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Abstract

Serpulidae (Sabellida, Annelida) is a large group of sedentary polychaetes that live in the calcareous tubes they secrete. In addition to being an important component of marine hard-bottom benthic communities, serpulids include several economically important invasive and/or fouling species. In this paper we describe the serpulids from Hong Kong, based on specimens collected from a coral community, a fish farm, a public pier and a shipping channel. Seventeen serpulid taxa belonging to five genera are recorded. The most diverse genus in the present material is *Hydroides* (9 species), followed by *Spirobranchus* (5 taxa). The highest diversity (13 taxa) is found on dead coral skeleton. One species, *Spirobranchus tetraceros*, is associated with live corals in high density. For each taxon, the habitat, distribution and morphological features are described. Including literature records, 20 taxa of serpulids have been reported from Hong Kong. An identification key to all these recorded taxa is provided.

Key words: Polychaeta, Serpulidae, *Hydroides*, *Spirobranchus*, Hong Kong

Introduction

Among polychaetes, species in Serpulidae can be recognized easily by their calcareous tube, characteristic operculum (in most cases) and colourful radiolar crown. Serpulids have been reported from many habitats from the intertidal to abyssal zone (Kupriyanova & Badyaev 1998; ten Hove & Kupriyanova 2009; Kupriyanova & Nishi 2010; Kupriyanova *et al*. 2011). In shallow locations, serpulids occur widely on various underwater solid substrates such as rocks, mooring buoys, ship hulls, aquaculture nets and marine water intake pipes (Ben-Eliahu & ten Hove 1992; Relini *et al.* 1999; Bastida-Zavala 2008; ten Hove & Kupriyanova 2009). They are also a common component of coral communities, with their tube either adhered to or embedded in coral skeleton (Bailey-Brock 1976, 1985, 1991; Mak 1982). Some serpulids have been reported to cause bio-invasion through transportation by ocean-going vessels, resulting in changes in community structure and a loss in biodiversity (Arakawa 1971; Thorp *et al*. 1987; Lewis *et al*. 2006). Their presence on various underwater man-made structures is especially problematic as it decreases ship speed, increases the weight of buoys and blocks water intake pipes and aquaculture nets (Ben-Eliahu & ten Hove 1992; Wang & Huang 1993; Chandra Mohan & Aruna 1994; Relini *et al.* 1999). However, not all serpulids are pests. Some species have a magnificent colourful tentacle (radiolar) crown and are collected for the marine aquarium trade (Murray *et al.* 2012). Other species may be beneficial to the health of hard corals, as their tentacle crown creates water currents while they feed, which may improve circulation on coral surface (Mokady *et al*. 1998; Nakamura *et al*. 2003; Ben-Tzvi *et al*. 2006) or protect corals against predation by *Acanthaster* due to the sharply pointed opercular tooth (Devantier *et al*. 1986).

Traditionally, identification of serpulids is based on the morphology of the tube, operculum, chaetae and uncini. A recent review by ten Hove and Kupriyanova (2009) has provided up-to-date information on Serpulidae *sensu lato* worldwide including 46 genera with detailed generic diagnoses and a list of 350 nominal species. Systematic studies in recent decades have been conducted for serpulids from several coastal regions in the Pacific. Among them, Bailey-Brock (1991), Knight-Jones and Knight-Jones (1991), Bastida-Zavala (1993, 1995, 2008) and Bastida-Zavala and ten Hove (2003) reported species from eastern Pacific and Hawaii; ten Hove and Smith (1990), ten Hove (1994), Pillai and ten Hove (1994), Nishi and Asakura (1996), ten Hove and Nishi (1996), Fiege and Sun (1999), Fiege and ten Hove (1999), Sun and Yang (2000, 2001a, b) and Pillai (2009) reported species from the Indo-West Pacific; Kupriyanova and Nishi (2010, 2011) and Kupriyanova *et al*. (2010, 2011) described serpulids from the deep sea of the Pacific. In southern China, there have been several recent studies (Fiege & Sun 1999; Sun & Yang 2000, 2001a–b), which in total reported 63 species of serpulids in 15 genera from the Chinese coasts, especially Hainan Island and adjacent waters of the South China Sea, but species from Hong Kong were not included.

Hong Kong is situated approximately 150 km south of the Tropic of Cancer (22°9′–22°33′N, 113°5′–114°26′E) on the southeast coast of China. The marine fauna is diverse and composed of both tropical and subtropical species (Morton & Morton 1983). Although serpulids are known to be common in both the fouling (Morton & Morton 1983; Scott 1984; Wang & Huang 1993; Qiu & Qian 1997) and coral (Mak 1982) communities, there is only one systematic account of serpulids (Mak 1982), which reported 15 species belonging to 6 genera. However, the serpulids in Mak (1982) were recorded with only brief text descriptions, without figures showing their key characters. The identity of some of the species listed in the paper must be questioned as they are mentioned under species

names previously reported only from temperate regions or the Atlantic Ocean, as pointed out by Oliver (1993) for many benthic polychaetes in Hong Kong. For example, the distribution of *Hydroides fusicola* (Mörch, 1863) and *Pomatostegus stellatus* (Abildgaard, 1789) is restricted to temperate region and Caribbean respectively (ten Hove & Kupriyanova 2009) and should not be present in Hong Kong. Besides, some taxonomic names in Mak (1982) are outdated. For example, *Spirobranchus tricornis* (Mörch, 1863) has been synonymized with *S. giganteus* (Pallas, 1766); *S. tricornis* **not** (Mörch) *sensu* Straughan (1967: 244, figs 14 b-d) and *sensu* Mak (1982: 609) should belong to *S. tetraceros*; and *S. semperi* Mörch, 1863 has been synonymized with *S. tetraceros* (Schmarda, 1861) (ten Hove 1970; ten Hove & Kupriyanova 2009).

The aim of this paper is to provide an update of the faunistic record and illustrations of serpulids from Hong Kong, including coral associated species and common fouling species found on piers, rocks of the intertidal, and artificial substrates, and to generate an identification key to these species. Previously recorded taxa are commented upon, their names are given in ***bold italics*** if regarded to be valid records, in *italics* only if the specific name evidently has been used in error. Latin names used in this paper have been checked against the online World Polychaeta Database (Read & Fauchald 2011), part of WoRMS.

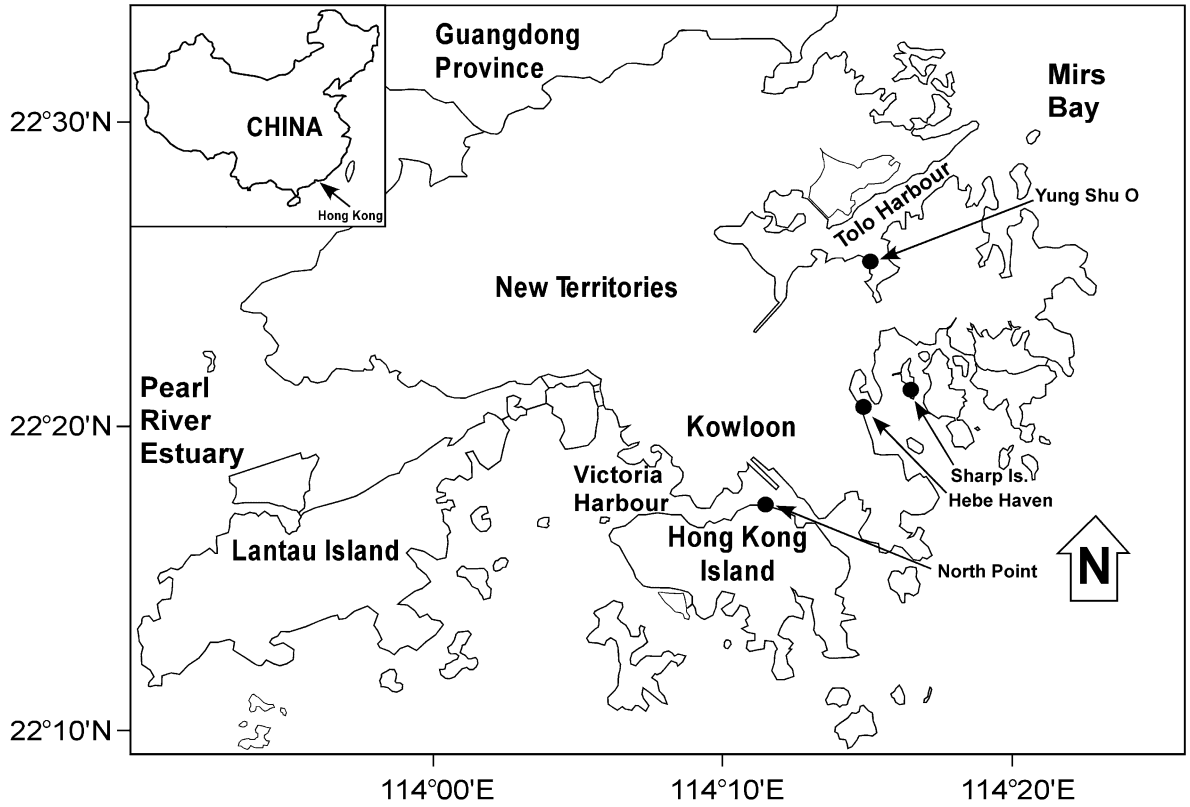

FIGURE 1. Map of Hong Kong showing sampling locations.

Material and methods

Samples were collected (April to May 2009) from 4 different locations using various techniques to cover the common substrates for serpulids in local waters (Figure 1). These included a coral community of Sharp Island, a fouling community of a fish farm in Yung Shu O, a public pier (North Point) in the commercial shipping channel of Victoria Harbour and a public pier in the recreational boating center Hebe Haven. Sharp Island has one of the most diverse coral communities in local waters, and is dominated by the massive corals *Pavona decussata* Dana and *Platygyra carnosus* Veron. Samples of serpulids were collected from different corals and rocks by snorkeling and SCUBA diving, from the surface to the bottom (~ 6 m). Most of the coral-associated samples were collected from the dead skeleton. For some species that lived in live corals, sampling was conducted by chiseling off a small piece of the coral tissue bearing the serpulids. Serpulids in the Yung Shu O fish farm were collected by hauling submerged structures, including ropes and styrofoams, onto the floating rafts and hand-picking the tubes from these

structures. Samples in the public piers were collected by dislodging the serpulid tubes from concrete columns using a knife.

Specimens were narcotized in 7% $MgCl_2$ in sea water for a few hours, then preserved in 75% ethanol, and later transferred to fresh 75% ethanol for storage. Specimens were observed under dissecting and compound microscopes and scaled photographs of the body structures were taken using a Nikon Digital Sight DS-SM camera. For species represented by a single specimen, line-drawings based on the photographs were made using Adobe Illustrator CS 4. For species with more material, one specimen was sacrificed for observation of the details of the operculum and selected chaetae by Scanning Electron Microscopy (SEM). Specimens were dehydrated with graded concentrations of ethanol, critical point dried using a BAL-TEC CPD 030 Critical Point Dryer, gold-coated using a SPI MODULE™ Sputter/Carbon Coater, and observed under a LEO 1530 FESEM scanning electron microscope. The format of the description, including measurements of morphological characters, followed Bastida-Zavala and ten Hove (2002). A taxonomic key to the genus level was prepared by following that of Fauchald (1977) and ten Hove and Kupriyanova (2009), and was expanded to cover all species recorded from Hong Kong. Specimens are deposited in the Australian Museum (AM), Sydney.

Results

A total of 124 serpulid specimens were collected and examined. They belonged to 17 taxa including 13 identified species belonging to five genera. Three taxa were identified to the genus level only due to the incompleteness of specimens or uncertain taxonomic state. The most specious genus was *Hydroides* (9 species), followed by *Spirobranchus* (5 species). A comparison with Mak (1982) shows 7 species in common between the two studies [*Hydroides albiceps* (Grube, 1870), *H. diramphus* Mörch, 1863 (Figure 2A), *H. elegans* (Haswell, 1883) (Figure 2B), *H. exaltatus* (Marenzeller, 1885), *H. rhombobulus* Chen and Wu, 1980, *Spirobranchus kraussii* (Baird, 1865) (as *Pomatoleios*, Figure 2E), and *Vermiliopsis glandigerus* Gravier, 1906]. Seven species are new records for Hong Kong waters [*Hydroides longistylaris* Chen and Wu, 1980, *H. operculatus* (Treadwell, 1929), *H. sanctaecrucis* Krøyer [in] Mörch, 1863, *H. tambalagamensis* Pillai, 1961, *Protula bispiralis* (Savigny, 1822), *Spirobranchus polytrema* (Philippi, 1844) and *S. tetraceros* (Schmarda, 1861)]. Among these, three species [*Hydroides operculatus*, *H. sanctaecrucis*, and *Protula bispiralis* (Figure 2C–D)] are new records for Chinese waters. Most of the species were restricted to one type of habitat. Eleven taxa were collected from dead coral. One species, *Spirobranchus tetraceros*, was collected from living coral, especially *Platygyra carnosus* and *Porites lutea* (Figure 2F). Five taxa (*Spirobranchus kraussii*, *Hydroides diramphus*, *H. elegans*, *H. operculatus*, and *H. sanctaecrucis*) came from fouling communities of the pier and fish farm. Among them, *Hydroides elegans* was the most common and dominant in the fouling communities of the fish farm with occasional occurrence of *H. diramphus*, *H. operculatus*, and *H. sanctaecrucis*. *Spirobranchus kraussii* was present only on rocks of the higher intertidal zone, and was dominant in the intertidal community.

Some serpulids are notorious invasive species in the British Isles (Zibrowius & Thorp 1989) and Japan (Nishi & Kato 2004). Nishi & Kato (2004) listed 23 serpulids that have been recorded as introduced, alien, or cryptogenic in Japan. Seven species collected in the present study [*Hydroides albiceps*, *H. diramphus*, *H. elegans*, *H. operculatus*, *H. sanctaecrucis*, *Spirobranchus kraussii* (as *Pomatoleios*), *S. tetraceros*] are in their list. However, except *H. diramphus* and *H. sanctaecrucis*, the other five species have been recorded widely in the Indo-Pacific, and it is difficult to determine whether they are indigenous or introduced to Hong Kong. *Hydroides sanctaecrucis*, originating from the Caribbean Sea and mentioned as an invasive species in N. Australia (Lewis *et al.* 2006) but not yet reported from the South China Sea, is likely an invasive species to Hong Kong. It was present in low densities in fouling communities from the shipping channel Victoria Harbour and the fish farm in Tolo Harbour. In the coral communities, serpulid diversity was high but most species occurred in low densities. *Spirobranchus tetraceros,* a species with a beautiful tentacle crown, however, was present on several species of live massive corals in high densities, with up to 20-30 individuals per coral head (Figure 2F). Due to its small size and beneficial effects (enhancing water flow around the coral, enhancing dispersal of waste materials from the host), the presence of *S. tetraceros* should not be regarded as an unhealthy sign for the host coral. In the Red Sea, the association between *Spirobranchus* and stony corals has been considered as beneficial [Ben-Tzvi *et al*. 2006, erroneously referring to the geographically restricted Caribbean *S. giganteus*; their material should belong to the *S. corniculatus*-complex, most probably *S. cruciger* (Grube, 1862)].

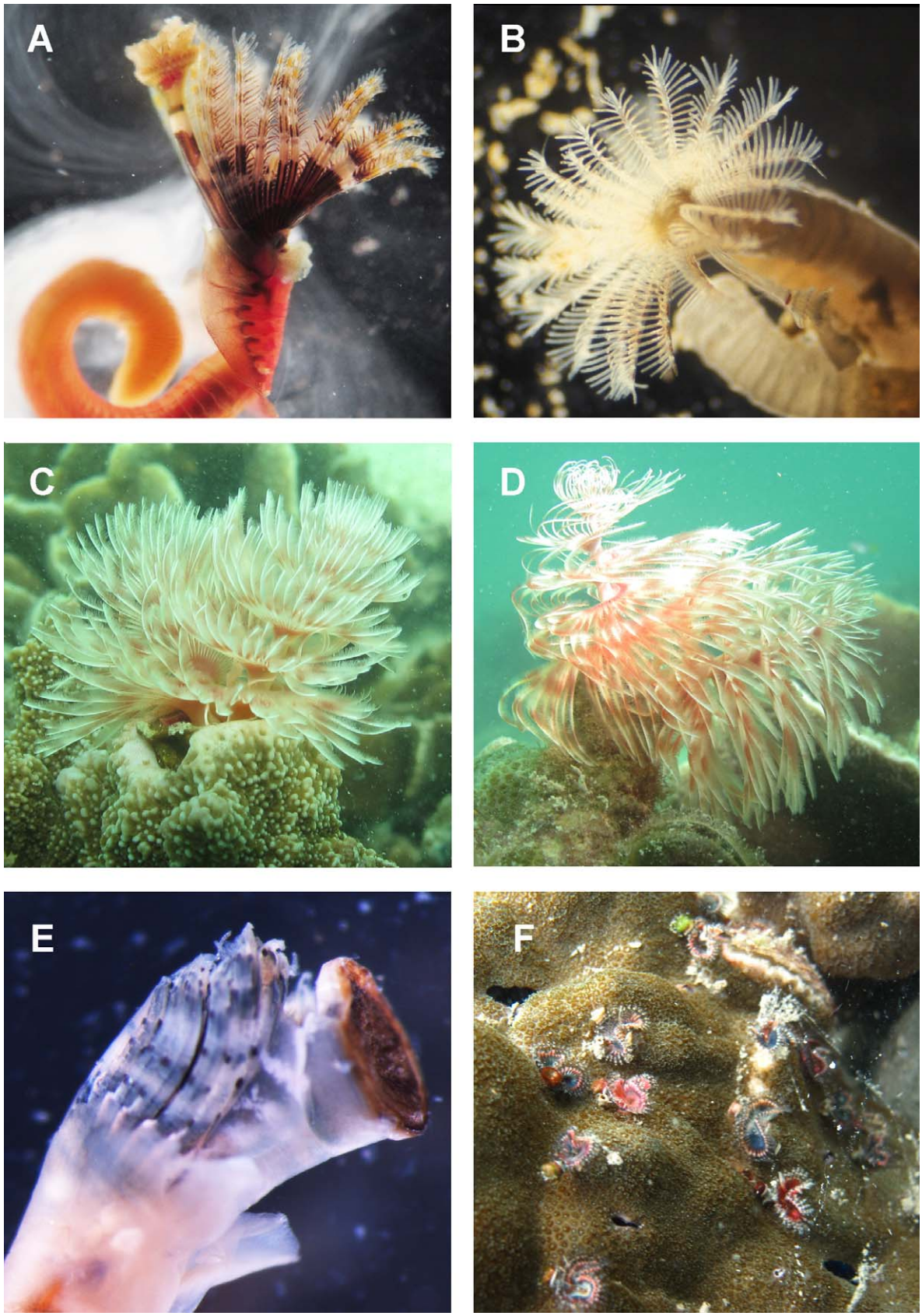

FIGURE 2. A, *Hydroides diramphus*, AM W40539, lateral view, removed from tube. B, *Hydroides elegans*, AM W40540, showing the operculum and branchial crown. C–D, *Protula bispiralis*, associated with living corals, showing the branchial crown. E, *Spirobranchus kraussii*, AM W41410, operculum, lateral view, removed from tube. F. *Spirobranchus tetraceros*, associated with *Porites lutea*, showing the opercula and branchial crowns.

Key to species of Serpulidae from Hong Kong

1	With operculum	2
-	Without operculum	21
2(1)	Opercular peduncle with wings	3
-	Opercular peduncle without wings	9
3(2)	Operculum with calcareous end plate	*Spirobranchus* ... 4
-	Operculum with chitinous column bearing several serrated disks	*Pomatostegus actinoceras*
4(3)	Collar without chaetae; operculum without projection	*Spirobranchus kraussii*
-	Collar with chaetae; operculum variable	5
5(4)	Operculum terminated by white calcareous plate or cap	6
-	Operculum terminated by semi-transparent, almost brown/purplish thinly calcareous cap	*Spirobranchus* cf. *polytrema*
6(5)	Operculum with one calcareous plate	7
-	Operculum with more than four successive calcareous plates	8
7(6)	Operculum with a pair of horns	*Spirobranchus corniculatus*-complex
-	Operculum with three branched spines	*Spirobranchus tetraceros*
8(6)	Operculum with four to five calcareous plates and a horn on apex	*Spirobranchus* sp. A
-	Operculum with eight to ten calcareous plates, without horns	*Spirobranchus* sp. B
9(2)	Peduncle flattened, ribbon-like	*Metavermilia acanthophora*
-	Peduncle cylindrical	10
10(9)	Opercular peduncle annulated anteriorly	*Vermiliopsis glandigerus*
-	Opercular peduncle smooth, not annulated	11
11(10)	Operculum complex, with proximal funnel and distal verticil	*Hydroides* ... 12
-	Operculum simple funnel	*Serpula* ... 20
12(11)	Spines of verticil with T-shaped tips	*Hydroides diramphus*
-	Spines of verticil with acute tips	13
13(12)	Verticil spines with external spinules	*Hydroides sanctaecrucis*
-	Verticil spines without external spinules	14
14(13)	Verticil spines with lateral spinules	15
-	Verticil spines without lateral spinules	16
15(14)	Verticil spines with one pair of outer lateral spinules in the middle	*Hydroides tambalagamensis*
-	Verticil spines with three to four pairs of lateral spinules	*Hydroides elegans*
16(14)	Verticil spines similar in shape and size	17
-	Verticil spines with one or more spines larger than others	18
17(16)	Peduncle long, with a long yellowish chitinized constriction; verticil spines six, thin	*Hydroides longistylaris*
-	Peduncle without a long chitinized constriction; verticil spines five, broad rhomboid	*Hydroides rhombobulus*
18(16)	Tip of verticil spines blunt	*Hydroides albiceps*
-	Tip of verticil spines pointed	19
19(18)	Smaller spines of verticil curving inward	*Hydroides operculatus*
-	Smaller spines of verticil curving outward	*Hydroides exaltatus*
20(11)	Opercular funnel deep with long radial grooves; with 33–35 radii	*Serpula watsoni*
-	Opercular funnel shallow; with 55–58 radii	*Serpula* cf. *granulosa*
21 (2)	Forms open colonies consisting of large number of tiny tubes	*Salmacina* cf. *dysteri*
-	Solitary tubes	*Protula bispiralis*

Systematics

Family Serpulidae Rafinesque, 1815

Genus *Hydroides* Gunnerus, 1768

Type-species: *Hydroides norvegicus* Gunnerus, 1768

Number of species: 95

Diagnosis. Tube white, circular or trapezoidal in cross-section. Distinct keels absent. Operculum with a soft basal funnel of fused radii and a distal crown of chitinized verticil spines arising from center of funnel radii. Peduncle cylindrical, smooth, without wings. Pseudoperculum present. Radioles arranged in semi-circles; stylodes and branchial eyes absent. Thorax with seven chaetigers. Collar trilobed, tonguelets absent. Thoracic membranes long, forming ventral apron. Collar chaetae bayonet and limbate. Subsequent chaetae of two sizes, limbate and capillaries. *Apomatus* chaetae absent. Uncini along entire thorax saw-shaped, anterior fang pointed. Abdominal notochaetae uncini, neurochaetae flat trumpet-shaped.

Hydroides albiceps (Grube, 1870)

(Figure 3A–B, Figure 4A–H)

Serpula (*Eupomatus*) *albiceps* Grube, 1870: 520–521.

Hydroides albiceps—Fauvel 1953: 460; Imajima 1976a: 133–135; Mak 1982: 601–602; Imajima and ten Hove 1984: 43–44; Yang and Sun 1988: 311; Wang and Huang 1993: 1–12; Fiege and Sun 1999: 112–114.

Material examined. AM W40534, 11 specimens (22°21'N, 114°17'E, Sharp Island, on dead coral, 3–6 m, May 21, 2009).

Description. TUBE: white, with two longitudinal ridges. Subtrapezoid in cross-section. Medial keel absent. External tube diameter from 1.0 mm to 1.6 mm (n=5, μ=1.3±0.3), lumen diameter from 0.6 mm to 1.2 mm (n=5, μ=0.9±0.2).

BRANCHIAE: radioles on each side arranged in semicircle, numbers ranging from 7 to 12 (n=6, μ=10±1.8), terminal filaments long. Interradiolar membrane absent.

PEDUNCLE: smooth, circular in cross-section, inserted just below left branchial lobe (n=3). Constriction hardly visible. Pseudoperculum club-shaped, present in all specimens.

OPERCULUM: funnel light yellowish, bearing conical radii with blunt and slightly chitinized tip, numbers of radii ranging from 12 to 24 (n=9,μ=20.4±3.1) (Figure 3A–B). Verticil milky white basally, yellowish marginally, consisting of one large vesicular spine with a dorsolateral extension on each side of its tip, and eight smaller, subequal conical spines with blunt, outward curving tip (Figure 3A–B). Interradial grooves almost 3/4 of funnel length. Lateral and internal spinules absent. Central tooth absent. Three specimens with two opercula each. Operculum length from 0.5 mm to 1.0 mm (n=9, μ=0.7±10.2), width from 0.5 mm to 1.0 mm (n=9, μ=1.6±0.2).

COLLAR AND THORACIC MEMBRANES: collar high, with entire edge.

THORAX: with 7 chaetigers, 6 uncinigerous. Collar chaetae of two types: bayonet-type with two conical teeth at the base of a finely striated blade and finely striated capillaries (Figures 4A–B). Subsequent chaetae of two sizes (limbate and capillary, Figure 4C). Uncini along entire thorax saw-shaped, with 7 to 8 curved teeth including anterior fang (Figure 4 D). Tori of similar size throughout.

ABDOMEN: total number of abdominal chaetigers varies from 63 to 80 (n=3, μ=72.3±12). Uncini saw-shaped anteriorly, with fang and 5 to 6 teeth (Figure 4E–F); rasp-shaped with 2 to 4 rows of teeth, fang and 8 to 9 teeth in profile view posteriorly (Figure 4G–H). Chaetae flat trumpet-shaped. Capillaries present posteriorly, glandular pad absent.

SIZE: total worm length: 11.4 mm to 20.0 mm (n=3, μ=15.6±6.1), width of thorax: 0.5 mm to 1.0 mm (n=6, μ=0.7±0.1). Branchiae and operculum accounting for one fifth of entire length.

COLOUR: in ethanol pale white or yellowish.

Habitat. Depth, 3–6 m, on dead corals.

Distribution. Widely distributed in tropical and subtropical waters of the Indian Ocean and Pacific Ocean.

Remarks. The opercula of *Hydroides albiceps* show a large variability in morphology. The tips of the radii and verticil spines may range from blunt (our specimens from Hong Kong) to laterally dilated as mentioned in the literature, *e.g.* in the holotype. It remains to be studied if such differences are ontogenetic, or if there is a geographical component to these variations.

Hydroides diramphus Mörch, 1863

(Figure 2A, Figure 5A–I)

Hydroides (Eucarphus) dirampha Mörch, 1863: 379.

Hydroides lunulifera—Day 1967: 807.

Hydroides dirampha—Huang and Mak 1982: 780; Mak 1982: 600, 602; Morton and Morton 1983: 278; Wang and Huang 1993: 1–12.

Hydroides diramphus—Bastida-Zavala and ten Hove 2003: 83–86; Ben-Eliahu and ten Hove 2011: 17–19.

Material examined. AM W40539, 10 specimens (22°25'N, 114°16'E, Tolo Harbour, on the submerged side of the floating Styrofoam boxes in the fish farm, 3–10 m, April 15, 2009); AM W41404, 3 specimens (22°17'N, 114°11'E, Victoria Harbour, on pier concrete columns, 0–1 m, May 20, 2009).

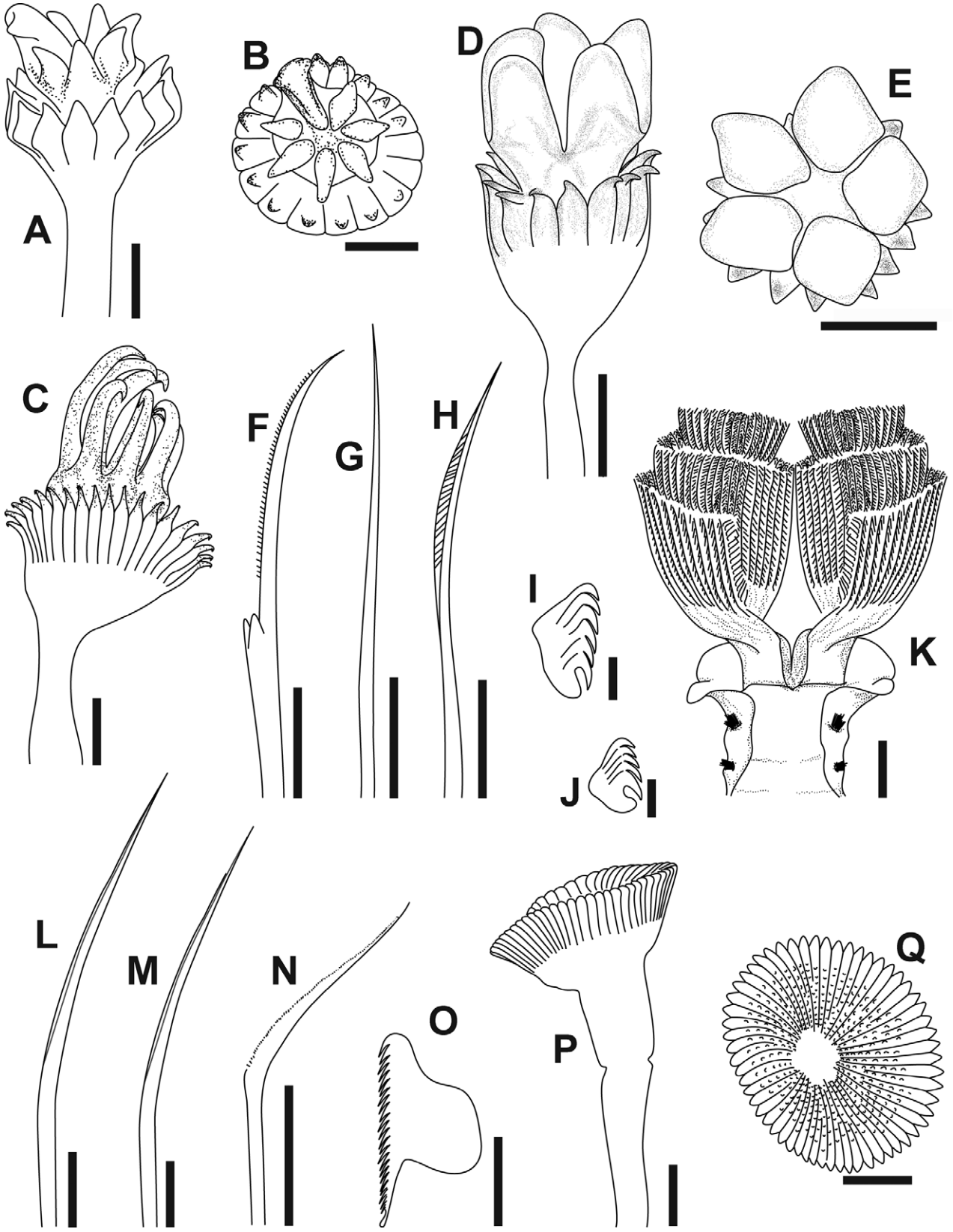

FIGURE 3. A–B: *Hydroides albiceps*, AM W40534, operculum, lateral and apical view. C: *Hydroides operculatus*, AM W41406, operculum, lateral view. D–J: *Hydroides rhombobulus*, AM W41407. D–E, operculum, lateral and apical view. F, G, collar chaetae. H, thoracic limbate chaeta. I, thoracic uncinus. J, abdominal uncinus. K–O: *Protula bispiralis*, AM W41409. K, dorsal view; L, limbate collar chaeta. M, limbate chaeta from chaetiger 6. N, abdominal sickle-shaped chaeta. O; abdominal uncinus. P–Q: *Serpula* cf. *granulosa*, AM W40554, operculum, lateral and apical view. (Scale bars: A–E=0.2 mm, F–G, O=50 µm, I–J=10 µm, K=5 mm, L–N=100 µm, P–Q=1 mm)

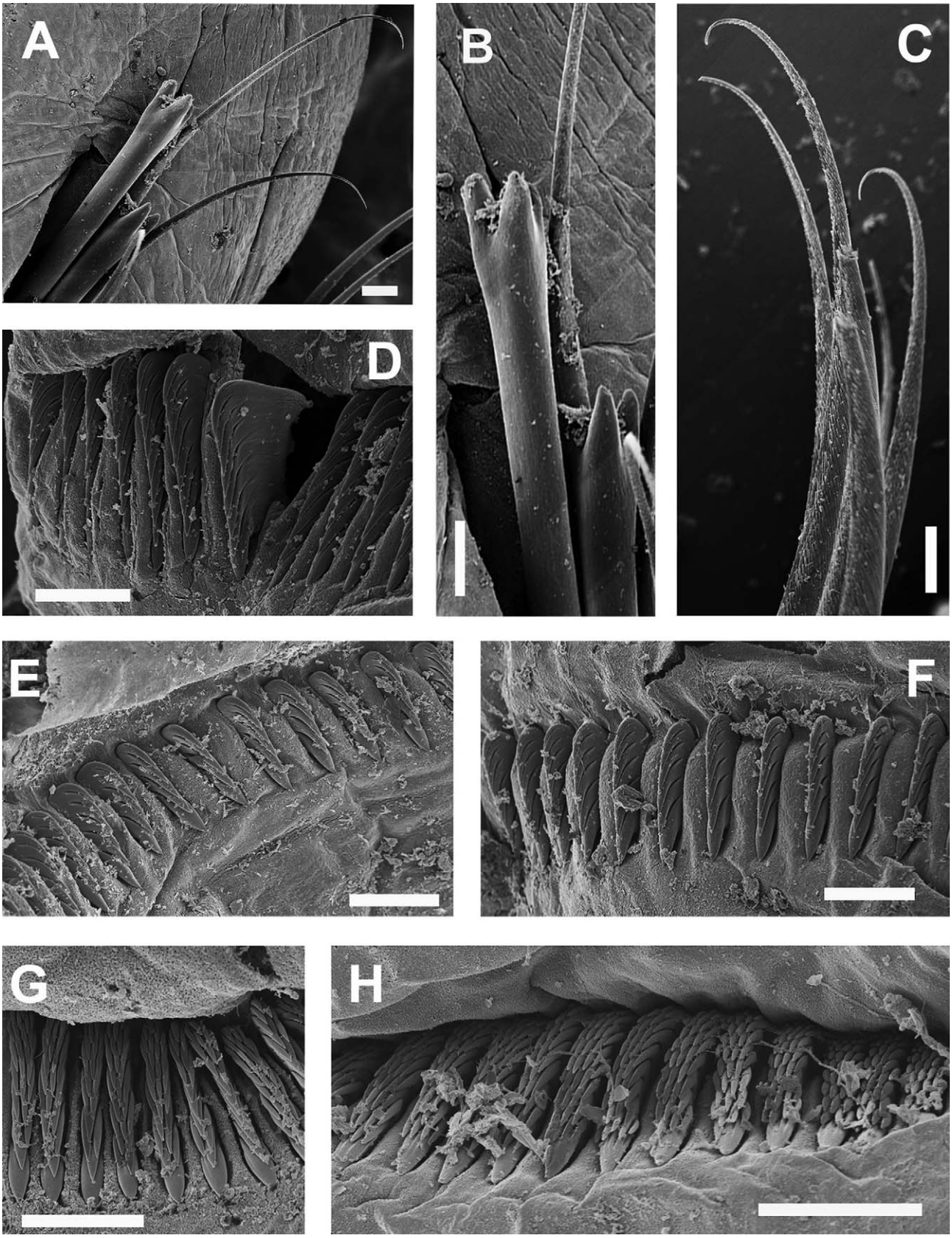

FIGURE 4. *Hydroides albiceps*, AM W40534. A, bayonet collar chaetae. B, detail of distal tip of bayonet collar chaeta. C, thoracic limbate chaetae. D, uncini from chaetiger 4. E, anterior abdominal uncini. F, middle abdominal uncini. G, H, posterior abdominal uncini. (Scale bars: A–F=10 µm)

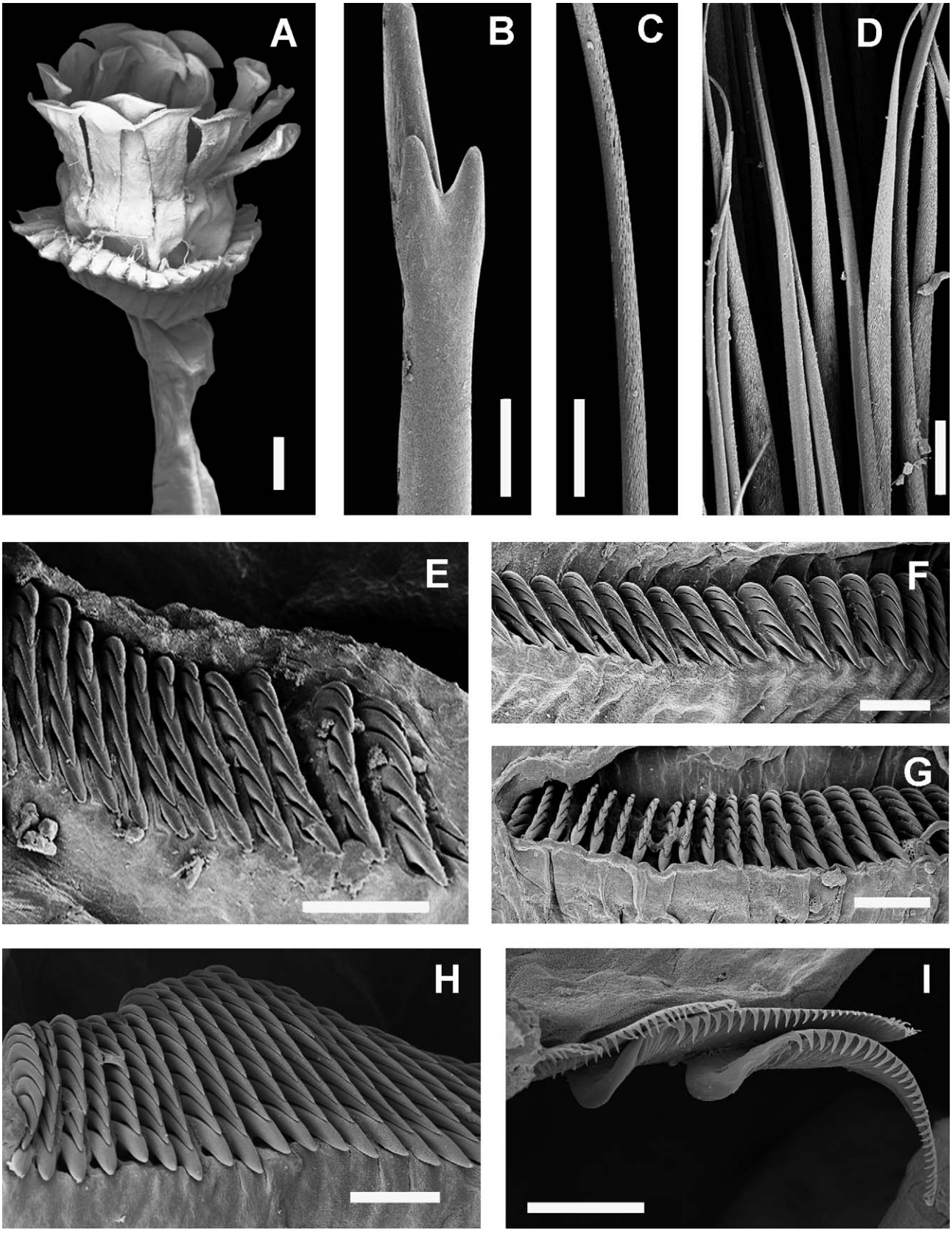

FIGURE 5. *Hydroides diramphus*, AM W40539. A, operculum. B, bayonet collar chaetae. C, detail of denticulate capillary collar chaeta. D, thoracic limbate and capillary chaetae. E, uncini from chaetiger 7. F, anterior abdominal uncini. G, middle abdominal uncini. H, posterior abdominal uncini. I, toothed edge of flat-trumpet chaetae from posterior abdomen. (Scale bars: A=200 μm, B–C=30 μm, D–H=20 μm, I=10 μm)

Description. TUBE: white, circular in cross-section; longitudinal ridges, if present, very low, collar-like rings absent. Transversal ridges present throughout the whole tube. External tube diameter from 1.4 mm to 2.6 mm (n=8, μ=1.9±0.4), lumen diameter from 1.1 mm to 2.0 mm (n=8, μ=1.5±0.3).

BRANCHIAE: radioles on each side arranged in semicircle, numbers ranging from 14 to 18 (n=8, μ=15.6±1.6). Interradiolar membrane absent. Terminal filament long.

PEDUNCLE: smooth, circular in cross-section, inserted below left branchial lobe in 12 specimens, right in 1 specimen. Constriction well-defined. Pseudoperculum club-shaped with an inflated tip, present in all specimens.

OPERCULUM: funnel radii with pointed tip, numbers ranging from 30 to 42 (n=8 μ=35.5±5.6). Interradial grooves almost 3/4 of funnel length. Verticil with 12 to 18 yellowish spines (n=8, μ=14.3±3.2), straight, all spines similar in size and shape. Tip of spines T-shaped and flattened (Figure 5A), each having a basal internal spinule. External and lateral spinules absent. Central tooth absent. Length of operculum from 0.8 mm to 1.8 mm (n=8, μ=1.1±0.4), width from 1.1 mm to 1.8 mm (n=8, μ=1.3±0.3).

COLLAR AND THORACIC MEMBRANES: collar high, continuous with well-developed thoracic membranes.

THORAX: with 7 chaetigers, 6 uncinigerous. Collar chaetae of two types: bayonet chaetae with two long pointed teeth and smooth distal blade (Figure 5B), and capillaries with minute denticles (Figure 5C). Subsequent chaetae of two sizes (limbate and capillary, Figure 5D). Uncini along entire thorax saw-shaped with 7 curved teeth including anterior fang (Figure 5E). Tori of similar size throughout, approaching each other posteriorly, leaving a ventral depression.

ABDOMEN: total number of abdominal chaetigers varies from 64 to 103 (n=8, μ=85.3±12.9). Uncini saw-shaped throughout with fang and 4 teeth anteriorly, increasing to 8 to 9 teeth (incl. fang) posteriorly (Figure 5F–H). Chaetae flat trumpet-shaped (Figure 5I). Capillaries present posteriorly, glandular pad absent.

SIZE: total worm length: 12.0 mm to 32.0 mm (n=8, μ=19.4±8.2), thoracic width: 1.2 mm to 2.0 mm (n=8, μ=1.6±0.5). Branchiae and operculum accounting for one fifth of entire length.

COLOUR: yellow to light brown.

Habitat. Depth: 1–10 m, on pier piles or other artificial substrate, fouling.

Distribution. Circum(sub)tropical.

Remarks. *Hydroides diramphus* has been reported as a fouling species, being ship-transported easily (Bastida-Zavala & ten Hove 2003) and present in both polluted and non polluted areas (Bastida-Zavala 2008). In Hong Kong, *Hydroides diramphus* occasionally occurs in the fouling community of local fish farms, co-occurring with *Hydroides sanctaecrucis* and *Hydroides elegans* on various submerged surfaces, with the latter species being dominant.

Hydroides elegans (Haswell, 1883)

(Figure 2B, Figure 6A–H)

Eupomatus elegans Haswell, 1883: 633.
Hydrodies [**sic!**] *multispinosa* **not** Marenzeller, 1885 *sensu* Lee and Trott 1973: 103.
Hydroides norvegica **not** Gunnerus *sensu* Day 1967: 805; Greene and Morton 1977: 231–232, 235–236.
Hydroides elegans—Imajima 1976b: 237–238; Huang and Mak 1982: 767–768, 771, 775–780; Mak 1982: 602–603; Mak and Huang 1982: 817–822; Morton and Morton 1983: 77, 88, 90, 121–122; Wang and Huang 1993: 1–12; Qiu and Qian 1997: 79–88; 1998: 127–134; Tan and Morton 1998: 392–401; Bastida-Zavala and ten Hove 2002: 164–165; Ben-Eliahu and ten Hove 2011: 19–25 [for partial, complicated synonymy].
Hydroides sp.—Thompson *et. al.* 1982: 748, 756.
Protohydroides elegans—Shin 1982: 170.

Material examined. AM W41405, 4 specimens (22°21'N, 114°17'E, Sharp Island, on dead coral, 3m, May 21, 2009); AM W40540, 20 specimens (22°25'N, 114°16'E, Tolo Harbour, on artificial substrate: fouling plates in the fish farm, 10 m, April 15, 2009)

Description. TUBE: white, circular in cross-section, fragmentary, with numerous transversal ridges, without longitudinal ridges. Collar-like rings absent. External tube diameter from 0.7 mm to 1.3 mm (n=8, μ=1.0±0.2), lumen diameter from 0.5 mm to 1.0 mm (n=8, μ=0.8±0.2).

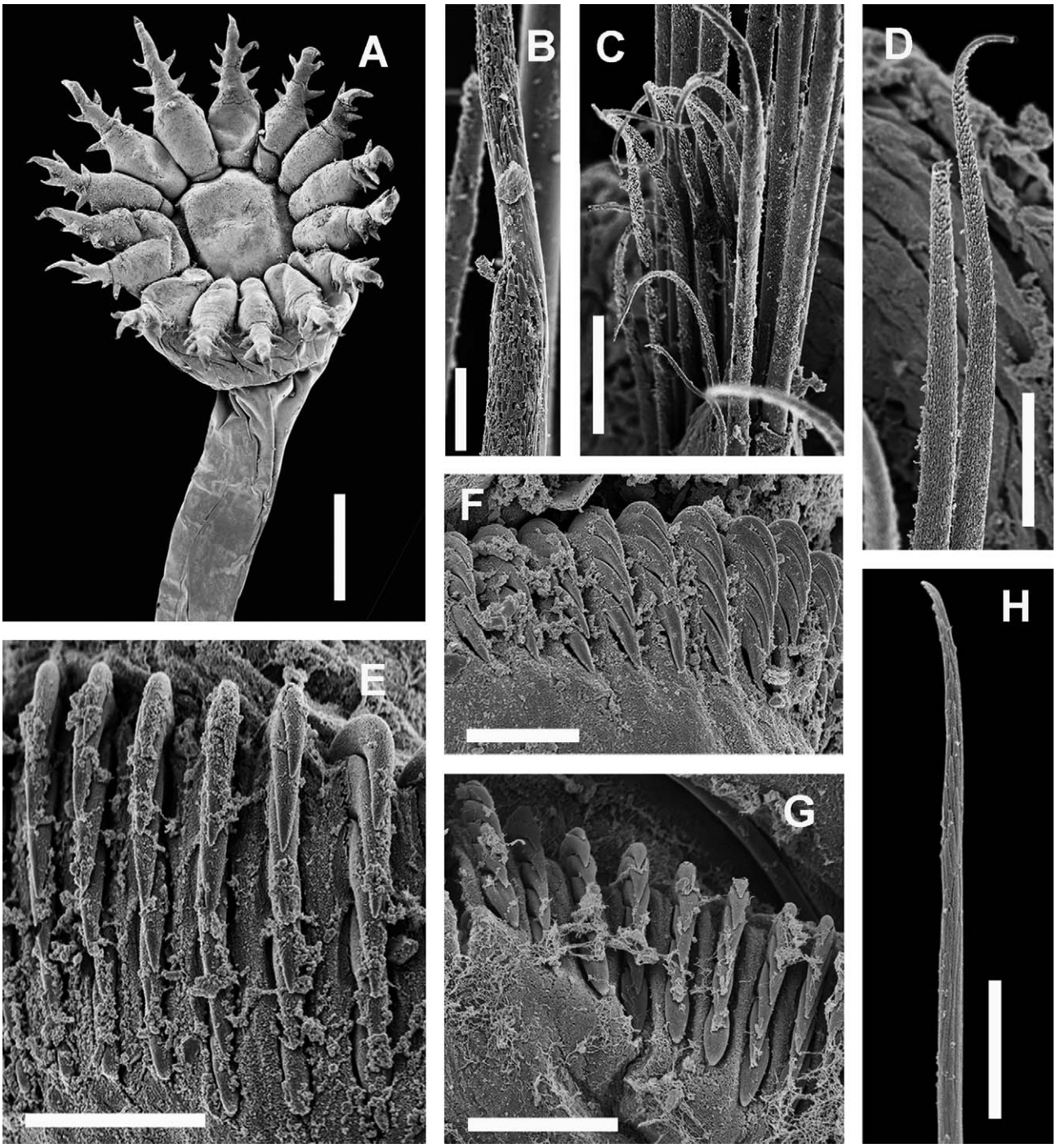

FIGURE 6. *Hydroides elegans*, AM W40540. A, operculum. B, bayonet collar chaeta. C, limbate chaetae from chaetiger 4. D, details of limbate chaetae from chaetiger 4. E, uncini from chaetiger 4. F, anterior abdominal uncini. G, middle abdominal uncini. H, posterior abdominal capillary. (Scale bars: A=100 μm, B, D–F=10 μm, C=20 μm)

BRANCHIAE: radioles on each side arranged in semicircle, numbers ranging from 8 to 14 (n=8, μ=1.0±0.2). Interradiolar membrane absent. Terminal filament about 1/5 of whole radiolar length.

PEDUNCLE: long, smooth, circular in cross-section, inserted below left branchial lobe in five specimens, right in eighteen specimens. Constriction absent. Pseudoperculum present in 18 specimens, with an inflated tip or a primary operculum (of the *Serpula*-type) only.

OPERCULUM: numbers of radii ranging from 22 to 27 (n=8, μ=24.5±2.4), radii with rounded, non-chitinized tips. Interradial grooves 2/3 of funnel length. Verticil with 9 to 16 straight, pointed spines (n=8, μ=10.8±2.0); spines yellowish, similar in shape, with 3 to 4 pointed lateral spinules on both sides and 1 to 3 internal spinules (Figure 6A). Central tooth present in fourteen specimens, absent in eight, similar in shape and size to lateral

spinules. External spinules absent. Opercular length from 0.4 mm to 0.9 mm (n=8, μ=0.7±0.2), width from 0.4 mm to 0.9 mm (n=8, μ=0.7±0.2).

COLLAR AND THORACIC MEMBRANES: collar high, thoracic membranes well-developed.

THORAX: with 7 chaetigers, 6 uncinigerous. Collar chaetae of two types: bayonet chaetae with two well-defined denticulate zones delimited by a conspicuous notch, distal one with rows of tiny serrations, proximal zone with four large pointed teeth and many smaller denticles proximally (Figure 6B); and finely striated capillaries. Subsequent chaetae of two sizes (limbate and capillary, Figure 6C–D). Uncini along entire thorax saw-shaped with 6 curved teeth (Figure 6E). Tori of similar size throughout.

ABDOMEN: total number of abdominal chaetigers varies from 26 to 68 (n=8, μ=45.4±13.9). Uncini saw-shaped with fang and 3 to 4 teeth anteriorly, increasing to 5 to 6 in the middle of the abdomen (Figure 6F–G); rasp-shaped posteriorly with 2 to 3 rows of teeth and 7 to 8 teeth (incl. fang) in profile view. Chaetae flat trumpet-shaped. Capillaries present posteriorly (Figure 6H), glandular pad absent.

SIZE: total worm length: 8.1 mm to 25.5 mm (n=8, μ=12.7±5.9), thoracic width: 0.6 mm to 1.1 mm (n=8, μ=0.9±0.2). Branchiae and operculum accounting for one fifth of entire length.

COLOUR: in ethanol yellowish.

Habitat. Depth: 3–10 m, on dead coral, artificial substrate of the fish farm. Fouling.

Distribution. Widely distributed in tropical and subtropical waters around the world.

Remarks. *Hydroides elegans* is an invasive and fouling species (Zibrowius 1994; Bastida-Zavala & ten Hove 2002). It is the most common serpulid in Hong Kong. Structures submerged in eastern Hong Kong waters for several months during winter and spring can be coated by *H. elegans* with a thickness up to 3.8 cm and wet-weight reaching 12.5 kg m^{-2} (Wang & Huang 1993). Material from Sharp Island seemed to have slightly higher numbers of lateral spinules (4–6) to the verticil spines, the relevance of this occasional observation should be ascertained from further study.

Hydroides exaltatus (Marenzeller, 1885)

(Figure 7A–I)

Eupomatus exaltatus Marenzeller, 1885: 217.

Hydroides exaltata—Imajima 1976a: 127–128; Mak 1982: 603; Imajima and ten Hove 1984: 48; 1986: 4–5; Sun and Yang 2000: 121; Fiege and Sun 1999: 116; Pillai 2009: 115–116.

Material examined. AM W40542, 9 specimens (22°21'N, 114°17'E, Sharp Island, on dead coral, 3–6 m, May 21, 2009).

Description. TUBE: white, trapezoidal in cross-section, with two longitudinal ridges. Collar-like rings absent. External tube diameter: from 1.7 mm to 2.3 mm (n=3, μ=2.0±0.4), with lumen diameter from 1.3 mm to 1.7 mm (n=3, μ=1.4±0.2).

BRANCHIAE: each lobe with 10 to 15 radioles (n=5, μ=12.4±1.9) arranged in semicircle. Interradiolar membrane absent. Terminal filament long, about 1/5 of whole radiolar length.

PEDUNCLE: smooth, circular in cross-section, inserted below left branchial lobe. Constriction well-defined, chitinized. Pseudoperculum short, club-shaped.

OPERCULUM: numbers of radii ranging from 21 to 27(n=7, μ=24.4±2.2); tips yellowish, pointed, chitinized, curving outward. Interradial grooves 1/2 to 2/3 of funnel length. Verticil consisting of 7 to 9 spines (n=7, μ=7.7±1.1). The most dorsal one much larger, expanding upward before curving inward, tapering to a pointed tip, a slight depression present externally on each lateral side beneath expanded part. Remaining smaller spines similar in shape and size, all strongly curving outward, tapering to a pointed tip (Figure 7A). All spines with a small internal spinule arising from the base of spine. Central tooth absent. Opercular length from 0.8 mm to 2 mm (n=6, μ=1.4±0.5), width from 0.5 mm to 1.2 mm (n=6, μ=0.9±0.2).

COLLAR AND THORACIC MEMBRANES: collar high, thoracic membranes well-developed, apron present.

THORAX: with 7 chaetigers, 6 uncinigerous. Collar chaetae of two types: bayonet chaetae with two long pointed teeth and smooth distal blade, and capillaries with minute denticles (Figure 7B). Subsequent chaetae of two sizes (limbate and capillary, Figure 7C–D). Uncini along entire thorax saw-shaped with 6–7 curved teeth including anterior fang (Figure 7E). Tori of similar size throughout.

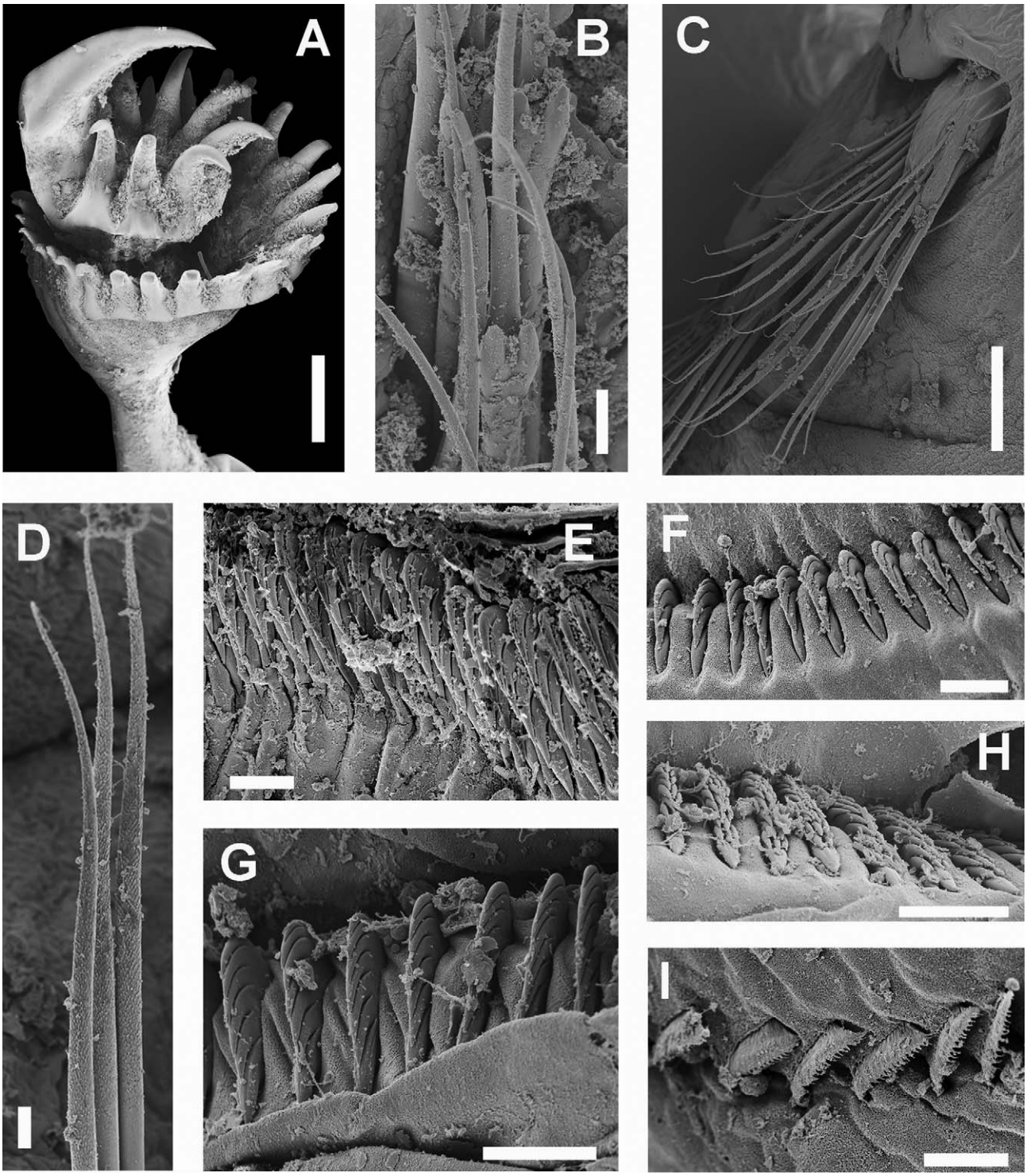

FIGURE 7. *Hydroides exaltatus*, AM W40542. A, operculum. B, collar chaetae. C, limbate and capillary chaetae from chaetiger 4. D, details of limbate chaetae from chaetiger 4. E, uncini from chaetiger 4. F, anterior abdominal uncini. G, middle abdominal uncini. H, posterior abdominal uncini. I, toothed edge of flat-trumpet chaetae from posterior abdomen. (Scale bars: A=200 µm, B=20µm, C=100 µm, D–I=10 µm)

ABDOMEN: total number of abdominal chaetigers varies from 52 to 59 (n=2, µ=55.5±4.9). Uncini saw-shaped with 4 to 5 teeth anteriorly (Figure 7F), increasing to 6 to 7 in the middle (Figure 7G); rasp-shaped posteriorly with 2 to 3 rows of teeth and 7 to 8 teeth (incl. fang) in profile view (Figure 7H). Chaetae flat trumpet-shaped (Figure 7I). Capillary chaetae not observed. Posterior glandular pad absent.

SIZE: total worm length: 9.6 mm to 19.4 mm (n=5, µ=13.2±3.8), thoracic width: 0.9 mm to 1.2 mm (n=5, µ=1.1±0.1). Branchiae and operculum accounting for one fourth of entire length.

COLOUR: white.

Habitat. Depth: 3–6 m, on dead corals.

Distribution. Widely distributed in tropical and subtropical waters of the Indian Ocean and Pacific Ocean.

Remarks. The collar capillaries of this species have been described differently: limbate (Imajima 1976a), smooth (Fiege & Sun 1999; this study), or without mentioning whether they are limbate or smooth (Mak 1982; Pillai 2009); this probably is rather a matter of quality of optics and of interpretation than of real differences. The present specimens agree with Imajima's description. The position of the internal spinules has been reported to be on halfway of each spine (Pillai 2009), in error, as his figures clearly depict a basal position.

Hydroides ezoensis Okuda, 1934

Remarks. A taxon similar to *H. ezoensis* was mentioned by Wang and Huang (1993: 7, 10) from the fouling communities of Hong Kong; however, this species was not found by us. *H. ezoensis* essentially is a temperate species (Zibrowius 1978, Zibrowius & Thorp 1989: 276–277, Pollard & Pethebridge 2002: 24, ten Hove *et al.* 2011). Although it cannot be excluded that it was ship-transported and (temporarily?) present in Hong Kong waters, a more likely explanation might be that Wang and Huang (1993) mistook the similar but at that time still relatively unknown *H. longistylaris* (see below) for this species.

Hydroides fusicola Mörch, 1863

Remarks. This is a temperate species (e.g. Imajima 1976b: 236–237, 1979: 169). The tentative record of this species from Hong Kong by Mak (1982) likely belongs to *H. longistylaris*, see below.

Hydroides longistylaris Chen and Wu, 1980
(Figure 8A–I)

Hydroides longistylaris Chen and Wu, 1980: 249–250; Fiege and Sun 1999: 118–119; Sun and Yang 2000: 124.
? *Hydroides* cf. *fusicola* **not** Mörch, 1863 *sensu* Mak 1982: 603–604.
?? *Hydroides* cf. *ezoensis* **not** Okuda, 1934 *sensu* Wang and Huang 1993: 7, 10.

Material examined. AM W40546, 10 specimens (22°21'N, 114°17'E, Sharp Island, on dead coral, 3–6 m, May 21, 2009).

Description. TUBE: white, trapezoidal in cross-section with two longitudinal ridges. Collar-like rings absent. External tube diameter: from 1.0 mm to 1.4 mm (n=3, r: 1.0–1.4, μ=1.2±0.2), lumen diameter from 0.8 mm to 1.0 mm (n=3, μ=0.9±0.1).

BRANCHIAE: radioles on each side arranged in semicircle, numbers ranging from 6 to 13 (n=7, μ=8.4±2.5). Interradiolar membrane absent. Terminal filament long.

PEDUNCLE: long, smooth, with a long yellowish chitinized constriction below funnel, circular in cross-section, inserted below right branchial lobe. Pseudo-operculum club-shaped in six specimens, with an inflated tip in four.

OPERCULUM: Opercular funnel with 16 to 25 radii (n=8, μ=20.5±3.3); distally brown, tips black, pointed and curving outward. Interradial grooves 1/3 of funnel length. Verticil small, strongly chitinized, with 5 to 8 smooth spines (n=8, μ=20.5±3.3), curving outward to almost parallel with funnel radii (Figure 8A). Central tooth absent. Opercular length from 0.4 mm to 1.2 mm (n=8, μ=0.7±0.3), width from 0.5 mm to 0.8 mm (n=8, μ=0.6±0.1).

COLLAR AND THORACIC MEMBRANES: collar high, thoracic membranes well-developed, apron present.

THORAX: with 7 chaetigers, 6 uncinigerous. Collar chaetae of two types: bayonet chaetae with two long pointed teeth and smooth distal blade, and capillaries with minute denticles (Figure 8B). Subsequent chaetae of two sizes (limbate and capillary, Figure 8C–D). Uncini along entire thorax saw-shaped with 8 curved teeth including fang (Figure 8E). Tori of similar size throughout. Ventral depression present.

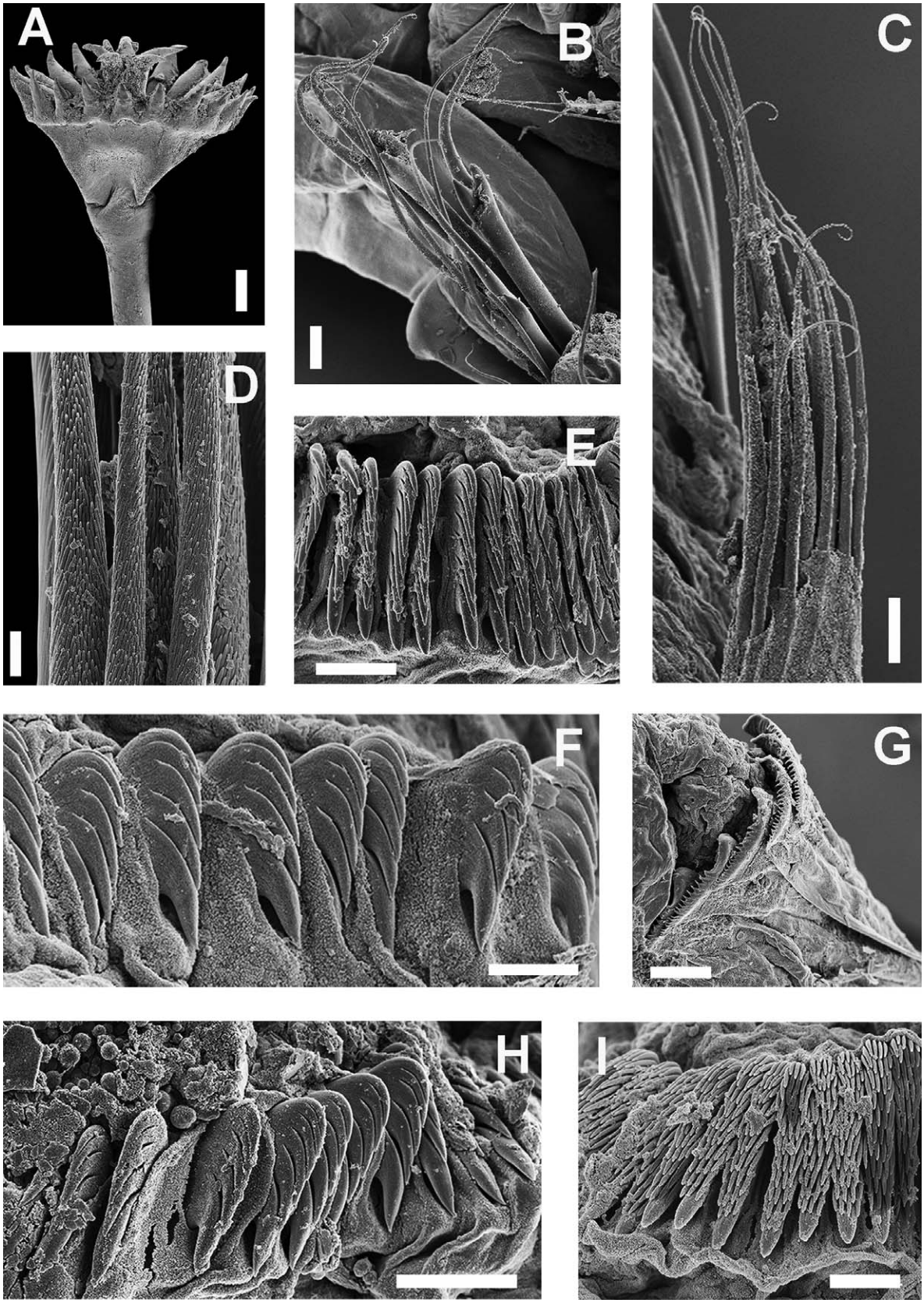

FIGURE 8. *Hydroides longistylaris*, AM W40546. A, operculum. B, collar chaetae. C, limbate and capillary chaetae from chaetiger 4. D, details of limbate chaetae from chaetiger 4. E, uncini from chaetiger 4. F, anterior abdominal uncini. G, toothed edge of flat-trumpet chaetae from posterior abdomen. H, middle abdominal uncini. I, posterior abdominal uncini. (Scale bars: A=200 µm, B–C=30 µm, D=2 µm, E, H=10 µm, F, G, I =5 µm)

ABDOMEN: total number of abdominal chaetigers varies from 52 to 64 (n=3, μ=51±11.5). Uncini saw-shaped with 5 to 6 teeth anteriorly (Figure 8F, H), rasp-shaped posteriorly with 3 to 4 rows of teeth and 10 to 12 teeth (incl. fang) in profile view (Figure 8I). Chaetae flat trumpet-shaped (Figure 8G). Capillary chaetae not observed. Posterior glandular pad absent.

SIZE: total worm length: 8.3 mm to 13.8 mm (n=5, μ=10.8±2.4), thoracic width: 0.4 mm to 1.3 mm (n=7, μ=0.7±0.3). Branchiae and operculum accounting for one fifth of entire length.

COLOUR: in ethanol white.

Habitat. Depth: 3–6 m, on deal corals.

Distribution. South China Sea. Currently reported from Chinese coasts only.

Remarks. *Hydroides longistylaris* can be distinguished from other Hong Kong species of the genus by the presence of an elongated peduncle with a long chitinized constriction; such a chitinized part is present in *H. rectus* Straughan, 1967 as well, but this taxon has one enlarged vertical spine. The present specimens agree with the descriptions of Chen and Wu (1980), Fiege and Sun (1999), except for the numbers of radioles in the branchial crown (9 versus 15–23 pairs). Mak´s (1982: 603) statement for his *H.* cf. *fusicola* "The proximal half of the peduncle is fleshy and the distal half is transparent with a central chitinous column visible inside", as well as the 7 outward curving verticil spines clearly point to *H. longistylaris* rather than to the temperate *H. fusicola*.

Hydroides operculatus (Treadwell, 1929)

(Figure 3C, Figure 9A–H)

Eupomatus operculata Treadwell, 1929: 12.
Hydroides inornata—Huang and Mak 1982: 780; Mak 1982: 605; Wang and Huang 1993: 1–12.
Hydroides operculatus—Ben-Eliahu and ten Hove 1992: 44.

Material examined. AM W41406, 3 specimens (22°21'N, 114°17'E, Sharp Island, on dead coral, 3–6 m, May 21, 2009); AM W40550, 2 specimens (22°25'N, 114°16'E, Tolo Harbour, on artificial substrate: fouling plates in fish farm, 10 m, April 15, 2009).

Description. TUBE: white, trapezoidal in cross-section with two to three long longitudinal ridges and numerous transversal ridges. Collar-like rings absent. External tube diameter: from 0.7 mm to 1.3 mm (n=3, μ=1.2±0.5), lumen diameter from 0.3 mm to 1.3 mm (n=3, μ=0.8±0.5).

BRANCHIAE: radioles on each side arranged in semicircle, numbers ranging from 10 to 11 (n=3, μ=10.7±0.6). Interradiolar membrane absent. Terminal filament long.

PEDUNCLE: long, smooth, at most slightly constricted near funnel, circular in cross-section, inserted below right branchial lobe. Pseudo-operculum short club-shaped.

OPERCULUM: numbers of radii ranging from 28 to 38 (n=4, μ=34.3±5.1); pointed and curving outward. Interradial grooves 1/2 of funnel length. Verticil dark brown, consisting of 8 to 9 smooth spines (n=5, μ=8.8±0.4), hooked, tips all curving inwards; one to three spines larger; other spines similar in shape and size; one short basal internal spinule arising from inner base of each spine (Figure 3C, Figure 9A). External and lateral spinules or knobs absent. Central tooth absent. Opercular length from 0.9 mm to 1.3 mm (n=5, μ=1.1±0.2), width from 0.5 mm to 1.0 mm (n=5, μ=0.7±0.2).

COLLAR AND THORACIC MEMBRANES: collar high, thoracic membranes well-developed, apron present.

THORAX: with 7 chaetigers, and 6 uncinigerous. Collar chaetae of two types: bayonet chaetae with two pointed teeth at base of smooth blade, and capillaries with minute denticles (Figure 9B). Subsequent chaetae of two sizes (Figure 9C). Uncini along entire thorax saw-shaped with 5 curved teeth including anterior fang (Figure 9D). Tori of similar size throughout. Ventral depression present.

ABDOMEN: total number of abdominal chaetigers varies from 64 to 79 (n=2, μ=71.5±10.6). Uncini saw-shaped with 4 to 5 teeth anteriorly (Figure 9E–F); rasp-shaped posteriorly with 2 to 3 rows of teeth and 6 to 7 teeth in profile view (Figure 9G–H). Chaetae flat trumpet-shaped. Capillary chaetae not observed. Posterior glandular pad absent.

SIZE: total worm length: 18.0 mm to 28.0 mm (n=4, μ=23.8±4.2), thoracic width: 0.8 mm to 1.0 mm (n=4, μ=0.9±0.1). Branchiae and operculum accounting for one fifth of entire length.

COLOUR: in ethanol white.

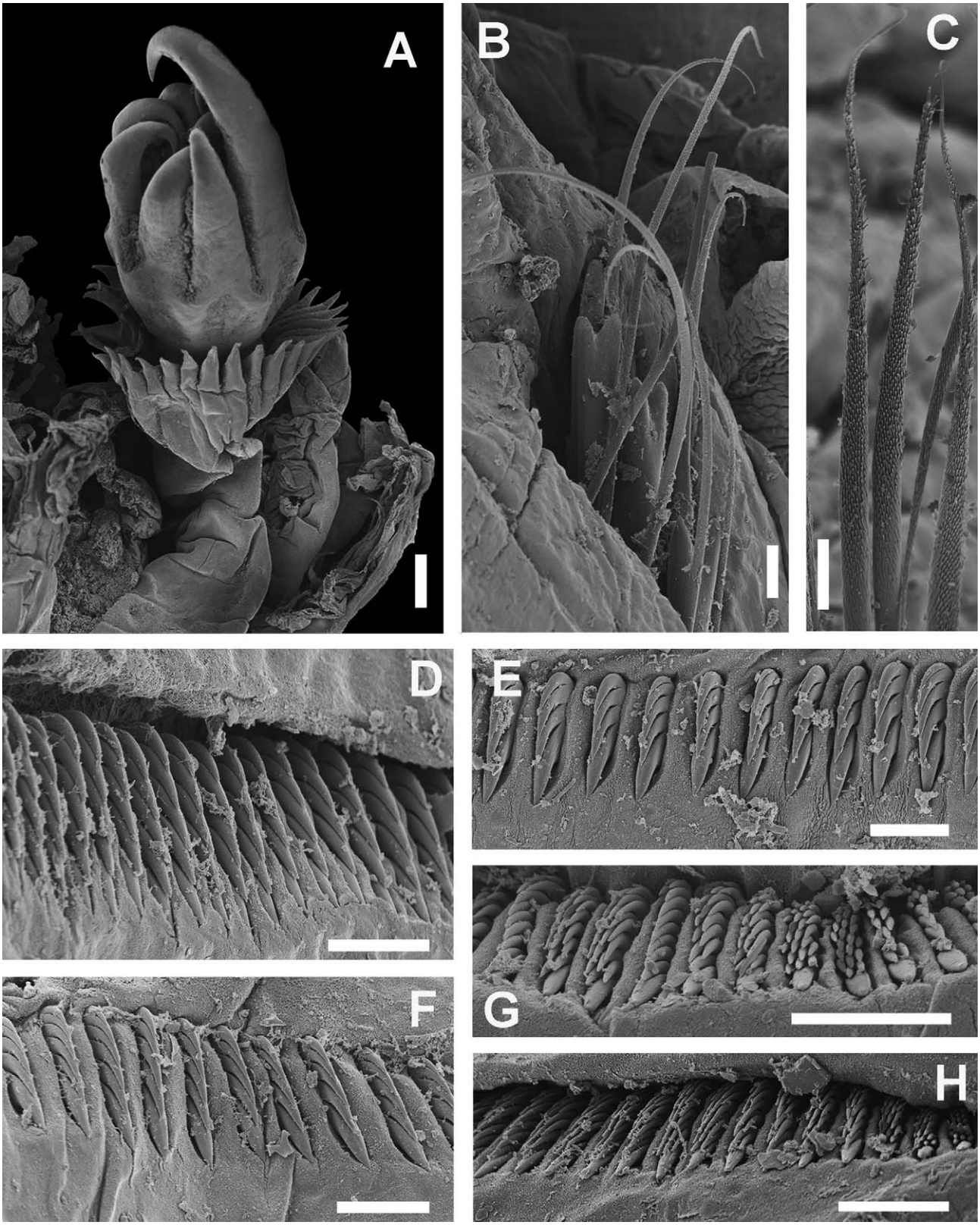

FIGURE 9. *Hydroides operculatus*, AM W41406. A, operculum. B, collar chaetae. C, limbate and capillary chaetae from chaetiger 4. D, uncini from chaetiger 4. E, anterior abdominal uncini. F, middle abdominal uncini. G,H, posterior abdominal uncini. (Scale bars: A=100 µm, B=20 µm, D–H=10 µm)

Habitat. Depth: 3 m, on dead corals and artificial substrate in fish farm.

Distribution. Indian-Pacific Ocean, Lessepsian migrant in E. Mediterranean.

Remarks. One of our specimens has 9 verticil spines, three of them large, which is regarded to be an opercular variation. *Hydroides operculatus* has been recorded as a ship-transported species (Bastida-Zavala & ten Hove 2002). It is recorded herein from fouling communities of the fish farm in Tolo Harbour.

Hydroides rhombobulus Chen and Wu, 1980

(Figure 3D–J)

Hydroides rhombobulus Chen and Wu, 1980: 248–249; Mak 1982: 605–606; Sun and Yang 2000: 128.

Material examined. AM W41407, 1 specimen (22°21'N, 114°17'E, Sharp Island, on dead coral, 3 m, May 21, 2009).

Description. TUBE: lilac, up to 1.1 mm wide with lumen 0.8 mm, thin, trapezoidal in cross-section with three long longitudinal ridges and numerous transversal ridges. Collar-like rings absent.

BRANCHIAE: each lobe with 9 radioles arranged in semicircle. Interradiolar membrane absent. Terminal filament long.

PEDUNCLE: long, smooth with slight constriction near funnel, circular in cross-section, inserted below left branchial lobe. Pseudo-operculum not found.

OPERCULUM: Opercular funnel with 16 radii, distally brown, tips black, pointed and curving outward. Interradial grooves 1/3 of funnel length. Verticil almost similar in width to funnel, consisting of 5 broad valvular spines, smooth, similar in size and shape, each spine transparent light brown marginally, with a convex outside and rounded tip; spines fused basally (Figure 3D–E). Central tooth absent. Length of the operculum about 0.6 mm, width 0.4 mm.

COLLAR AND THORACIC MEMBRANES: collar high, thoracic membranes well-developed, apron present.

THORAX: with 7 chaetigers, 6 uncinigerous. Collar chaetae of two types: bayonet chaetae with two pointed teeth at base of finely serrated blade, and capillaries (Figure 3F, G). Subsequent chaetae of two sizes (limbate, Figure 3H, and capillary). Uncini along entire thorax saw-shaped with 7 curved teeth including fang (Figure 3I). Tori of similar size. Ventral depression present.

ABDOMEN: abdominal chaetigers 70. Uncini saw-shaped with 4 to 5 teeth anteriorly (Figure 3J); rasp-shaped posteriorly with 2 to 3 rows of teeth and 7 to 8 teeth in profile view including fang. Chaetae flat trumpet-shaped. Capillaries not observed. Posterior glandular pad absent.

SIZE: length up to 8.9 mm, thoracic width 0.8 mm. Branchiae and operculum accounting for one fifth of entire length.

COLOUR: in ethanol white.

Habitat. Depth: 3 m, on dead corals.

Distribution. South China Sea. Reported from Chinese coasts only.

Remarks. The number of radioles shows some variation, maybe ontogenetic: 12 pairs for holotype from Fujian, China (Chen & Wu 1980); 7 pairs for specimens from Hong Kong, Hoi Ha Wan (Mak 1982), and 9 pairs for specimen from Sharp Island, present study.

Many Indo-West Pacific *Hydroides* species are characterized by a low number of rather undifferentiated valvular verticil spines, pointed funnel radii numbering between 16 and 30, and rather undifferentiated bayonet chaetae with two large teeth: *H. kimberleyensis* Pillai, 2009, *perezi* Fauvel, 1918, *rhombobulus*, *trilobulus* Chen and Wu, 1978, *tuberculatus* Imajima, 1976, *uniformis* Imajima and ten Hove, 1986 and *xishaensis* Chen and Wu, 1978. These nominal species have been distinguished from each other by (partly presumed) differences in numbers (3, 4–5, 7–8) or shape of verticil spines ("valvular" versus "triangular"), white versus bluish tubes, bayonet collar chaetae with or without accessory teeth (e.g. Imajima 1976: 133, Imajima & ten Hove 1986: 7–8). Though the latter not even considered *H. tuberculatus* in their differential diagnosis of *H. uniformis,* apparently being too clear-cut different, in later and larger samples it sometimes was difficult if not impossible to distinguish between the two nominal species (ten Hove 1994: 108). It is not known whether the blue tube colour may disappear in preservative, nor is it clear if the other characters used for distinction are robust or merely due to small sample sizes. Since a

revision, only worthwhile if based on comparison of actual material, falls outside the scope of present paper, we have used the "local" name *H. rhombobulus* for our specimens.

Hydroides sanctaecrucis **Krøyer [in] Mörch, 1863**
(Figure 10A–G)

Hydroides (Eucarphus) sanctae-crucis Krøyer [in] Mörch, 1863: 378–379.
Hydroides sanctaecrucis—Bastida-Zavala and ten Hove 2002: 146–149; 2003: 101–102; Bastida-Zavala 2008: 29.

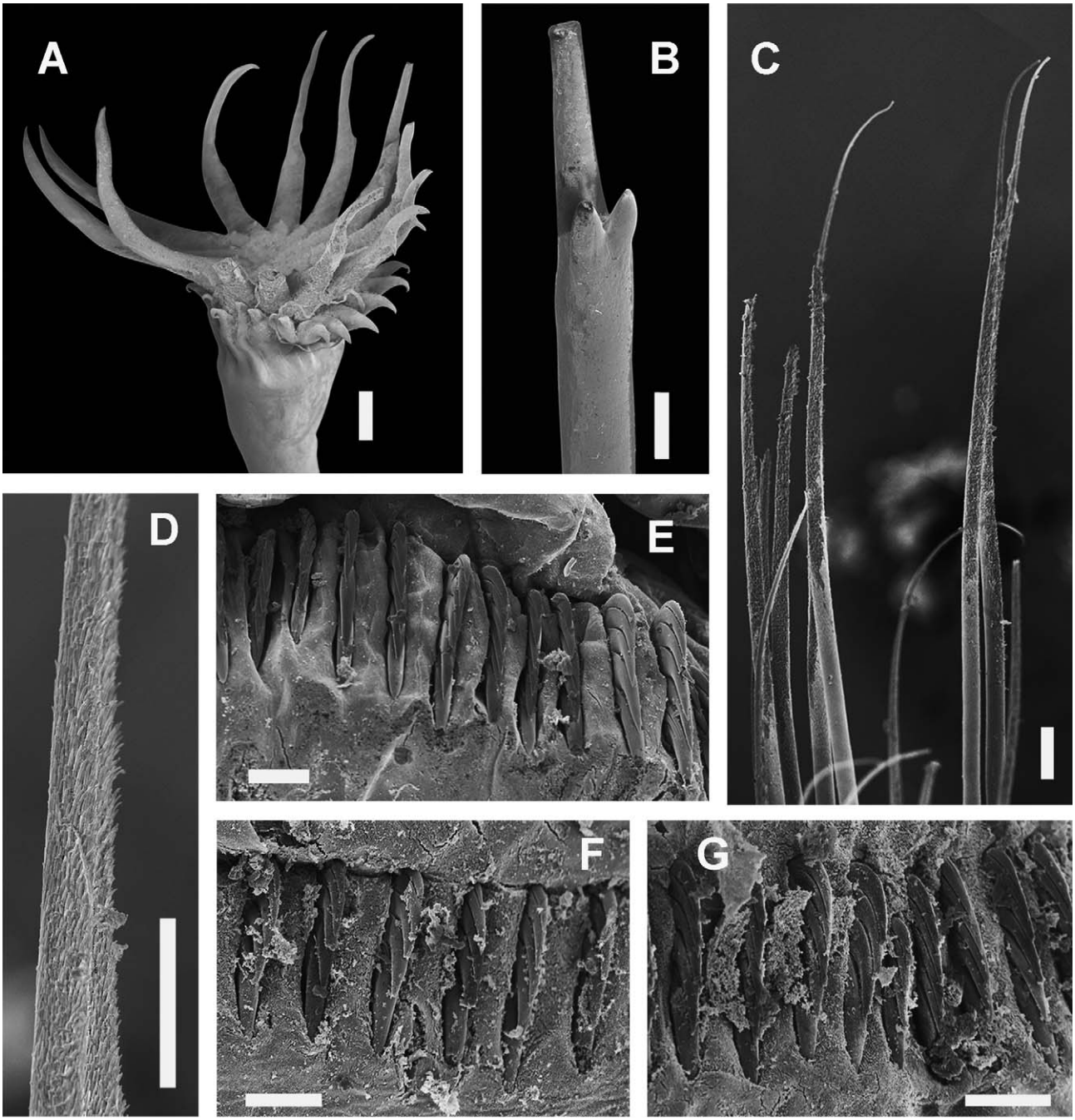

FIGURE 10. *Hydroides sanctaecrucis*, AM W40548. A, operculum. B, bayonet collar chaeta. C, limbate chaetae from chaetiger 4. D, details of limbate chaetae from chaetiger 4. E, uncini from chaetiger 4. F, anterior abdominal uncini. G, middle abdominal uncini. (Scale bars: A=200 µm, B–D=20 µm, E–G=10 µm)

.

Material examined. AM W40548, 3 specimens (22°25'N, 114°16'E, Tolo Harbour, on artificial substrate: fouling plates in fish farm, 10 m, April 15, 2009); AM W41408, 1 specimen (22°17'N, 114°11'E, Victoria Harbour, on pier piles, 0–1 m, May 20, 2009).

Description. TUBE: white, circular in cross-section. Peristomes and longitudinal ridges absent. Transversal ridges present. External tube diameter: from 1.5 mm to 1.8 mm (n=2, μ=1.6±0.2), lumen diameter from 1.5 mm to 1.8 mm (n=2, μ=1.6±0.2).

BRANCHIAE: radioles on each side arranged in semicircle, numbers ranging from 12 to 15 (n=3, μ=13.3±1.5). Interradiolar membrane absent. Terminal filament long.

PEDUNCLE: smooth, circular in cross-section, inserted just below left branchial lobe. Constriction hardly defined. Pseudo-operculum club-shaped.

OPERCULUM: numbers of radii ranging from 14 to 24 (n=3, μ=20±5.3), with pointed tip. Interradial grooves almost 1/3 of funnel length. Verticil with 10 to 12 spines (n=3, μ=11±1.0), all spines with pointed tip, dorsal spines slightly larger than ventral ones. Each spine with one external spinule, larger in ventral spines than in dorsal ones, and one basal internal spinule (Figure 10A). Lateral spinules absent. Central tooth absent. Opercular length from 0.8 mm to 0.9 mm (n=3, μ=0.9±0.1), width from 0.4 mm to 0.6 mm (n=3, μ=0.5±0.1).

COLLAR AND THORACIC MEMBRANES: collar high, continuous with well-developed thoracic membranes, forming apron across anterior abdominal chaetigers.

THORAX: with 7 chaetigers, 6 uncinigerous. Collar chaetae of two types: bayonet chaetae with two long pointed teeth and smooth distal blade (Figure 10B), and capillaries with minute denticles. Subsequent chaetae of two sizes (limbate and capillary, Figure 10C–D). Uncini along entire thorax saw-shaped with 5 to 6 curved teeth including anterior fang (Figure 10E). Tori of similar size throughout, ventral depression present.

ABDOMEN: total number of abdominal chaetigers varies from 70 to 90 (n=3, μ=78.7±10.3). Uncini saw-shaped with 4 to 5 teeth including anterior fang in anterior and middle abdominal chaetigers (Figure 10F–G), rasp-shaped with up to 7 teeth in profile view posteriorly. Chaetae flat trumpet-shaped. Capillaries present posteriorly, glandular pad absent.

SIZE: total worm length: 9.2 mm to 15.0 mm (n=3, μ=11.6±3.0), thoracic width: 0.7 mm to 1.0 mm (n=3, μ=1.0±0.5). Branchiae and operculum accounting for one fourth of entire length.

COLOUR: body yellow to light brown, verticil yellow to brown.

Habitat. Depth: 1–3 m, on rock piers or artificial substrate, fouling.

Distribution. Circum(sub)tropical.

Remarks. *Hydroides sanctaecrucis* is common in the Caribbean (Bastida-Zavala & ten Hove 2003). As a ship-transported species, *Hydroides sanctaecrucis* is a dominant fouling serpulid in Mexico, Panama and Oaxaca, and has been recorded as an invasive species in Northern Australia and Singapore (Lewis *et al.* 2006; Bastida-Zavala 2008; Hutchings 2008). In Hong Kong, *Hydroides sanctaecrucis* was found in low densities on the pier and the fish farm, where *Hydroides elegans* dominated the fouling community.

Hydroides tambalagamensis Pillai, 1961

(Figure 11A–J)

Hydroides tambalagamensis Pillai 1961: 36–38; Imajima 1976a: 231–232; Imajima and ten Hove 1984: 49.

Material examined. AM W40552, 4 specimens (22°21'N, 114°17'E, Sharp Island, on dead coral, 3 m, May 21, 2009).

Description. TUBE: white, trapezoidal in cross-section, with two long longitudinal ridges. Thick, transparent, chitinous layer present inside the tube. Up to 1.1 mm wide with lumen 0.7 mm.

BRANCHIAE: radioles on each side arranged in semicircle, numbers ranging from 10 to 11 (n=2, μ=10.5±0.7). Interradiolar membrane absent. Terminal filament thin and long, up to 0.5 mm.

PEDUNCLE: smooth, with a brown pigmented constriction near funnel, insertion just below right branchial lobe. Pseudo-operculum club-shaped in two specimens, with an inflated tip in one.

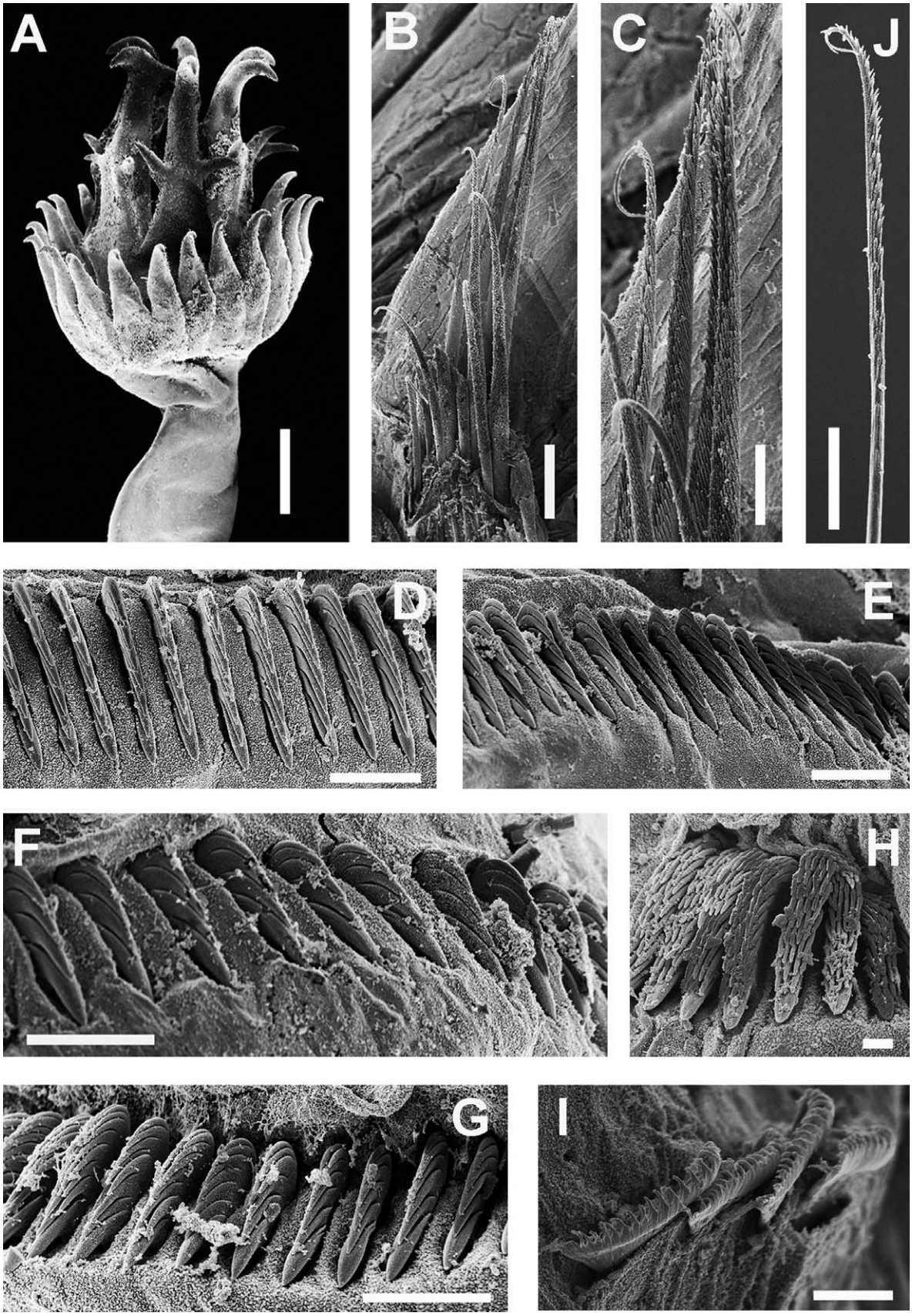

FIGURE 11. *Hydroides tambalagamensis*, AM W40552. A, operculum. B, limbate chaetae from chaetiger 4. C, details of limbate chaetae from chaetiger 4. D, uncini from chaetiger 4. E, uncini from chaetiger 7. F, anterior abdominal uncini. G, middle abdominal uncini. H, posterior abdominal uncini. I, toothed edge of flat-trumpet chaetae from posterior abdomen. J, posterior abdominal capillary. (Scale bars: A=100 µm, B=20 µm, D–G, J=10 µm, H, I=2 µm)

OPERCULUM: with distal verticil inserted into proximal oblique radial symmetrical funnel on long stalk. Verticil dark brown to black, consisting of 7 to 8 spines similar in shape and size (n=3, μ=7.7±0.6); all spines incurving towards centre of crown, but distally curving outwards in a tapering, pointed tip; each spine with a pair of lateral spinules in the middle, and one internal spinule directed to centre of verticil almost level with the lateral spinules. Number of radii ranging from 25 to 29 (n=3, μ=26.7±2.1); light brown, tips chitinized, curving outward. Interradial grooves 1/2 of funnel length (Figure 11A). Opercular length from 0.8 mm to 0.9 mm (n=3, μ=0.9±0.1), width from 0.7 mm to 0.8 mm (n=3, μ=0.7±0.1).

COLLAR AND THORACIC MEMBRANES: collar with laciniate edge, continuous with thoracic membranes, forming apron across anterior abdominal chaetigers ending at chaetiger 4.

THORAX: with 7 chaetigers, 6 uncinigerous. Collar chaetae of two types: bayonet with two pointed teeth at base of serrated blade, and smooth capillaries; subsequent chaetae of two sizes (limbate and capillary, Figure 11B–C). Uncini along entire thorax saw-shaped, with 7 curved teeth including anterior fang (Figure 11D–E). Tori of similar size along thorax. Ventral depression present.

ABDOMEN: total number of abdominal chaetigers varies from 39 to 46 (n=2, μ=42.5±4.9). Uncini saw-shaped with 5 to 7 teeth including fang anteriorly (Figure 11F, G); rasp-shaped posteriorly with 4 to 5 rows of teeth and 8 to 9 teeth in profile view (Figure 11H). Chaetae flat trumpet-shaped (Figure 11I). Capillaries present posteriorly (Figure 11J), glandular pad absent.

SIZE: total worm length: 12.8 mm to 14.0 mm (n=2 , μ=13.4±0.8), thoracic width: 0.7 mm to 0.8 mm (n=2, μ=0.8±0.1). Branchiae and operculum accounting for one fourth of entire length.

COLOUR: body yellow to light brown, verticil black.

Habitat. Depth: 6 m, on dead corals.

Distribution. Widely distributed in tropical and subtropical waters of the Indian Ocean and Pacific Ocean.

Genus *Metavermilia* Bush, 1905

Type-species: *Vermilia multicristata* Philippi, 1844

Number of species: 14

Metavermilia acanthophora (Augener, 1914)

Vermiliopsis acanthophora Augener, 1914: 155–158.
Metavermilia acanthophora—Imajima 1976a: 138–139; Mak 1982: 606–607.

Remarks. Not a new record. Mak's diagnosis seems sufficient for a reliable identification.

Metavermilia cf. *inflata* Imajima, 1977

? *Metavermilia inflata* Imajima, 1977: 99–100.
Metavermilia cf. *inflata*—Mak 1982: 607.

Remarks. Not a new record. Mak's tentative identification is accompanied by a rather short diagnosis. Since 1982 several new species of *Metavermilia* have been described, see overview in Nishi *et al.* (2007). As mentioned by Mak, the yellowish horny distal cap of the operculum is unlike *M. inflata*, and in the light of present knowledge might indicate that he had a juvenile specimen of *M. nanshaensis* Sun, 1998 in hand. More material and a description of the tube are needed for a reliable identification.

Genus *Pomatoceros* Schmarda, 1861

Type-species: *Serpula triquetra* Linnaeus, 1758

Number of species: 5

Pomatoceros triqueter (Linnaeus, 1758)

Remarks. Currently placed in the genus *Spirobranchus* according to Pillai (2009), *S. triqueter* is an Atlantic-Mediterranean species, not present in Hong Kong. Morton and Morton's (1983) record belongs to *S. kraussii*, see below.

Genus *Pomatostegus* Schmarda, 1861

Type-species: *Pomatostegus macrosoma* Schmarda, 1861
Number of species: 3

Pomatostegus actinoceras Mörch, 1863

Pomatostegus actinoceras Mörch, 1863: 400.
Pomatostegus stellatus **not** (Abildgaard, 1789) *sensu* Mak 1982: 608.

Remarks. Not a new record. Following Hartman (1959), until recently the only recognized species of was *Pomatostegus stellatus*, thought to occur circumtropical. Ten Hove and Kupriyanova (2009) distinguished 3 species with a more restricted distribution. Herein we correct Mak's identification to that of the Indo-West Pacific taxon.

Pomatostegus stellatus (Abildgaard, 1789)

Remarks. A strictly Caribbean species (ten Hove & Kupriyanova 2009: 78) reported to be present in Hong Kong (Mak 1982). See *Pomatostegus actinoceras* for more discussion.

Genus *Protula* Risso, 1826

Type-species: *Protula rudolphi* Risso, 1826, junior synonym of *Serpula tubularia* Montagu, 1803
Number of species: 23

Diagnosis. Tube white, (semi-) circular in cross-section, collar-like rings and keels absent. Operculum and pseudo-operculum absent. Radioles arranged in two semi-circles to a spire of up to 6 whorls, up to 320 per lobe. Interradiolar membrane present. Branchial eyes present or absent. Stylodes absent. Mouth palps present. 7 thoracic chaetigerous segments. Collar trilobed, tonguelets absent. Thoracic membrane large, forming ventral apron across anterior abdominal segments. Thoracic triangular depression absent. Collar chaetae limbate. *Apomatus* chaetae present. Abdominal neurochaetae sickle-shaped with serrated blade. Uncini rasp-shaped throughout with rows of teeth and elongated terminal pegs. Posterior capillary chaetae present.

Protula bispiralis (Savigny, 1822)
(Figure 3K–O)

Serpula bispiralis Savigny, 1822: 75.
Protula magnifica Straughan, 1967: 41.
Protula bispiralis—Day 1967: 818; ten Hove 1994: 109; Pillai 2009: 99.
Spirobranchus sp. **not** Blainville, 1818, *sensu* Scott 1984 fig. 22.

Material examined. AM W41409, 1 specimen (22°22'N, 114°17'E, Sharp Island, in crevice of rocks, 6 m, May 21, 2009).

Description. TUBE: white, circular in cross-section, rugose outside. Collar-like rings and medial keel absent. Up to 10 mm wide, lumen diameter 0.8 mm.

BRANCHIAE: branchial crown consisting of up to 80 radioles on each side, arranged in spiral with three whorls. Radioles with short pinnules and filiform tips; joined for one-third of their length (Figure 3K). Branchial eyes absent.

PEDUNCLE: absent.

OPERCULUM: absent.

COLLAR AND THORACIC MEMBRANES: collar trilobed; thoracic membranes well developed, extending past chaetiger 7 in apron across anterior abdominal chaetigers.

THORAX: with 7 chaetigers. Collar chaetae and other thoracic notochaetae limbate capillaries (Figure 3L–M), *Apomatus*-chaetae not observed. Thoracic uncini absent.

ABDOMEN: abdominal neurochaetae faintly sickle-shaped, with finely serrated blade (Figure 3N). Abdominal uncini rasp-shaped with 2 to 4 rows of teeth and 22 teeth in profile view and rounded peg (Figure 3O).

SIZE: length up to 79 mm, width of thorax 8.5 mm.

COLOUR: living worm with a pinkish branchial crown, colour in formalin pale yellow.

Habitat. Depth: 6 m. In coral sand or rock-crevices.

Distribution. Widely distributed in the Indo-West Pacific.

Remarks. The present specimen agrees with the description of Day (1967) except that uncini are missing in all thoracic chaetigers, rather than in just the first three. *Protula bispiralis* is considered to be a species complex (ten Hove & Kupriyanova 2009). Scott (1984: 26, fig. 22) gave a good colour photograph of the branchial crown but erroneously identified the specimen as *Spirobranchus* sp.

Genus *Salmacina* Claparède, 1870

Type-species: *Salmacina incrustans* Claparède, 1870

Number of species: 11 (?10)

Salmacina cf. *dysteri* (Huxley, 1855)

Salmacina dysteri **not** (Huxley, 1855) *sensu* Tan and Morton 1998: 392.

Remarks. Not a new record, mentioned by Tan and Morton (1998) for Hong Kong. Originally described from boreal temperate waters (U.K., South Wales), Indo-West Pacific records most probably belong to different taxa (Ben-Eliahu & ten Hove 2011: 62–71). We have mentioned the record here re-named to *S.* cf. *dysteri,* to stress that Tan and Morton's material may have been similar to the temperate species, but most probably is a different taxon. This emphasizes the need to deposit voucher specimens in museum collections to enable a later check of the identification.

Genus *Serpula* Linnaeus, 1758

Type-species: *Serpula vermicularis* Linnaeus, 1767, designated by Heppell 1963

Number of species: 28

Diagnosis. Tube white, pink, yellowish; (semi-)circular to trapezoidal in cross-section. Keels and hyaline granular layer may be present. Operculum soft funnel-shaped, with numerous fused radii. Peduncle smooth, without wings, inserted between first and second dorsal radiole on one side. Pseudo-operculum present. Radioles arranged in semi-circles, interradiolar membrane and branchial eyes may be present. Stylodes absent. Seven thoracic segments (exceptionally up to 12). Collar trilobed, tonguelets absent. Thoracic membranes long, usually forming ventral apron. Collar chaetae bayonet type and capillaries. Subsequent .chaetae of two sizes, limbate and capillary. *Apomatus* chaetae absent. Uncini saw-shaped, with approximately 5 curved teeth, including anterior fang. Thoracic triangular depression present. Abdominal chaetae flat trumpet-shaped; uncini similar to thoracic ones but smaller. Achaetous anterior abdominal zone absent. Capillary chaetae present posteriorly. Glandular pad absent.

Serpula cf. *granulosa* Marenzeller, 1885

(Figure 3P–Q, Figure 12A–F)

Serpula granulosa Marenzeller, 1885: 316–317.

? *Serpula vermicularis* not Linnaeus, 1767, *sensu* Mak 1982: 609; Morton and Morton 1983: 278; Wang and Huang 1993: 8.

Material examined. AM W40554, 2 specimens (22°21'N, 114°17'E, Sharp Island, on dead coral, 6 m, May 21, 2009).

Description. TUBE: thick-walled, rough, with a median longitudinal keel, circular in internal cross-section. Median keel violet, grading into pale pink on both sides; tube white inside. Peristomes absent. Up to 6.5 mm wide with lumen up to 4.5 mm diameter.

BRANCHIAE: each lobe with 23 to 25 radioles (n=2, μ=24±1.4), arranged in semicircle. Interradiolar membrane of 1/8th of the radiole. Pinnules short and thin; each radiole ending in thin terminal filament, as long as pinnules.

PEDUNCLE: smooth, circular in cross-section, inserted just below right branchial lobe. Clear constriction just below operculum. Pseudo-operculum evident in one specimen, with globular inflated tip.

OPERCULUM: symmetrical, fleshy funnel with 55–58 radii, with pointed conical tips (Figure 3P–Q). Funnel distally shallow, not deeply cupped. Lengths of the operculum from 3.0 mm to 3.4 mm (n=2, μ=3.2±0.2), widths from 3.3 mm to 3.5 mm (n=2, μ=3.4±0.1). External grooves about 1/3rd of opercular length; apical grooves variable in extension, 1/3rd, 2/3rd of width or almost reaching centre. Tubercles on apical radii present.

COLLAR AND THORACIC MEMBRANES: collar high, trilobed, lateral lobes large and continuous with well-developed thoracic membranes, merging with ventrum, not forming an (continuous) apron in the sense of ten Hove (1984: 158), but interrupted above anterior abdominal chaetigers.

THORAX: with 7 chaetigers, 6 uncinigerous. Collar chaetae of two types: bayonet chaetae with two teeth having blunt tips at base of blade, and smooth capillaries (Figure 12A–B). Subsequent chaetae of two sizes (limbate and capillary, Figure 12C). Uncini along entire thorax saw-shaped, with 4–5 teeth, including pointed anterior fang (Figure 12D).

ABDOMEN: total number of abdominal chaetigers varies from 110 to 138 (n=2, μ=124±19.8). Achaetous region absent. Uncini saw-shaped, with 3 teeth anteriorly (Figure 12E), 5 to 6 teeth in middle and posterior abdomen (Figure 12F). Chaetae flat trumpet-shaped. Capillaries present in posterior chaetigers.

SIZE: total worm length: 25.0 mm to 45.0 mm (n=2, μ=35±14.1); thoracic width of both specimens 4.0 mm (n=2, μ=4.0±0). Branchiae and operculum accounting for approximately one fifth of entire length.

COLOUR: Living worm brightly reddish, colour in ethanol pale yellow.

Habitat. Depth: 6 m, on the surface of dead corals.

Remarks. Difficulties in identifying various taxa of *Serpula* have been discussed by ten Hove and Kupriyanova (2009: 93) and Ben-Eliahu and ten Hove (2011: 78). Six taxa have been recorded from Chinese waters (Sun & Yang 2001a): *Serpula* cf. *hartmanae* Reish, 1968, *S. sinica* Wu and Chen, 1979 (in Wu, Sun & Chen 1979), *S. tetratropia* Imajima and ten Hove, 1984, *S.* cf. *vasifera* Haswell, 1885, *S. vermicularis* **not** Linnaeus, *sensu auct.* (see below) , and *S. watsoni* Willey, 1905. In narrowing down the identity of the present specimens we can exclude *Serpula* cf. *hartmanae*, *S. sinica, S. tetratropia* and *S.* cf. *vasifera* on the basis of fewer opercular radii (11–16, 32, 18–26, respectively 29 as opposed to 55–58), as well by differences in tubes, which have all at least two longitudinal ridges instead of one medial keel. *Serpula watsoni* is easily recognized by its operculum, a deep funnel with very long radial grooves, almost extending to the peduncle, as well as tube with 2 longitudinal ridges.

Mak (1982) described specimens as *S. vermicularis*, with a flat operculum bearing 28 to 63 marginal radii, and a thick tube with a medial longitudinal keel. Our material probably is the same, with its high number of opercular radii and triangular tube. However, as amongst others mentioned by ten Hove and Kupriyanova (2009), *S. vermicularis* has a distribution limited to Western Europe. A number of larger sized taxa, with high numbers of radii have been described for Indo-West Pacific waters (see discussion in Ben-Eliahu & ten Hove 2011: 83–87). Our present material agrees best, but maybe not fully, with the description of *S. granulosa*. For instance, colour of the tube is missing in the original description and not recorded either when the holotype (Naturhistorisches Museum Wien Evertebrata varia: 1998) was re-examined by one of us (HAtH) a couple of decades ago and the posterior thoracic membranes were damaged. Also because of the confused state of the *Serpula jukesi* / *granulosa*-complex (Ben-

Eliahu & ten Hove 2011: 84–87), we have given the tentative identification of cf. *granulosa* to our material. *Serpula granulosa* Marenzeller is a homonym of the fossil *S. granulosa* von Hagenow, 1840.

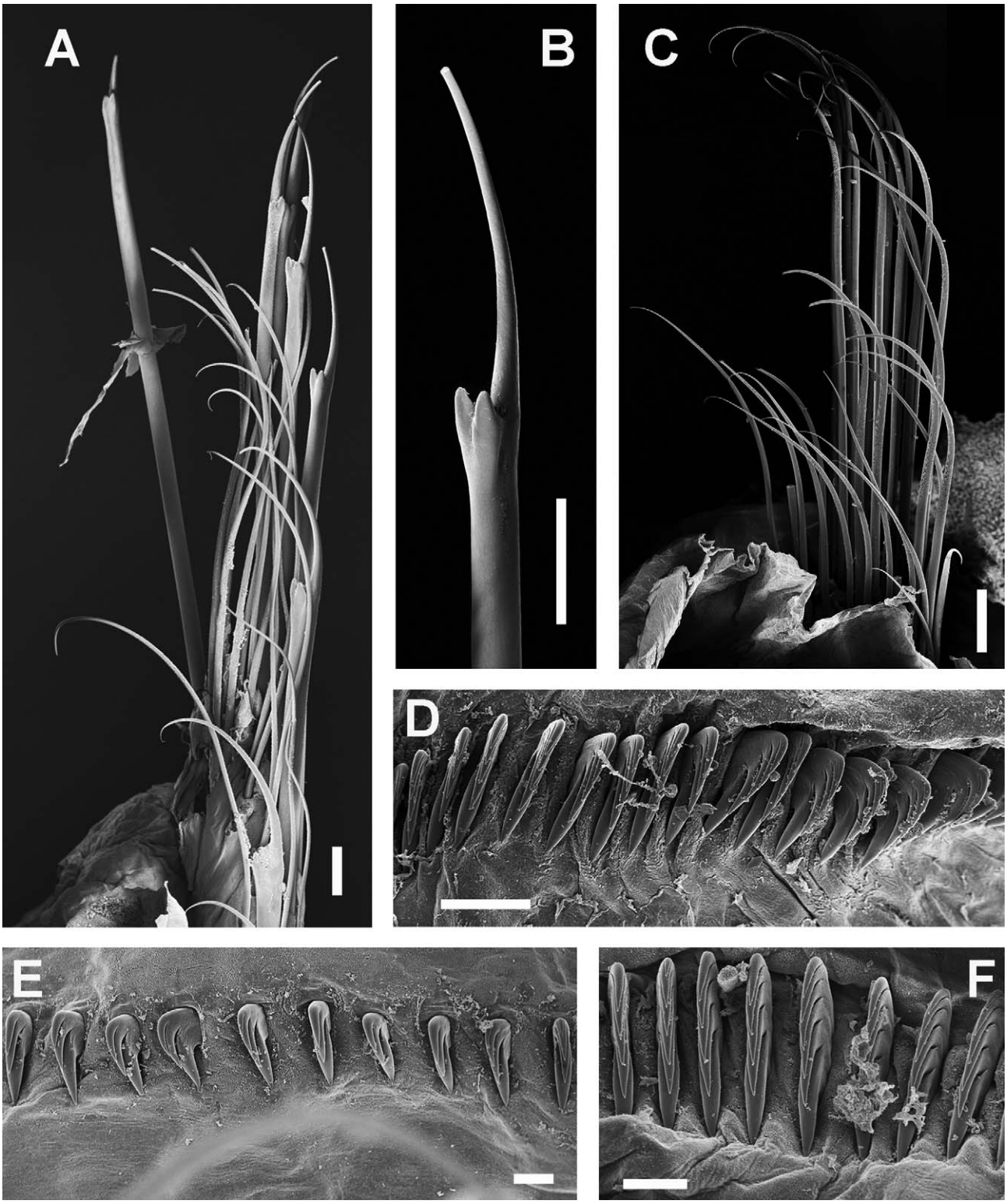

FIGURE 12. *Serpula* cf. *granulosa*, AM W40554. A, bayonet and capillary collar chaetae. B, bayonet collar chaeta. C, limbate and capillary chaetae from chaetiger 4. D, uncini from chaetiger 4. E, anterior abdominal uncini. F, middle abdominal uncini. (Scale bars: A–C=100 μm, D–F=10 μm)

Serpula vermicularis Linnaeus, 1767

Remarks. Being an Atlantic/Mediterranean species only (e.g. Ben-Eliahu & ten Hove 2011: 85–87), it is not present in Hong Kong, but see *Serpula* cf. *granulosa* Marenzeller, 1885, above.

Serpula watsoni Willey, 1905

Serpula watsoni Willey, 1905: 317; Imajima 1977: 91–92; Mak 1982: 609; Morton and Morton 1983: 278; Wang and Huang 1993: 7; Pillai 2009: 140–143.

Remarks. Not a new record. As stated by Mak (1982: 609) the species can easily be recognized by its long opercular funnel which has a deep hollow. A further distinguishing character is its radial grooves, extending for almost the entire opercular funnel length (Imajima 1977 fig. 2a).

Genus *Spirobranchus* Blainville, 1818

[including *Pomatoceros* Philippi, 1844 and *Pomatoleios* Pixell, 1913 *fide* Pillai (2009)].

Type-species: *Serpula gigantea* Pallas, 1766

Number of species: 35

Diagnosis. Tube white, blue, pink, sometimes salmon inside. Typically (sub)triangular in cross-section. Longitudinal keels may be present, hyaline granular layer absent. Operculum with inverse conical ampulla, covered by calcareous endplate, with or without processes. Peduncle broad with lateral wings, triangular in cross-section, inserted at base of branchial crown just left of median line. Pseudo-operculum absent. Radioles arranged in circles or in a spiral of up to 8 whorls, interradiolar membrane present, branchial eyes maybe present. Stylodes absent. 7 thoracic segments. Collar trilobed, tonguelets present. Thoracic membranes forming ventral apron across anterior abdominal segments. Collar chaetae usually bayonet type and narrowly limbate capillaries; sometimes limbate only or absent. Subsequent chaetae of two sizes, limbate and capillary. *Apomatus* chaetae absent. Uncini saw-shaped, anterior fang gouged, apparently rounded. Thoracic triangular depression present. Abdominal chaetae true trumpet-shaped, abruptly bent, distally with two rows of denticles separated by a groove; uncini similar to thoracic ones but smaller. Achaetous anterior abdominal zone absent. Posterior capillary chaetae absent. Posterior glandular pad absent.

Spirobranchus corniculatus-complex

Spirobranchus tricornis **not** (Mörch) *sensu* Morton and Morton 1983: 278–279.

Remarks. *Spirobranchus tricornis sensu auct.* has been reported from Hong Kong by Mak (1982: 609) and by Morton and Morton (1983: 279). From Mak's diagnosis it is evident that he was referring to *S. tetraceros* (see below). However, Morton and Morton (1983: 278–279) clearly depict a spiralised branchial crown, with colours white, yellow, orange and red, living in corals. This only can refer to a member of the *Spirobranchus corniculatus*-complex (see Fiege and ten Hove 1999, figure 4), unfortunately Morton´s notes are insufficient for a more detailed identification of the taxon involved.

Spirobranchus kraussii (Baird, 1865)

(Figure 13A–F)

Placostegus cariniferus var. *Kraussii* Baird, 1865: 14.

Pomatoleios kraussii—Day 1967: 800–801; Morton and Morton 1983: 88–89; Wang and Huang 1993: 1–12; Tan and Morton 1998: 392–401; Fiege and Sun 1999: 130–131; Sun and Yang 2001b: 213–214; Ben-Eliahu and ten Hove 2011: 43–45.

Pomatoceros triqueter **not** (Linnaeus, 1758), Morton and Morton 1983: 77 (error for *Pomatoleios kraussii*).

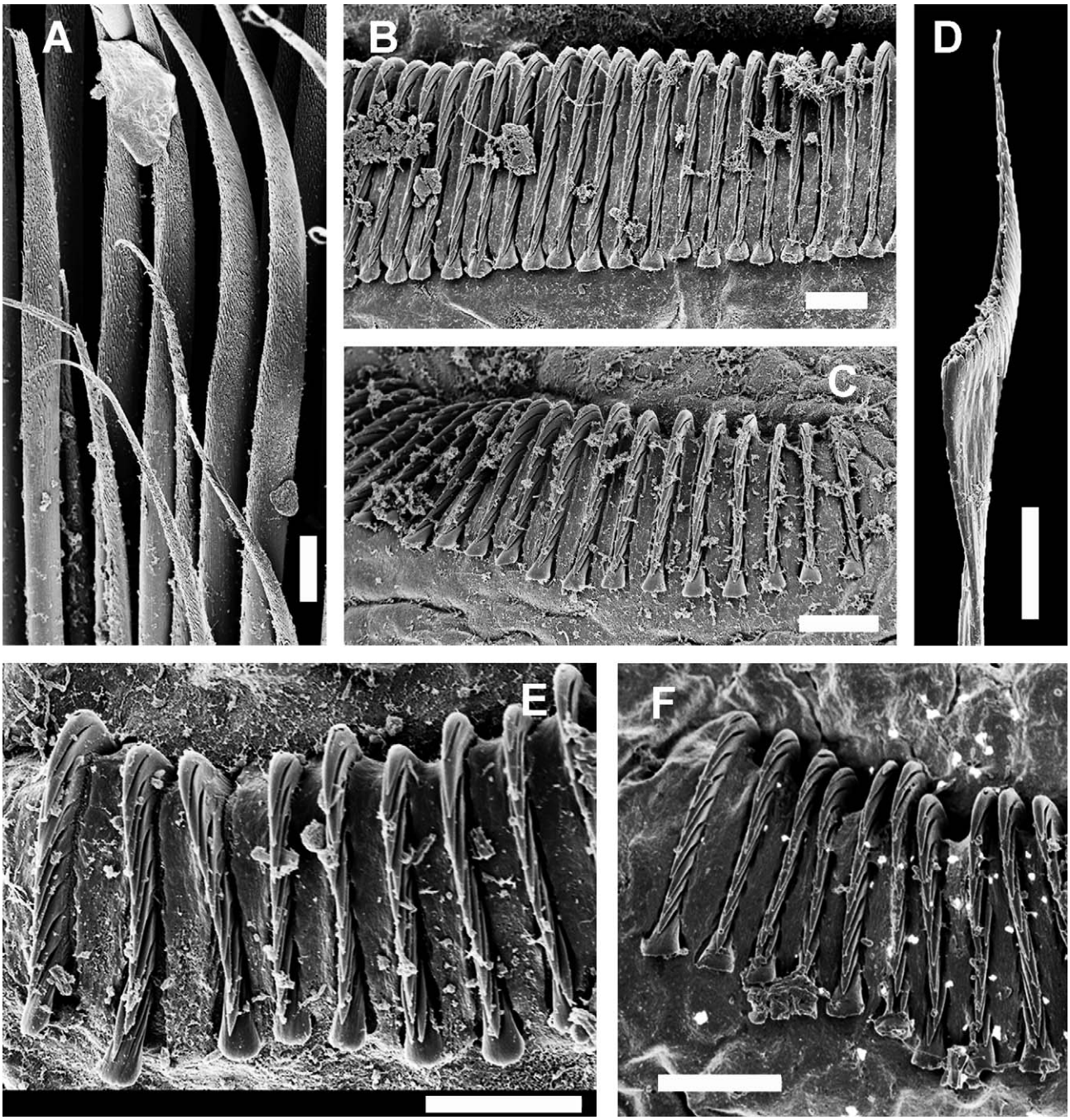

FIGURE 13. *Spirobranchus kraussii*, AM W41410. A, limbate and capillary chaetae from chaetiger 4. B, thoracic uncini. C, anterior abdominal uncini. D, serrated edges of trumpet-shaped chaetae from posterior abdomen. E, middle abdominal uncini. F, posterior abdominal uncini. (Scale bars: A–F=10 μm)

Material examined. AM W41410, 10 specimens (22°21'N, 114°15'E, Hebe Haven, rocky intertidal, 0–1 m, May 25, 2009).

Description. TUBE: Tube white to blue, triangular in cross-section, with medial keel projecting into flap over the entrance. External tube diameter: from 1.9 mm to 2.4 mm (n=3, μ=2.2±0.3), lumen diameter from 1.5 mm to 2.0 mm (n=3, μ=1.8±0.3).

BRANCHIAE: radioles on each lobe arranged in circles, connected by interradiolar membrane for about one third of their length; numbers ranging from 21 to 26 (n=5, μ=23.4±1.9). Terminal filaments short. Branchial eyes not observed.

PEDUNCLE: subtriangular in cross-section, inserted just below left branchial lobe in all specimens. Pair of lateral wings proximal to opercular ampulla present, constriction not observed. Pseudo-operculum absent.

OPERCULUM: operculum slightly concave, talon absent. Opercular length from 3.8 mm to 4.6 mm (n=5, μ=4.3±0.3), width from 0.9 mm to 1.2 mm (n=5, μ=1.1±0.1).

COLLAR AND THORACIC MEMBRANES: collar high, with entire edge. Thoracic membranes forming apron across anterior abdominal chaetigers.

THORAX: with 6 chaetigers. Collar chaetae absent. Thoracic chaetae of two sizes, largest (limbate) finely serrated (Figure 13A). Uncini along entire thorax saw-shaped, with 9 curved teeth and gouged fang (Figure 13B). Tori of similar size along thorax, approaching each other posteriorly, leaving ventral depression.

ABDOMEN: total number of abdominal chaetigers varies from 68 to 86 (n=5, μ=78.8±0.2). Uncini saw-shaped throughout, with 8 to 9 teeth and gouged peg (Figure 13C, E–F). Chaetae true trumpet-shaped, abruptly bent, distally with two rows of denticles separated by a groove forming long pointed tip (Figure 13D). Posterior abdominal capillaries absent.

SIZE: total worm length: 7.0 mm to 11.0 mm (n=5, μ=9.1±1.5), thoracic width: 1.5 mm to 1.8 mm (n=5, μ=1.7±0.1). Branchiae and operculum accounting for one fourth of entire length.

COLOUR: in ethanol operculum bluish, peduncle and wings light blue with dark blue pigmentation, branchial radioles banded blue and white, thorax and anterior abdomen blue, posterior abdomen colourless.

Habitat. Depth: 1 to 3 m, on rocks in higher intertidal zone.

Remarks. *Spirobranchus kraussii* has been reported as one of the dominant species in fouling communities in Hong Kong, forming intertidal aggregations (Wang and Huang 1993, as *Pomatoleios kraussii*).

Distribution. Widely distributed in the Indo-Pacific; South Africa; Lessepsian migrant to the Mediterranean Levant.

Spirobranchus cf. *polytrema* not (Philippi, 1844), Type A *sensu* Imajima 1977

(Figure 14A–C, Figure 15A–E)

Spirobranchus cf. *polytrema*—Imajima 1977: 102–106; Fiege and Sun 1999: 126–129.
Spirobranchus polytrema **not** (Philippi, 1844) *sensu* Sun and Yang 2001a: 200–201.

Material examined. AM W41412, 2 specimens (22°21'N, 114°17'E, Sharp Island, on dead coral, 6 m, May 21, 2009).

Description. TUBES: white, subtriangular with a flattened area of attachment in cross-section, with a small longitudinal additional tube (or hollow keel) on top, flanked by a row of pits, a lateral longitudinal ridge and a row of slits at either side (Figure 14A). About 1.0 mm wide with lumen 0.4 mm, however, anterior part of tube missing.

BRANCHIAE: together only 7 radioles, 4 on the right side, 3 on the left, arranged in a circle. Terminal filaments long, about three times longer than pinnules, approximately 0.5 mm. Branchial eyes not observed.

PEDUNCLE: smooth, flattened in cross-section, bearing a pair of wings, fringed along anterior margin with 4–6 digitiform processes. Inserted just below left branchial lobe.

OPERCULUM: with a fleshy, slightly translucent bulbous base and a tilted cone-shaped cap (Figure 14B–C, Figure 15A). Length of the operculum about 1 mm, width 0.5 mm.

COLLAR AND THORACIC MEMBRANES: collar low.

THORAX: with 7 chaetigers, 6 uncinigerous. Collar chaetae bayonet type, with striated blade and numerous small teeth forming squarish emboss at base of blade, and limbate chaetae. Other thoracic notochaetae limbate capillaries (Figure 15B). Uncini along entire thorax saw-shaped 9 to 10 saw-shaped, incidentally with 3 to 4 teeth above peg, anterior peg gouged (Figure 15C). Tori of similar size along thorax, approaching each other posteriorly, leaving a ventral depression.

ABDOMEN: incomplete. Uncini of anterior and mid-body rasp-shaped, with 10–12 teeth seen in profile, 3 teeth in a row, anterior peg gouged and curved underneath (Figure 15D). Chaetae true trumpet-shaped, abruptly bent distally, with two rows of denticles separated by a hollow groove and forming long lateral spine (Figure 15E).

SIZE: incomplete specimens, up to 8.8 mm long and 1 mm wide.

COLOUR: in ethanol pale yellow, with brown operculum.

Habitat. Depth: 3–6 m, on dead coral skeletons.

Remarks. The occurrence of the temperate/subtropical Atlantic/Mediterranean species *Spirobranchus polytrema* (Philippi, 1844) in tropical Asian seas is rather doubtful; it is more likely that similar (*cf.*) material from these

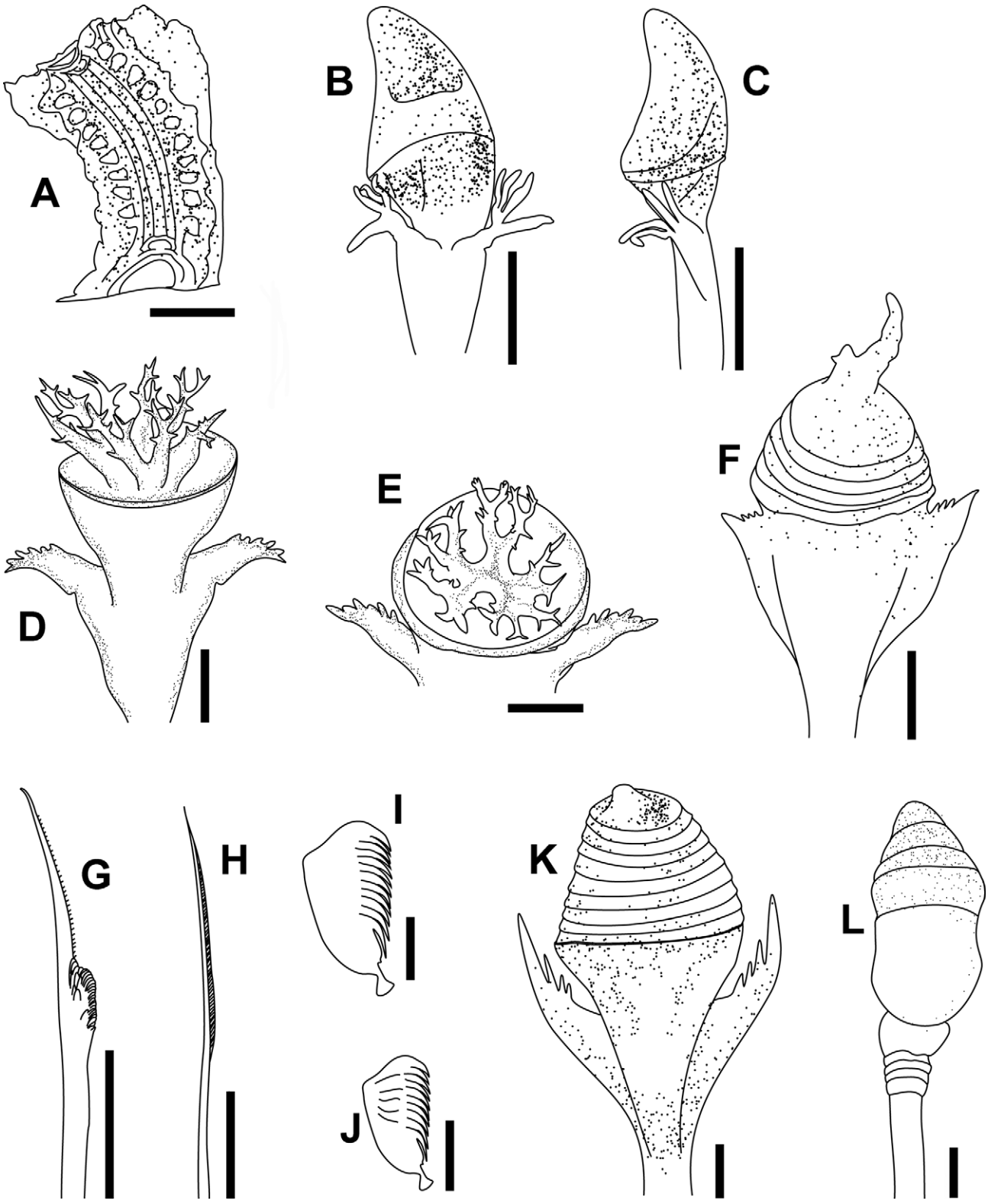

FIGURE 14. A–C: *Spirobranchus* cf. *polytrema* type A, AM W41412. A, tube. B–C, operculum, lateral and apical view. D–E: *Spirobranchus tetraceros*, AM W41411, operculum, lateral and apical view. F–J: *Spirobranchus* sp. A, AM W41413. F, operculum, lateral view. G, bayonet-like collar chaeta. H, thoracic chaetaa. I, thoracic uncinus. J, anterior abdominal uncinus. K: *Spirobranchus* sp. B, AM W41414, operculum, lateral view. L: *Vermiliopsis glandigerus*, AM W41415, operculum, lateral view. (Scale bars: A, D–E=1 mm, B–C, F=0.5 mm, G–H=100 µm, I–J=20 µm, K–L=0.2 mm)

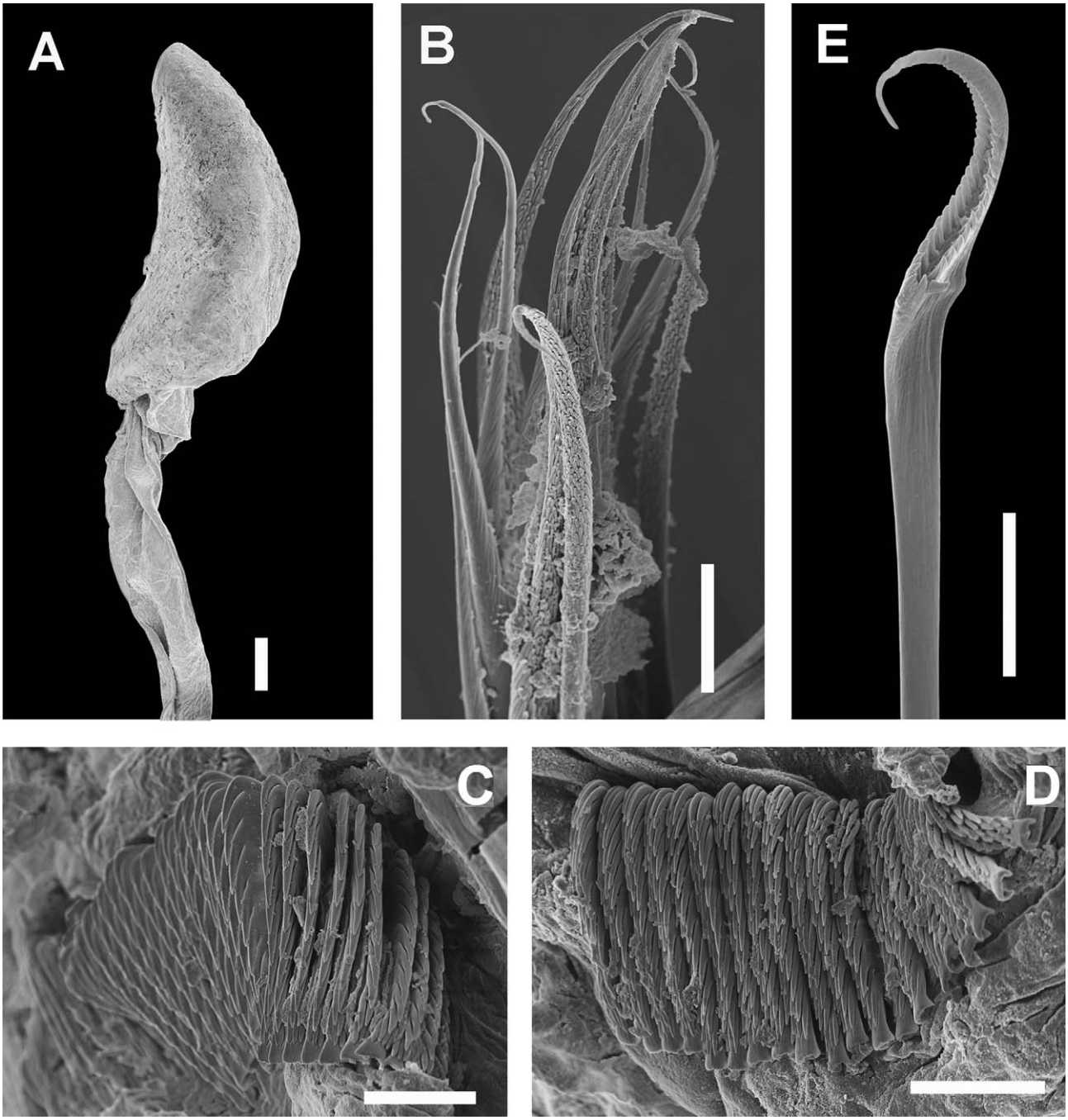

FIGURE 15. *Spirobranchus* cf. *polytrema* Type A *sensu* Imajima, AM W41412. A, operculum. B, chaetae from chaetiger 2. C, uncini from chaetiger 4. D, middle abdominal uncini. E, abdominal trumpet-shaped chaeta. (Scale bars: A=100 μm, B–E=10 μm)

seas will prove to be genetically different. See discussions in Imajima (1977: 106) and Pillai (2009: 153) as well. Records of *Spirobranchus* cf. *polytrema* from the Indo-West Pacific include two morphotypes, type A and type B (Imajima 1977; Fiege & Sun 1999), both have an operculum consisting of a fleshy proximal part (ampulla) and a distal calcareous cone with rounded knobs, but differ from each other by the shape of tube and peduncular wings. Our material resembles type A in the shape of peduncular wings and tube. However, the opercula have a single tip to their calcareous cap instead of rounded knobs. Sun and Yang (2001a, Figure 10) figured specimens with and without rounded knobs on the distal calcareous cone of the operculum in their material from Hainan Island. To our knowledge this is the first report of a hollow keel, almost an additional tube, in the genus *Spirobranchus* (though Figure 16E of Fiege and Sun 1999 leaves room for an interpretation as one being present).

Distribution. Indo-West Pacific, Sri Lanka, Australia, Japan.

Spirobranchus tetraceros (Schmarda, 1861)

(Figure 2F, Figure 14D–E, Figure 16A–G)

Pomatoceros tetraceros Schmarda, 1861: 30.

Spirobranchus tetraceros—Imajima 1979: 177–178; Imajima and ten Hove 1984: 51–52; Tan and Morton 1998: 392; Sun and Yang 2001a: 201–202; Pillai 2009: 159–162; Ben-Eliahu and ten Hove 2011: 88–95 [for partial, complicated synonymy].

Spirobranchus tricornis **not** (Mörch) *sensu* Straughan 1967: 244, 246 [*fide* ten Hove 1970: 47]; Mak 1982 : 609; Wang and Huang 1993: 1–12.

Spirobranchus tetraceros-complex—Fiege and Sun 1999: 129–130.

Material examined. AM W41411, 23 specimens (22°21'N, 114°17'E, Sharp Island, in living corals, 3–6 m, May 21, 2009).

Description. TUBES: thin, pink outside and white inside, almost circular in cross-section, with one longitudinal ridge. All embedded in coral skeleton (Figure 2F). Up to 3.2 mm wide with lumen up to 2.9 mm.

BRANCHIAE: radioles arranged in a circle on each side; numbers arranging from 15 to 30 (n=19, μ=20.9±3.8). Interradiolar membranes extending to about half of radiolar length, fringes folded with 2–3 papillae present between radioles. Terminal filament longer than pinnules. Branchial eyes not observed.

PEDUNCLE: smooth, subtriangular in cross-section, inserted just below right branchial lobe. Pair of triangular wings with 4-6 digitiform processes along anterior margin.

OPERCULUM: opercular plate flat, bearing four branched spines arising from common base (Figure 14D–E). Opercular length from 5.8 mm to 9.5 mm (n=19, μ=7.8±1.5), width from 1.1 mm to 3.0 mm (n=19, μ=2.4±0.6).

COLLAR AND THORACIC MEMBRANES: collar high, trilobed, continuous with well-developed thoracic membranes, forming apron across anterior abdominal chaetigers.

THORAX: with 7 chaetigers, 6 uncinigerous. Collar chaetae of two types: bayonet-like chaetae, with numerous small teeth forming squarish emboss at base of striated blade (Figure 16A) and slender, almost smooth capillaries (Figure 16B). Subsequent chaetae of two sizes, limbate and capillary (Figure 16C–D). Uncini saw-shaped, with 11 teeth in a single row and gouged peg (Figure 16E). Tori increasing in length along thorax, approaching each other posteriorly, leaving a ventral depression.

ABDOMEN: total number of abdominal chaetigers varies from 74 to 110 (n=14, μ=92±12.2). Uncini saw-shaped, with peg and 10 to 12 teeth in a row anteriorly (Figure 16F), increasing to 11 to 13 teeth in a row in middle and posterior abdomen. Chaetae true trumpet-shaped, with two rows of denticles separated by a hollow groove and forming long bend lateral spine (Figure 16G). Posterior capillaries present.

SIZE: total worm length: 23.0 mm to 56.0 mm (n=14, μ=38±10.8). thoracic width: 1.2 mm to 3.6 mm (n=19, r: 1.2–3.6, μ=2.5±0.6). Branchiae and operculum accounting for approximately one tenth of entire length.

COLOUR: living worms brightly coloured, opercular plate and horns generally overgrown, light brown to greenish, peduncle and wings blue with dark blue patches, branchial radioles purplish blue or deeply red at basal two-thirds, becoming pink to white distally, thorax and anterior abdomen purplish blue, becoming pink or colourless posteriorly (Figure 2F).

Habitat. Depth: 3–6 m. Embedded in living corals.

Remarks. *Spirobranchus tricornis sensu auct.* has been reported from Hong Kong by Mak (1982: 609), Wang and Huang (1993) and by Morton and Morton (1983: 279). From Mak's diagnosis it is evident that he was referring to *S. tetraceros*. Since Mak was involved in Wang and Huang's study (1993: 10), we assume that their material belonged to the same taxon. However, Morton and Morton (1983: 278–279) clearly depict a spiralised branchial crown, referring to a member of the *Spirobranchus corniculatus*-complex, see above.

Spirobranchus tetraceros is considered to be a species-complex (ten Hove 1994: 113; ten Hove & Kupriyanova 2009: 98; Ben-Eliahu & ten Hove 2011: 91). Except for the white to bluish colour of the tube, the present specimens agree in general with the description of *S. tetraceros* as given by Pillai (2009) for specimens from the intertidal in Western Australia, tubes of which were mostly covered by corals. The present specimens were collected from living corals, especially *Platygyra carnosus* Veron and *Porites lutea* Edwards & Haime; their tubes, except the openings, were embedded in the corals.

Distribution. Widely distributed in tropical Indo-West Pacific waters. This is the first report of its common occurrence in live massive corals in local waters. Mak (1982, as *Spirobranchus tricornis*) reported this species from Hong Kong, but did not point out whether the specimens were collected from live or dead corals.

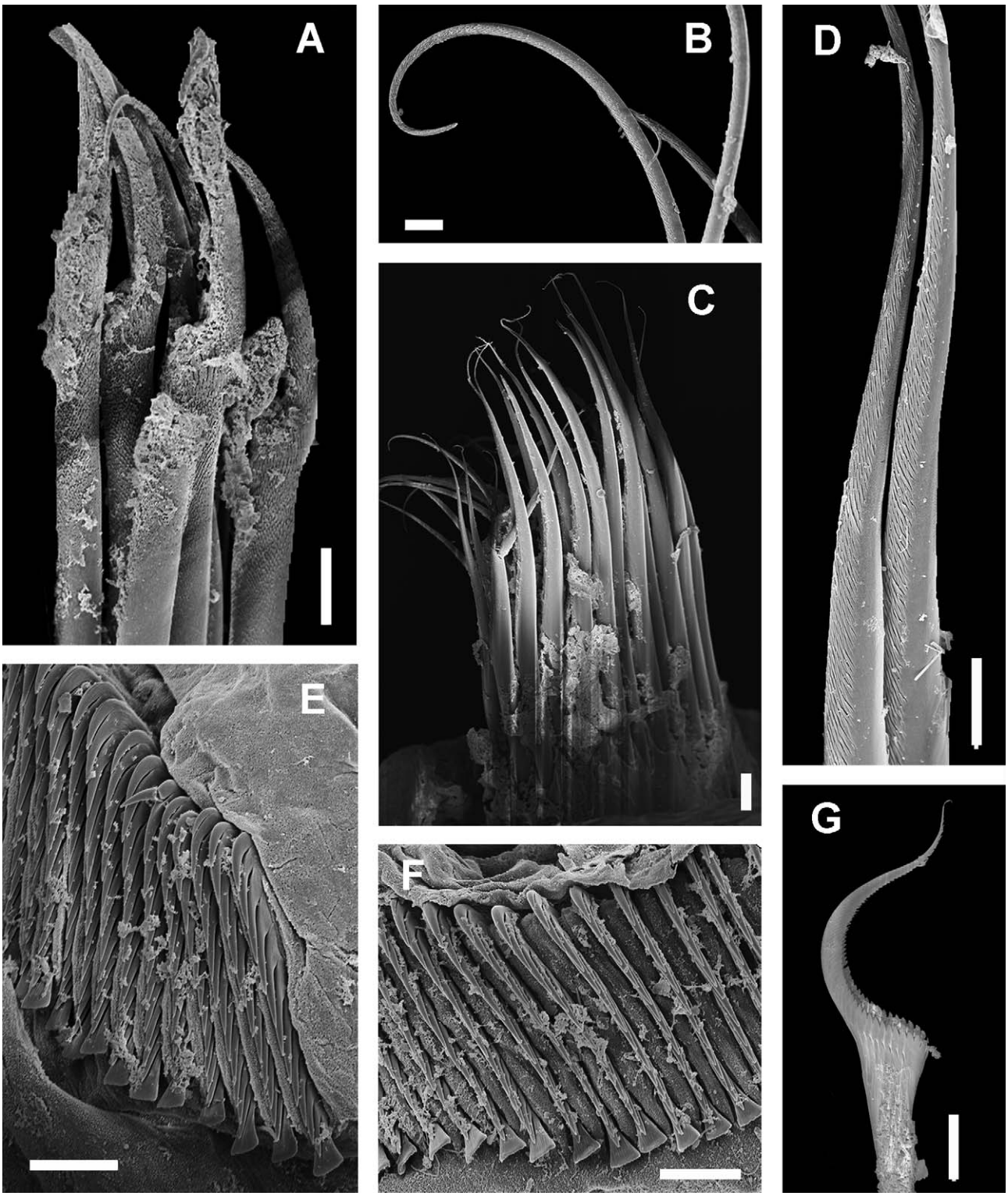

FIGURE 16. *Spirobranchus tetraceros*, AM W41411. A, bayonet-like collar chaetae. B, capillary collar chaetae. C, chaetae from chaetiger 4. D, details of limbate chaetae from chaetiger 4. E, uncini from chaetiger 4. F, anterior abdominal uncini. G, abdominal trumpet-shaped chaeta. (Scale bars: A, C, G=20 µm, B, D–F=10 µm)

***Spirobranchus* sp. A**
(Figure 14F–J)

Material examined. AM W41413, 2 specimens (22°21'N, 114°17'E, Sharp Island, on dead coral, 3 m, May 21, 2009).

Description. TUBES: white, with two almost medial longitudinal ridges, and a series of pits along both sides of these ridges. Subtriangular in cross-section. Up to 1.1 mm wide with lumen 0.7 mm.

BRANCHIAE: radioles arranged in a circle on each lobe, numbers ranging from 10 to 13 (n=2, μ=11.5±2.1); interradiolar membranes extending to about half of radiolar length, fringed between radioles. Pinnules and terminal filament thin and long. Branchial eyes not observed.

PEDUNCLE: smooth, flat in cross-section, inserted just below right branchial lobe. Pair of lateral wings present, fringed with 4–6 digitiform processes along anterior margin.

OPERCULUM: opercular plate conical, with 4 to 5 indistinct annuli, one horn with two broken off spines arising from apex of plate (Figure 14F). Opercular length from 2.9 mm to 3.5 mm (n=2, μ=3.2±0.4), width from 0.9 mm to 1.1 mm (n=2, μ=1.0±0.1).

COLLAR AND THORACIC MEMBRANES: collar high, trilobed, continuous with well-developed thoracic membranes, forming apron across anterior abdominal chaetigers.

THORAX: with 7 chaetigers, 6 uncinigerous. Collar chaetae of two types: bayonet-like with striated blade and numerous small teeth forming squarish emboss at base of blade (Figure 14J) and slender, almost smooth capillaries. Subsequent chaetae of two sizes, limbate (Figure 14H) and capillary. Uncini saw-shaped, with 10-12 teeth in a single row and gouged peg (Figure 14G). Tori increasing in length along thorax, approaching each other posteriorly, leaving a ventral depression.

ABDOMEN: abdominal chaetigers 49. Uncini saw-shaped, with peg and 9 to 10 teeth in a row anteriorly (Figure 14J), increasing to 13 to 14 teeth in a row in middle and posterior abdomen. Chaetae true trumpet-shaped, with asymmetrical distal ends.

SIZE: incomplete specimens, length up to 7 mm, width of thorax 0.7 mm.

COLOUR: in ethanol operculum blue posteriorly and light brown anteriorly, peduncle and wings light blue with darker blue spots, branchial radioles banded alternatingly blue and white, thorax and anterior abdomen blue, posterior abdomen colourless.

Habitat. Depth: 3 m, on dead coral skeleton.

Remarks. *Spirobranchus* sp. A most probably belongs to the *S. tetraceros*-complex (Ben-Eliahu & ten Hove 2011: 91, fig.33). It is similar to *S. elatensis* described by Pillai (2009) in having a conical operculum with a brown apex. However, these two species differ in the morphology of their tubes: that of *S. elatensis* does not show series of pits and has three longitudinal ridges (Pillai 2009) while that of *Spirobranchus* sp. A has numerous pits and two longitudinal ridges only. Since Ben-Eliahu and ten Hove (2011: 91) consider *S. elatensis* to be a synonym of *S. tetraceros*, however, the tubes of the two specimens under consideration here differ by the rows of pits along the medial keels from the tubes of our *S. tetraceros*, we prefer to describe the material fully, but not to assign this material to a definite name.

Spirobranchus sp. B

(Figure 14K, Figure 17A–E)

Material examined. AM W41414, 4 specimens (22°21'N, 114°17'E, Sharp Island, on dead coral, 3–6 m, May 21, 2009).

Description. TUBE: missing.

BRANCHIAE: radioles arranged in a circle on each lobe, numbers ranging from 9 to 10 (n=3, μ=9.7±0.6), interradiolar membranes extending to about half of radiolar length, without marginal fringes. Terminal filament thin and long, approximately 0.4 mm. Branchial eyes not observed.

PEDUNCLE: smooth, flat in cross-section. Pair of triangular lateral wings, fringed along anterior margin, with 4–6 short processes.

OPERCULUM: Opercular plate conical, consisting of 8–10 transverse annuli with numerous small projections on surface of each annulus; topmost disc slightly concave, with a small convex projection (Figure 14K). Length of the operculum from 2.8 mm to 3.4 mm (n=3, μ=3.1±0.3), widths from 0.9 mm to 1.1 mm (n=3, μ=1.0±0.1).

COLLAR AND THORACIC MEMBRANES: collar high, trilobed, continuous with well-developed thoracic membranes, forming apron across anterior abdominal chaetigers.

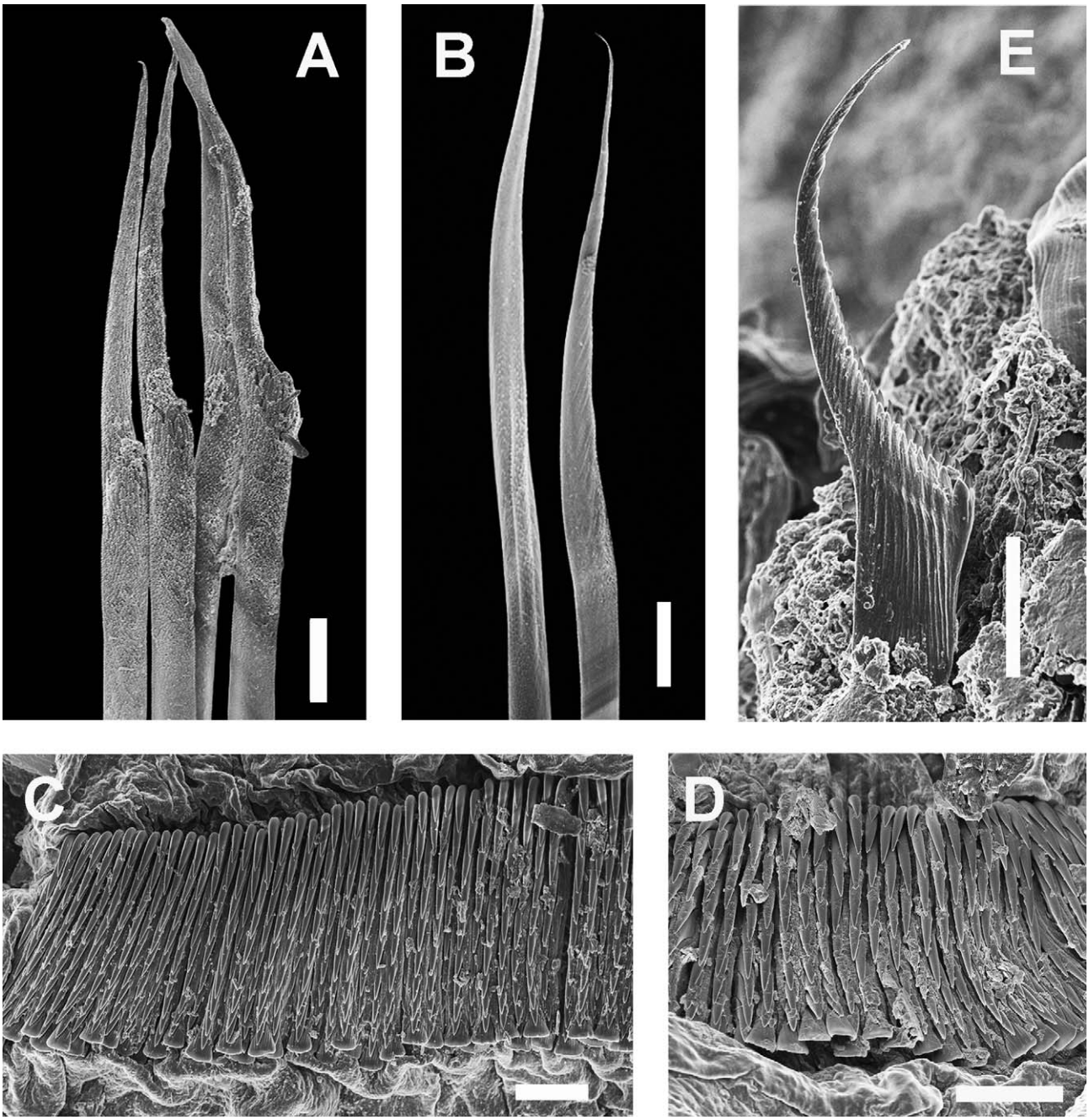

FIGURE 17. *Spirobranchus* sp. B. AM W41414. A, bayonet-like collar chaetae. B, limbate chaetae from chaetiger 4. C, uncini from chaetiger 4. D, anterior abdominal uncini. E, abdominal trumpet-shapedi chaeta. (Scale bars: A–B=20 µm, C–E=10 µm)

THORAX: with 7 chaetigers, 6 uncinigerous. Collar chaetae bayonet-like, with striated blade and numerous small teeth forming squarish emboss at base of blade (Figure 17A). Subsequent chaetae of two sizes, limbate (Figure 17B) and capillary. Uncini saw-shaped, with 9–10 teeth in a single row and gouged peg (Figure 17C). Tori increasing in length along thorax, approaching each other posteriorly, leaving a ventral depression.

ABDOMEN: total number of abdominal chaetigers varies from 65 to 76 (n=2, µ=70.5±7.8). Uncini saw-shaped, with 7 to 8 teeth in a row anteriorly (Figure 17D), increasing to 13 to 14 teeth in a row in middle abdomen and posteriorly. Chaetae true trumpet-shaped, abruptly bent distally, with two rows of denticles separated by a hollow groove and forming long lateral spine (Figure 17E).

SIZE: total worm length: 10.6 mm to 17.8 mm (n=2, µ=14.2±5.1), thoracic width: 1.0 mm to 1.1 mm (n=3, µ=1.0±0.1).

COLOUR: in ethanol operculum light brown, peduncle and wings light blue with dark blue pigmentation, branchial radioles purplish blue proximally and light blue distally, collar blue, thorax and abdomen yellowish.

Habitat. Depth: 3–6 m, on dead coral skeleton.

Remarks. *Spirobranchus* sp. B is similar to *S. acuiconus* described by Pillai (2009) in having an annulated calcareous operculum. However, the operculum of *S. acuiconus* bears more annuli than our specimens (13 vs. 8–10). Moreover, projections arising from operculum plates, observed in our specimens, are absent in *S. acuiconus*. Alternatively, the light brown colour of the operculum and the fringed peduncular wings indicate its similarity with *S. tetraceros*, as with the previous sp. A it might fall in the range of variability as described for this taxon as defined by Ben-Eliahu and ten Hove (2011 fig.33). In view of the uncertainties within the *S. tetraceros*-complex we prefer to describe the material fully, but not to assign this material to a definite name.

Genus *Vermiliopsis* Saint-Joseph, 1894

Type-species: *Vermilia multivaricosa* Mörch, 1863, new name for *Vermilia infundibulum sensu* Philippi, 1844.

Number of species: 16.

Diagnosis. Tube white, circular to sub-quadrangular in cross-section, usually with 3–7 longitudinal keels and peristomes. Granular layers absent. Operculum with inverse conical ampulla, covered by flat to conical chitinized horny cap bearing internal septa. Peduncle wrinkled, cylindrical, without wings, constriction present. Pseudo-operculum generally absent. Radioles arranged in (semi-)circles, interradiolar membrane absent. Branchial eyes may be present. Stylodes absent. Thorax with seven chaetigers. Collar trilobed, tonguelets absent. Collar chaetae limbate and capillaries. Thoracic chaetae limbate, capillaries and *Apomatus* chaetae. Thoracic uncini saw-shaped, with blunt peg. Abdominal chaetae flat narrow geniculate with a crenulated margin. Abdominal uncini rasp-shaped, anterior peg blunt. Anterior achaetous abdominal zone absent. Long posterior capillary chaetae present. Posterior glandular pad present.

Vermiliopsis glandigerus Gravier, 1906

(Figure 14L, Figure 18A–E)

Vermiliopsis glandigerus Gravier, 1906: 121.
Vermiliopsis glandigera—Pillai 2009: 104–108.
Vermiliopsis infundibulum/*glandigera* group—Imajima 1976a: 139–141; Mak 1982: 610–611; Imajima and ten Hove 1984: 59; Fiege and Sun 1999: 134–135; Sun and Yang 2001a: 203–204.

Material examined. AM W41415, 2 specimens (22°21'N, 114°17'E, Sharp Island, on dead coral, 3 m, May 21, 2009).

Description. TUBE: white, with 6 longitudinal ridges. Circular in cross-section. Up to 0.9 mm wide with lumen 0.7 mm.

BRANCHIAE: each lobe with 6 pairs of radioles; terminal filaments short. Branchial eyes absent.

PEDUNCLE: circular in cross-section, inserted just below right branchial lobe, with 4 to 5 annuli anteriorly, uppermost one inflated. Pseudo-operculum absent.

OPERCULUM: operculum consisting of a bulbous translucent fleshy ampulla, and a round conical, translucent chitinized cap with three internal septa (Figure 14L). Opercular length: from 1.1 mm to 1.2 mm (n=2, μ=1.1±0.1), width of both specimens 0.6 mm (n=2, μ=0.6±0).

COLLAR AND THORACIC MEMBRANES: collar trilobed, lateral lobes larger, continuous with narrow thoracic membranes extending to chaetiger 4.

THORAX: with 7 chaetigers, 6 uncinigerous. Collar chaetae of two types: limbate, with serrated blades and slender capillaries (Figure 18A). Chaeta of segment 2 similar to collar, chaetigers 3 to 7 with *Apomatus* chaetae in addition (Figure 18B–C). Uncini along entire thorax saw-shaped, with 12 curved teeth and rounded peg (Figure 18D). Tori of similar size along thorax.

ABDOMEN: Uncini saw-shaped anteriorly, with 11 teeth and blunt peg (Figure 18E). Anterior abdominal chaetae flat narrow geniculate with blunt teeth. Posterior abdominal chaetae capillary.

SIZE: total lengths of worms: 10.3 mm to 12.6 mm (n=2, μ=11.4±1.6), thoracic widths: 0.6 mm to 0.8 mm (n=2, μ=0.7±0.2). Branchiae and operculum accounting for one fifth of entire length.

COLOUR: in ethanol yellowish, with brown pigmentation on branchial crown and thoracic neuropodia.

Habitat. Depth: 3 m, on dead corals.

Remarks. Ten Hove (1975) considered *Vermiliopsis infundibulum/glandigera* to be a species complex. In a recent study, Pillai (2009) attributed the western Pacific specimens of this complex to *V. glandigerus*, which we have followed in this paper. However, for a more detailed discussion of the taxonomic problems in this genus see ten Hove & Kupriyanova (2009: 100) and Ben-Eliahu and ten Hove (2011: 95).

Distribution. Tropical and subtropical waters of western Pacific Ocean.

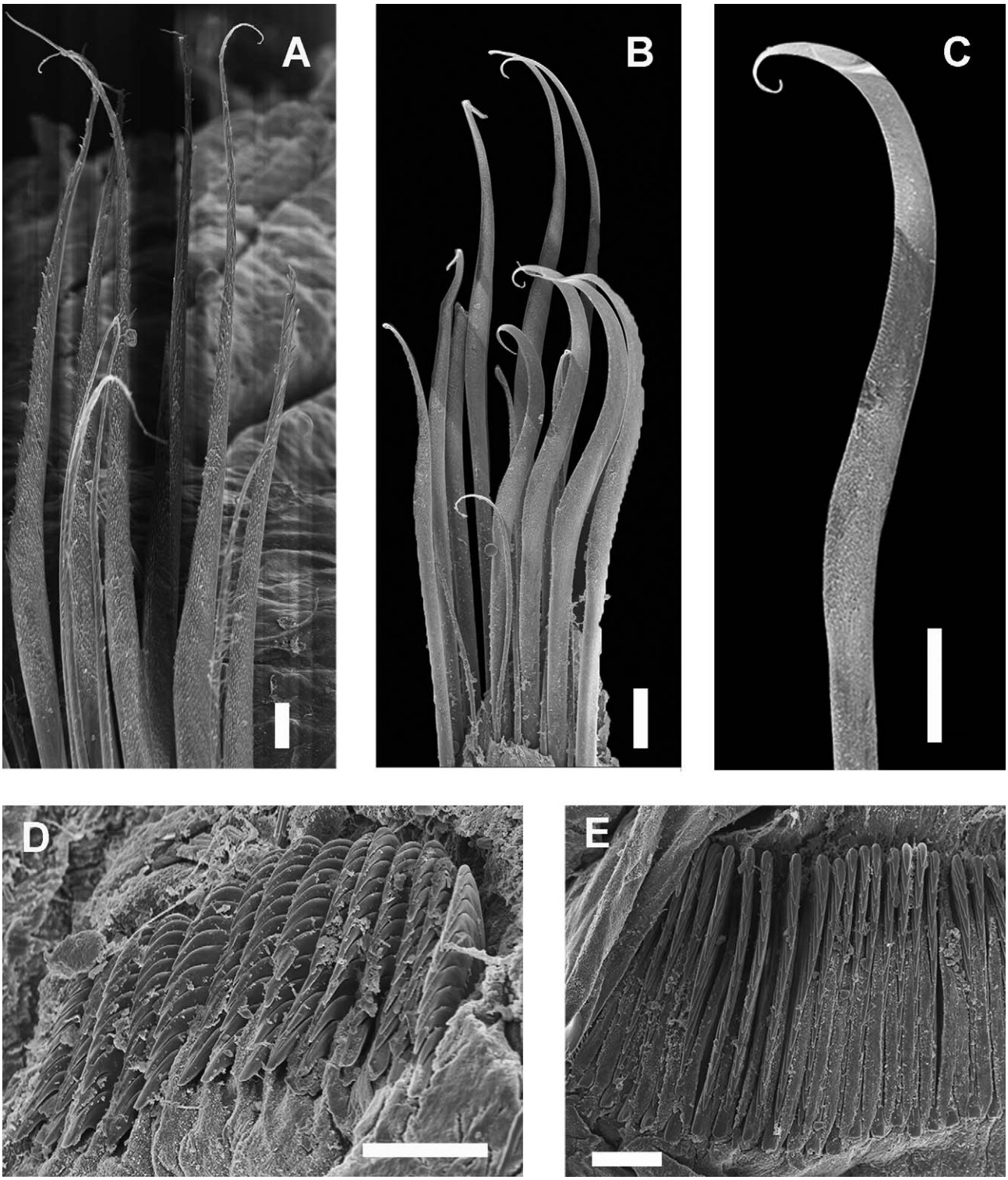

FIGURE 18. *Vermiliopsis glandigerus*, AM W41415. A, limbate and capillary collar chaetae. B, three types of chaetae from chaetiger 4. C, *Apomatus* chaeta. D, uncini from chaetiger 4. E, anterior abdominal uncini. (Scale bars: A, D–E=20 μm, B–C=10μm)

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