

Serpulid Polychaetes Associated with Living and Dead Corals at Okinawa Island, Southwest Japan

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Abstract I investigated coral-reef polychaetes in order to clarify their ecological habits, especially their association with living and dead coral in Okinawa, and provide here brief taxonomic accounts. Altogether, 25 species of 15 genera were found, and 12 serpulid species are found associated with living coral; 2 species, *Spirobranchus corniculatus* (Grube, 1862) and *Floriprotis sabiuraensis* Uchida (1978) seems to be obligate inhabitants of living corals. On dead coral skeletons, 24 serpulid species occurred. Four forms of association between serpulids and corals can be distinguished: I) buried in living coral skeletons, II) worm tubes partly covered by living coral skeletons, III) worm tubes running on the surface of living corals, and IV) whole tubes attached to dead coral skeleton.

Key words: Serpulid polychaete, coral associates, coral reef, Okinawa

Introduction

The biology of coral-reef serpulid polychaetes is not well known, though more than 30 species are presently known to exist in the Okinawan islands. The coral-boring polychaete *Spirobranchus giganteus* Pallas is the only species for which various information regarding its taxonomy and ecology is available. The habitats of coral-reef serpulid polychaetes have been usually recorded simply as intertidal, rock, dead coral, living coral, or fouling organisms (see Imajima, 1987, regarding Okinawan serpulids).

Many serpulid polychaetes associated with living and dead corals were collected during the studies of annelid fauna around Okinawa Islands. By closer observation on these specimens, the serpulids were noticed to inhabit differently live and/or dead corals, not always clearly known facultatively or obligately, although the habit of living of the coral-reef serpulid polychaetes had been commonly noted just as "buried in living coral" or "attached to dead coral skeleton".

In this paper, the modes of association of the serpulid polychaete species with host coral species are compared and summarized, and the taxonomical and ecological accounts are given for these serpulid species.

Study Sites, Materials and Methods

The survey of serpulid polychaetes associated with dead corals were done on 20 dead colonies of *Pocillopora damicornis*, *Acropora* spp. and *Porites* spp. that were collected by myself by hand or using chisel and hammer at Sesoko Island, just off Motobu in northern part of Okinawa Island, June, 1992. Additional samplings were done during 1991 to 1995 on living and dead coral skeletons at Sesoko Island, Maeda Cape and Zampa Cape, southern central part of Okinawa Island. All the serpulids obtained were identified to the species level where possible.

Specimens were deposited in Natural History Museum and Institute, Chiba (CBM-ZW), or uncatalogued because of drying on SEM stab.

Results and Discussion

In total 23 species of Serpulidae occurred on over 20 coral species (Table 1). On living corals, 12 serpulid species occurred (Table 1); except for *Spirobranchus corniculatus* (Grube, 1864) and *Floriprotis sabiuraensis* Uchida (1978), all the rest species also occurred on dead coral. On dead coral skeletons, 22 serpulid species, including 5 unidentifiable species, occurred (Table 1). Morphological description and taxonomical and ecological remarks are noted below.

The habits of association of serpulids on living corals can be separated into following 4 types. I) Tubes wholly embedded in living coral skeletons have openings not buried in living coral tissues; Scott (1987) defined a "living infaunal associate" as one that lives in the coral skeleton and whose aperture opens through the living coral tissue. II) Some or most part of the tube is embedded in the coral skeleton, with the remaining top part of the tubes lying on the living coral or erected upwards. III) Tubes lying attached over the surface of the living coral skeleton. IV) Whole tubes attached to dead coral skeletons. Detailed habit of association between serpulid polychaetes and corals are noted in remarks if possible.

Filigranella sp.

Material examined: CBM-ZW-188 (colony of worms), Sesoko Island, Okinawa, July 20, 1990, 1-2 m deep, on dead coral skeletons.

Floriprotis sabiuraensis Uchida, 1978

Floriprotis sabiuraensis Uchida, 1978, pp. 18-19; Nishi, 1992a, pp. 16-17.

Serpula spec., 2?: ten Hove, 1994, pp. 111-112.

Material examined: CBM-ZW-163 (tube is preserved in ethanol, trunk on SEM stab), Maeda Cape, Okinawa Island, 1-2 m deep, August 20, 1991.

Description: The body size is 15 to 20 mm in total length. The tube was buried in the coral skeletons and white and smooth on the inner surface. The operculum is absent. The thoracic membrane covers all the thoracic segments. The collar setae are of two types; capillary and blade setae. Abdominal setae are geniculate.

Remarks: Three specimens from living corals appeared in Zampa Cape, Maeda Cape, and Sesoko Island. Only one worm could be collected and tentatively described (Nishi, 1992a). Up to now, this species is reported to attach only on the living coral inclusive of my unpublished data (in Amakusa, west Kyushu, this species occurred commonly buried in living coral: CBM-ZW-179 (1 worm), Ushibuka, Amakusa, west Kyushu, about 10m deep, on live coral, November 19, 1993).

Hydroides elegans (Haswell, 1883)

Hydroides elegans (Haswell, 1883): ten Hove, 1974, p. 46; Imajima, 1976b, pp. 237-238; Nishi, 1993a, p. 12.

Material examined: CBM-ZW-159 (2 worms), Sesoko Island, Okinawa, 1-2m deep, on living coral, July 27, 1991.

Remarks: Two specimens on living corals and over 20 worm underside of dead corals occurred. This species occurred abundantly on the wall and shells in the aquarium (Nishi, 1993b).

Table 1. List of serpulid polychaetes found associated with living and dead corals at Okinawa, 1991-1995.

Serpulid species	Coral species associated with serpulid
Buried in coral skeleton	
<i>Hydroides elegans</i>	<i>Montastrea</i> sp.
<i>Hydroides exaltata</i>	<i>Pocillopora damicornis</i>
<i>Serpula</i> cf. <i>watsoni</i>	<i>Porites cylindrica</i>
<i>Spirobranchus corniculatus</i>	<i>Pavona decussata</i>
	<i>Pocillopora damicornis</i>
	<i>Pocillopora verrucosa</i>
	<i>Porites rus</i>
	<i>Porites cylindrica</i>
	<i>Porites lutea</i>
	<i>Porites nigrescens</i>
	<i>Porites contigua</i>
	<i>Acropora</i> sp.
	<i>Goniastrea</i> sp.
	<i>Goniastrea retiformis</i>
	<i>Stylophora pistillata</i>
	<i>Psammocora digitata</i>
	<i>Psammocora</i> sp.
	<i>Montastrea annulata</i>
	<i>Caurastrea</i> sp.
	<i>Echinopora</i> sp.
	<i>Montipora informis</i>
	<i>Montipora hispida</i>
	<i>Montipora</i> sp.
	<i>Cyphastrea microphthalma</i>
	<i>Pectinia</i> sp.
	<i>Hydnophora</i> sp.
	<i>Acanthastrea echinata</i>
	<i>Acropora digitifera</i>
	<i>Acropora nobilis</i>
	<i>Acropora aspera</i>
	<i>Millepora platyphylla</i>
	<i>Favites abdida</i>
	<i>Favites chinensis</i>
	<i>Favites russelli</i>
	<i>Favites</i> sp.
	<i>Platygyra pini</i>
	<i>Platygyra ryukyuensis</i>
	<i>Favia speciosa</i>
	<i>Favia pallida</i>
<i>Spirobranchus tetlaceros</i>	<i>Porites cylindrica</i>
<i>Vermiliopsis infundibulum glandigera</i>	<i>Pavona decussata</i>
	<i>Goniopora lobata</i>
<i>Floriprotis sabiuraensis</i>	<i>Porites lutea</i>
	<i>Cyphastrea</i> sp.

Serpulid species	Coral species associated with serpulid
Partly buried in coral skeleton	
<i>Pomatostegus stellatus</i>	<i>Cyphastrea</i> sp. <i>Pavona decussata</i>
Attached to the surface of living coral tissues	
<i>Salmacina dysteri</i>	<i>Pocillopora damicornis</i> <i>Pavona divaricata</i>
<i>Paraprotis dendrova</i>	<i>Pocillopora verrucosa</i>
<i>Rhodopsis pusilla</i>	<i>Porites cylindrica</i>
<i>Josephella marenzelleri</i>	<i>Porites cylindrica</i>
Attached to dead coral skeleton	
<i>Hydroides elegans</i>	<i>Pocillopora damicornis</i>
<i>Hydroides exaltata</i>	<i>Pocillopora damicornis</i>
<i>Hydroides tambalagamensis</i>	<i>Acropora</i> sp.
<i>Serpula</i> cf. <i>watsoni</i>	<i>Pocillopora damicornis</i>
<i>Serpula</i> cf. <i>kaempferi</i>	<i>Porites cylindrica</i>
<i>Serpula</i> cf. <i>vittata</i>	<i>Porites</i> sp.
<i>Pomatoleios kraussii</i>	<i>Porites</i> sp.
<i>Pomatostegus stellatus</i>	<i>Porites cylindrica</i>
<i>Protula tubularia</i>	<i>Pocillopora damicornis</i> <i>Porites cylindrica</i> <i>Acropora</i> sp.
<i>Paraprotis dendrova</i>	<i>Acropora</i> sp.
<i>Salmacina dysteri</i>	<i>Pocillopora damicornis</i>
<i>Rhodopsis pusilla</i>	<i>Acropora</i> sp. <i>Pocillopora damicornis</i>
<i>Josephella marenzelleri</i>	<i>Porites</i> sp.
<i>Vermiliopsis infundibulum glandigera</i>	<i>Porites</i> sp.
<i>Vermiliopsis</i> sp.	<i>Pocillopora damicornis</i>
<i>Filigranella</i> sp.	<i>Pocillopora damicornis</i>
<i>Metavermilia</i> sp.	<i>Acropora</i> sp.
<i>Spirobranchus tetlaceros</i>	<i>Pocillopora damicornis</i>
<i>Spirobranchus polytrema</i>	<i>Acropora</i> sp.
<i>Pseudovermilia</i> sp.	<i>Acropora</i> sp.
<i>Protula</i> sp.	<i>Acropora</i> sp.

Hydroides exaltata (Marenzeller, 1884)

Eupomatus exaltata Marenzeller, 1884: Willey, 1905, pp. 312-313; Pixell, 1913, pp. 11-18; Imajima & Hartman, 1964, p. 368.

Hydroides exaltata (Marenzeller, 1884): Dew, 1959, pp. 27-28; Pillai, 1960, pp. 10-12; Straughan, 1967, p. 220; Imajima, 1976b, pp. 127-128; Imajima, 1987, p. 77.

Material examined: Two worms on living coral, two on dead coral skeletons (one worm on SEM stab, preserved materials lost), July 27, 1991.

***Hydroides tambalagamensis* Pillai, 1961**

Hydroides tambalagamensis Pillai, 1961, pp. 36-38; Straughan, 1967, p. 33; Imajima, 1976a, pp. 123-125; Imajima, 1987, p. 76.

Material examined: CBM-ZW-148 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeleton, April 10, 1992.

***Josephella marenzelleri* Caullery & Mesnil, 1896**

(Fig. 4f)

Josephella marenzelleri Caullery & Mesnil, 1896, pp. 484-486-36; Dew, 1959, pp. 52-53; Uchida, 1978, pp. 34-36; Imajima, 1979, p. 181; Bailey-Brock, 1991, pp. 199-201; Nishi, 1992c, pp. 109-110.

Material examined: CBM-ZW-141 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on living coral, July 27, 1991.

Remarks: Some worms occur on dead and living corals, usually with *Rhodopsis pusilla* Bush, 1904. This species is about the same in body size as *R. pusilla* Bush, 1904, and characterized by chitinous cup-like opercular plate (Fig. 4f). This species is colonial, and perform asexual reproduction (Nishi, 1992c) as in *R. pusilla* Bush, 1904 (Nishi & Yamasu, 1992c). *Rhodopsis pusilla* Bush, 1904 and *J. marenzelleri* Caullery & Mesnil 1896 can not be distinguished by external tube morphology except for the presence of brood chamber of the former species.

***Metavermilis* sp.**

(Fig. 2e, f)

Material examined: CBM-ZW-138 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeleton, July 27, 1991; CBM-ZW-167 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeleton, July 27, 1991.

***Paraprotis dendrova* Uchida, 1978**

(Fig. 4e)

Paraprotis dendrova Uchida, 1978, pp. 16-17; Nishi, 1992b, p. 18; Nishi & Yamasu, 1992b, p. 85.

Material examined: CBM-ZW-157 (4 worms), Sesoko Island, Okinawa, on aquarium wall of Sesoko Marine Science Center, 1 m deep, March 10, 1992; CBM-ZW-156 (10 worms), Sesoko Island, Okinawa, underside of dead coral skeleton, 2-3 m deep, July 27, 1991; uncatalogued dried specimen on SEM stab (6 juveniles), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeleton, October 21, 1991; uncatalogued dried specimen on SEM stab (5 specimens), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeleton, October 21, 1991.

Remarks: This species is a solitary small species without operculum, with unique reproductive apparatus. Among the branchial crown, a pair of brooding appendages with many eggs and larvae occur (Fig. 4e; Nishi, 1992a; Nishi & Yamasu, 1992b). Tube is usually erected and whirled as in spirorbid polychaete. This species usually occurred on aquarium wall (Nishi, 1992a), and rarely did underside of dead coral skeleton.

***Pomatoleios kraussii* (Baird, 1865)**

Pomatoleios kraussii (Baird, 1865): Nishi, 1993b, p. 10; Nishi, 1993c, pp. 32-36.

Materials examined: None, identified in field.

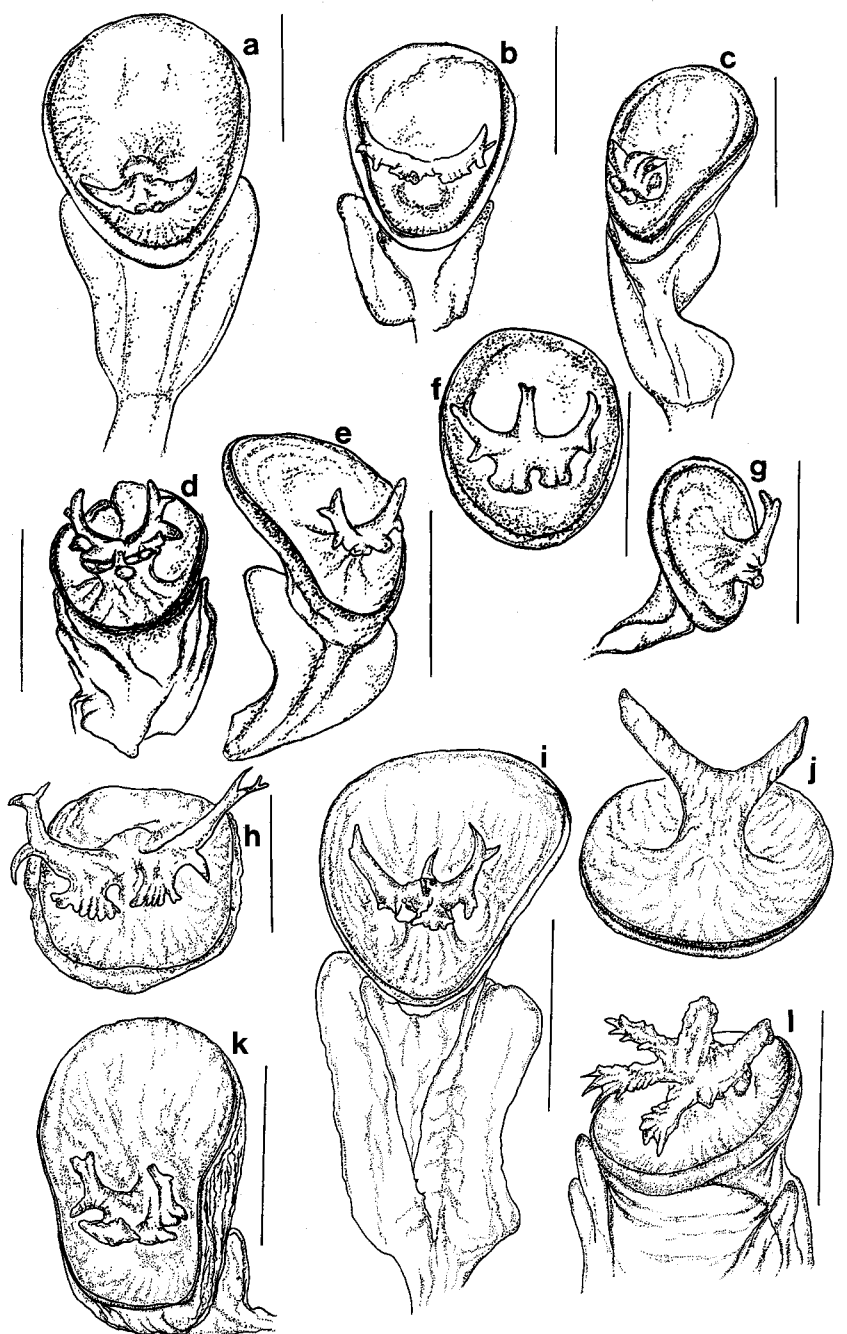


Fig. 1. Operculum of *Spirobranchus corniculatus* (a to k) and *Spirobranchus tellaceros* (l). f, h, and j show only opercular plate, others opercular plate and peduncle. a: CBM-ZW-168; b: CBM-ZW-168; c: CBM-ZW-168; d: CBM-ZW-165; e: CBM-ZW-172; f: CBM-ZW-54; g: CBM-ZW-170; h: CBM-ZW-169; i: CBM-ZW-171; j: CBM-ZW-23; k: CBM-ZW-175; l: CBM-ZW-140. Scale bars: 1 mm.

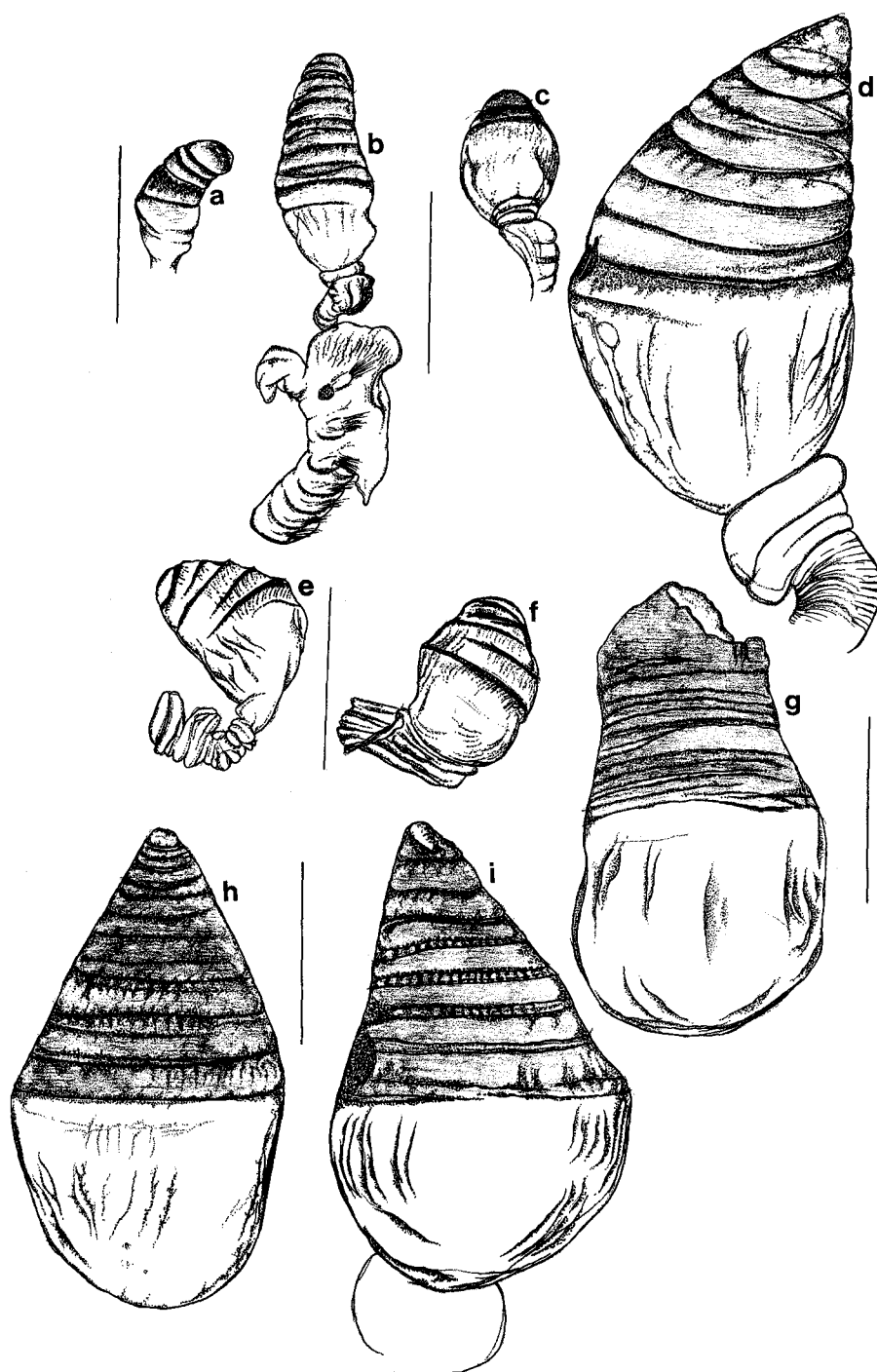


Fig. 2. Operculum of *Vermiliopsis infundiburum/glandigera* (a-d, h, and i), *Vermiliopsis* sp. (g) and *Metavermilina* sp. (e and f). b shows operculum and thoracic part. a: CBM-ZW-144; b: CBM-ZW-144; c: CBM-ZW-164; d: CBM-ZW-143; e and f: CBM-ZW-138; g: CBM-ZW-145; h: CBM-ZW-143; i: CBM-ZW-143. Scale bars: 1 mm.

***Pomatostegus stellatus* (Abildgaard, 1789)**

Pomatostegus stellatus (Abildgaard, 1789): Pixell, 1913, p. 79; Okuda, 1937, pp. 309-311; Dew, 1959, pp. 41-42; Pillai, 1960, pp. 23-25; Straughan, 1967, p. 238; Imajima, 1979, pp. 101-102; Imajima, 1987, p. 80; Nishi, 1995a, pp. 29-31.

Material examined: CBM-ZW-139 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on living coral; CBM-ZW-47 (1 worm), Sesoko Island, Okinawa, 2-3 m deep, on living coral, May 12, 1992; uncatalogued dried specimen (3 worms), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeleton, October 20, 1991.

***Protula tubularia* (Montagu, 1803)**

Protula tubularia (Montagu, 1803): Uchida, 1992, p. 144.

Material examined: CBM-ZW-153 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeleton, May 12, 1992; CBM-ZW-154 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on living coral, July 27, 1991.

***Protula* sp.**

Material examined: CBM-ZW-189 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeletons, May 12, 1992.

***Pseudovermilia* ? sp.**

Material examined: CBM-ZW-164 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeleton, July 27, 1991.

***Rhodopsis pusilla* Bush, 1904**

Rhodopsis pusilla Bush, 1904, pp. 289-290; Ben-Eliahu & ten Hove, 1989, p. 383; Bailey-Brock, 1991, pp. 201-204; Nishi & Yamasu, 1992c, pp. 34-39; ten Hove & San Martin, 1995, p. 19.

Material examined: CBM-ZW-159 (2 worms), Sesoko Island, Okinawa, 1-2 m deep, on living coral, July 27, 1991.

Remarks: Colonies of worms occur on dead corals and the surface of living corals (Table 1). This minute species is characterized by a chitinous opercular plate (showing dimorphism) bearing numerous spines (Fig. 4a-c; see also Ben-Eliahu & ten Hove, 1989). Pouch-like brood chambers on the tube associated with rings making peristome were found on some tubes (Fig. 4d). This species occurred abundantly on bare concrete wall and on shells in the aquarium (Nishi, 1993a,b; Nishi & Yamasu, 1992c).

***Salmacina dysteri* (Huxley, 1855)**

Salmacina dysteri (Huxley, 1855): Nishi, 1993b, pp. 12-14; ten Hove, 1994, p. 110.

Material examined: CBM-ZW-155 (2 specimens), Sesoko Island, Okinawa, 1-2 m deep, on living coral, July 27, 1991; CBM-ZW-162 (3 specimens), Sesoko Island, Okinawa, 2-3 m deep, on living coral, January 23, 1992.

Remarks: The tubes are entangled and form colonies on various substrates (Nishi & Nishihira, 1993, 1994; Nishi & Yamasu, 1992a). On living *Porites cylindrica* and *Pavona decussata*, their tubes occurred, and the base of the colony was found out on dead part of the corals.

Serpula cf. *kaempferi* (Kinberg, 1867)
(Fig. 3a-f)

Serpula cf. *kaempferi* (Kinberg, 1867): Imajima, 1978, pp. 50-52.

Material examined: CBM-ZW-160 (2 worms), Sesoko Island, Okinawa, 2-3 m deep, on dead coral skeleton, January 31, 1992; CBM-ZW-161 (3 worms), Sesoko Island, Okinawa, 2-3 m deep, on dead coral skeletons, January 31, 1992; CBM-ZW-166 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeletons, July 27, 1991.

Serpula cf. *vittata* Augener, 1914
(Fig. 3g-j)

Serpula vittata Augener, 1914, pp. 137-139; Imajima, 1979, pp. 160-162; Imajima, 1987, p. 79; ten Hove, 1994, p. 111.

Material examined: CBM-ZW-151 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeleton, July 27, 1991; CBM-ZW-152 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeleton, July 27, 1991.

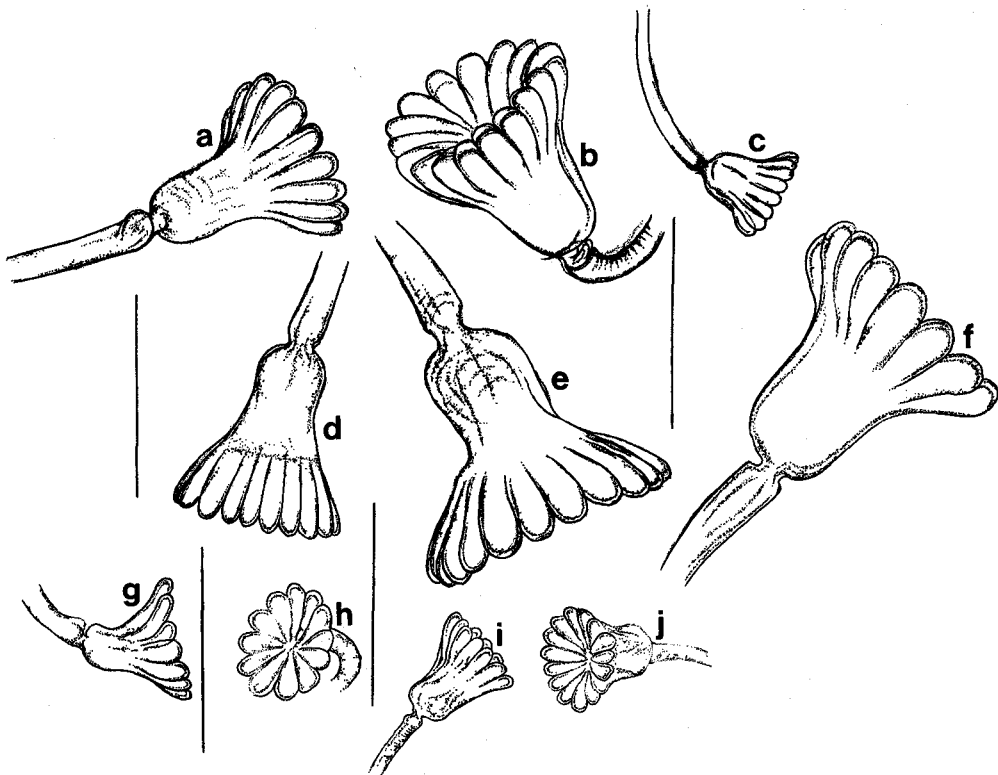


Fig. 3. Operculum of genus *Serpula*. a to f: *Serpula* cf. *kaempferi*; g to j: *Serpula vittata*. a: CBM-ZW-161; b: CBM-ZW-161; c: CBM-ZW-161; d: CBM-ZW-166; e: CBM-ZW-160; f: CBM-ZW-160; g: CBM-ZW-152; i and j: CBM-ZW-151. Scale bars: 1 mm.

***Serpula cf. watsoni* Willey, 1905**

Serpula watsoni Willey, 1905, p. 317; Imajima, 1977, pp. 91-92; Imajima, 1987, p. 78; Nishi, 1992b, pp. 79-80.

Material examined: Uncatalogued dried specimen on SEM stab (1 worm), Maeda Cape, Okinawa, 2-3 m deep, on living coral, March 2, 1992.

***Spirobranchus corniculatus* (Grube, 1862)**

(Fig. 1a-k)

Serpula corniculatus Grube, 1862, p. 66.

Spirobranchus giganteus Pallas, 1766: Fauvel, 1936, p. 87-89.

Spirobranchus giganteus corniculatus ten Hove, 1970, p. 24-32; Imajima, 1987, p. 80; Nishi & Asakura, 1996, pp. 56-60.

Material examined: CBM-ZW-53 (1 specimen), Zampa Cape, Okinawa, subtidal, 1-3 m deep, on living coral *Montastrea* sp., May 20, 1992; CBM-ZW-54 (1 specimen), Zampa Cape, Okinawa, subtidal, 1-3 m deep, on living coral, *Montastrea* sp., January 27, 1993; CBM-ZW-165 (8 specimens), Zampa Cape, Okinawa, 2-5 m deep, on living coral, May 4, 1995.

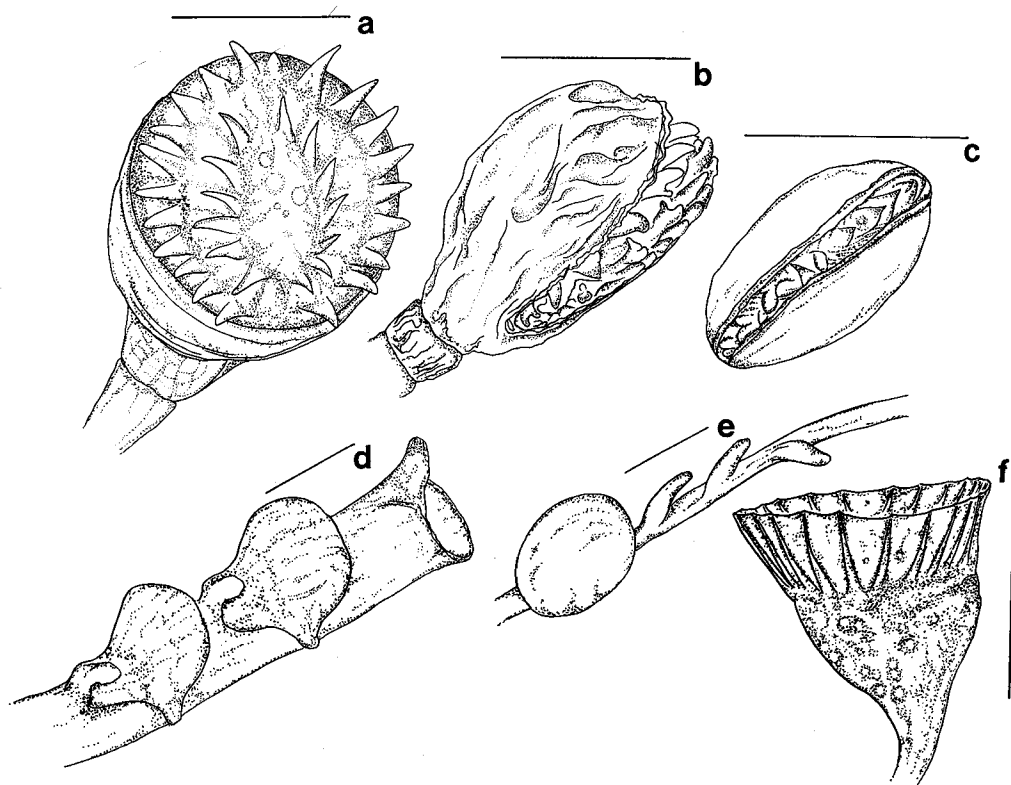


Fig. 4. Operculum and reproductive apparatus of *Rhodopsis*, *Josephella*, and *Paraprotis*. a to c: operculum of *Rhodopsis pusilla*; d: brooding chamber of *R. pusilla* on tube; e: brooding appendage with one egg of *Paraprotis dendrova*; f: operculum of *Josephella marenzelleri*. Scale bars: 0.05 mm.

Description: Worms measure 4–90 mm from the tip of the operculum to the posterior end of the abdomen. The morphology of the opercular plate is varied among the worms; it is usually wide and has a short central spine that divides into two, four or five branches, each of which commonly divides into fine spines (Fig. 1a–k). Small worms below 5 mm in body length were found on the outside of living corals and their operculum bears simple spines (Fig. 1j). The opercular plate is nearly flat (Fig. 1g,j) or deeply concave (Fig. 1a–c,i,k), and the plate is usually from semi-circular to egg-shaped. The plate edge is commonly tinged with pale pink, and the rest part of the plate is white or cream-coloured. The opercular peduncle is somewhat flattened with lateral wings extending half to two-third the length of the peduncle. The lateral wings have entire edge and a rounded distal tip (Fig. 1b,e,i). There are seven thoracic segments, six of which are uncinigerous; collar setae is "*Spirobranchus*" type and penetrates the base of the collar.

Over 200 worms were observed on 37 living coral species (Table 1), and 30 worms were collected from 12 species of corals.

Remarks: This species is associated with over 30 species of corals in Okinawa (this study) and 32 species in Taiwan (Dai & Yang, 1995). Because *Spirobranchus giganteus* (Pallas, 1766) inhabits many coral species (ten Hove, 1989; Scott, 1987), ten Hove (1989) noted that there appears to be no preferential selection of coral species. Contrary, Marsden et al. (1990) have shown that the planktonic larvae of *S. giganteus* (Pallas, 1766) prefer certain coral species for settlement. Hunte et al. (1990) noted a non-random distribution of *S. giganteus* (Pallas, 1766) on corals. Nishi & Kikuchi (1996) also noted a non-random distribution of *S. corniculatus* (Grube, 1862) on corals at Okinawa. The host coral preference of *Spirobranchus* worm is possibly different with the sea areas concerned, but more detailed studies, like works on *Spirobranchus* at coral reefs of Taiwan by Dai & Yang (1995), are needed for confirmation.

Spirobranchus corniculatus (Grube, 1862) is obligately associated with living corals at Okinawa, and almost all of the worms are fully embedded in coral skeletons. Very rarely, a few adult worms have been found attached to bare coral skeletons (only 5 instances among over 1000 worms), but the host coral was probably alive when the polychaete juvenile was alive. Nevertheless, this species frequently occurred on bare natural rocks and dead coral skeletons in Izu Peninsula, central Japan (CBM-ZW-185, 1 worm; CBM-ZW-186, 1 worm), and rarely on live coral (CBM-ZW-183, 1 worm; CBM-ZW-184, 3 worms).

***Spirobranchus cf. polytrema* (Philippi, 1844)**

Spirobranchus polytrema (Philippi, 1844): Straughan, 1967, p. 230; Pillai, 1971, pp. 94–96; Imajima, 1977, pp. 102–106; Imajima, 1987, p. 79.

Material examined: Uncatalogued one worm on SEM stab.

***Spirobranchus tetlaceros* (Schmarda, 1861)**

(Fig. 1l)

Spirobranchus tetlaceros (Schmarda, 1861): ten Hove, 1970, pp. 3–14; Imajima, 1979, pp. 177–178; Imajima, 1987, p. 79.

Material examined: CBM-ZW-140 (1 worm), Sesoko Island, Okinawa, 1–2m deep, on living coral (*Porites* sp.), July 27, 1991.

Description: The tube is round in cross section, and a median ridge and some indistinct longitudinal ridges ornament the tube. The tube is basically white but tinged with pale pink. Radioles and opercular stalk are banded with blue. The branchial membrane extends one-thirds the length of the radiole. The opercular plate has six branches from one common

base, and each branch bears lateral fine spines (Fig. 11). The peduncle has lateral wings along its entire length, and the tips are not divided.

Remarks: Only two worms were found out; one is buried in living coral, *Porites* sp., and the other under dead coral skeleton. From *S. corniculatus* (Grube, 1862), this species can be easily distinguished by the opercular and tube morphology.

Vermiliopsis infundiburum / glandigera

(Fig. 2a-d, h-j)

Vermiliopsis infundiburum / glandigera: Imajima, 1976a, pp. 139-141 (for synonymy); Imajima, 1987, p. 80; ten Hove, 1994, p. 113; Nishi, 1995a, pp. 28-29.

Material examined: CBM-ZW-142 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on live coral, March 20, 1992; CBM-ZW-143 (5 worms), Sesoko Island, on concrete aquarium wall of Sesoko Marine Science Center, 1 m deep, January 16, 1992; CBM-ZW-144 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeleton, July 27, 1991; CBM-ZW-164 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeleton, March 20, 1992.

Description: The operculum is composed of a fleshy ampulla and a conical, brown chitinous cup, divided into 2 to 5 layers by partitions (Fig. 2d, h, i). The peduncle is round in cross section, and its surface is wrinkled.

Remarks: Three worms occurred on living corals and 10 worms underside the dead corals. The tubes were buried in coral skeletons except for the aperture, or only a small portion of the tube was covered by living corals. This species is a form with variable opercular features, and is now placed under the complexed taxa *Vermiliopsis infundiburum / glandigera* (ten Hove, 1975; ten Hove & Wolf, 1984; Nishi, 1995a).

***Vermiliopsis* sp.**

(Fig. 2g)

Material examined: CBM-ZW-145 (1 worm), Sesoko Island, Okinawa, 1-2 m deep, on dead coral skeleton, July 27, 1991.

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