



Three new serpulids (Polychaeta: Serpulidae) from the Brazilian Exclusive Economic Zone

JOÃO MIGUEL DE MATOS NOGUEIRA¹ & ADRIANO ABBUD

Departamento de Zoologia, Instituto de Biociências, Universidade de São Paulo - USP, Rua do Matão, travessa 14, nº 101, 05508-900, SP, Brazil. E-mail: nogueira@ib.usp.br

¹Corresponding author

Abstract

Three new species of serpulids from Brazil are described herein, two of which were described, but not named, by Zibrowius are here considered as new species and given specific names. *Vermiliopsis zibrowii* sp. nov. is characterized by an operculum with a single endplate or several septa progressively nearer to each other towards the tip and which are separated by conspicuous ribs. *Pseudovermilia harryi* sp. nov. has an operculum with several septa separated by short ribs and its tube is different from similar congeners. *Filogranula revizee* sp. nov. has an operculum with a sunken funnel and, frequently, a slender, distally sharp spine. Comparisons between these three species and related species are provided.

Key words: Polychaeta, Serpulidae, *Vermiliopsis*, *Pseudovermilia*, *Filogranula*, Brazil

Resumo

Três espécies novas de serpulídeos do Brasil são aqui descritas, duas das quais já haviam sido descritas, mas não nomeadas, por Zibrowius, são aqui consideradas como espécies novas para a ciência e a elas são atribuídos nomes específicos. *Vermiliopsis zibrowii* sp. nov. é caracterizada pelo opérculo com placa distal única, ou com diversos septos progressivamente mais próximos entre si em direção à ponta, separados uns dos outros por costelas marcadas. *Pseudovermilia harryi* sp. nov. tem opérculo com diversos septos separados entre si por curtas costelas e tubos diferentes daqueles dos congêneres mais parecidos. *Filogranula revizee* sp. nov. tem opérculo com um funil afundado no bulbo e, frequentemente, uma espinha fina e pontiaguda. São fornecidas comparações entre estas três espécies e os congêneres mais parecidos.

Introduction

Although very common in marine environments, especially in hard substrates such as rocks, corals, and shells, serpulids are one of the most difficult families of polychaetes to work with. Most of the known taxa are extremely variable and overlap with closely related taxa, often making it difficult to establish the limits between species; frequently specimens cannot be identified beyond genus (e. g., see Zibrowius 1970; ten Hove & Wolf 1984; Bastida-Zavala & Salazar-Vallejo 2000a).

Besides the great intraspecific variability, characters used to distinguish taxa are often confusing and difficult to study. Chaetae, for example, present little variation within many genera and the shape of opercula and tubes seem to be more useful. However, tubes are rarely preserved after extraction of

the worms and specialists frequently receive material without or with incomplete tubes, as in the case of *Filogranula revizee* sp. nov.

In an attempt to find more characters for phylogenetic purposes, we describe here the arrangement of capillaries of two of our new species as revealed with SEM. The arrangement of thoracic notochaetae and abdominal neurochaetae is known to be of taxonomic value in the related sabellids (Knight-Jones 1983; Fitzhugh 1989); however, this character is not mentioned in the literature of serpulids and was not used in recent morphological reviews (ten Hove & Kupriyanova 2009) or phylogenetic analyses of the family (Kupriyanova 2003; Kupriyanova et al. 2006). We suggest that subsequent authors investigate this character, to check if it is also useful in the systematics of Serpulidae.

Few taxonomic studies have dealt with Brazilian serpulids. Zibrowius (1970) conducted a major survey of serpulids along most of the Brazilian coast; ten Hove (1975) included Brazilian material in his review of *Pseudovermilia* Bush, 1907; Nonato & Luna (1970), Santa-Isabel et al. (2000) and Neves & Omena (2003) recorded serpulids as part of benthic studies off the northeastern coast; Rullier & Amoureux (1979) inventoried the polychaete fauna along the Atlantic coast of South America; Silva et al. (1980) studied the encrusting communities in Guanabara Bay, Rio de Janeiro; and Nogueira & ten Hove (2000) described a new species of *Salmacina* Claparède, 1870 from São Paulo.

In addition, several unpublished theses, most of them focused on ecology, also recorded species of serpulids (e.g., Morgado 1980; Rocha 1993; Attolini 1997; Nogueira 2000), but the serpulids in Brazilian waters are still poorly known, especially for the subfamily Spiorbinae.

In this paper, we describe three new species of Serpulidae collected by the REVIZEE Project along southeastern shelf and slope off Brazil, from 50–650 m. Two of these species, *Vermiliopsis zibrowii* sp. nov. and *Filogranula revizee* sp. nov. were already described by Zibrowius (1970; as *Vermiliopsis* sp., in part, and *Omphalopoma* sp., respectively).

Materials and methods

The REVIZEE Project analyzed the entire fauna in the Brazilian Exclusive Economic Zone (EEZ), up to 200 miles off the coast. Collections were made with dredges, box corers, and van-Veen grabs. Material was immediately fixed in 4 % formalin, identified to family level and preserved in 70 % ethanol.

We received the Serpulidae from Cabo de São Tomé, in the State of Rio de Janeiro, to Arroio do Chuí, in the State of Rio Grande do Sul, and, for the present paper, dealt with samples from Cabo de São Tomé to Baía de Paranaguá, in the State of Paraná.

For identification, specimens or detached parapodia were mounted in glycerin-jelly on semi-permanent slides, and observed under a high-power light microscope. Drawings were made with the aid of a drawing tube from slide-mounted specimens or from animals in Petri dishes observed under a stereomicroscope.

Eleven specimens of *Vermiliopsis zibrowii* sp. nov., 11 of *Pseudovermilia harryi* sp. nov., and 3 of *Filogranula revizee* sp. nov., covering as much of the variation within each taxon as possible, were studied in detail to describe the characteristics of the species. Type-material was deposited at Museu de Zoologia, Universidade de São Paulo (MZUSP), Brazil, Zoological Museum of Amsterdam (ZMA), the Netherlands, and Zoological Museum, University of Copenhagen (ZMUC), Denmark.

The descriptions of the species were made from the whole type-series of each species, data from the holotype are shown between parentheses immediately after the range of variation within the

type-series, for each character. Measurements were taken as follows: *body*: from base of collar to pygidium; *crown*: from base to tip of radioles; *width*: at the widest point of thorax; *diameter of operculum*: at the base of horn cap. The precise number of abdominal segments was not possible to count due to inconspicuous segmentation and therefore a range of variation is provided for each specimen of the type-series.

Photos of specimens were taken in a Petri dish with black wax on bottom. Images of specimens photographed at different focal lengths were made using an Olympus C-7070 digital camera. All photos were edited with Adobe Photoshop CS software.

Specimens of *Vermiliopsis zibrowii* sp. nov. and *Pseudovermilia harryi* sp. nov. were critical-point dried, coated with 30 nm of gold, and observed with the scanning electron microscope (SEM) at the Laboratório de Microscopia Eletrônica, Universidade Estadual de Campinas (UNICAMP).

Results

Family Serpulidae Rafinesque, 1815

Subfamily Serpulinae Rafinesque, 1815

Vermiliopsis Saint-Joseph, 1894

Type species: *Vermilia multivaricosa* Mörch, 1863, new name for *Vermilia infundibulum* Philippi, 1844, designated by Bush (1905).

Diagnosis. Tubes with flaring peristomes along their extension; with cylindrical to conical operculum, distal horn cap divided by internal septa visible on the outside as annuli. Opercular stalk in cross-section rounded to slightly flattened distally, with annulations throughout. Thorax with seven chaetigers. Collar chaetae all limbate, organized in two rows, the anterior row with longer chaetae with wider limbatation. From chaetiger 2 onwards, thoracic notopodia as short cones, with chaetae arranged in two longitudinal groups; superior (dorsal) group with long, limbate chaetae, arranged in an arc at dorsal base of notopodial cone; inferior (ventral) group on top of notopodial cone, with limbate chaetae alternating with much thinner, almost alimbate chaetae; inferior limbate chaetae replaced by *Apomatus*-chaetae somewhere on thorax, depending on taxon. Abdominal neuropodia with geniculate chaetae with triangular dentate blades and elongate capillaries on posteriormost chaetigers. Thoracic uncini saw-shaped and elongate, with rounded to pointed, never curved, anterior peg. Abdominal uncini rasp-shaped, at least posteriorly; anterior peg as in thoracic uncini.

Remarks. *Vermiliopsis* is one of the several genera of Serpulidae with a very complicated taxonomic history. As initially defined, the genus comprised species of serpulids with opercular stalks lacking both pinnules and wings, collar chaetae exclusively limbate chaetae and *Apomatus*-chaetae present on some thoracic notopodia (Saint-Joseph 1894). However, Bush (1905, 1907a–b, 1910) recognized that this group included species with very different morphologies of uncini and thoracic membranes of variable lengths and proposed a new classification, dividing it into four genera: *Vermiliopsis* s.s., *Paravermilia* Bush, 1905, *Pseudovermilia* Bush, 1907 and *Metavermilia* Bush, 1905, all of which were later considered as synonyms by Hartman (1959).

Believing that a group with such great variation in regards to uncini and thoracic membranes could not represent a natural unit, Zibrowius initially resurrected *Pseudovermilia* (Zibrowius 1968a, 1970), then *Metavermilia* (Zibrowius 1971). Zibrowius (1973a) reviewed some abyssal serpulids and found that they did not fit into any previously described genus and erected *Bathyvermilia* Zibrowius, 1973 to accommodate these species. Finally, to accommodate several aberrant species that had been identified only as “? *Vermiliopsis*” by Zibrowius (1972, 1973b), ten Hove (1975) erected

another genus, *Semivermilia* ten Hove, 1975.

Therefore, the former *Vermiliopsis* is now divided into five genera: *Vermiliopsis* s.s., *Bathyvermilia*, *Metavermilia*, *Pseudovermilia* and *Semivermilia*, which are separated by the morphology of the tubes (with or without flaring peristomes) and opercular stalk (in cross section cylindrical or flattened and ribbon-like), the insertion of the opercular stalk (as first or second radiole), length of the thoracic membrane and by the morphology of the anterior peg of uncini (curved or not). For more details regarding the differences between those genera, see Zibrowius (1968a, 1970, 1971, 1972, 1973a, b) and ten Hove (1975).

The *Vermiliopsis*-group is traditionally considered as belonging to the subfamily Serpulinae, however recent phylogenetic analysis (Kupriyanova et al. 2006; Lehrke et al. 2007) have suggested that this group is closer to the Filograninae and the Spirorbinae than to the Serpulinae, although Kupriyanova et al. (2006) have considered that more extensive taxon sampling and further molecular and morphological data were required to confirm those results. Because of that, in this paper we follow the traditional classification and consider the group as belonging to the subfamily Serpulinae.

In Brazil, the only record of the genus came from Zibrowius (1970), who described a *Vermiliopsis* sp., part of which is possibly the same species we describe here (see below). Nonato & Luna (1970) identified one specimen from the state of Alagoas, NE Brazil, as *V. acanthophora* Augener, 1914; however, ten Hove (1975) considered that record a misidentification and assigned the specimen to *Pseudovermilia fuscostriata* ten Hove, 1975.

***Vermiliopsis zibrowii* sp. nov.**

Figures 1A–B, 2–4, 5D–F; Tables 1–2

Vermiliopsis sp. Zibrowius, 1970: 7–8, pl. 1, figs. 7–17, in part.

Material examined. Type series. Holotype and paratype 1 from Sta. 6754 (23°26.700'S 42°14.050'W), 17 Feb 1998, dredge, 131 m; **holotype** (Fig. 1A–B) and paratype 1 (Fig. 3H) complete specs, extracted from the tubes. Paratypes 2–4 from Sta. 6661 (24°07.113'S 43°52.198'W), 9 Jan 1998, dredge, 50 m; paratype 2 complete spec., extracted from the tube, paratypes 3–4 inside the tubes (Fig. 3A). Paratypes 5–6 from Sta. 6665 (24°20.844'S 44°09.913'W), 10 Jan 1998, box corer, 258 m; paratypes 5–6 complete specs, extracted from the tubes. Paratypes 7–10 from Sta. 6669 (24°07.421'S 42°42.220'W), 11 Jan 1998, dredge, 101 m; paratypes 7–9 complete specs, extracted from the tubes, paratype 10 inside the tube (Fig. 3B). Morphological data for each specimen from the type-series is provided in Table 1. Type-material deposited as follows: holotype and paratypes 1–3 at the MZUSP (holotype: MZUSP 00589; paratypes: MZUSP 00590), paratypes 4–7 at the ZMA (ZMA V.Pol. 5372) and paratypes 8–10 at the ZMUC (ZMUC-POL-2015).

Additional material. Sta. 6658 (25°11.890'S 47°08.090'W), 16 Dec 1997, 34 specs and 1 operculum, dredge, 50 m. Sta. 6661 (24°07.113'S 43°52.198'W): 9 Jan 1998, dredge, 150 m, 6 specs. Sta. 6739 (24°02.580'S 43°30.800'W), 14 Feb 1998, dredge, 147 m, 4 specs and 1 operculum. Sta. 6762 (23°26.315'S 41°13.887'W), 28 Feb 1998, dredge, 150 m, 2 specs.

FIGURE 1. *Vermiliopsis zibrowii* sp. nov., holotype (MZUSP 00589), A, whole worm, ventral view; B, anterior end, dorsal view. *Pseudovermilia harryi* sp. nov., holotype (MZUSP 00591), C, whole worm, right lateral view; D, anterior end, left lateral view. *Filogranula revizee* sp. nov. E–F, holotype (MZUSP 00593), right ventrolateral and right dorsolateral views, respectively; G–H, opercula; photo G from paratype 1, photo H from paratype 2 (both paratypes MZUSP 00594); I, fragment of the tube. All photos from stereomicroscope. Scale bars: A–B, D = 2 mm; C, I = 1 mm; E–F = 0.5 mm; G–H = 0.25 mm.



Material from other taxa used for comparison. *V. annulata*, 3-keeled form, Netherland Antilles, Curaçao, Santa Marta Baai, second lagoon, Sta. 1332, 3 specs extracted from the tubes and many tubes, 3 Mar 1955, legit P. Wagenaar Hummelinck; 5-keeled form, Netherland Antilles, Curaçao, Spaanse Water, Brakkeput Ariba, NE Isla Grandi, Sta. 2075C, 4 specs, 10 opercula and 3 specs inside the tubes, 4 Sep 1970, legit H.A. ten Hove.

Description. Measurements. Body 1.5–15.8 mm long, 0.3–2 mm wide, with 7 thoracic and 23–80 abdominal chaetigers; paratype 9 shortest specimen, measuring 1.5 mm in length, by 0.3 mm in width, with 23–28 abdominal segments; holotype longest specimen, measuring 15.8 mm, by 2 mm in width, with 63–68 abdominal segments (Table 1).

Tube. Roughly circular in cross section, with five longitudinal keels along superior midline and irregularly placed peristomes; keels dentate in most specimens. Laterally, tubes with short transverse growth-lines, which are not elevated enough to be considered real ridges (Figs. 3A–B, 5D–E). All those structures may be inconspicuous due to erosion.

Operculum. Opercular stalk inserted between first and second dorsalmost radioles of either side of crown, lower than bases of radioles; stalk basally rounded and smooth, progressively widening laterally towards distal end, with irregular annulations along entire length, last annulation wider and distinctly longer than others (Figs. 2A, 3I–L, 5F). Opercular bulb white, fleshy and cup-shaped, with distal dark brown horn cap divided by 1–7 (1) flat and concave septa (Figs. 1A–B, 2A, 3A–B, H–L, 5F); most specimens, including holotype, with horn cap with single endplate, concave or dome-like on top (dome-like; Table 1). Specimens with more than one septum on horn cap, with second septum about same size as basal septum and following septa, if present, progressively closer to each other (superficially with progressively narrower annuli) and not centered, roughly aligned on one side; conspicuous separation between annuli, forming ribs (Fig. 3H, K). Diameter of opercular horn cap varying between 0.35–1.95 (1.95) mm (Table 1); diameter of horn cap strongly related to size. Pseudoperculum absent in all specimens.

Branchial crown. With 5–28 (28) pairs of radioles (Table 1) in a pectinate arrangement, radioles 0.9–11 (11) mm long (Table 1), progressively shorter from dorsal to ventral sides of body (Fig. 1A–B). Distal half of radioles with 1–2 rows of irregularly placed, conspicuously lensed eyespots, transparent in fixed material (Fig. 2D).

Body. Collar with one pair of dorsolateral lobes and one pair of higher ventral lobes (Figs. 1A–B, 3C–E); thoracic membrane extending to chaetiger 5 (Figs. 2A, 3C). Anterior abdominal chaetigers with segmentation poorly marked, inconspicuous; middle abdominal segments long, with conspicuous segmentation; last 15–20 chaetigers short and compact.

Collar chaetae arranged in two oblique rows, both with slender and limbate chaetae, those from posterior row much thinner, almost alimbate (Fig. 4A). From chaetiger 2, thoracic notopodia as short cones, with chaetae arranged in two longitudinal groups; dorsal group with long, limbate chaetae, arranged in an arc at dorsal base of notopodial cone (Figs. 4B–C); ventral group with limbate chaetae (Figs. 2F, 4B–C) alternating with much thinner, almost alimbate chaetae; on chaetigers 2–3, ventral limbate chaetae slightly curved, sickle-shaped, but without typically serrated blades which characterize *Apomatus*-chaetae (Figs. 2F, 4B–C); typical *Apomatus*-chaetae replacing these limbate chaetae on chaetigers 4–7, with short, rounded teeth (Figs. 2E, 4D–E). Thoracic neuropodia with progressively longer tori (Figs. 2A, 3D); tori with saw-shaped uncini progressively longer towards ventral edge of tori (Fig. 4F); uncini with entire anterior peg and about 12 teeth on anterior chaetigers (Fig. 4F), posteriorly with 14–17 teeth in a single row (Fig. 2B), occasionally with pair of teeth immediately above peg.

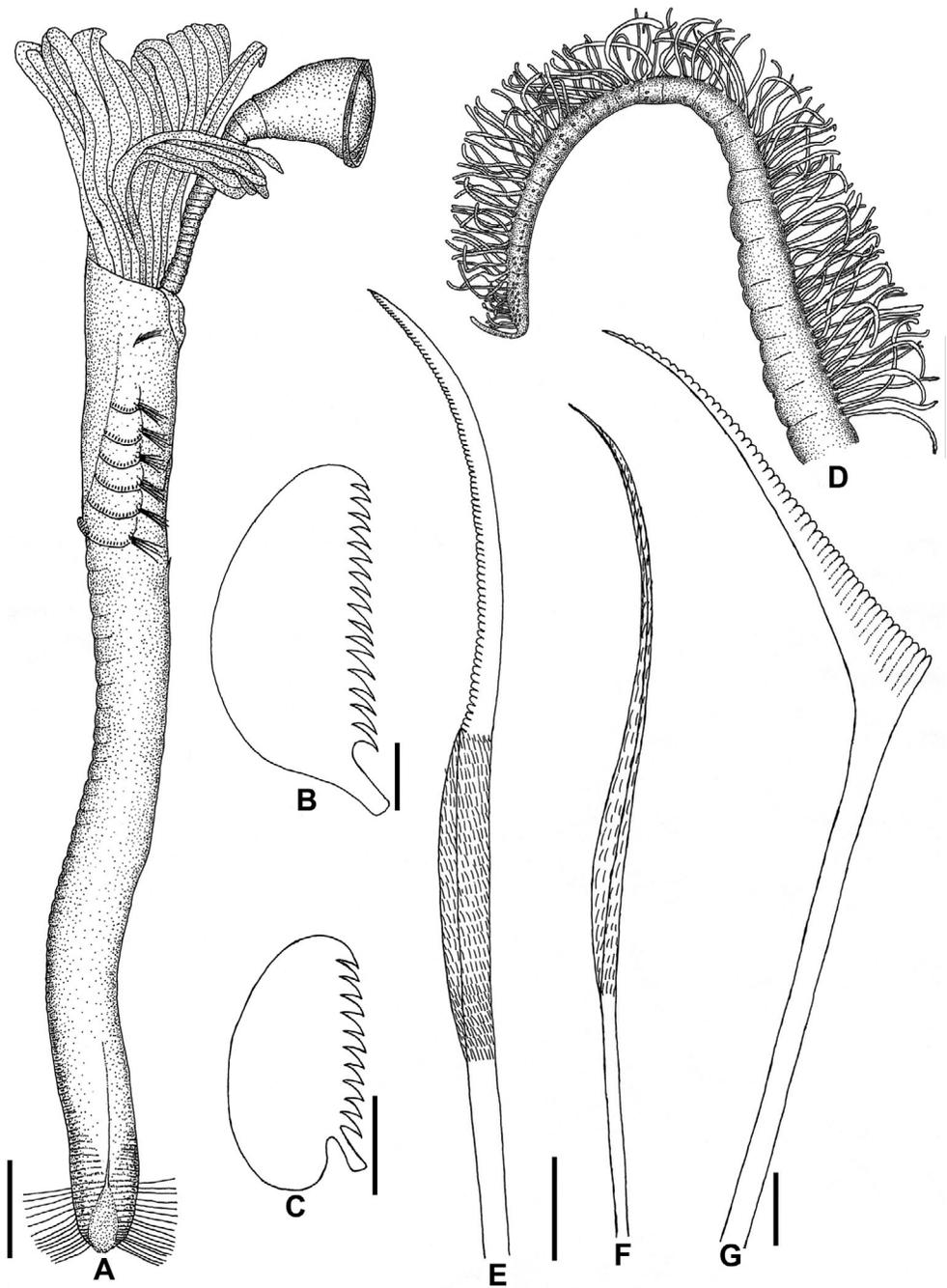


FIGURE 2. *Vermiliopsis zibrowii* sp. nov. A, paratype 2 (MZUSP 00590), left lateral view; B, thoracic uncinus; C, abdominal uncinus; D, radiole; E, *Apomatus*-chaeta; F, thoracic limbate chaeta; G, abdominal neurochaeta. Scale bars: A, D = 1 mm; B–C, E–G = 10 µm.

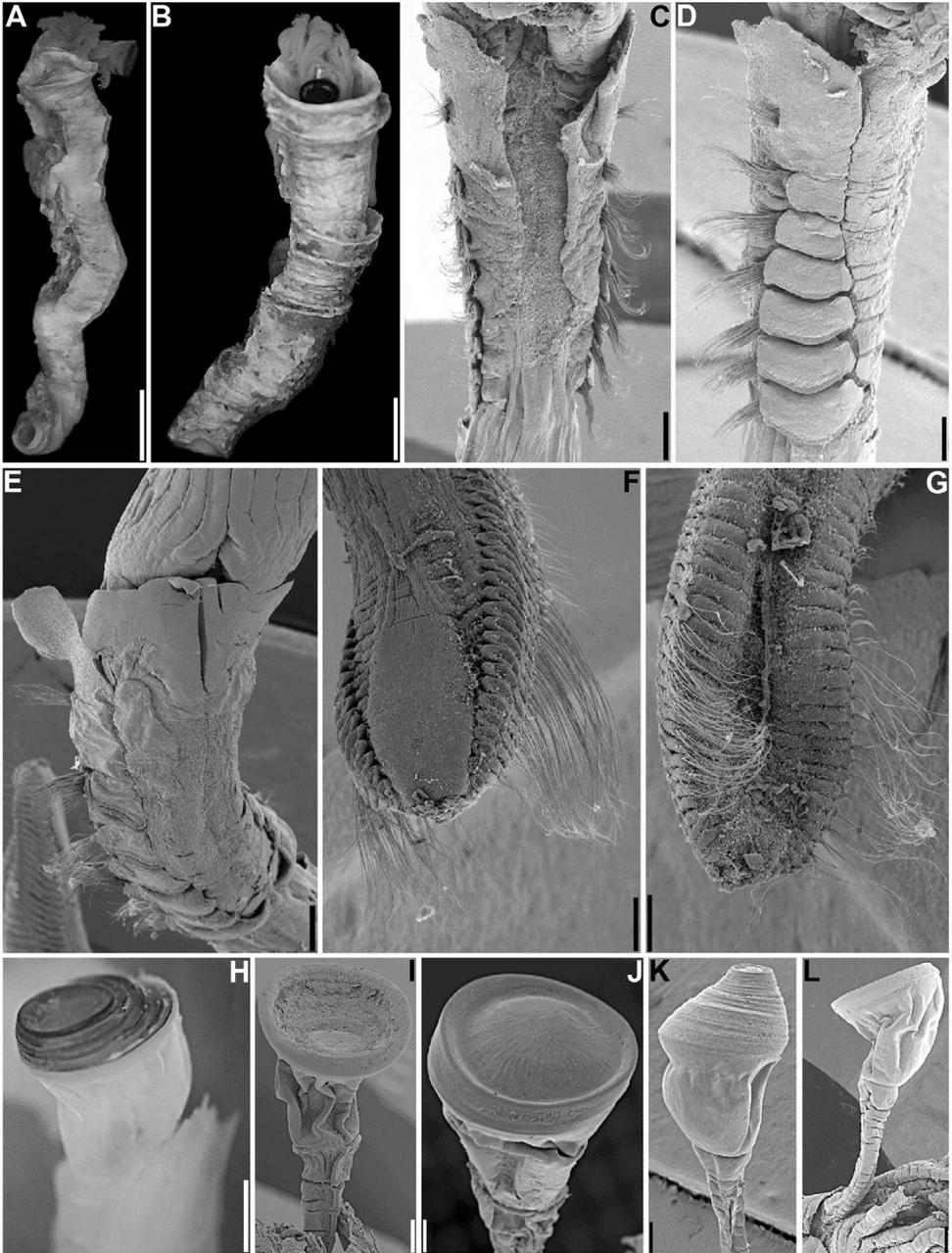


FIGURE 3. *Vermiliopsis zibrowii* sp. nov. A–B, paratypes 3 (MZUSP 00590) and 10 (ZMUC-POL-2015), respectively, inside the tubes; C–E, anterior end, dorsal, right ventrolateral and ventral views, respectively; F–G, posterior end, dorsal and right ventrolateral views, respectively; H–L, opercula; photo H from paratype 1 (MZUSP 00590). Photos A–B, H from stereomicroscope, all others from SEM. Scale bars: A = 2 mm; B = 1 mm; C = 0.4 mm; D–E = 0.3 mm; F–G = 0.2 mm; H = 0.5 mm; I, K–L = 0.3 mm; J = 0.2 mm.

TABLE 1. Morphological variation within the type-series of *Vermilipopsis zibrowii* sp. nov. For specimens inside the tubes (paratypes 3, 4 and 10), the tubes, instead of the specimens, were measured.

	Holotype	Paratype											
	1	2	3	4	5	6	7	8	9	10	10	10	10
Collection number	MZUSP 00589	MZUSP 00590	MZUSP 00590	ZMA V.Pol.5372	ZMUC-POL-2015	ZMUC-POL-2015	ZMUC-POL-2015	ZMUC-POL-2015	ZMUC-POL-2015				
Length x width (mm)	15.8 x 2	7 x 1.02	10 x 0.8	13 x 1.8 (tube)	15 x 2 (tube)	10 x 1.6	4.2 x 0.9	3.6 x 0.8	5.3 x 0.8	1.5 x 0.3	1.5 x 2 (tube)	1.5 x 2 (tube)	1.5 x 2 (tube)
Operculum	1.95	1.2	1.1	1.02	1.15	1.48	0.95	0.79	0.94	0.35	1.2	1.2	1.2
Diameter (mm)	1	5	1	2	6	1	1	1	3	1	3	3	3
Number of septa	Dome-like	Concave	Dome-like	Concave	Concave	Dome-like	Concave	Dome-like	Dome-like	Concave	Concave	Concave	Concave
Top	Left side	Right side	Right side	Right side	Right side	Right side	Right side	Right side	Right side	Right side	Right side	Right side	Left side
Insertion on crown	Left side	Right side	Right side	Right side	Right side	Right side	Right side	Right side	Right side	Right side	Right side	Right side	Left side
Branchial crown	11	3.5	3	—	4	2	1.9	2	0.9-1	—	—	—	—
Length (mm)	28	10	14	—	16	9	6	~10	5	—	—	—	—
Number of pairs of radioles													

TABLE 2. Comparison between *Vermilitopsis zibrowii* sp. nov. and its congeners with single endplated opercular horn-cap (sources: Zibrowius 1968a–c).

	<i>Vermilitopsis glaciatis</i>	<i>Vermilitopsis zibrowii</i>	<i>Vermilitopsis labiata</i>	<i>Vermilitopsis monodiscus</i>
Operculum	Always with single, thin, flat and calcified endplate, with concentric growth-lines	With single, thin and flat to concave endplate, sometimes with one dome inside, or with up to seven septa, all thin and concave, separated by conspicuous ribs	With brown and flat endplate, covered by terminal calcareous reinforcement shaped like a coral calyx; if this is accidentally lost, thus with single flat endplate	Always with single and flat endplate, sometimes with central elevation or concavity
Size (total length; diameter of operculum; mm)	Up to 10; ca. 0.55	Up to 2.6; up to 1.95	Up to 10; 1.5	Up to 35; 2.5
Number of pairs of radioles; pigmentation of branchial crown	15	Up to 28; ethanol preserved specimens with white crown, with 1–2 rows of ocelli (all pigmentation lost in preserved material, only eye-lenses remain)	10; ethanol preserved specimens without pigmentation, but previously described as with two rows of ocelli	25–30; live specimens with transverse red bands
Tube	Quadrangular in cross-section, with three dentate keels at the superior surface, one at each vertex and one at midline; smooth laterally and between keels	Circular in cross-section, with five dentate keels along superior midline	Semicircular in cross-section, with five keels and numerous transversal ridges in between	Quadrangular cross-section, with three smooth keels at the superior surface, one at each vertex and one at midline; with transversal ridges laterally and between keels
Thoracic membrane	Until chaetiger 2	Until chaetiger 5	Until chaetiger 3	Until chaetiger 4
<i>Apomatus</i>-chaetae present on chaetigers	3–7	4–7	3–7	3–7
Thoracic uncini	With 6–8 teeth	With 12 teeth anteriorly and 14–17 teeth posteriorly	With 10–15 teeth	With 16–19 teeth
Abdominal uncini	On anterior abdomen, uncini saw- to rasp-shaped with 7 teeth in profile, row above anterior peg with 2 teeth; posterior chaetigers with rasp-shaped uncini only, with 10–12 teeth in profile, 3 teeth per row	On anterior abdomen, uncini saw-shaped with 11 teeth; posterior abdomen with rasp-shaped uncini with 11–13 teeth in profile, 2–4 teeth per row	On anterior abdomen, uncini saw-shaped with about 10 teeth; posterior abdomen with rasp-shaped uncini, with 13 teeth in profile	On anterior abdomen, uncini saw-shaped with 12–13 teeth; posterior abdomen with rasp-shaped uncini, with 15 teeth in profile, 3 teeth per row

Abdominal neuropodia with 1–2 geniculate chaetae on anterior chaetigers, 3–4 on posterior segments, with long, serrated blades (Figs. 2G, 4H), posteriormost 15–20 chaetigers with elongate capillaries, about same length as body width (Fig. 3F–G). Anterior $\frac{3}{4}$ of abdominal chaetigers with saw-shaped uncini, with entire anterior peg and up to 11 teeth each (Figs. 2C, 4G); last abdominal notopodia with rasp-shaped uncini, with 11–13 teeth rows in profile, 2–4 teeth per row, increasing in number towards posterior end (Fig. 4I–J).

Specimens in ethanol with white thorax, sometimes with orange to brown patches below neuropodia and light brown abdomen (Fig. 1A–B), with dorsal brown patches. Posterior end ventrally depressed before anus and with white dorsal glandular pad usually continuing as a thin middorsal line along part of abdomen (Figs. 2A, 3F–G).

Remarks. Besides the diagnosis of the genus itself, discussed above, there is also great confusion in regard to the identity of the species of *Vermiliopsis*, since most of the taxa present such great intraspecific variability that taxa overlap with each other. The morphology of the tubes seems to be one of the most valuable diagnostic features to distinguish among species; however, tubes are frequently unavailable.

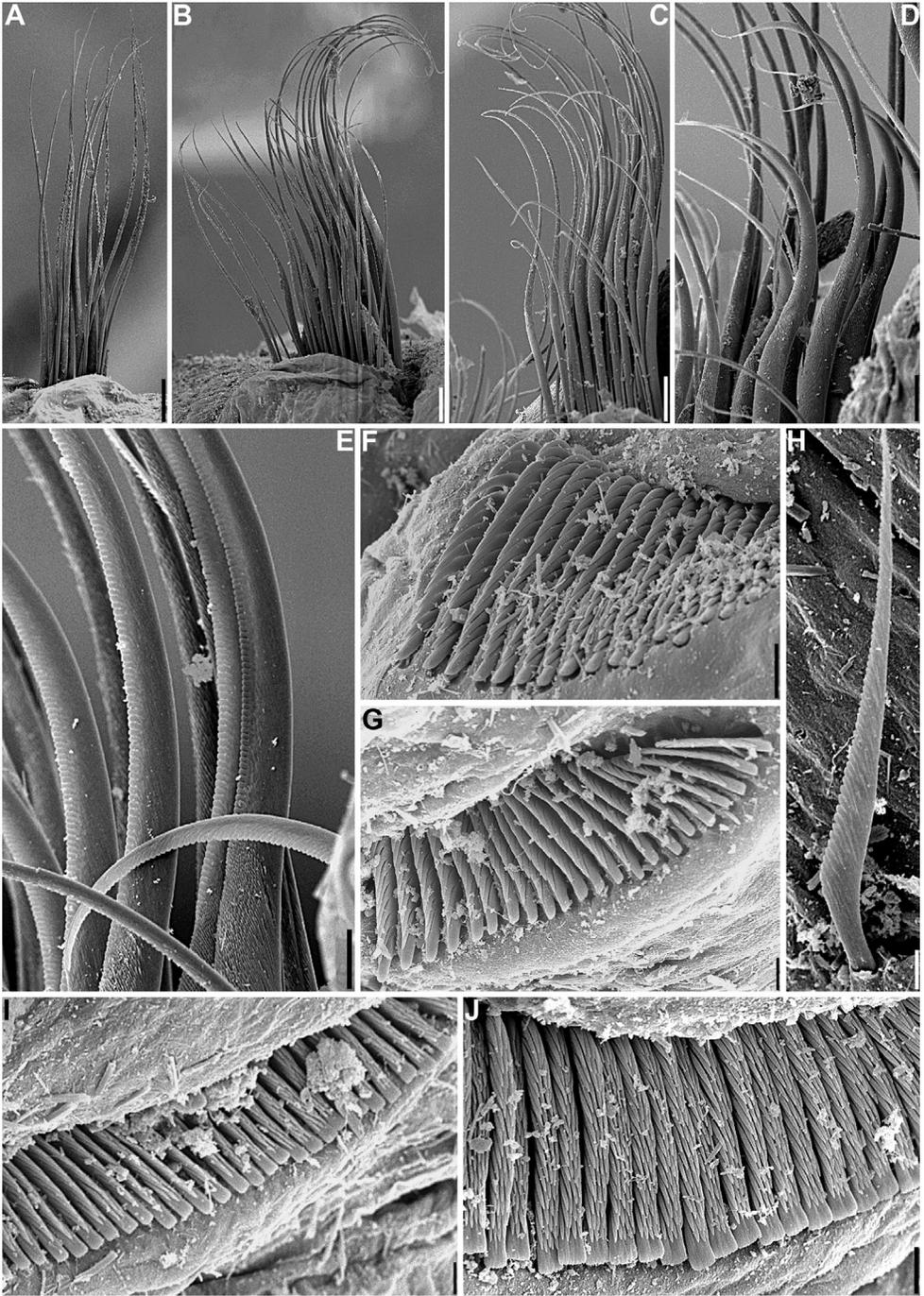
In the Caribbean and adjacent areas, for example, seven nominal species have been reported (Schmarda 1861; Bush 1905, 1907a,b, 1910; Augener 1906; Treadwell 1936; ten Hove & Wolf 1984; ten Hove & San Martín 1995; Bastida-Zavala & Salazar-Vallejo 2000b). However, ten Hove & Wolf (1984) and ten Hove & San Martín (1995), identified all of them as *V. annulata* (Schmarda, 1861) and suggested the possibility of a second species, preliminarily named as *Vermiliopsis* cf. *annulata*, which had tubes with three longitudinal keels, instead of five, as in *V. annulata* s. s. (ten Hove & Wolf 1984; ten Hove & San Martín 1995).

On the other hand, Bastida-Zavala & Salazar-Vallejo (2000b) recognized three different morphotypes of what they called *V. annulata*, differing mostly in the morphology of opercula. Two of those morphotypes had tubes with five longitudinal keels and the remaining with three, but those taxa could not be separated by depth of occurrence.

According to the description by Bastida-Zavala & Salazar-Vallejo (2000b), *V. zibrowii* sp. nov. is similar to the species included in the *V. annulata* complex in regard to morphology of chaetae, soft parts such as shape of the collar and extension of the thoracic membrane, and morphology of the tubes. However, *V. zibrowii* sp. nov. is distinguished from all other congeners, with the possible exception of *V. annulituba*, which is undeterminable, by having opercular septa flattened, distally concave, with conspicuous ribs between septa. We examined material of *V. annulata* with 3- and 5-keeled tubes, kindly donated by Dr. Harry ten Hove, and observed that opercula on those specimens have a laterally smooth horn cap, divided by rounded to distally pointed septa; the last septum may sometimes be concave, but due to accidental folding.

With regard to the shape of opercular horn cap, specimens of *V. zibrowii* sp. nov. with a single endplate resemble *V. glacialis* Monro, 1939, according to the redescription by Zibrowius (1968b), *V. labiata* (Costa, 1861) and *V. monodiscus* Zibrowius, 1968b, but they are distinguished from these species by their size, morphology of operculum and tube, extension of thoracic membrane and morphology of uncini (Table 2).

FIGURE 4. *Vermiliopsis zibrowii* sp. nov. A, collar chaetae; B–C, notochaetae, chaetigers 2 and 3, respectively; D, ventral group of notochaetae, chaetiger 4; E, detail of the blade of *Apomatus*-chaetae, chaetiger 4; F, uncini, chaetiger 2; G, anterior abdominal uncini; H, abdominal neurochaeta; I–J, abdominal uncini, middle and posterior chaetigers, respectively. All photos from SEM. Scale bars: A–C = 50 μ m; D = 20 μ m; E–F = 10 μ m; G–J = 5 μ m.



Finally, the Brazilian specimens described by Zibrowius (1970) as *Vermiliopsis* sp. possibly belong to two separate species, *V. annulata* and *V. zibrowii* sp. nov. Zibrowius (1970) examined 11 specimens, eight of which came from NE Brazil (one from the State of Pernambuco, referred to as spec. Mus. 23, all the others from the State of Bahia, referred to as specs SME 1819, SME 1824 and St. I) and three from SE Brazil (from the State of São Paulo, in the same area as part of the material collected for the present study, referred to as specs SME 1778 and 1779, Mus. 23); in addition, he also examined some empty tubes from NE (specs SME 1819, SME 1830 and St. I), SE (specs St. B), and S Brazil (specs SME 1767, from the State of Santa Catarina). According to his data, specimens from the NE coast have operculum with several septa, smooth laterally and convex to pointed distally (Zibrowius 1970: 7–8, pl. 1, figs. 7–10, 16), while those from the SE and the S coast either have a single endplated operculum, or have two septa, with the second convex and aligned dorsally (Zibrowius 1970: 7–8, pl. 1, figs 14–15). Therefore the material from Brazilian NE coast is similar to what ten Hove & Wolf (1984) identified as *V. annulata*, while that from the SE coast of the country is within the range of variation of *Vermiliopsis zibrowii* sp. nov.

The coast of São Paulo is very peculiar because it lies in a transitional zone bathed by both the Brazil and Falkland Currents, the first directed southwards from the equator, with warm water, and the latter directed northwards from Antarctica, with cold water. After a major review of the literature, Palacio (1982) proposed a biogeographic province, the Paulista province, limited to both the north and south by the 23°C isotherm, extending between the states of Espírito Santo and Rio Grande do Sul, and with a unique fauna transitional between the Tropical (Caribbean) and Magellanic (Patagonian) provinces, with representatives from both areas. Palacio (1982) provided several examples of differences in faunal composition between the Tropical and Paulista Provinces and it seems very likely that the presence of *V. annulata* in NE and *V. zibrowii* sp. nov. from SE Brazil southwards is one more example of biogeographical differences between these provinces.

Etymology. We name this species after Dr. Helmut Zibrowius, for having been the first to describe this taxon and also as deserved homage to a researcher who has studied the taxonomy and the relationships within the family Serpulidae for more than 40 years.

***Pseudovermilia* Bush, 1907**

Type species: *Spirobranchus occidentalis* McIntosh, 1885, designated by Bush (1907b).

Diagnosis. Tubes usually with transversal ornamentations, but without peristomes; with cylindrical to conical operculum, with distal horn cap usually with a distal spine. Opercular stalk smooth, in cross-section rounded to slightly flattened distally, inserted between first and second radioles (ten Hove 1975). Thorax with seven chaetigers. Collar chaetae organized in two rows, anterior row with longer limbate chaetae, posterior row with almost alimbate capillaries. From chaetiger 2 onwards, thoracic notopodia as short cones, with chaetae arranged in two longitudinal groups; superior (dorsal) group with long, limbate chaetae, arranged in almost straight arc at dorsal base of notopodial cone; inferior (ventral) group with limbate chaetae alternating with much thinner, nearly alimbate capillaries; inferior limbate chaetae replaced by *Apomatus*-chaetae from chaetiger 2 or 3, varying between species and, sometimes, intraspecifically. Abdominal neuropodia with geniculate chaetae with triangular dentate blades; on posteriormost chaetigers, slightly elongated capillaries present. Thoracic uncini saw-shaped and elongate, anterior peg curved, bifurcate in superior view, under light microscope; abdominal uncini rasp-shaped, at least posteriorly, and with anterior peg as in thoracic uncini.

Remarks. See Remarks for *Vermiliopsis*.

***Pseudovermilia harryi* sp. nov.**

Figures 1C–D, 5A–C, 6–8; Table 3

Material examined. Type series. Holotype and paratypes 1–8 from Sta. 6665 (24°20.844'S 44°09.913'W), 10 Jan 1998, box corer, 258 m; holotype (Fig. 1C–D) complete spec., extracted from the tube; paratypes 1–4, 6–7 extracted from the tubes, paratypes 1–3, 6–7 (Figs. 6A, 7L) complete specs, paratype 4 (Fig. 7A, J) posteriorly incomplete spec.; paratypes 5 (Fig. 7B, K) and 8 (Fig. 7C, I) inside the tubes. Paratype 9 from Sta. 6750 (23°40.080'S 42°31.800'W), 10 Jan 1998, dredge, 162 m; paratype 9 complete spec., extracted from the tube. Paratype 10 from Sta. 6686 (25°37.021'S 45°13.586'W), 13 Jan 1998, dredge, 153 m; paratype 10 complete spec., extracted from the tube. Morphological data of each specimen from the type-series is provided in Table 3. Type-material deposited as follows: holotype and paratypes 1–3 deposited at the MZUSP (holotype: MZUSP 00591; paratypes: MZUSP 00592), paratypes 4–7 deposited at the ZMA (ZMA V.Pol. 5373) and paratypes 8–10 deposited at the ZMUC (paratype 8: ZMUC-POL-2012; paratype 9 ZMUC-POL-2013; paratype 10: ZMUC-POL-2014).

Additional material. Sta. 6665 (24°20.844'S 44°09.913'W), 10 Jan 1998, box corer, 258 m, 27 specs. Sta. 6666 (24°17.129'S 44°12.149'W), 10 Jan 1998, dredge, 163 m, 1 spec. Sta. 6681 (25°11.000'S 44°56.650'W), 12 Jan 1998, dredge, 167 m, 1 spec. Sta. 6739 (24°02.580'S 43°30.800'W), 14 Feb 1998, dredge, 147 m, 5 specs and 9 opercula. Sta. 6741 (23°49.900'S 43°14.400'W), 15 Feb 1998, dredge, 138 m, 3 specs. Sta. 6762 (23°26.315'S 41°13.887'W), 28 Feb 1998, dredge, 150 m, 6 specs and 3 opercula.

Material from other taxa used for comparison. *Pseudovermilia fuscostriata*: Netherlands Antilles, Bonaire, Santa Barbara, near Hato, Sta. 2112Fd: 12 specs plus tubes, 30 Jun 1970, legit H.A. ten Hove.

Description. Measurements. Body 3.7–9.7 mm long, 0.25–0.5 mm wide, with 7 thoracic and 46–70 abdominal chaetigers; paratype 1 shortest specimen, measuring 3.7 mm in length, by 0.3 mm in width, with 48–53 abdominal segments; holotype longest specimen, measuring 9.7 mm in length, by 0.48 mm in width, with 65–70 abdominal segments (Table 3).

Tube. Tube white, part occupied by worm quadrangular in cross section, with thick walls. Upper part with three keels, one at each vertex of rectangle and another at midline of upper surface; central keel usually higher; probably synchronously, keels develop one tooth each, more or less regularly spaced, forming dentate bands. Laterally, tubes covered by transverse ridges separated by shallow sulci (grooves), continuing between keels of upper surface. Lateral surfaces varying from reduced, rounded, around central rectangle, to expanded large flattened and triangular flanges attached to substratum (Figs. 5A, C, 7B–C). Keels, teeth, transversal ridges, and sulci may be inconspicuous due to erosion. Transparent lining present between worm and tube.

Operculum. Opercular stalk inserted between first and second dorsalmost radioles of left side of crown in all specimens, lower than bases of radioles. Stalk about twice as wide as radioles, smooth to irregularly constricted, basally rounded, in cross section, progressively widening laterally towards distal end (Figs. 1C, 5A–C, 6A, 7A–C). Operculum separated from stalk by conspicuous constriction; operculum with white, fleshy, globular to cup-shaped bulb indented at midline, and distal horn cap divided by 5–24 (24) septa, iridescent transparent to light brown (Figs. 1C–D, 5A–C, 6A, 7A–C, I–Q; Table 3); bulb continuing inside horn cap as dome, observed through transparent cap (Fig. 1C–D). Operculum flattened, or, more frequently, acuminate distally, with septa progressively closer to each other towards distal end, with or without (with) central spine; annulations of horn cap forming low ribs. Operculum 0.87–2.7 (2.7) mm in length by 0.35–0.55 (0.53) mm in diameter; horn cap 0.4–1.47 (1.47) mm long (Table 3).

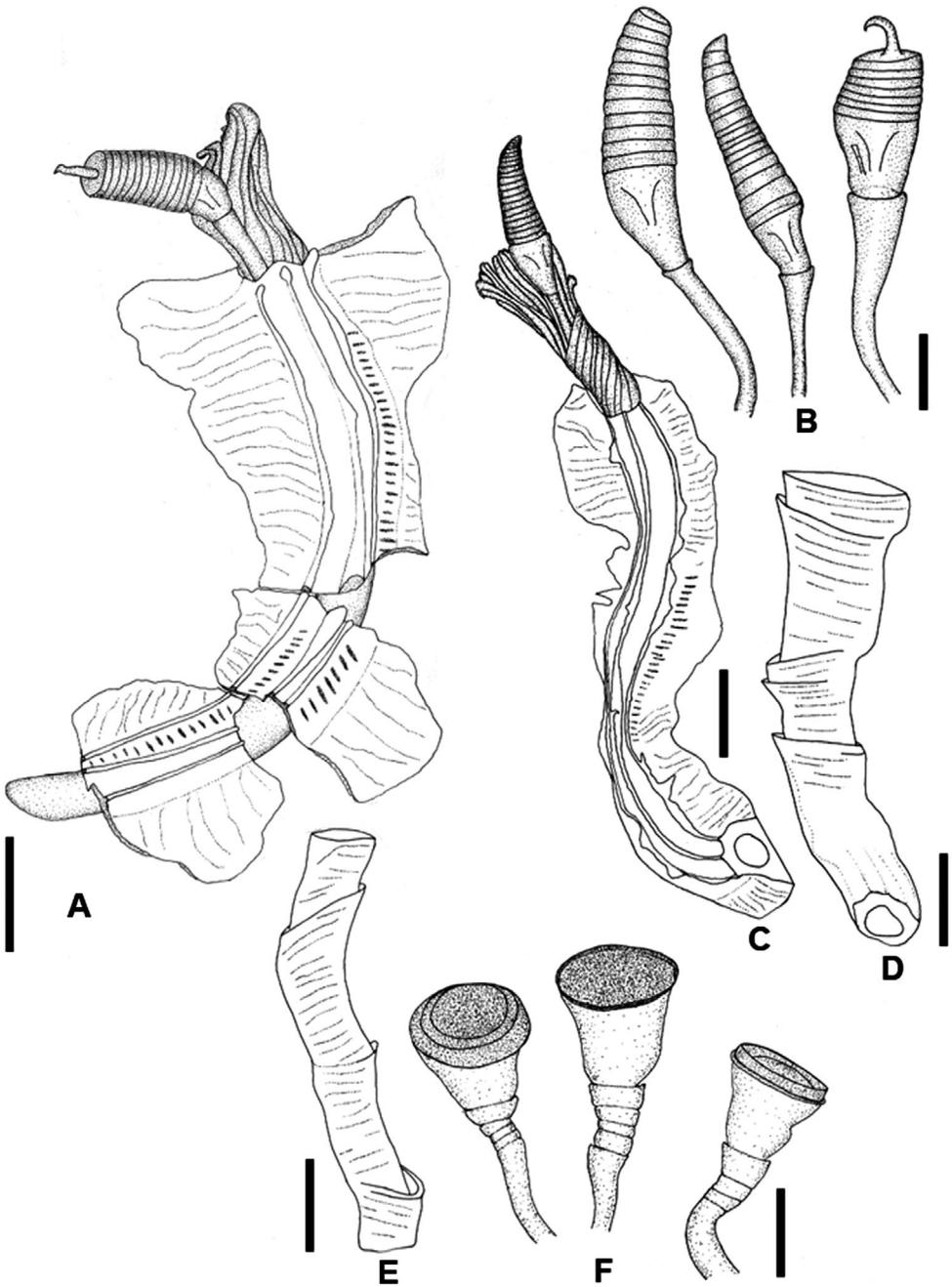


FIGURE 5. *Pseudovermia harryi* sp. nov., A, C, paratypes 8 (ZMUC-POL-2012) and 5 (ZMA V.Pol. 5373), respectively, inside the tubes; B, opercula. *Vermiliopsis zibrowii* sp. nov., D–E, tubes; F, opercula. Scale bars: A, C, F = 1 mm; B = 0.5 mm; D–E = 1.5 mm.

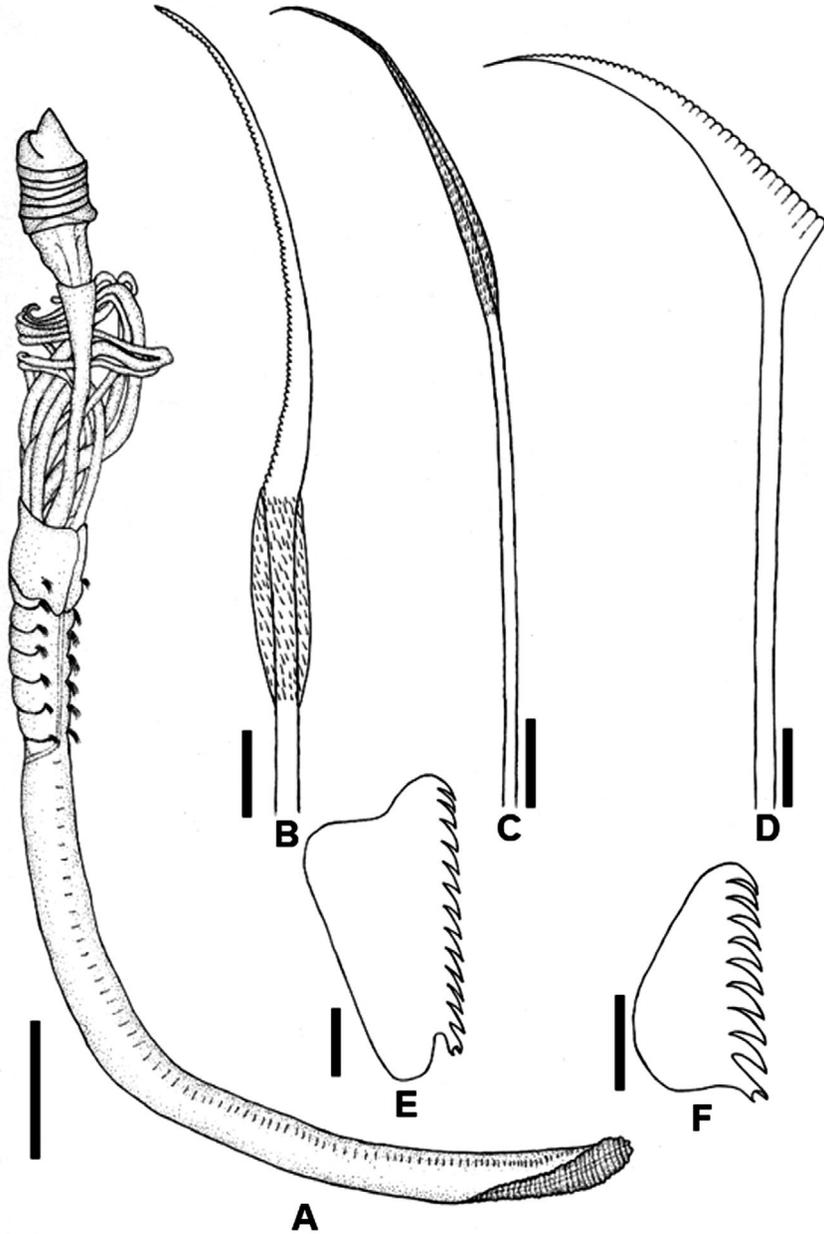


FIGURE 6. *Pseudovermilia harryi* sp. nov. A, paratype 2 (MZUSP 00592), left dorsolateral view; B, *Apomatus*-chaeta; C, thoracic limbate chaeta; D, abdominal neurochaeta; E, thoracic uncinus; F, abdominal uncinus. Scale bars: A = 2 mm; B = 20 μ m; C = 30 μ m; D, F = 5 μ m; E = 10 μ m.

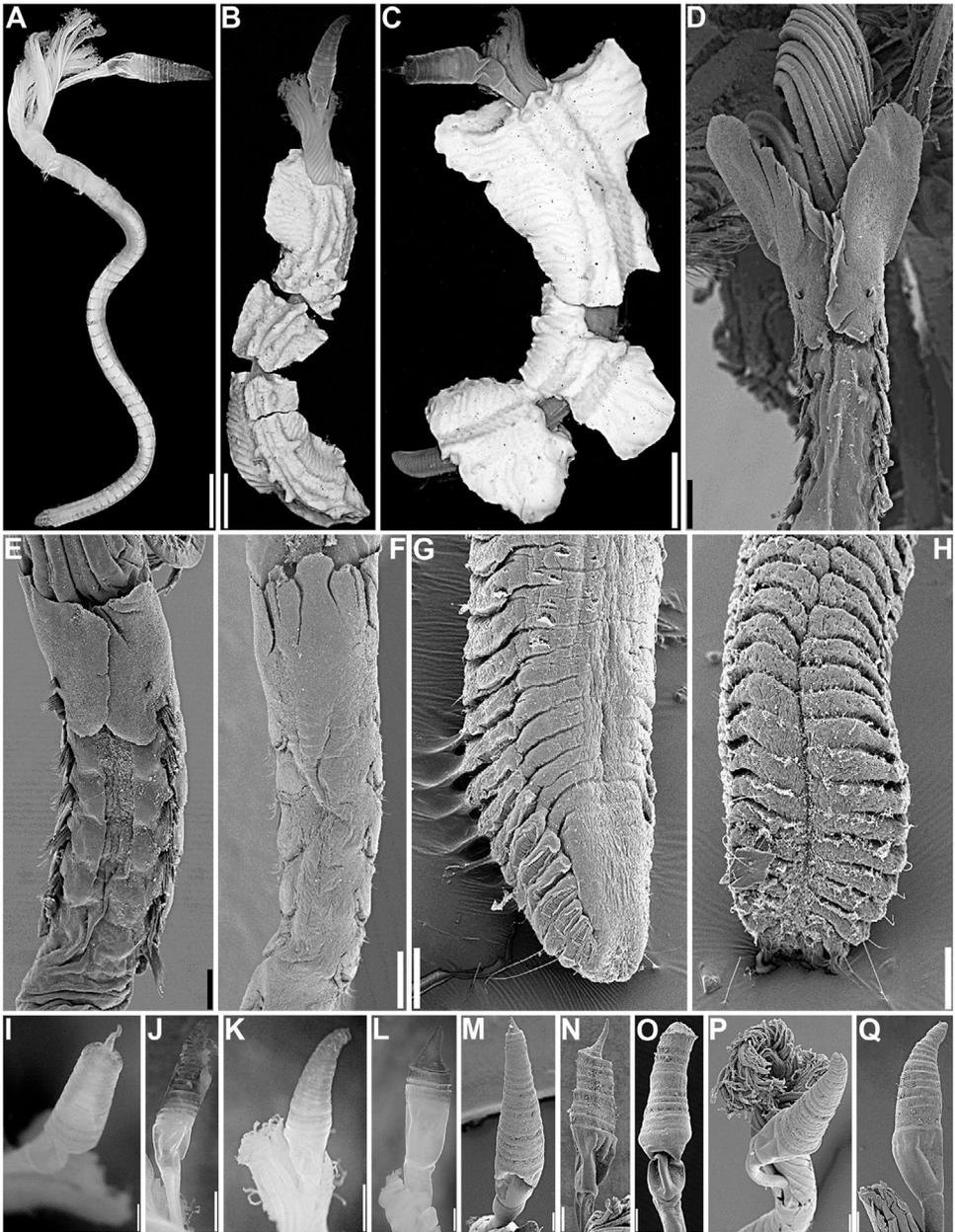


FIGURE 7. *Pseudovermilia harryi* sp. nov. A–C, paratypes 4–5 (both paratypes ZMA V.Pol. 5373) and 8 (ZMUC-POL-2012), respectively; D–F, anterior end, dorsal, dorsal and ventral views, respectively; G–H, posterior end, left dorsolateral and ventral views, respectively; I–Q, opercula, photo I from paratype 8 (ZMUC-POL-2012), photo J from paratype 4, photo K from paratype 5, photo L from paratype 7 (paratypes 4, 5 and 7 ZMA V.Pol. 5373). Photos A–C, I–L from stereomicroscope, all others from SEM. Scale bars: A–C = 1 mm; D–F, M–N, P–Q = 0.2 mm; G–H = 0.1 mm; I, L = 0.25 mm; J–K = 0.5 mm; O = 0.3 mm.

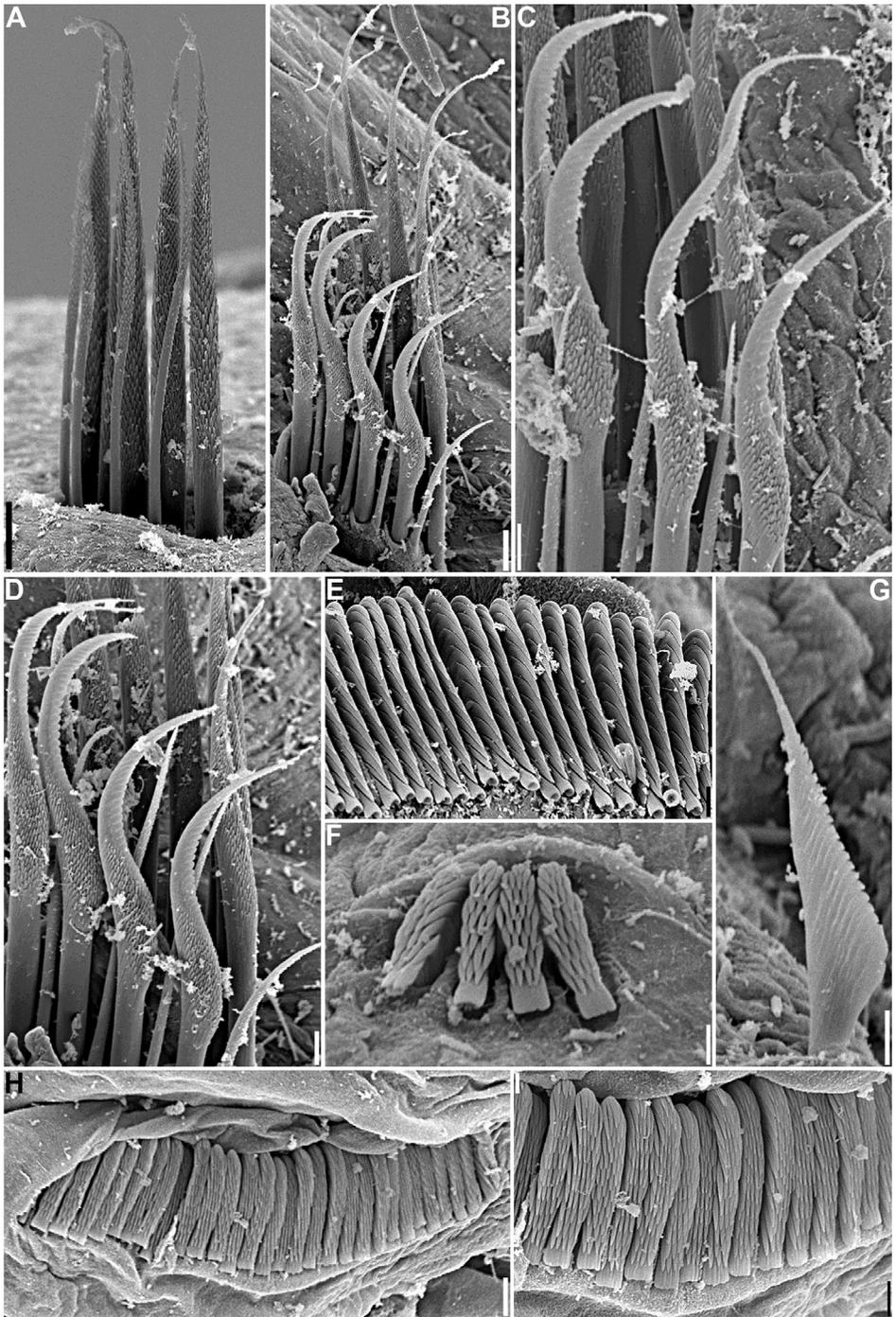


FIGURE 8. *Pseudovermilia harryi* sp. nov. A, collar chaetae; B, notochaetae, chaetiger 5; C–D, ventral groups of notochaetae, chaetigers 2 and 5, respectively; E, uncini, chaetiger 3; F, anterior abdominal uncini; G, abdominal neurochaeta; H–I, posterior abdominal uncini. All photos from SEM. Scale bars: A–B = 10 µm; C–E, H = 5 µm; F = 2 µm; G, I = 3 µm.

Branchial crown. With 7–10 (10) pairs of radioles, arising from paired lobes in pectiniform arrangement, radioles 1.6–3.1 (3.1) mm long, progressively shorter from dorsal to ventral sides of body (Fig. 1D; Table 3).

Body. Collar with one pair of large dorsolateral lobes and three ventral lobes, ventral lobes rectangular, medial ventral lobe slightly higher (Figs. 6A, 7D–F). Thoracic membrane reaching posterior part of chaetiger 2, fused to body close to second pair of notopodia (Figs. 6A, 7D–E). Anterior abdominal chaetigers with segmentation poorly marked, inconspicuous; middle abdominal segments long, with conspicuous segmentation; last 15–20 chaetigers short and compact.

Collar chaetae arranged in two oblique rows, those from anterior row longer, with broader limbation, chaetae from posterior row almost alimbate (Fig. 8A). From chaetiger 2, thoracic notopodia short cones, with chaetae arranged in two longitudinal groups; dorsal group with long, limbate chaetae, arranged in an arc at dorsal base of notopodial cone (Figs. 6C, 8B–D); ventral group with *Apomatus*-chaetae (Fig. 6B) alternating with much thinner, almost alimbate capillaries (Fig. 8B–D); *Apomatus*-chaetae with swollen limbation at base of serrated blade (Figs. 6B, 8B–D). Thoracic neuropodia with progressively larger tori (Fig. 1C–D); tori with saw-shaped uncini, with about 11–13 teeth and curved, trapezoidal anterior peg, slightly divergent distally, seeming bifurcate in superior view, under light microscope (Figs. 6E, 8E).

Abdominal neuropodia with 1–2 geniculate chaetae with long, serrated blades (Figs. 6D, 8G); in some specimens, including holotype, posteriormost 6–10 chaetigers with elongated capillaries, shorter than body width (Fig. 7G–H). Abdominal notopodia with rasp-shaped uncini, with 7–10 teeth in profile, 3–4 teeth per row on anterior chaetigers (Figs. 6F, 8F); with 10–11 teeth in profile, 4–6 teeth per row posteriorly (Fig. 8H–I); abdominal uncini with anterior peg faintly curved, almost straight throughout; number of uncini per torus increasingly towards posterior end, except for last chaetigers.

Specimens in ethanol with white and light brown body (Fig. 1C–D, 7A). Posterior end with dorsal unsegmented glandular pad covering last 5–6 chaetigers, ventrally depressed before anus (Fig. 7G–H).

Remarks. *Pseudovermilia harryi* sp. nov. is characterized by the morphology of its tube and operculum. Regarding the shape of the operculum, the species most similar to *P. harryi* sp. nov. are *P. conchata* ten Hove, 1975, *P. fuscostriata* ten Hove, 1975, and *P. holcopleura* ten Hove, 1975.

Pseudovermilia conchata has an operculum with the stalk distally indented and a light brown horn cap divided by numerous septa, distally acuminate and curved, or flattened, with a central spine. This pattern is very similar to *P. harryi* sp. nov. However, the tubes of *P. conchata* are characterized by having conchiform wings on both sides of the mouth and lacking both transverse ridges and rows of pits, while in *P. harryi* sp. nov. the tubes do not have conchiform wings and have both transverse ridges and rows of pits, as shallow sulci between the ridges. There are also slight differences between these species with regard to the collar morphology and number of rows of teeth of abdominal uncini.

TABLE 3. Morphological variation within the type-series of *Pseudovermitia harryi* sp. nov. In the cases of specimens inside the tubes (paratypes 5 and 8), the tubes and the part occupied by the worm, instead of the specimens, were measured.

	Holotype	Paratype 1	Paratype 2	Paratype 3	Paratype 4	Paratype 5	Paratype 6	Paratype 7	Paratype 8	Paratype 9	Paratype 10
Collection number	MZUSP 00591	MZUSP 00592	MZUSP 00592	MZUSP 00592	ZMA V,Pol.5373	ZMA V,Pol.5373	ZMA V,Pol.5373	ZMA V,Pol.5373	ZMUC- POL-2012	ZMUC- POL-2013	ZMUC- POL-2014
Length x width (mm)	9.7 x 0.48	3.7 x 0.3	4 x 0.42	4 x 0.3	9.6 x 0.39	7.5 x 1.7 (tube; occupied: 0.52)	4.4 x 0.5	6 x 0.45	8 x 2.8 (tube; occupied: 0.7)	4.2 x 0.33	5.3 x 0.25
Operculum											
Diameter (mm)	0.53	0.37	0.55	0.4	0.47	0.35	0.55	0.5	0.5	0.43	0.4
Total length x length of horn cap (mm)	2.7 x 1.47	1.07 x 0.72	0.97 x 0.5	1.07 x 0.82	2.02 x 1.42	1.72 x 1.15	1.6 x 1.1	1.02 x 0.4	1.27 x 0.82	0.87 x 0.4	1.45 x 1.25
Number of septa	24	13	6 (distally broken)	15	24	24	21	5	14	10	20 (distally broken)
Distal spine; length (mm)	Absent	Absent	Present (broken at the base)	Absent	Present, tiny	Present, tiny	Present, tiny	Present, thick; 0.42	Present, thin; 0.42 mm	Present, thick; 0.35 mm	-
Insertion on crown	Left side	Left side	Left side	Left side	Left side	-	Left side	Left side	-	Left side	Left side
Branchial crown											
Length (mm)	3.1	1.6	2.6	1.7	3.1	-	2	2	-	1.8	2.1
Number of pairs of radioles	10	8	7	7	9	-	8	8	-	7	8
Number of abdominal segments	65-70	48-53	65-70	65-70	55-60	-	46-51	58-63	-	51-56	60-65

Pseudovermilia fuscostriata also has an operculum with an iridescent to brown horn cap with many septa and the taxon has already been recorded from the Brazilian coast (Nonato & Luna 1970; ten Hove 1975). However its tubes differ from those of *P. harryi* sp. nov., with seven dentate keels, alternating with rows of pits, and characteristically alternating white and brown transverse bands of pigmentation. Furthermore, the operculum of *P. fuscostriata* has transverse ribs between opercular annuli that are larger than those of *P. harryi* sp. nov. We examined material of *P. fuscostriata* from Bonaire, kindly donated by Dr. ten Hove, and all of those differences were conspicuous.

Finally, *P. holcopleura* also has an operculum that superficially resembles that of *P. harryi* sp. nov. and, in addition, has already been reported for the Brazilian coast from an area close to where the specimens used for the present study were collected (ten Hove 1975). However, it is a considerably smaller species in all measurements and its tube has different morphology. The specimens described by ten Hove (1975) achieve a maximum length of 11 mm, from the pygidium to the tip of the operculum, and most of them are about 6 mm long, while our longest specimen is about 12.8 mm long, from the pygidium to the tip of the radioles and the shortest, 5.3 mm long. The distance from the pygidium to the tip of the operculum was not measured in the present study, but would be about 0.87–2.7 mm longer. In the original description of *P. holcopleura*, the number of abdominal segments varied from 20–40, with most of the specimens having 24–32; the present material has 46–70 abdominal segments, with most specimens having more than 55 abdominal segments (Table 3). The specimens studied by ten Hove (1975) have a shorter operculum, with a horn cap 0.2–0.58 mm long, 0.23–0.44 wide, and with up to ten septa, while the horn cap of the operculum of *P. harryi* sp. nov. is 0.4–1.47 mm long, 0.35–0.55 mm wide, and has 5–26 septa. Finally, *P. holcopleura* tubes are rounded to trapezoidal in cross section and, in nearly all tubes, the superior part has one longitudinal groove or thin transparent lines on both sides (see ten Hove 1975), while in *P. harryi* sp. nov. the upper part of the tube always has three keels, which may be eroded and difficult to recognize, but are never grooved.

Etymology. We name this species after Dr. Harry A. ten Hove, not only for the help he gave us in the past and for the present paper, but especially as a deserved homage for his dedication to serpulids, studying the taxonomy and relationships within the family for more than 40 years.

Filigranula Langerhans, 1884

Type species: *Filigranula gracilis* Langerhans, 1884, by original designation (Langerhans 1884).

Diagnosis. Tubes typically with base attached to substratum and raised distal part, with dentate peristomes. Operculum cylindrical to conical, with fleshy cup-shaped bulb and flat to hollow conical distal horn cap, embedded into bulb, sometimes with a central spine. Opercular stalk rounded in cross-section, sometimes slightly wrinkled, possibly an artifact of preservation. Thorax with 6–7 chaetigers. Collar chaetae bilimbate and fin-and-blade; remaining thoracic notopodia with limbate chaetae and *Apomatus*-chaetae; abdominal neuropodia with geniculate chaetae with triangular dentate blades and, on posteriormost chaetigers, elongate capillaries. Thoracic uncini saw-shaped and elongate, with curved, trapezoidal anterior peg, slightly divergent distally, seeming bifurcate in superior view, under light microscope; abdominal uncini rasp-shaped, with anterior peg as in thoracic uncini.

Remarks. *Filigranula* was considered to be a junior synonym of *Omphalopoma* Mörch, 1863 in the literature (e.g., Zibrowius 1968a). However, Zibrowius (1973b), considering the lack of information on many characters in the original description of the type-species *O. umbilicalis* Mörch, 1863, considered that synonymy could not be proved before more material of this taxon was

obtained; as a consequence, he referred Atlantic and Mediterranean species to the well-defined genus *Filogranula*.

In Brazil, Zibrowius (1970) recorded the presence of a "*Omphalopoma* sp." in the states of São Paulo and Santa Catarina, which we assume is the same species as our *Filogranula revizee* sp. nov. (see below).

***Filogranula revizee* sp. nov.**

Figures 1E–I, 9; Table 4

Omphalopoma sp. Zibrowius, 1970: 12, plate I: 18–23.

Material examined. Type series. Holotype from Sta. 6829 (33°41.360'S 51°32.850'W), 03 Mar 1998, dredge, 100 m; holotype complete spec., extracted from the tube (Fig. 1E–F, I). Paratypes 1–2 from Sta. 6665 (24°20.844'S 44°09.913'W), 10 Jan 1998, box corer, 258 m; paratype 1 complete spec., extracted from the tube (Figs. 1G, 9A); paratype 2 complete spec., extracted from the tube (Fig. 1H). All type specimens deposited at MZUSP (holotype: MZUSP 00593; paratypes: MZUSP 00594).

Description. Measurements. All specimens 4 mm long, 0.35–0.4 (0.4) mm wide, with 7 thoracic and 33–47 (43–47) abdominal chaetigers (Table 4).

Tube. Worms already extracted from tubes, however, four small fragments of a tube present in holotype vial. These fragments show a nearly triangular tube in cross section, laterally smooth, with a central, apparently not dentate, keel (Fig. 1I). Distal part of tube, often species-specific in other taxa, could not be studied.

Operculum. Opercular stalk derived from second dorsalmost radiole of either side of crown (Table 4). Stalk as wide as radioles, without pinnules; stalk basally rounded in cross section, progressively widening laterally towards distal end, smooth to irregularly wrinkled, clearly constricted at base of operculum (Figs. 1G, 9A). Operculum with white, fleshy, cup-shaped to cylindrical bulb and distal chitinized funnel, amber in color, with or without central spine (Figs. 1E–H; 9A); if present, spine thin and sharp, curved ventralwards; diameter of operculum 0.5–0.54 (0.54) mm (Table 4).

Branchial crown. With 7–8 (8) pairs of radioles arranged in two semicircles, 2–2.5 (2) mm long (Table 4).

Body. Collar with one pair of dorsolateral lobes and three ventral lobes, medial ventral lobe higher; thoracic membrane reaching neuropodia of chaetiger 2 (Fig. 9A). Thoracic ventral shields indistinct; ventrally, thorax with conspicuous longitudinal line marking end of neuropodia.

Collar chaetae bilimbate chaetae and fin-and-blade chaetae, fin with 2–3 rows with up to 8–9 teeth each and long and serrated blade (Fig. 9G). On chaetigers 2–7, notopodia with limbate chaetae (Fig. 9D) and, on chaetigers 3–7, *Apomatus*-chaetae with basal limbation and serrated blades with rectangular teeth (Fig. 9B). Thoracic neuropodia with saw-shaped uncini, with 14–15 teeth and curved, trapezoidal anterior peg (Fig. 9E).

Abdominal neuropodia each with 1–2 geniculate chaetae, with serrated blades (Fig. 9C); posteriormost 6–10 chaetigers with elongated capillaries shorter than body width (Fig. 9A). Anterior abdominal notopodia with rasp-shaped uncini, with anterior peg as in thoracic uncini, 9–11 teeth in profile, 4 teeth per row; posterior abdominal notopodia with uncini with more rows of teeth, 14–16 teeth in profile, 5–6 teeth per row (Fig. 9F).

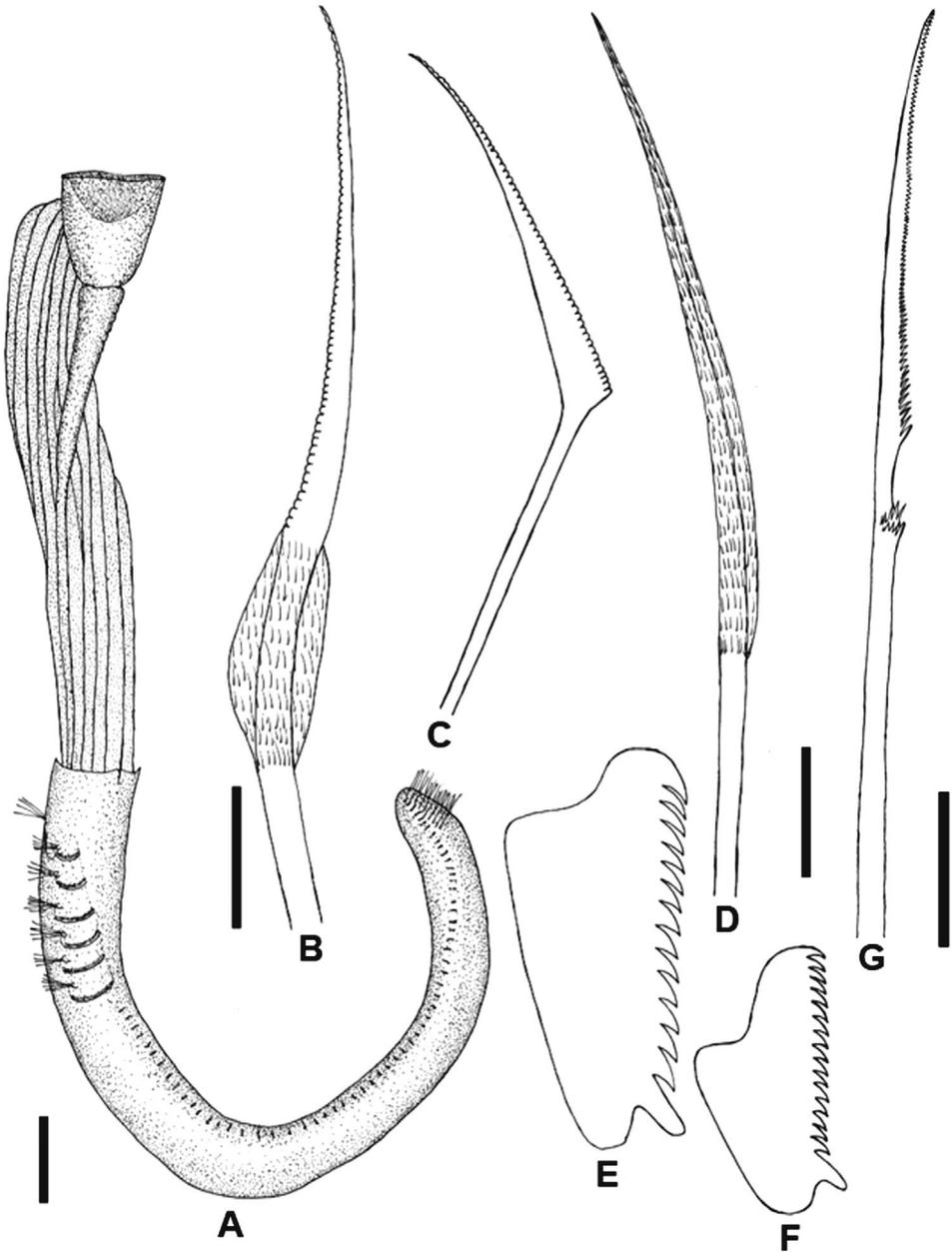


FIGURE 9. *Filogranula revizee* sp. nov. A, paratype 1 (MZUSP 00594), right lateral view; B, *Apomatus*-chaeta; C, abdominal neurochaeta; D, thoracic limbate capillary; E, thoracic uncinus; F, abdominal uncinus; G, fin and blade chaeta. Scale bars: A = 0.5 mm; B = 20 µm; C–F = 10 µm (scale bar on right side of Figure D refers to Figures C–F); G = 30 µm.

TABLE 4. Morphological variation within the type-series of *Filigranula revizee* sp. nov.

	Holotype	Paratype 1	Paratype 2
Collection number	MZUSP 00593	MZUSP 00594	MZUSP 00594
Length x width (mm)	4 x 0.4	4 x 0.35	4 x 0.35
Operculum			
Diameter (mm)	0.54	0.52	0.5
Distal spine	Present	Absent	Present
Insertion on crown	Right side	Left side	Right side
Branchial crown			
Length (mm)	2	2.3	2.5
Number of pairs of radioles	8	7	7
Number of abdominal segments	43–47	40–44	33–37

Specimens in ethanol with white and light brown body (Fig. 1E). Posterior end with dorsal glandular pad above anus.

Remarks. *Filigranula* is characterized by the morphology of the tubes and the species are mostly separated by this character. Information on soft parts and chaetal structure are rarely provided, making it difficult to identify the species when tubes are not available.

The genus comprises five described and named species, *F. annulata* (Costa, 1861), *F. calyculata* (Costa, 1861), *F. exilis* Imajima, 1979, *F. gracilis* Langerhans, 1884 and *F. stellata* (Southward, 1963). In addition, ten Hove & Wolf (1984) described *Filigranula* sp. A from the Gulf of Mexico, but did not name the species because tubes were not present; however, the morphology of operculum, when compared with the other known species of the group, suggests that this is definitely a separate taxon. In addition, ten Hove (1994) diagnosed another taxon from the Seychelles without naming it.

In the present study, we examined three specimens in which the opercula differ from those of all known species of the genus. In addition, we studied four small tube fragments that were in the same vial as the holotype; although we did not see the worm inside that tube, we assume it belongs to the animal, especially because those fragments are similar to the description provided by Zibrowius (1970) for the tube of his *Omphalopoma* sp. According to Zibrowius (1970), the tubes of “*Omphalopoma* sp.” are triangular to circular in cross section, with a single keel at midline, with few teeth; no information on the distal part was given. The tube fragments examined for the present study did not include the distal part of the tube, but the fragments we studied match the description above, except for not having teeth on its keel. In addition, all specimens by Zibrowius (1970) had opercula without a spine, but since he examined only three specimens and one of our specimens also lacks this spine, we assume that material from both collections belongs to the same species and that this character is indicative of the intraspecific variability in *F. revizee* sp. nov.

Filigranula revizee sp. nov. is characterized by having an operculum with a nearly cylindrical bulb and distal cap usually with a thin, distally sharp central spine. Of the previously known species, *F. annulata*, *F. gracilis*, *F. stellata*, and *Filigrana* sp. sensu ten Hove 1994 have an opercular cap as a single funnel, without a central spine (Zibrowius 1968a, 1972), while *F. exilis* has two distal horns (Imajima 1979), in *F. calyculata* the cap has a thick, branched spine (Zibrowius 1968a), and *Filigrana* sp. A sensu ten Hove & Wolf 1984 has a thick, distally blunt spine. Moreover, in all those taxa except *Filigrana* sp. A, the bulb is somewhat basally swollen, which does not occur in *F. revizee* sp. nov.

Among these six taxa, *Filigranula* sp. A seems to have an opercular shape most similar to *F.*

revizee sp. nov., but, according to the description provided by ten Hove & Wolf (1984: p. 55.27), these taxa differ in three other aspects: thoracic membranes are shorter in *Filogranula* sp. A, terminating at the beginning of chaetiger 2, well before the parapodia, while in *F. revizee* sp. nov. they terminate posterior to the neuropodia of chaetiger 2; posterior thoracic uncini are rasp-shaped with three rows of teeth in *Filogranula* sp. A, while in *F. revizee* sp. nov. all thoracic uncini are saw-shaped; in *Filogranula* sp. A thoracic capillaries are narrower and alimbate, while in *F. revizee* sp. nov. they are distinctly limbate.

Etymology. We name this species after the REVIZEE Project, during which all material used for the present study was collected.

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