hessle, 1917). The genus contains six species, none of which are known to inhabit Mediterranean and European coasts: *Spinosphaera barega* Nogueira & Hutchings, 2007 (Western Australia); *Spinosphaera carrerai* Londoño-Mesa, 2003 and *Spinosphaera hutchingsae* Londoño-Mesa (Caribbean Sea); *Spinosphaera harrisae* Londoño-Mesa, 2003 and *Spinosphaera oculata* Hartman, 1944 (California); and *Spinosphaera pacifica* Hessle, 1917 (Japan).

This study formally describes the first known Mediterranean species of *Spinosphaera*, compares it with its closely related species, and provides a dichotomous key to all species.

Materials and methods

The specimens of the new species were collected along the Aegean Sea coast of Türkiye and in the Çanakkale Strait (Sea of Marmara) at 27–80 m depth on sandy mud bottoms from 2005 to 2023. Sites were sampled using a van Veen grab, which sampled a total area of 0.1 m^2 (Figure 1, Table 1).

Samples were sieved through a 0.5 mm mesh, fixed with 5% formalin, and transferred to a laboratory, where they were washed with tap water through a 0.5 mm mesh, sorted under a stereomicroscope, and preserved in 70% ethanol. Specimens were measured with an ocular micrometer, and some were stained with Shirlastain A or methyl green to increase the contrast of the key morphological features and to highlight glandular structures. Photographs were taken with a digital camera (Olympus OM-D E-M5 Mirrorless) mounted on stereo- and binocular microscopes.

Scanning electron microscope (SEM) observations were carried out at the Central Research Test and Analysis Laboratory Application and Research Centre (EGE-MATAL, Ege University, Izmir, Turkey). Specimens were dehydrated in a graded ethanol series (70, 80, and 96%), transferred to absolute ethanol for 30 min, critical-point-dried with liquid CO_2 in a Leica EM

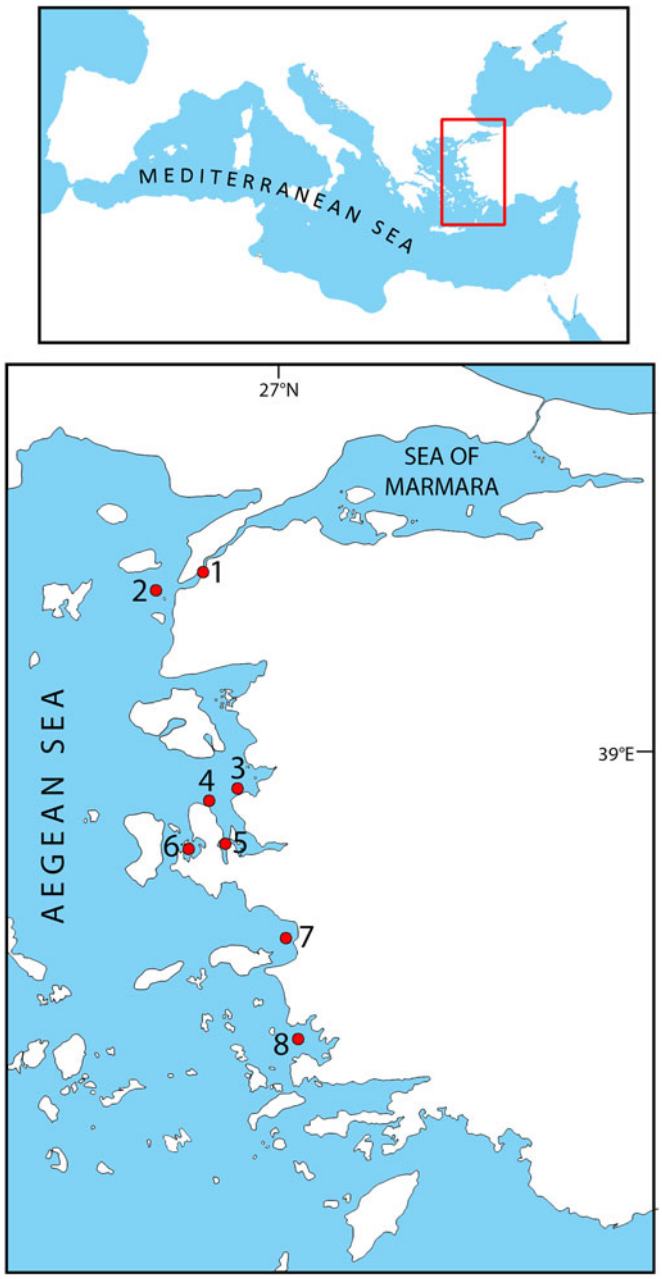

Figure 1. Study area showing the sampling sites.

CPD300, coated with gold (80%)–palladium (20%) in a Leica EM ACE600 sputter, and observed using a Thermo Scientific Apreo SEM.

All specimens were deposited at the Museum of the Faculty of Fisheries (ESFM) of the Ege University, at Izmir, Türkiye.

Result

Taxonomic account

Family TEREBELLIDAE Grube, 1850
Genus *Spinosphaera* Hessle, 1917
Type species: *Spinosphaera pacifica* Hessle, 1917, by monotypy
***Spinosphaera latachaeta* sp. nov.**
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(Figures 2–5, Table 2)

Material examined. Holotype: ESFM-POL/2017-219, station 8, Güllük Bay, 05.05.2017, 80 m. Paratypes: ESFM-POL/2005-3255, station 7, off Kuşadası, 08.10.2005, 50 m, 2 specimens (mounted for SEM); ESFM-POL/2013-1431, station 1, Çanakkale Strait, 06.06.2013, 50 m, 1 specimen; ESFM-POL/2017-216, station 6, Ildırı Bay, 13.10.2017, 60 m, 1 specimen; ESFM-POL/2017-217, station 8, Güllük Bay, 05.05.2017, 80 m, 3 specimens; ESFM-POL/2017-218, station 2, off Gökçeada, 14.05.2017, 45 m, 2 specimens; ESFM-POL/2021-003, station 4, off Karaburun, 19.08.2021, 71 m, 3 specimens (mounted for SEM); ESFM-POL/2021-004, station 5, Gülbahçe Bay, 22.08.2021, 27 m, 1 specimen; ESFM-POL/2023-001, station 3, off Foça, 4.10.2023, 58 m, 2 specimens; ESFM-POL/2023-002, station 4, off Karaburun, 27.09.2023, 70 m, 1 specimen.

Table 1. Sampling date, coordinates, habitat structure and depth of the stations

Stations	Coordinates	Date	Habitat	Depth (m)
1	40.11639°N, 26.36778°E	6.06.2013	Muddy sand	50
2	39.99278°N, 26.05222°E	14.05.2017	Sandy mud with pebbles	45
3	38.76110°N, 26.84040°E	4.10.2023	Maerl bed	58
4	38.68167°N, 26.51567°E	19.08.2021	Sandy mud with pebbles	71
		27.09.2023	Sandy mud with pebbles	70
5	38.43317°N, 26.65000°E	22.08.2021	Mud	27
6	38.39861°N, 26.33389°E	13.10.2017	Sandy mud with pebbles	60
7	37.86389°N, 27.22444°E	8.10.2005	Sandy mud with pebbles	50
8	37.24306°N, 27.26972°E	5.05.2017	Sandy mud with pebbles	80

Description. All specimens incomplete anterior fragments. Holotype: 6.3 mm long (4–18 mm in paratypes), 0.4 mm wide at chaetiger 7 (excluding parapodia) (0.4–1.2 mm in paratypes), with 29 chaetigers (16–43 in paratypes). Body yellowish in alcohol, lacking markings, elongate. Anterior segments dorsally inflated, slightly expanded laterally from chaetigers 7–9, weakly tessellated dorsally and ventrally, becoming smooth posteriorly after chaetigers lacking neuropodia (Figures 2A & 3A–C). Prostomium one basal annulation at base of upper lip, with many small brownish eye spots irregularly scattered laterally, and one distal annulation, smooth, semicircular, with buccal tentacles of one type, thick, cylindrical, weakly grooved, not annulated (Figure 3B, C).

Peristomium ventrally distinct, with a short, smooth, crescent-shaped upper lip with grooves leading to mouth, a swollen, oblong, longer than wide lower lip and a semicircular pharyngeal organ (Figures 3A, B & 4A). Segment 1 visible dorsally, ventrally, and laterally, forming ventral lobe below lower lip (Figures 3A–C & 4B). Lateral lobes absent. Segments 2 and 3 slightly thickened laterally (Figure 3B, C). Ventral shields from segments 2 to 22, one on each segment, oblong, wider than long, with smooth surfaces;

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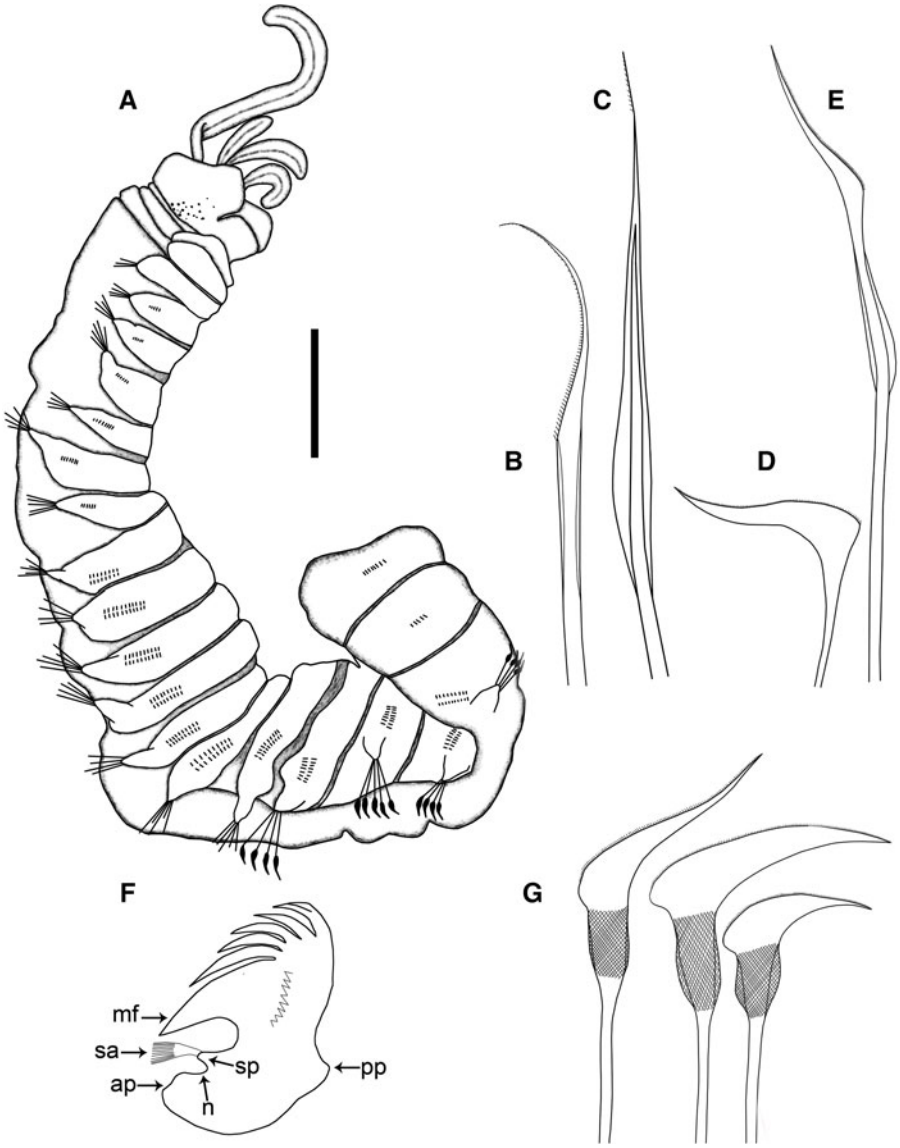

Figure 2. *Spinosphaera latachaeta* sp. nov. Holotype (ESFM-POL/2017-219): (A) lateral view; (B) saw-like chaeta of segment 6; (C) bilimbate chaeta of segment 6; (D) saw-like chaeta of segment 10; (E) *Spinosphaera*-chaeta of segment 10; (F) uncinus of segment 13; (G) *Spinosphaera*-like chaetae of segment 20. ap, anterior process; mf, main fang; n, notch; pp, posterior process; sa, subrostral appendix; sp, subrostral process. Scale bar: A, 850 µm; B, 57 µm; C, 22 µm; D, 57 µm; E, 57 µm; F, 20 µm; G, 67 µm.

shields on segments 2 and 3 shorter than subsequent ones (Figures 3A & 4A). Mid-ventral groove not observed. Branchiae absent.

Notopodia from segments 4 to 21 (Figures 2A & 4B), short, more or less triangular. Notochaetae in two rows of three types: bilimbate capillaries, saw-like, and *Spinosphaera*-chaetae (Figure 2B–E, G). Chaetigers 1–7 with bilimbate capillaries and saw-like only; bilimbate capillaries in posterior row, with asymmetrical wings, minutely serrated alimbate tip and alimbate proximal region (Figure 2C). Eight to ten saw-like in anterior row of chaetiger 1, until last parapodia; sickle-shaped on chaetigers 1–7, with serrated cutting edge, perpendicular to bilimbate shaft (Figure 2B), from chaetiger 8 to posterior end with serrated cutting edge (distal part) abruptly widening and bending at about 90° angle to shaft (Figures 2D; 3G; & 5A–F). From chaetigers 8–14, limbate capillaries suddenly change to *Spinosphaera*-chaetae; limbation limited to short middle part on chaetigers 7–14, with indistinct, colourless transverse spines and distal part with serrated cutting edge, slightly curved (Figures 2E; 3G; & 5D–G); from chaetigers 15 to 18, *Spinosphaera*-chaetae suddenly change to *Spinosphaera*-like chaetae, limbate and distal part completely fused, middle part greatly expanded, covered with distinct, orange spines and distal part abruptly bent at 90° angle, with serrated cutting edge convex, more or less triangular, largely expanded and a bulbous swelling at base of serration (Figures 2G; 3H; 4C; & 5F, H–K).

Neuropodia from segment 5 (chaetiger 2), as low ridges from body surface throughout. Uncini in single row on chaetigers 2–7, double rows (arranged face to face) on chaetigers 8–18, and single from chaetiger 19 to body end (Figures 2A & 4D–G). Uncini short-handled and similar on all segments; posterior process (i.e. heel) triangular with smooth tip; a downwardly directed anterior process broad and rounded (i.e. prow); a subrostral process (i.e. dorsal button) at about proximal third, between base of main fang and tip of anterior process; subrostral appendix brush-shaped, extending beyond main fang tip; a deep notch just below subrostral process, at around midway distance between base of main fang and tip of anterior process. Main fang surmounted by about five rows of pointed teeth; first row of secondary teeth in front of others in anterior body, then in the same line in posterior body (Figure 4H, I); minute teeth on lateral side of rostrum (Figures 2F; 3D,E; & 4H, I). Nephridial papillae not observed. Pygidium unknown.

Methyl green pattern. Posterior ventral margin of segment 1 stained with rectangular to trapezoidal shape. Ventral shields of segments 1–14 stained deeply (Figure 3A). Remaining structures lightly stained.

Reproduction. A specimen from Ildırı Bay in the Aegean Sea, collected in October, had coelomic oocytes (150–260 µm in diameter) from chaetiger 20 to the posterior body end.

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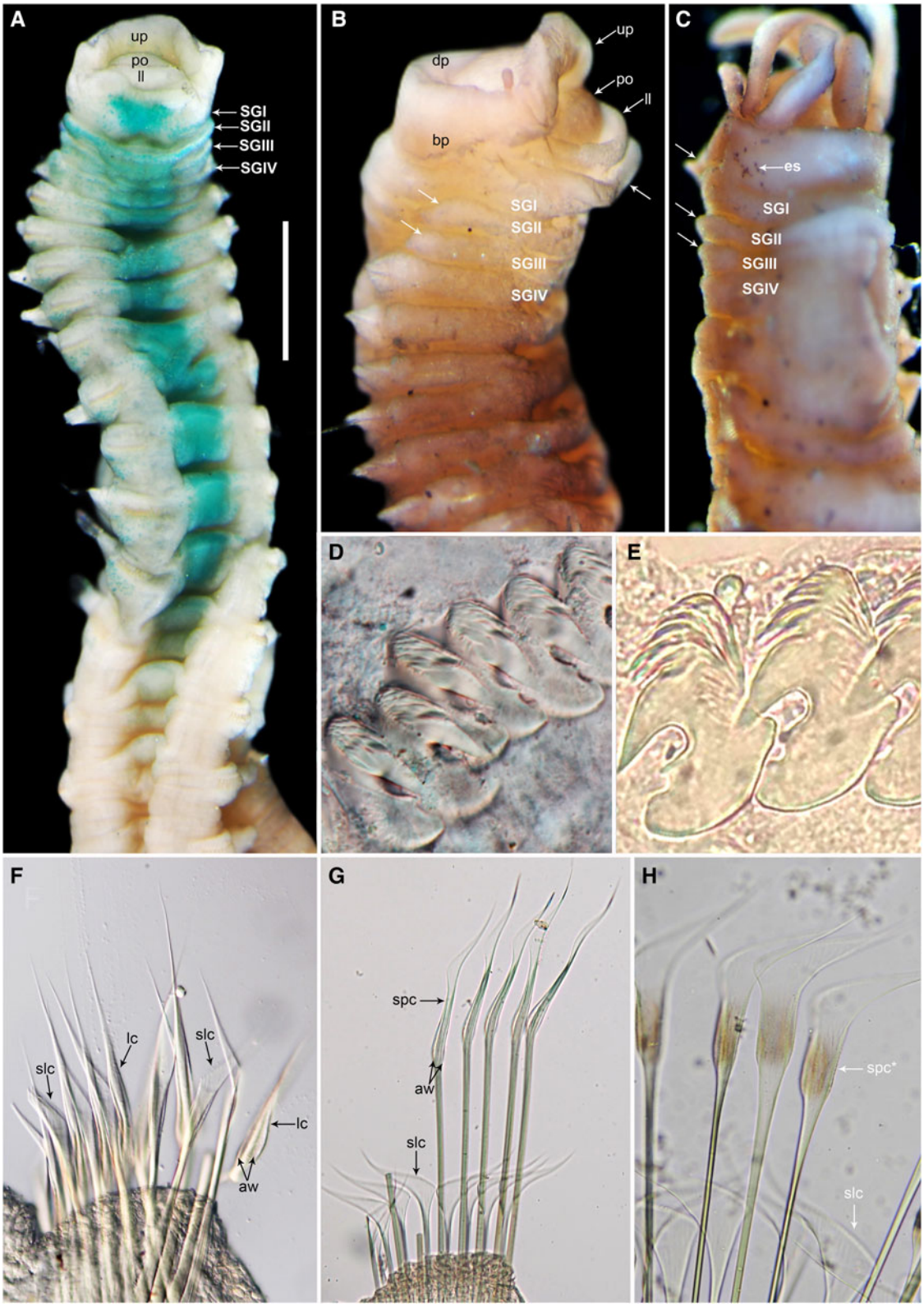

Figure 3. *Spinosphaera latachaeta* sp. nov. (A) ventral view, methyl green stained (ESFM-POL/2005-3255); (B) antero-lateral view, Shirlastain A stained (ESFM-POL/2017-216), arrows point to thickening; (C) antero-dorsal view of body stained with Shirlastain A (ESFM-POL/2017-219), arrows pointing to thickening; (D) uncini of segment 6 (ESFM-POL/2023-001); (E) uncini of segment 25 (ESFM-POL/2017-216); (F) Notochaetae of segment 6 (ESFM-POL/2023-001); (G) Notochaetae of segment 12 (ESFM-POL/2017-216); (H) *Spinosphaera*-like chaetae of segment 20 (ESFM-POL/2017-216). Roman numbers: segment numbers. aw, asymmetrical wings; bp, basal part of prostomium; dp, distal part of prostomium; es, eye spots; ll, lower lip; up, upper lip; po, pharyngeal organ; lc, limbate chaeta; slc, saw-like chaeta; spc, *Spinosphaera*-chaetae before chaetiger 18; spc*, *Spinosphaera*-like chaetae from chaetiger 18 and after; SG: segment. Scale bar: A, 550 μm; B, 450 μm; C, 650 μm; D, 21 μm; E, 28 μm; F, 90 μm; G, 105 μm; H, 76 μm.

Etymology. The species name refers to the broad ('lata' in Latin) shape of the *Spinosphaera*-like chaeta.

Type locality. Güllük Bay, Aegean Sea, eastern Mediterranean, Türkiye.

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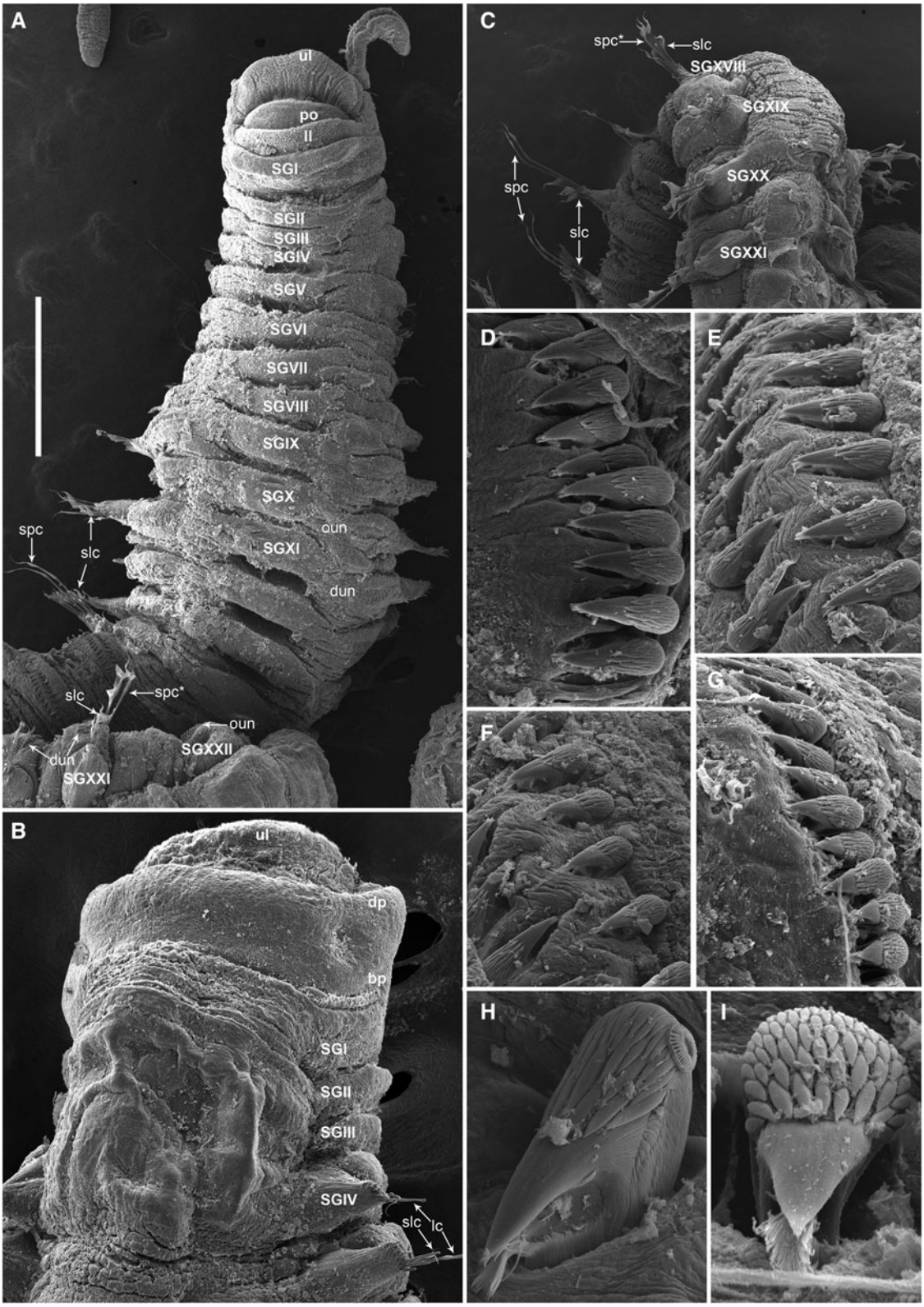

Figure 4. *Spinosphaera latachaeta* sp. nov. (ESFM-POL/2005-3255): (A) antero-ventral view; (B) antero-dorsal view; (C) segments containing last notopodia; Uncini: (D) segment 7; (E) segment 11; (F) segment 21; (G) segment 23; Uncinus: (H) segment 15; (I) segment 23. Roman numbers: segment numbers. bp, basal part of prostomium; dp, distal part of prostomium; ll, lower lip; ul, upper lip; po, pharyngeal organ; dun, double rows of uncini; oun, one row of uncini; lc, limbate chaeta; slc, saw-like chaeta; spc, *Spinosphaera*-chaetae before chaetiger 18; spc*, *Spinosphaera*-like chaetae chaetiger from 18 and after; SG: segment. Scale bar: A, 550 μm; B, 276 μm; C, 597 μm; D, 28 μm; E, 43 μm; F, 36 μm; G, 30 μm; H, 11 μm; I, 7 μm.

Ecology and distribution. Found on sandy mud bottoms and maerl beds in the Aegean Sea and the Sea of Marmara between 27 and 80 m depth.

Discussion

Spinosphaera latachaeta sp. nov. is mainly characterized by having 11 pairs of broad *Spinosphaera* chaetae and 18 pairs of

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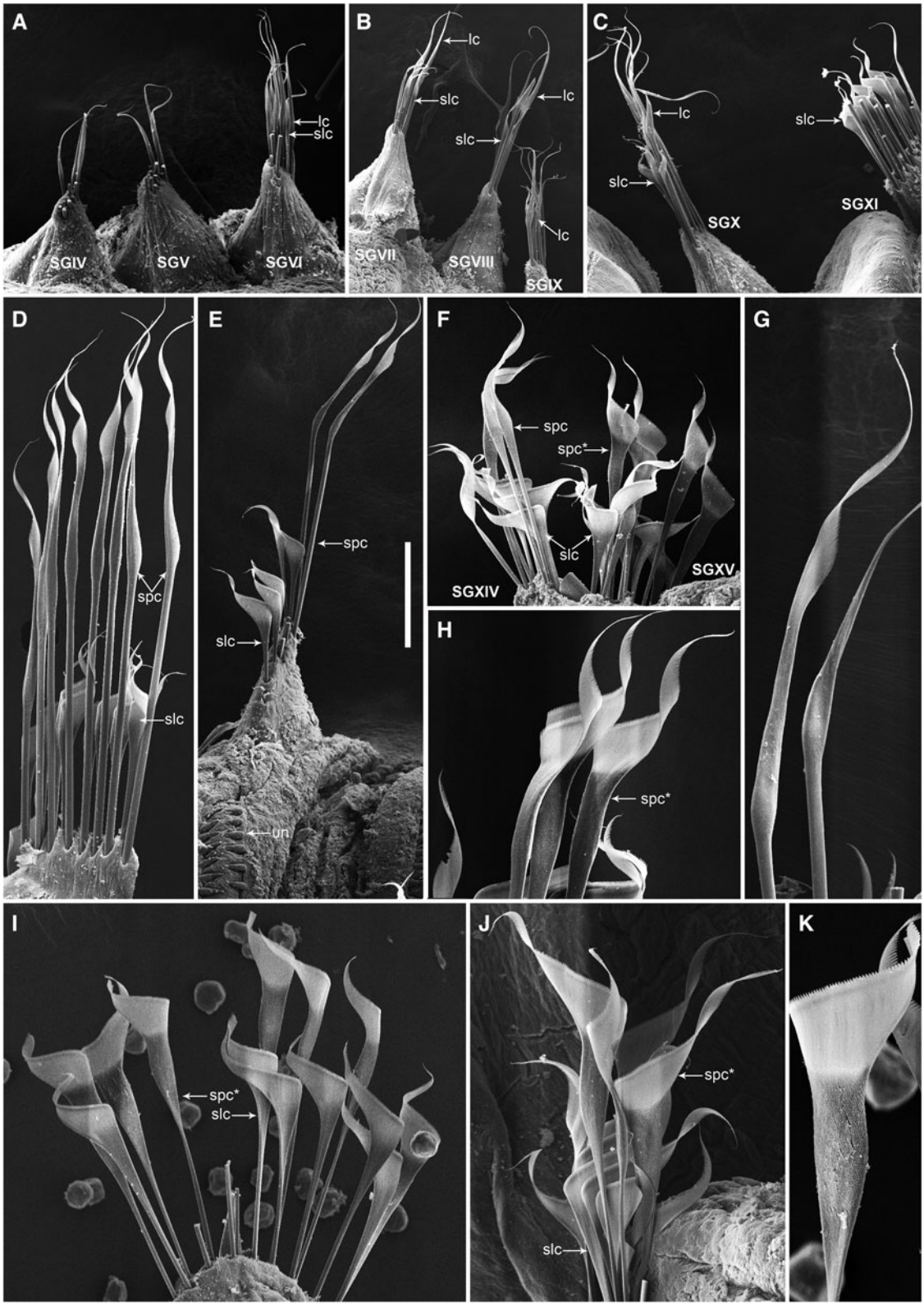

Figure 5. *Spinosphaera latachaeta* sp. nov. (ESFM-POL/2021-003). Notopodia: (A) chaetigers 1–3; (B) chaetigers 4–6; (C) chaetigers 7 and 8; (D) Notochaetae of chaetiger 10; (E) parapodium of chaetiger 12; (F) Notochaetae of chaetigers 14 and 15; (G) *Spinosphaera*-chaetae of chaetiger 12. *Spinosphaera*-like chaetae: (H) of chaetiger 15; (I) of chaetiger 16; (J) of chaetiger 17; (K) enlargement of the spiny region. Roman numbers: segment numbers. lc, limbate chaeta; slc, saw-like chaeta; spc, *Spinosphaera*-chaetae before chaetiger 18; spc*, *Spinosphaera*-like chaetae on chaetiger 18 and after; SG: segment. Scale bar: A, 128 μm; B, 157 μm; C, 117 μm; D, 68 μm; E, 108 μm; F, 34 μm; G, 93 μm; H, 40 μm; I, 69 μm; J, 30 μm; K, 10 μm.

notopodia ending on the last segment with the double rows of uncini. The new species resembles *Spinosphaera carrerai*, a Caribbean species, in that it has double rows of uncini, and notopodia are placed on the same segments, which distinguishes them from the other species such as *Spinosphaera barega*, *Spinosphaera harrisae*, and *Spinosphaera pacifica* (ending before the last notopodia), and *Spinosphaera hutchingsae* and *Spinosphaera oculata* (ending after the last notopodia) (Table 2). A notch below the

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Table 2. Diagnostic features of all species of *Spinosphaera*

Species	Type locality	Notopodium pairs	Number of chaetigers with *Spinosphaera* chaeta	First chaetiger with *Spinosphaera* chaeta first occurring	End of double rows of uncini	Ventral shields	Notch in uncinus	Eye spots	Reference
Spinosphaera latachaeta sp. nov.	Eastern Mediterranean, Türkiye	18	11	8 (segment 11)	Segment 21	21 pairs	Present	Present	This study
Spinosphaera barega	Abrolhos Islands, Western Australia	23	16	8 (segment 11)	Segment 25	13 pairs	Present	Present	Nogueira and Hutchings (2007)
Spinosphaera carrerai	Off Punta Herradura, Mexican Caribbean Sea	15	9	7 (segment 10)	Segment 75 (close to the pygidium)	11 pairs	Absent	present	Londoño-Mesa (2003)
Spinosphaera harrisae	Off San Diego, California, USA	20	13	8 (segment 11)	Segment 22	10–11 pairs	Absent	Present	Londoño-Mesa (2003)
Spinosphaera hutchingsae	Contoy Islands, Mexican Caribbean Sea	22	15	8 (segment 11)	Segment 35 (end of the fragment)	11 pairs	Absent	Present	Londoño-Mesa (2003)
Spinosphaera oculata	Tomales Point, California, USA	41	34	8 (segment 11)	Close to pygidium	13 pairs	Absent	Present	Londoño-Mesa (2003)
Spinosphaera pacifica	Japan	23	16	8 (segment 11)	Segment 25	Unknown	Absent	Absent	Hessle (1917)

subrostral process is present in *S. latachaeta* sp. nov. and *S. barega*, whereas it is absent in other species. Notopodia are 18 pairs in *S. latachaeta* sp. nov., in contrast 23 pairs in *S. barega* and *S. pacifica*, 15 pairs in *S. carrerai*, 20 pairs in *S. harrisae*, 22 pairs in *S. hutchingsae*, and 41 pairs in *S. oculata*. The *Spinosphaera*-like chaeta is present on 11 chaetigers in *S. latachaeta* sp. nov., whereas it is present on 16 chaetigers in *S. barega*, on 9 chaetigers in *S. carrerai*, on 13 chaetigers in *S. harrisae*, on 15 chaetigers in *S. hutchingsae*, on 34 chaetigers in *S. oculata*, and on 16 chaetigers in *S. pacifica*. The ventral shields are present on 21 segments in *S. latachaeta* sp. nov., whereas on 13 segments in *S. barega* and *S. oculata*, and on 10–11 segments in *S. carrerai*, *S. hutchingsae*, and *S. harrisae* (Table 2).

Spinosphaera contains only six species worldwide (Table 2), all characterized by having the *Spinosphaera*-chaetae first described by Hessle (1917) and later in more detail by Nogueira *et al.* (2010). The transition from limbate to *Spinosphaera*-chaetae occurs suddenly at segment 11 (chaetiger 8) (Nogueira *et al.*, 2010) in all species, including *S. latachaeta* sp. nov., except in *S. carrerai* (chaetiger 7) (Table 2). *Spinosphaera latachaeta* sp. nov. has the saw-like chaeta sickle-shaped in the anterior-most chaetigers, with the serrated distal part perpendicular to the shaft, and then become broad, with the serrated distal part bending at almost 90° to the shaft in most posterior chaetigers (Figures 2B, D; 3G, H; 4C & 5C, I). However, the currently available information does not allow us to assess whether this is a unique feature of the new species or has been overlooked or undescribed in other species of the genus.

The *Spinosphaera*-chaetae are divided into three regions: limbate, hirsute, and distal serrated blade (Nogueira *et al.*, 2010). *Spinosphaera*-chaetae that include all three regions are only present in *S. barega*, *S. harrisae*, and *S. pacifica*, while *S. carrerai*, *S. hutchingsae*, and *S. oculata* lack the limbate regions (Londoño-Mesa, 2003). Nogueira *et al.* (2010) suggested that the last three species will need to be placed in another genus. However, the description of *S. carrerai* included an illustration of the *Spinosphaera*-like chaetae from segment 15, where only the hirsute and blade regions are present (see figure 2C in Londoño-Mesa, 2003), as in *S. latachaeta* sp. nov. The *Spinosphaera*-like chaetae without the limbate region illustrated for *S. hutchingsae* was indicated as belonging to segment 11, but it might have belonged from a more posterior chaetiger, as shown in the SEM photograph (see figures 1D and 4D in Londoño-Mesa, 2003). The chaetae described for *S. oculata* are from a posterior segment, which only have chaetae with hirsute and blade regions (see plate 22 and figures 33 and 34 in Hartman, 1944). However, a recent redescription of the paratype illustrates a chaeta from segment 20, which also lacks the limbate region (see figure 5D in Londoño-Mesa, 2003). Therefore, the presence of *Spinosphaera*-chaetae with the limbate region in anterior chaetigers may have been overlooked for *S. carrerai*, *S. hutchingsae*, and *S. oculata*. In *S. latachaeta* sp. nov., the characteristic limbate region of *Spinosphaera*-chaetae disappears in posterior notopodia (chaetigers 15–18), where the limbation is not present as a separate region and the wings remain as thin structures at the margins within the broad spiny region (Figures 2G; 3H & 5H–K). In addition, the chaetigers have hirsute regions with orange-coloured spines that are significantly larger than those in the preceding chaetigers, while the blade tip is twice as wide as the spiny region (Figure 5J, K). The transformation of *Spinosphaera*-chaetae has not been described for any other species in the genus, and again further observations are required to confirm whether it is a species-specific characteristic or one that is widespread and previously overlooked character.

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Key to all species of *Spinosphaera*

1. Double rows of uncini and notopodia ending on same segment 2
   – Double rows of uncini and notopodia not ending on the same segment 3
2. 15 pairs of notopodia, *Spinosphaera*-chaetae on 9 segments . . . . . *S. carrerai* Londoño-Mesa, 2003
   – 18 pairs of notopodia, *Spinosphaera*-chaetae on 11 segments . . . . . .*S. latachaeta* sp. nov.
3. Double rows of uncini ending before last notopodia 4
   – Double rows of uncini ending after last notopodia 6
4. 23 pairs of notopodia 5
   – 20 pairs of notopodia.. . . . . *S. harrisae* Londoño-Mesa, 2003
5. Eyespots present. . . . . .*S. barega* Nogueira & Hutchings, 2007
   – Eyespots absent . . . .*S. pacifica* Hessle, 1917
6. 22 pairs of notopodia, *Spinosphaera*-chaetae on 15 segments . . . . . *S. hutchingsae* Londoño-Mesa, 2003
   – 41 pairs of notopodia, *Spinosphaera*-chaetae on 34 segments . . . . . *S. oculata* Hartman, 1944

Data. The data that support this study are available in the study.

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Author contributions. Deniz Erdoğan-Dereli: writing – original draft, investigation, data curation, and conceptualization. Melih Ertan Çinar: writing – original draft, investigation, methodology, validation, funding acquisition, and conceptualization.

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Competing interests. None.

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