

## ***Polydora* (Polychaeta: Spionidae) Species from Taiwan**

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**Vasily I. Radashevsky and Hwey-Lian Hsieh (2000)** *Polydora* (Polychaeta: Spionidae) species from Taiwan. *Zoological Studies* 39(3): 203-217. This report discusses 5 species of the genus *Polydora* (Polychaeta: Spionidae) from the shallow waters of Taiwan and off mainland China. These include *P. cf. agassizi* Claparède, 1869, *P. cornuta* Bosc, 1802, and 3 new species: *P. fusca*, *P. triglanda*, and *P. villosa*. *Polydora cf. agassizi* inhabits mud tubes on the surface of a horseshoe crab; *P. cornuta* and *P. fusca* inhabit mud tubes on soft bottoms while *P. villosa* bores into skeletons of living corals. *Polydora triglanda* is both a shell-borer and a tube-dweller, and no morphological differences were found between individuals from the 2 habitats. Five species are described and illustrated, and a key is provided for their identification. *Polydora* species with black bands on the palps, median antenna on the caruncle, and needlelike spines on the posterior notopodia are reviewed, and their morphological characteristics are compared.

**Key words:** Spionid polychaete, *Polydora*, Systematics, Morphology.

Spionid polychaetes from Taiwan have not yet been the subject of systematic study and to date only 1 species, *Pseudopolydora diopatra* Hsieh, is described from the region (Hsieh 1992). In recent studies on macrobenthic communities, a large number of spionids was collected along the western coast of Taiwan and from Kinmen Island, located just off mainland China (Fig. 1). Eight *Pseudopolydora* species found in these investigations have been described (Radashevsky and Hsieh 2000). The present paper deals with 5 *Polydora* species from the region. They are described and illustrated. A key is provided for their identification. The type and representative materials are deposited in the Institute of Zoology, Academia Sinica, Taipei, Taiwan (ASIZW), the Institute of Marine Biology, Vladivostok, Russia (IMBV), and the National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM). Detailed information about samples is given under the "Materials" paragraph for each species in the "Systematic Account" section. Unless otherwise indicated, the samples were collected by H. L. Hsieh. The number of specimens in a sample is given in

parentheses after the museum abbreviation and registration number.

### **SYSTEMATIC ACCOUNT**

#### **Key to identification of *Polydora* species from Taiwan**

1. Median antenna present on caruncle ..... 2  
Median antenna absent on caruncle ..... 4
2. Black bands present on palps in individuals with more than 60-100 segments; dorsal superior capillaries present on segment 5; bores into mollusc shells or inhabits mud tubes ..... *P. triglanda*  
Black bands absent on palps; dorsal superior capillaries absent on segment 5; inhabits mud tubes ..... 3
3. Separate needlelike spines present on posterior notopodia; black pigment scattered on head and anterior segments; caruncle to end of segment 2; ventral capillaries present on segment 5 ..... *P. fusca*  
Needlelike spines absent from posterior notopodia; black scattered pigment absent from body; caruncle to end of segment 3; ventral capillaries absent from segment 5 .....  
..... *P. cornuta*
4. Black bands present on palps; major spines on segment 5 with small lateral tooth; inhabits mud tubes .....  
..... *P. cf. agassizi*

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Black bands absent from palps; major spines on segment 5 falcate with lateral tooth or flange on 1 side and a shelf having a rough edge on the other side of distal end; bores into corals ..... *P. villosa*

**Genus *Polydora* Bosc, 1802**

***Polydora* cf. *agassizi* Claparède, 1869**

(Fig. 2)

?*Polydora agassizii* Claparède, 1869: 314-318, pl. 22, fig. 1.

?*Polydora ciliata*: Carazzi, 1893 (*Part.*): 17-20, pl. 2, figs. 4, 5.

Not *Polydora ciliata* (Johnston, 1838).

**Materials:** Fujian Prov., Kinmen Is. off mainland China, from mud tubes on ventral anterior part of carapace and walking legs of the horseshoe crab *Tachypleus tridentatus* Leach, bought from fishermen, 20 Aug. 1998, ASIZW 42 (200+), IMBV 3374 (10).

**Description:** Largest individual measuring 6.6 mm long and 0.4 mm wide at segment 7 for 65 segments. Black pigmentation often present on dorsal sides of peristomium; small individuals often with remains of larval pigmentation on anterior segments; body pigmentation absent in large individuals. Pro-stomium narrow, curved downwards and incised on anterior margin. Four black eyes forming a square-shaped pattern usually present; sometimes eyes absent or reduced to 2 or 3. Caruncle extending posteriorly up to middle of segment 3; median antenna absent (Fig. 2A). Palps extending back for 10-15 segments; with up to 12 paired black bars present along the palp in individuals having more than 35 segments; each pair of bars located on either side of ciliated food groove (Fig. 2B).

Segment 1 with well-developed neuropodial postchaetal lamellae, notopodial lamellae reduced or completely lacking; notochaetae absent but short neuropodial capillaries present. Posterior notopodia with only capillary chaetae. Hooded hooks in neuropodia from segment 7, not accompanied by capillaries; hooks bidentate, with slightly curved shaft having constriction in upper part (Fig. 2C), numbering up to 6 in a series.

Segment 5 larger than either segments 4 or 6, with dorsal musculature overlapping segment 6; with a bundle of 2-4 dorsal superior geniculate capillaries (Fig. 2D), curved horizontal row of 4-5 major spines alternating with pennoned companion chaetae (Fig. 2F), and a ventral tuft of 4-5 short winged capillaries (Fig. 2E). Major spines falcate, with small lateral accessory tooth.

Branchiae from segment 7 through 2/3 of body length, full-sized from segment 8 or 9 to midbody, then gradually reduced; free from notopodial postchaetal lamellae, with flattened surfaces oriented

laterally. Nototrochs from segment 7 onwards.

Pygidium cup-shaped or disclike with distinct dorsal gap (Fig. 2G).

No gizzardlike structure in digestive tract.

Glandular pouches from segment 7, usually largest in segment 7, then greatly diminishing in size and not discernible after segment 10; in the largest individual, pouches largest in segments 7-10 and then decreasing through segment 28.

Species gonochoristic, gametes present in both females and males from segments 18-25 to 35-50. Median part of male gonoducts enlarged, consisting of large urn-shaped cells. Female paired gonoducts terminating externally into 2 separate gonopores on dorsal side of every except the 1st fertile segment.

**Habitat:** *Polydora* cf. *agassizi* was found inhabiting mud tubes on the ventral anterior carapace and walking legs of the horseshoe crab *Tachypleus tridentatus*. Hundreds of specimens were found to form a dense aggregation on 1 of 6 examined horseshoe crabs obtained from fishermen who caught the horseshoe crabs somewhere off the coast of Kinmen Island.

**Remarks:** *Polydora agassizi* was originally described by Claparède (1869) from the Gulf of Naples, in the Mediterranean Sea as a common inhabitant of mud tubes on soft bottoms. Claparède noticed yellow bands regularly arranged on the palps. Worms from the same locality were described later by Carazzi (1893) who reported them as being identical to *P. agassizi* and noted that both palp and body pigmentation were black. Carazzi (1893) erroneously synonymized *P. ciliata* (Johnston, 1838) to *P. agassizi*. Although *P. ciliata* has never been described as

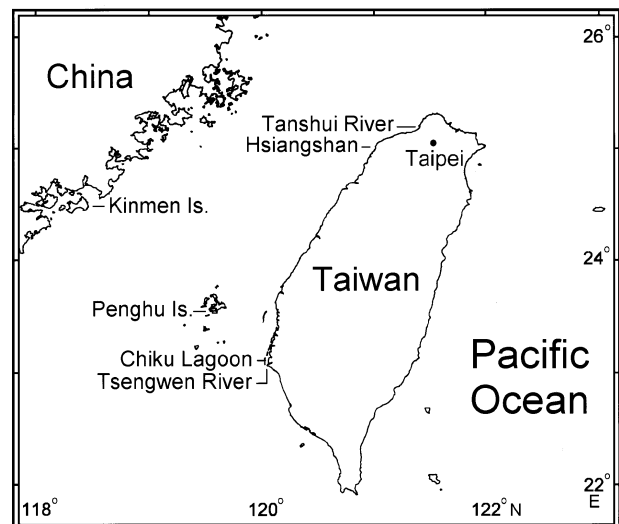


Fig. 1. Map showing localities mentioned in the text.

having palps with black bands, this synonymy has been accepted until the present. No *Polydora* species with banded palps has subsequently been reported from the Mediterranean Sea or from off the European coastline since the 19th century (see Fauvel 1927, Hartmann-Schröder 1971 1996).

The *Polydora* specimens from Kinmen Island fit most of the morphological characteristics provided by Claparède (1869) and Carazzi (1893) for *P. agassizi* (see Table 1). They differ in being smaller, 6.6 mm long and 0.4 mm wide for 65 segments, instead of 30 mm long and 1 mm wide for 160 segments, and in having smaller numbers of hooded hooks and major spines (usually associated with the size of the worm). However, black bands were described along the lateral sides of the anterior part of the prostomium and at the sides of the mouth in individuals from the Mediterranean (Carazzi 1893); these bands were not observed in the individuals examined in the present study. Because of these subtle morphological differences and the wide geographical separation of the 2 populations, we have identified the individuals from Kinmen Island as *P. cf. agassizi* and defer their final identification until more information is available about the Mediterranean

populations.

*Distribution:* ?Gulf of Naples, Mediterranean Sea; Kinmen Island off mainland China.

### ***Polydora cornuta* Bosc, 1802**

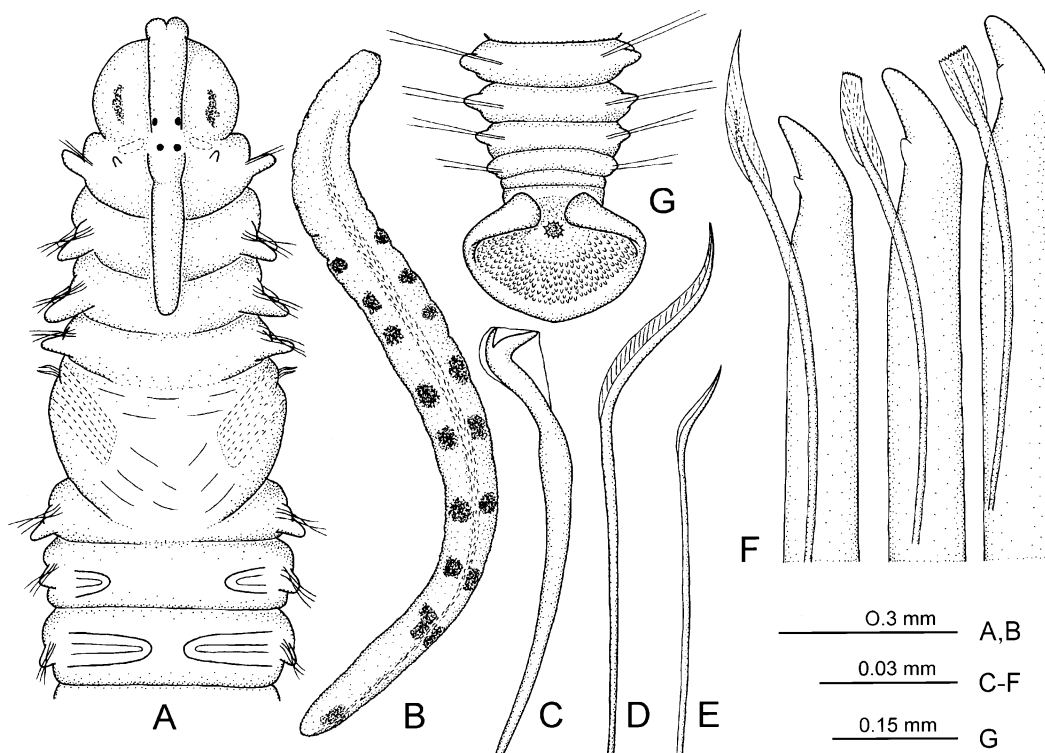
(Fig. 3)

*Polydora cornuta* Bosc, 1802: 150-153, pl. 5, figs. 7, 8.

*Polydora cornuta*: Blake and Maciolek, 1987: 11-15, fig. 1 (synonymy).

*Polydora ligni* Webster, 1879: 119, pl. 5, figs. 45-47. *Fide* Blake and Maciolek, 1987.

*Materials:* Hsinchu Co., Hsiangshan, 24°50'N, 120°54'E, intertidal, on tube of the onuphid, *Diopatra sugokai* Izuka, 28 Mar. 1990, ASIZW 43 (1). Tainan Co., Tsengwen R. estuary, 23°04'N, 120°05'E, < 2 m, mud, 26 May 1995: st. 4M, USNM 186413 (1); st. 4N, ASIZW 44 (1). Fujian Prov., Tzu Lake of Kinmen Is., 24°28'N, 118°18'E, < 2 m, sandy or muddy bottom: st. 2, 28 Feb. 1996, ASIZW 46 (2); st. 3, 28 Feb. 1996, ASIZW 47 (1); st. 4, 28 Feb. 1996, USNM 186415 (5); st. 4, 30 May 1996, ASIZW 48 (3); st. 5a, 28 Feb. 1996, ASIZW 50 (9); st. 5, 30 May 1996, ASIZW 49 (1); st. 7, 28 Feb. 1996, ASIZW 51 (1); st. 8, 28 Feb. 1996, USNM 186416 (2); st. 8, 30 May 1996, ASIZW 52 (1); st. 10, 28 Feb. 1996, USNM



**Fig. 2.** *Polydora cf. agassizi* Claparède, 1869. (A) Anterior end, dorsal view; (B) palp; (C) neuropodial bidentate hooded hook of segment 7; (D) dorsal superior capillary chaeta of segment 5; (E) ventral capillary chaeta of segment 5; (F) major falcate spines and pennoned companion chaetae of segment 5; (G) posterior end, dorsal view. A–G : ASIZW 42.

**Table 1.** Morphological characteristics of known *Polydora* species with black bands on palps<sup>a</sup>

Species	Reference	Prostomium (anterior edge)	Median antenna	Caruncle (maximal length)	Superior notochaetae on segment 5	Neurochaetae on segment 5	Accessory structures of major spines on segment 5	Modified spines in posterior notopodia	Habitat
<i>P. agassizi</i>	1, 2	incised	absent	end of segment 3	present	present	small lateral tooth	absent	tube-dweller
<i>P. alloporis</i>	6	entire	absent	end of segment 4	present	present	subdistal concavity bordered by collar	absent	borer of hydrocoral <i>Allopora californica</i>
<i>P. brevipalpa</i>	8	entire	absent	end of segment 3	absent	present	lateral flange	absent	shell-borer
<i>P. limicola</i>	3	incised	absent	end of segment 3	present? <sup>b</sup>	present	small lateral tooth	absent	tube-dweller
<i>P. maculata</i> <sup>c</sup>	4	incised	2	end of segment 1	absent	absent	low lateral flange	absent	shell-borer
<i>P. narica</i>	5	incised	absent	end of segment 4	present	present	small lateral tooth and subterminal cowl-like shelf	absent	commensally? in ampharetid tubes <sup>d</sup>
<i>P. neoacaeca</i>	11	incised	absent	middle of segment 4	present	present	lateral flange	absent	shell-borer
<i>P. triglanda</i> <sup>e</sup>	12	incised	1	end of segment 3	present	present	lateral flange	absent	shell-borer and tube-dweller
<i>P. uncinata</i>	10	incised	1	end of segment 3	present	present	large lateral tooth	single falcate hook	shell-borer
<i>P. wobberi</i> <sup>f</sup>	7	incised	absent	middle of segment 4	present	present	subdistal concavity bordered by flange	absent	borer of white gorgonacean <i>Lophogorgia</i> sp.
<i>Polydora</i> sp.	9	entire	absent	end of segment 4	present	present	large lateral tooth	absent? <sup>g</sup>	borer of calcareous substrata

<sup>a</sup>Pillai (1965: 152) reported that in *Polydora cavitensis* "Each palp has two transverse brown bands, one towards its middle and the other towards its distal end." The bands were not, however, depicted by the author (Pillai 1965: Fig. 16E). Although black pigment is known to become brown in alcohol, until further examination, the species has not been considered as having black bands on palps.

<sup>b</sup>Hartman (1961) did not notice the superior notochaetae on segment 5, but her description implies their presence.

<sup>c</sup>*Polydora maculata* is also distinctive in that it has bidentate hooded hooks in the neuropodia beginning from segment 9. They begin from segment 7 in all other species referred to in the table.

<sup>d</sup>*Polydora narica* is known from only a single specimen found in Monterey Canyon, California in about 65 m in association with an ampharetid.

<sup>e</sup>Black transverse bands present on palps only in individuals having more than 60-100 segments.

<sup>f</sup>*Polydora wobberi* is unique among the polydorid species in that it has a prominent and often pleated webbing joining adjacent branchiae from segment 12 to almost the end of the body.

<sup>g</sup>Only anterior fragments were available (Blake 1996).

References: 1. Claparède (1869), 2. Carazzi (1893), 3. Hartman (1961), 4. Day (1963), 5. Light (1969), 6. Light (1970a), 7. Light (1970b), 8. Radashevsky (1993), 9. Blake (1996), 10. Sato-Okoshi (1998), 11. Williams and Radashevsky (1999), 12. present study.

186414 (2); st. 12, 28 Feb. 1996, ASIZW 45 (1).

**Description:** Largest individual measuring 9.0 mm long, 0.9 mm wide at segment 7 for 57 segments. Body and palp pigmentation absent. Prostomium incised anteriorly and flaring laterally. Four black eyes in trapezoidal arrangement usually present; 1 individual without eyes and 1 individual with 2 eyes having small, probably regenerating head. Caruncle continuing posteriorly up to end of segment 3; with prominent cirriform median antenna (Fig. 3A). Palps extending posteriorly for 15-25 segments.

Segment 1 with long, cirriform notopodial lamellae and well-developed neuropodial lamellae; notochaetae absent but short capillary neurochaetae present. Posterior notopodia with only capillary chaetae. Hooded hooks in neuropodia from segment 7, not accompanied by capillaries; hooks bidentate, with slightly curved shaft having constriction in upper part, numbering up to 9 in a series.

Segment 5 larger than either segments 4 or 6, with dorsal musculature overlapping segment 6, with curved horizontal row of 5-7 major spines alternating with delicate companion chaetae; dorsal superior and ventral capillaries completely lacking. Worn major spines (anterior in a row) simple falcate; unworn major spines (posterior in a row) with small lateral tooth and accessory flange. Companion chaetae closely applied to convex side of major spines; with broomlike, feathery tips; being bunched on 1 side of the main stem, hairs of the broom giving the chaeta a

distinctive bifurcate appearance (Fig. 3C).

Branchiae from segment 7, nearly full-sized at first, absent from a few posterior segments; free from notopodial postchaetal lamellae, with flattened surfaces oriented laterally.

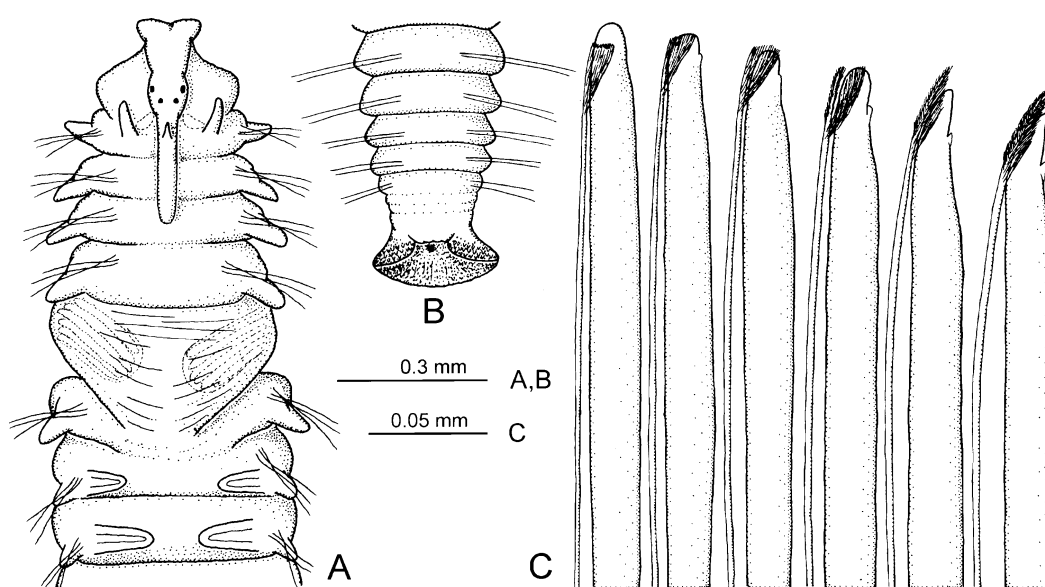
Pygidium cup-shaped or disclike with distinct dorsal gap (Fig. 3B).

No gizzardlike structure in digestive tract.

Glandular pouches from segment 7, usually well developed until about segment 13 and then diminishing in size.

**Habitat:** *Polydora cornuta* was found inhabiting mud tubes on soft muddy bottoms and was associated with large tubes of the onuphid *Diopatra sugokai* in estuarine and coastal intertidal environments. In some samples, the species was found together with *P. fusca* (see below).

**Remarks:** Extensive literature exists on the biology of *P. cornuta* (most of it referring to *P. ligni*, a junior synonym of *P. cornuta*) due to the ecological and economic importance of the species. The species has often been considered to be a pollution indicator (see Rice and Simon, 1980). *Polydora cornuta* is a widely distributed species, found in mud and sand flats of estuaries on the east, west, and gulf coasts of North America, and in Mexico, Argentina, Europe, and Australia. Lee and Cha (1997) reported on the species in Shihwa Lake on the western coast of Korea. This is the first record from the north-western Pacific and is reported here for the first time from Taiwan and the coast of mainland China.



**Fig. 3.** *Polydora cornuta* Bosc, 1802. (A) Anterior end, dorsal view; (B) posterior end, dorsal view; (C) major falcate spines and pennoned companion chaetae of segment 5. A, B: ASIZW 43; C: ASIZW 47.

*Distribution:* Widespread species, probably disseminated through human activities.

***Polydora fusca* sp. nov.**

(Fig. 4)

*Diagnosis:* A moderate-sized gonochoric *Polydora* species inhabiting mud tubes on soft bottom. Head and anterior segments with fine scattered black pigment. Prostomium incised anteriorly. Eyes present or absent. Caruncle reaching end of segment 2. Median antenna present on the caruncle. Posterior notopodia with needlelike spines in addition to capillaries. Segment 5 without dorsal superior capillaries but with ventral capillaries; major spines falcate, with small lateral tooth, alternating with pennoned companion chaetae. Branchiae from segment 7 through about 3/4 of body. Pygidium cup-shaped with dorsal gap.

*Type materials:* Fujian Prov., Tzu Lake of Kinmen Is., 24°28'N, 118°18'E, < 2 m, sandy or muddy bottom: st. 5, 28 Feb. 1996, ASIZW 56 (1); st. 6, 30 May 1996, ASIZW 57 (1); st. 7, 28 Feb. 1996, USNM 186417 (2); st. 7, 30 May 1996, ASIZW 58 (2); st. 8, 28 Feb. 1996, USNM 186418 (2); st. 9, 28 Feb. 1996, USNM 186419 (1); st. 9, 30 May 1996, ASIZW 60 (2); st. 9, 27 Aug. 1996, ASIZW 59 (1); st. 10, 28 Feb. 1996, ASIZW 54 (**holotype**); st. 10, 27 Aug. 1996, ASIZW 53 (1); st. 11, 30 May 1996, ASIZW 55 (1).

*Holotype:* Anterior 26-segment fragment measuring 6 mm long and 1.0 mm wide on segment 7.

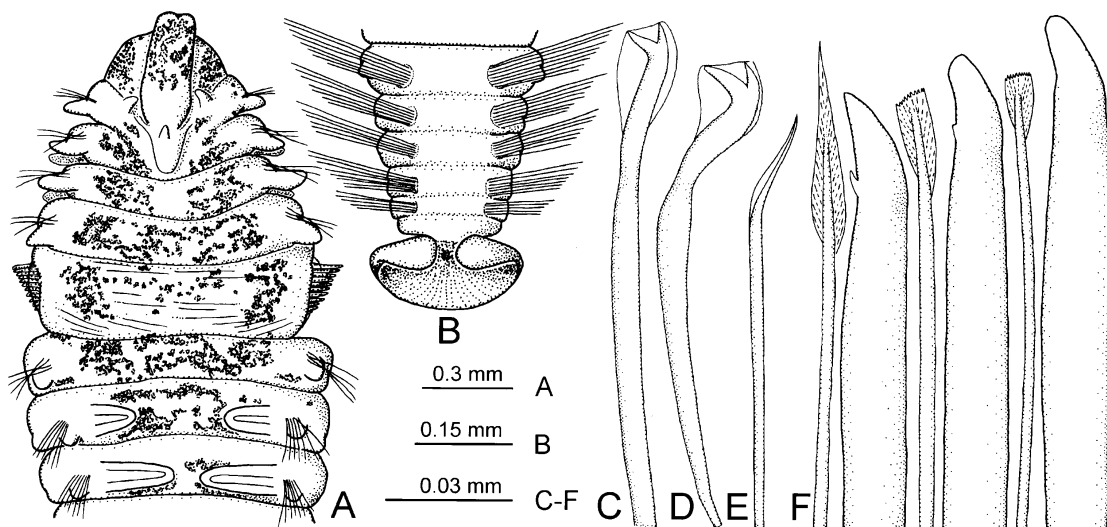
Prostomium, peristomium, and segments pigmented with numerous black spots; these spots small and round, scattered on dorsal side of 11 anterior segments and on ventral side of all segments. Prostomium blunt, with very shallow incision on anterior margin. Eyes absent. Caruncle extending posteriorly to end of segment 2. Median antenna fingerlike, present on caruncle on level between segments 1 and 2 (Fig. 4A). Palps lost.

Segment 1 with small noto- and neuropodial lamellae; notochaetae absent but short capillary neurochaetae present. Hooded hooks on neuropodia from segment 7, not accompanied by capillaries; hooks bidentate, with slightly curved shaft having constriction in upper part; constriction weak in hooks from anterior segments (Fig. 4C) but well developed in hooks from posterior segments (Fig. 4D); hooks numbering up to 10 in a series.

Segment 5 larger than either segments 4 or 6, with well-developed dorsal musculature, not overlapping segment 6; with curved horizontal row of 13 major spines alternating with pennoned companion chaetae; dorsal superior capillaries absent but 3 short ventral capillaries present (Fig. 4E). Worn major spines (anterior in a row) simple falcate; unworn spines (posterior in a row) with very small lateral accessory tooth (Fig. 4F).

Branchiae from segment 7 to end of the fragment, full-sized from segment 9; free from notopodial postchaetal lamellae, with flattened surfaces oriented laterally.

No gizzardlike structure in digestive tract.



**Fig. 4.** *Polydora fusca* sp. nov. (A) Anterior end, dorsal view; (B) posterior end, dorsal view; (C) neuropodial bidentate hooded hook of segment 7; (D) neuropodial bidentate hooded hook of segment 26; (E) ventral capillary chaeta of segment 5; (F) major falcate spines and pennoned companion chaetae of segment 5. A, C–F: ASIZW 54, holotype; B: ASIZW 59, paratype.

Glandular pouches from segment 7.

Female with oocytes up to 60  $\mu\text{m}$  in diameter present from segment 21 to end of fragment. Paired gonoducts revealed with methyl green staining from segment 22 onwards; gonoducts terminating externally into 2 separate gonopores on dorsal side of fertile segments.

**Variability:** The largest individual measures 18 mm long and 1.1 mm wide for 85 segments. Small individuals are usually unpigmented. In large individuals the prostomium, peristomium, and some other segments are pigmented with numerous black spots (dark brown in alcohol). Pigment spots are small, rounded, and scattered on both dorsal and ventral sides of segments. Segments 6 to 10 are often most intensively pigmented; black pigmentation is occasionally present on palps and branchiae. Prostomium is weakly incised on the anterior margin; the incision is best observed from a ventral view. Four or 6 eyes are usually present, with the anterior pair positioned slightly wider apart than the posterior pair; occasionally eyes are fewer or completely lacking. Median antenna on caruncle is short, finger-like, easily damaged, and lost on some specimens. Palps extend back for 15-20 segments.

All 3 complete specimens in the type series have separate needlelike spines and 2-3 capillaries in the notopodia of the 10-30 posteriormost segments (Fig. 4B). The needles are not gathered into a tight packet but separated individually and greatly protrude from the body wall. In 1 complete individual of 67 segments (ASIZW 59), the anterior notopodia, except for segments 1 and 5, possesses numerous winged capillaries which are arranged in 3 distinct groups or rows. Along the middle notopodia, the number of capillaries per fascicle gradually decreases to about 10 with rows becoming indistinct. On the posterior notopodia, the number of capillaries diminishes to 3 or 2 per fascicle with chaetae becoming longer, thinner, and alimbated. In the posteriormost 20 segments or so, separate needlelike spines appear in addition to capillaries; the spines become longer and increase in number posteriorly, to about 20 per fascicle (Fig. 4B).

Dorsal superior capillaries are absent from segment 5, but ventral capillaries are usually present. Two individuals were found with ventral capillaries on 1 side but none on the other. On segment 5, major spines are falcate with a small accessory tooth that can be observed only in an antero- or posterolateral view. The tooth is very low and on some spines it appears like a low lateral flange. Branchiae begin from segment 7 and continue to segments where notopodial needles first appear. Pygidium is small

cup- or thin disc-shaped with a dorsal gap or incision (Fig. 4B). Glandular pouches begin from segment 7, reach full size from segments 7-8 to 9-10, then gradually diminish in size over the following segments.

The species is gonochoristic; gametes develop in the middle part of the body beginning from segments 21-23.

**Habitat:** *Polydora fusca* was found inhabiting mud tubes on muddy bottoms in brackish-water environments. In some samples, the species was found together with *P. cornuta*.

**Remarks:** Some of the characteristics which distinguish *P. fusca* from related *Polydora* species are given in Table 2. The species is further characterized by the presence of scattered black pigmentation on the head and body, and has a specific adult pigmentation which probably develops after settlement and metamorphosis. It is not the remnants of larval pigmentation, which is retained in the adults of some *Polydora* species. *P. fusca* is distinctive because of this pigmentation.

**Etymology:** The species name, feminine for Latin *fuscus* (dusky, tawny) refers to the characteristic black (dark brown in alcohol) pigmentation scattered on the worm's head and body.

**Distribution:** Kinmen Island off mainland China.

### ***Polydora triglanda* sp. nov.**

(Figs. 5, 6)

**Diagnosis:** A moderate-sized gonochoristic *Polydora* species boring into mollusc shells and building mud tubes on soft bottoms. Body pigmentation absent. Black bands present on palps in large individuals with more than 60-100 segments. Prostomium incised anteriorly. Eyes, up to 6, usually present. Caruncle reaching end of segment 3; median antenna present. Posterior notopodia with only capillaries. Segment 5 with dorsal superior and ventral capillaries; major spines falcate, with lateral flange, alternating with pennoned companion chaetae. Branchiae from segment 7 usually to end of body. Pygidium disclike or cup-shaped with dorsal gap. Glandular pouches from segment 7, largest in segments 7-9 and drastically smaller in following segments.

**Type materials:** Taipei Co., Tanshui R. estuary, 25°10'N, 121°27'E: st. K-10, 8 m, from an aggregation of the mussel, *Mytilopsis sallei* (Recluz), on muddy bottom, 14 Aug. 1998, ASIZW 61 (200+), USNM 186420 (40); st. K-11, intertidal, mud, 20 Sept. 1991, ASIZW 68 (5); st. K-11, 5 m, mud, 11 Aug. 1997, ASIZW 67 (1); st. K-11, 5 m, mud, 14

**Table 2.** Morphological characteristics of known *Polydora* species without black bands on palps but with median antenna on the caruncle and/or needlelike spines on posterior notopodia

Species	Reference	Prostomium (anterior edge)	Median antenna	Caruncle (maximal length)	Superior notochaetae on segment 5	Neurochaetae on segment 5	Accessory structures of major spines on segment 5	Modified spines in posterior notopodia	Habitat
<i>P. aura</i> <sup>a</sup>	12	incised	1	end of segment 3	absent	present	lateral flange	packets of needles	shell-borer
<i>P. biocipitalis</i> <sup>b</sup>	4	incised	2	beyond segment 5	absent	absent	2 lateral teeth and a flange between them	absent	shell-borer
<i>P. cavitensis</i>	3	incised	1	end of segment 3	absent	present	subdistal concavity	absent	tube-dweller? <sup>c</sup>
<i>P. cirrosa</i>	1	incised	1	end of segment 2	absent	absent	absent	absent	tube-dweller
<i>P. cornuta</i>	9, 13	incised	1	end of segment 3	absent	absent	lateral tooth	absent	tube-dweller
<i>P. fusca</i>	13	incised	1	end of segment 2	absent	present	lateral tooth	separate needles	tube-dweller
<i>P. gaikwadi</i> <sup>d</sup>	6	incised	1	end of segment 4	absent	absent	absent	absent	shell-borer
<i>P. glycymerica</i>	10	incised	1	middle of segment 2	absent	present	lateral flange	absent	shell-borer
<i>P. kaneohe</i>	8	incised	1	end of segment 3	present	present	broad shelf forming subdistal concavity	acicular spines	coral-borer? <sup>e</sup>
<i>P. latispinosa</i>	7	incised	1	end of segment 2	absent	present	lateral flange	packets of needles	shell-borer
<i>P. nuchalis</i>	2	incised	1	end of segment 2	present	present	absent	absent	tube-dweller
<i>P. villosa</i>	13	incised	absent	end of segment 3	present	present	lateral tooth on 1 side and shelf on the other	separate needles	coral-borer
<i>P. vulgaris</i>	5, 11	incised	1	middle of segment 2	absent	presen	lateral flange	absent	shell-borer

<sup>a</sup> The type material of *Polydora aura* (CBM-ZW 904, 905) was examined (VIR, unpublished) and the following characters were found to differ from those reported in the original species description: prostomium was incised anteriorly, median antenna was present on the caruncle, and the caruncle extended posteriorly up to the end of segment 3.

<sup>b</sup> *Polydora biocipitalis* is also distinctive in that it has bidentate hooded hooks in the neuropodia beginning from segments 9-14. They begin from segment 7 in most other species referred to in the table.

<sup>c</sup> *Polydora cavitensis* is known only from the original description where it was reported as "found among oysters" (Pillai 1965: 152).

<sup>d</sup> *Polydora gaikwadi* is also distinctive in that it has bidentate hooded hooks in the neuropodia beginning from segment 12. They begin from segment 7 in most other species referred to in the table.

<sup>e</sup> *Polydora kaneohe* is known only from the original description where it was reported as "found within a coral settlement block" (Ward 1981: 722). Whether the species is capable of boring is not known.

References: 1. Rioja (1943), 2. Woodwick (1953), 3. Pillai (1965), 4. Blake and Woodwick (1972), 5. Mohammad (1972), 6. Day (1973), 7. Blake and Kudenov (1978), 8. Ward (1981), 9. Blake and Maciolek (1987), 10. Radashevsky (1993), 11. Manchenko and Radashevsky (1994), 12. Sato-Okoshi (1998), 13. present study.



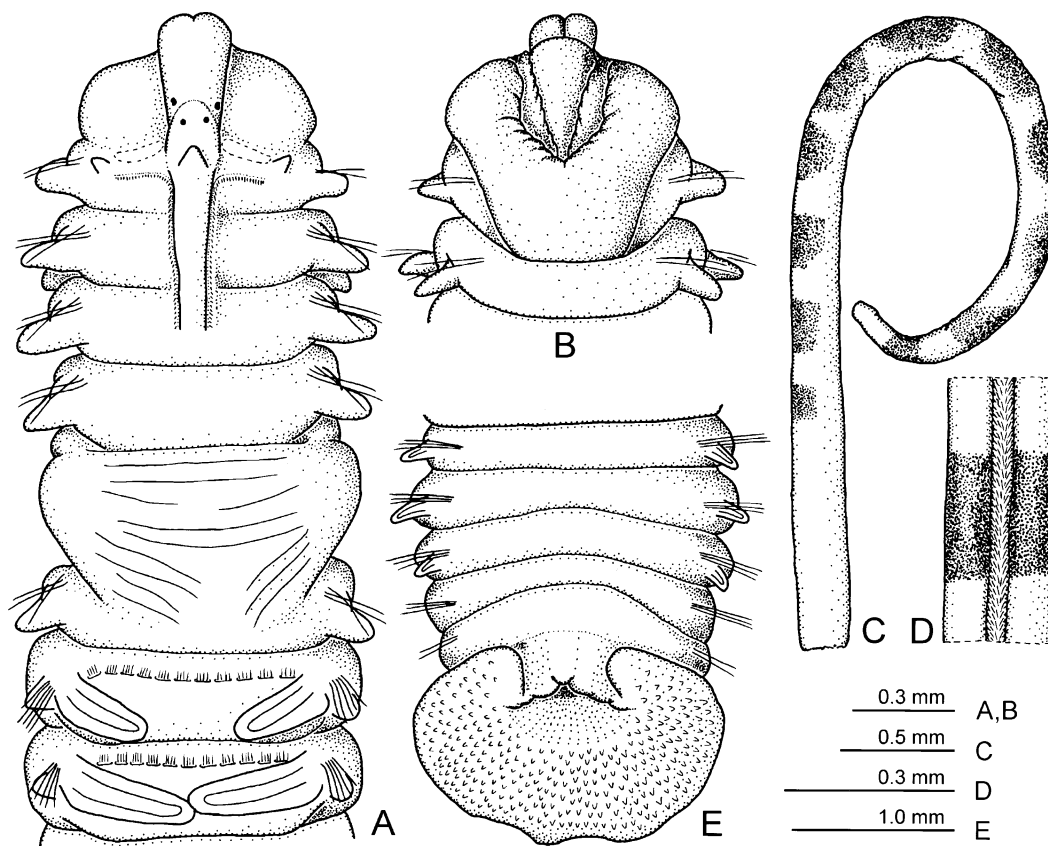
Aug. 1998, ASIZW 66 (6); st. K-12, 5 m, mud, 21 May 1997, ASIZW 69 (1); st. K-12, 5 m, mud, 11 Aug. 1997, ASIZW 70 (3); st. K-12, intertidal, from shells of the oyster, *Crassostrea gigas* (Thunberg), coll. V.I. Radashevsky, 29 Apr. 1999, ASIZW 65 (**holotype**), ASIZW 72 (7). Tainan Co., Tsengwen R. estuary, 23°04'N, 120°05'E, < 2 m, mud: st. 4, 26 May 1995, ASIZW 71 (14); st. 4, 2 Mar. 1995, IMBV 3376 (2); Lagoon at Chiku, 23°08'N, 120°04'E, < 2 m: st. 10, mud, 16 July 1996, ASIZW 62 (1); st. 13, mud, ASIZW 63 (2); st. 6, from shells of the oyster, *C. gigas*, 18 Sept. 1997, ASIZW 64 (24). Hsinchu Co., Hsiangshan, 24°50'N, 120°54'E, intertidal, from shells of the oyster, *C. gigas*, coll. V.I. Radashevsky, 19 July 1999, IMBV 3375 (3).

**Holotype:** A whole individual in 4 fragments combined measuring 37 mm long and 1.0 mm wide at segment 7 for 113 segments. Body light tan color in life. Prostomium narrow, curved downwards anteriorly, incised on anterior margin (Fig. 5B). Four black eyes present, arranged as a trapezoid shape with anterior pair more widely spaced than posterior pair. Caruncle extending posteriorly to middle of

segment 3, with short and wide median antenna. Nuchal organs with paired ciliated bands, running along either side of caruncle and across dorsal side of segment 1 (Fig. 5A). Palps extending back for 19 segments; 11 paired black bands arranged along left palp (Fig. 5C) while 8 bands present on right palp; each pigment pair divided by ciliated food groove (Fig. 5D).

Segment 1 with noto- and neuropodial lamellae; notochaetae absent but short neuropodial capillaries present. Posterior notopodia with only capillary chaetae. Hooded hooks in neuropodia from segment 7, capillaries absent; hooks bidentate, with slightly curved shaft having constriction in upper part; constriction weak in hooks from anterior segments (Fig. 6A), becoming more distinct in hooks from posterior segments (Fig. 6B); hooks numbering up to 10 in a series.

Segment 5 larger than either segments 4 or 6, with dorsal musculature overlapping segment 6; with a bundle of 4 dorsal superior geniculate capillaries (Fig. 6D) and a ventral tuft of 7 winged capillaries (Fig. 6C). Curved horizontal row of 7 major spines



**Fig. 5.** *Polydora triglandia* sp. nov. (A) Anterior end, dorsal view; (B) anterior end, ventral view; (C) palp, lateral view; (D) fragment of palp, frontal view; (E) posterior end, dorsal view. A–E: ASIZW 65, holotype.

alternating with pennoned companion chaetae (Fig. 6E); worn major spines (anterior in a row) simple falcate; unworn major spines (posterior in a row) with lateral accessory flange (Fig. 6E).

Branchiae from segment 7 to end of body, absent only from 2 posteriormost segments, full-sized from segment 9 or 10; free from notopodial post-chaetal lamellae, with flattened surfaces oriented laterally. Nototrochs from segment 7 onwards.

Pygidium disclike with dorsal gap, white colored (Fig. 5E).

No gizzardlike structure in digestive tract.

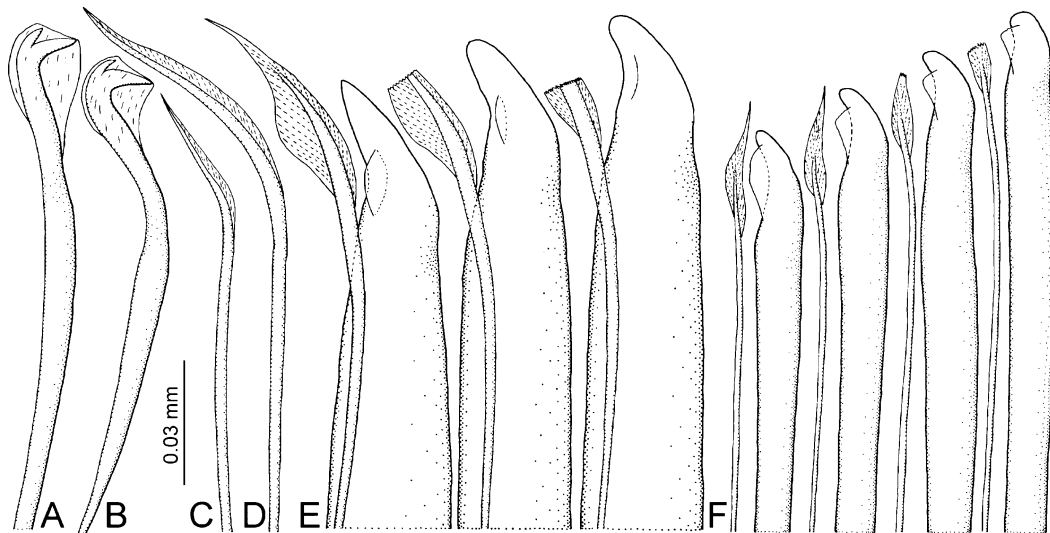
Glandular pouches from segment 7, largest in segments 7-9 and drastically smaller in following segments. Nephridia from segment 7.

Male, spermatids gathered in octads; spermatozoa measured as acrosome  $1.9 \pm 0.5 \mu\text{m}$ , nucleus  $5.6 \pm 0.5 \mu\text{m}$ , middlepiece  $3.8 \pm 0.5 \mu\text{m}$ , flagellum  $50 \pm 2 \mu\text{m}$ .

**Variability:** The holotype is from shell-boring habitat and is one of the largest individuals, having distinct palp pigmentation and with the largest number of black bands. Other boring specimens have shorter palps, extending posteriorly for 10-15 segments, usually with up to 6 black bands. Small individuals, with less than 60-70 segments, usually have no black bands on palps; occasionally black bands are faint and difficult to see even in larger individuals. Small individuals, approaching 30-40 segments, have black spots on anterolateral edges of anterior segments. Body pigmentation is absent in larger individuals. Four eyes are usually present,

but individuals with 2, 6, or no eyes occasionally occur. Caruncle extends posteriorly from the end of segment 2 to the end of segment 3. Segment 5 invariably has dorsal superior and ventral capillaries. The lateral flange on major spines varies in size and may be low or worn completely away such that in lateral view, the tip of the spines may resemble a subdistal concavity (Fig. 6E). In some individuals, the lateral flange on the spine is well developed and easy to recognize (Fig. 6F). In small juvenile individuals, major spines possess lateral flanges on 1 side and a small shelf or protuberance on the other. The latter structure was not usually observed in large individuals. The shelf is similar to that found in *P. villosa* (see below) but much smaller. Branchiae begin from segment 7 and continue to the end of the body in all boring individuals. Glandular pouches are largest in segments 7-9 and then become drastically smaller for both small and large individuals.

No differences have been revealed in morphology or in methyl green staining patterns between shell-boring and tube-dwelling individuals from the Tanshui River or from the Chiku Lagoon. Even subtle details, such as palp pigmentation, major spine morphology, and glandular pouch arrangement, are the same in individuals living in different habitats. The only apparent difference is the number of eyes: boring individuals usually have 4 eyes while tube-dwelling specimens usually have 6 eyes. The largest complete tube-building individual measures 13 mm long and 0.8 mm wide for approximately 70 segments. The largest anterior fragment measures



**Fig. 6.** *Polydora triglanda* sp. nov. (A) Neuropodial bidentate hooded hook of segment 7; (B) neuropodial bidentate hooded hook of a middle segment; (C) ventral capillary chaeta of segment 5; (D) dorsal superior capillary chaeta of segment 5; (E, F) major falcate spines and pennoned companion chaetae of segment 5. A-E: ASIZW 65, holotype; F: ASIZW 71, paratype.

about 20 mm long and 1.2 mm wide for approximately 65 segments.

The tube-dwelling individuals from the Tsengwen River differ slightly in morphology from those at the type locality. The former have branchiae occurring only through 1/2 or 3/4 of the body; black bands on palps are absent from individuals of less than about 100 segments. Furthermore, these individuals are smaller and more slender for the same number of segments. There are, however, no differences between the tube-dwelling individuals from the Tsengwen and Tanshui Rivers in other diagnostic morphological characteristics. These differences are insufficient to propose the presence of 2 species.

The species is gonochoric; gametes are present in females and males beginning from segments 20-38. Female paired gonoducts terminate externally into 2 separate gonopores on the dorsal side of fertile segments. Seminal receptacles were stained with methyl green in 1 female. They were located near the inner base of the branchia on fertile segments.

*Habitat:* *Polydora triglanda* bores into the shells of the oyster, *C. gigas*, (the holotype is a boring form) and also inhabits mud tubes on soft bottoms. The species occurs intertidally and shallow subtidally in

brackish-water environments. Up to 5 worms have been found boring into 1 shell. The burrows of the worms are pear-shaped. *Polydora triglanda* co-occurs with *Boccardiella hamata* (Webster 1879) in the same oyster shells.

*Remarks:* Some of the characteristics which distinguish *P. triglanda* from other similar *Polydora* species are given in Table 1. Furthermore, the species is characterized by the presence of large glandular pouches in segments 7-9 and abruptly smaller pouches in the following segments. In other examined polydorids, except *P. villosa*, the glandular pouches gradually diminish in size from anterior to posterior segments.

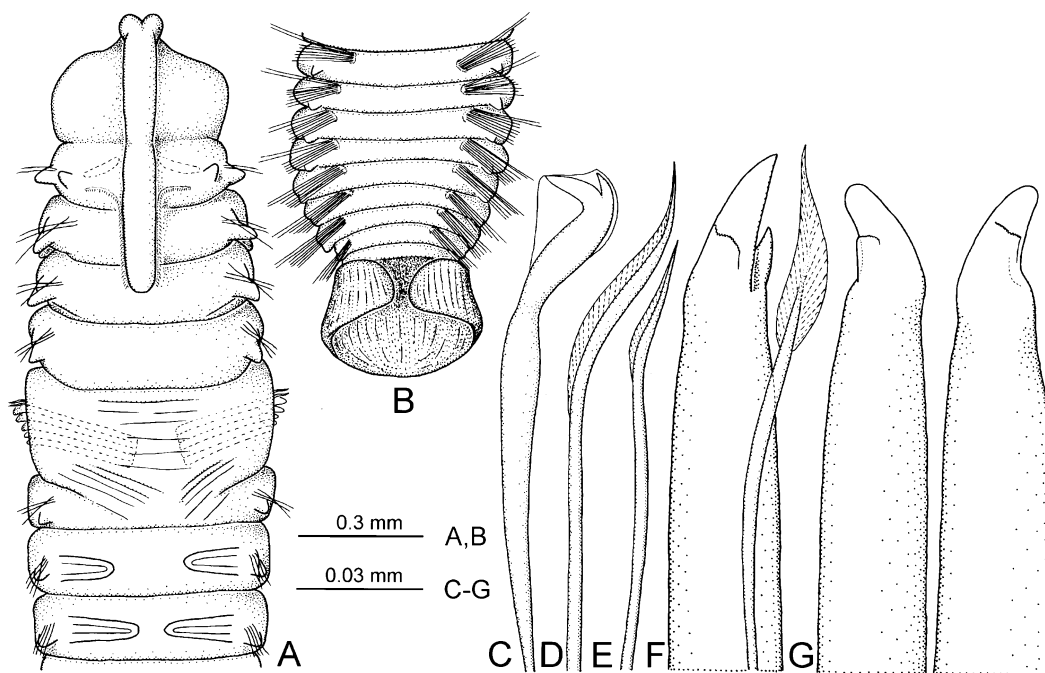
*Etymology:* The specific name refers to the characteristic feature of the species, the presence of 3 pairs of large glandular pouches in segments 7 to 9.

*Distribution:* Taiwan.

***Polydora villosa* sp. nov.**

(Figs. 7, 8)

*Diagnosis:* A moderate-sized *Polydora* species boring into corals. Prostomium weakly incised



**Fig. 7.** *Polydora villosa* sp. nov. (A) Anterior end, dorsal view; (B) posterior end, dorsal view; (C) neuropodial bidentate hooded hook of segment 20; (D) dorsal superior capillary chaeta of segment 5; (E) ventral capillary chaeta of segment 5; (F) unworn major falcate spine and pennoned companion chaeta of segment 5; (G) worn major falcate spine of segment 5 from right and left views. A–G: ASIZW 77, holotype.

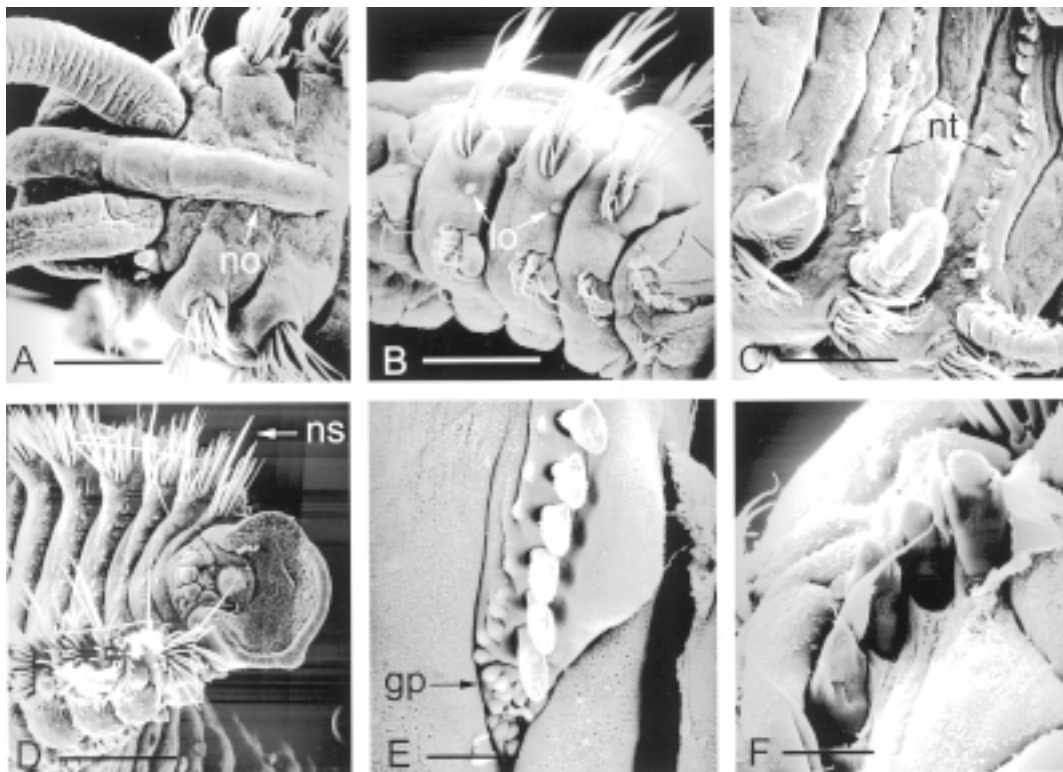
anteriorly. Eyes absent. Caruncle up to end of segment 3; median antenna absent. Posterior notopodia with separate needlelike spines in addition to capillaries. Segment 5 with dorsal superior and ventral capillaries; major spines falcate with lateral tooth or flange on 1 side and a shelf with rough edge on the other. Branchiae from segment 7 through most of body. Pygidium small disc- or cup-shaped with dorsal gap.

*Type materials:* Penghu Co., Taiwan Strait, Chin Bay of Penghu Is., 23°31.8'N, 119°33.0'E, fringed coral reef at about 2 m, coll. P.J. Liu: from coral *Porites* lichen, 28 June 1994, ASIZW 76 (1); from coral *Cyphastrea chalcidicum*, 30 June 1994, ASIZW 77 (**holotype**); from coral *Hydnophora exesa*, 29 June 1994, ASIZW 78 (1); from coral *Hydnophora exesa*, 29 June 1994, ASIZW 79 (1); from coral *Porites lobata*, 19 Mar. 1996, SEM stub, ASIZW 73 (1); from coral *Montipora* sp., 19 Mar. 1996, SEM stubs, ASIZW 74 (1), ASIZW 75 (1); from coral *Porites lobata*, 20 July 1994, ASIZW 80 (1); from coral *Montipora* sp., 20 Apr. 1994, USNM

186421 (4).

*Holotype:* A complete 148-segment individual, measuring 16 mm long and 0.6 mm wide at segment 7. Body and palp pigmentation absent. Prostomium incised anteriorly. Eyes absent. Caruncle extending posteriorly to middle of segment 3; median antenna absent (Fig. 7A). Palps extending posteriorly for about 10 segments.

Segment 1 with noto- and neuropodial lamellae; notochaetae absent but short neuropodial capillaries present. Separate needlelike spines and 2-3 capillaries present in notopodia of about 15 posterior segments. The needles not gathered into tight packets but separated individually and greatly protruding from body wall, giving posterior end a feathery appearance; number of needles gradually increasing in posterior segments from 1-3 to about 20 per fascicle. Hooded hooks on neuropodia from segment 7, not accompanied by capillaries; hooks bidentate, with slightly curved shaft having constriction in upper part (Fig. 7C); hooks numbering up to 10 in a series.



**Fig. 8.** *Polydora villosa* sp. nov. SEM micrographs. (A) Anterior end, dorsal view; (B) segments 1-5, lateral view (anterior end at left); (C) segments 7-9, dorso-lateral view (anterior end at left); (D) posterior end, dorso-lateral view; (E) neuropodial hooded hooks of segment 9 (dorsum on top); (F) major spines and companion chaetae of segment 5. A-D, F: ASIZW 73, paratype; E: ASIZW 75, paratype. no: nuchal organ; lo: lateral organs; nt: nototrochs; ns: notopodial needlelike spines; gp: external papillae of glandular pouches. Scale bars: A, B, D = 0.15 mm; C = 0.12 mm; E, F = 0.03 mm.

Segment 5 larger than either segments 4 or 6, with dorsal musculature overlapping segment 6, with a bundle of 4 dorsal superior geniculate capillaries (Fig. 7D) and ventral tuft of 5 winged capillaries (Fig. 7E). Curved horizontal row of 5 major spines alternating with pennoned companion chaetae; major spines falcate, with lateral tooth resembling wide flange on 1 side and a shelf with rough edge on the other (Fig. 7F, G).

Branchiae from segments 7 to 140, full-sized from segments 10-11, well developed on anterior 2/3 of body, greatly diminishing thereafter; free from notopodial postchaetal lamellae, with flattened surfaces oriented laterally.

Pygidium small, cufflike, with wide dorsal incision and white colored because of large number of mucous cells (Fig. 7B).

No gizzardlike structure in digestive tract.

Glandular pouches from segment 7.

**Variability:** The largest individual measures 25 mm long and 0.9 mm wide for 184 segments. Body pigmentation is usually absent; a 160-segment individual has intensive black pigment scattered on the dorsal side of segments from 107 onwards. Anterior margin of prostomium is weakly incised, the incision is often not seen from a dorsal view (Fig. 8A). Eyes and median antenna are absent in all the paratypes. Caruncle extends posteriorly up to the end of segment 3. Lateral organs are positioned between notopodial lobes on every segment but 4 and 5 (Fig. 8B). Numerous needlelike spines are present in posterior notopodia of individuals having more than 140-150 segments (Fig. 8D); smaller paratypes (the smallest complete individual had 94 segments) have 1 to 5 modified spines per notopodium in 10-15 posterior segments. These spines are 2 times wider than capillary chaetae in the same notopodia. A shelf on 1 side of the distal end of major spines on segment 5 was observed in all paratypes; a tooth or flange on the other side (Fig. 8F) was often broken on worn spines. Branchiae are well developed on the anterior 1/2 or 2/3 of body and greatly diminished thereafter. Nototrochs are arranged from segment 8 onwards; they consist of 1 row of cilia running between the tips of branchiae (Fig. 8C). Pygidium is usually a small disc with a wide dorsal gap (Fig. 8D). Glandular pouches were examined in 1 paratype and found to be the largest in segments 7-9 and drastically smaller on following segments. External openings of the glandular cells are seen on SEM micrographs as low papillae positioned in the lower part of the vertical row of hooded hooks (Fig. 8E). It is not known whether the species is gonochoristic or hermaphroditic.

**Habitat:** *Polydora villosa* bores into skeletons of the living scleractinian corals, *Porites lobata*, *P. lichen*, *Hydnophora exesa*, *Cyphastrea chalcidicum*, and *Montipora* sp. The burrows of the species are long and U-shaped. They communicate with the coral surface via 2 or more openings. The walls of the burrows are lined with mud, forming an internal mud tube. The tubes extend 1-2 mm above the coral surface. Ecology and burrow structure of *P. villosa* are described in detail by Liu and Hsieh (2000).

**Remarks:** Some of the characteristics which distinguish *P. villosa* from other similar *Polydora* species are given in Table 2. The species is unique among its relatives in that the major spines of segment 5 bear well-developed lateral accessory structures on both sides of the tip.

**Etymology:** The species name, feminine for Latin *villosus* (bearing bristles or having a thick pile), refers to numerous separate needles on the posterior notopodia.

**Distribution:** Taiwan.

## DISCUSSION

Members of *Polydora* and a few related polydorid genera of the polychaete family Spionidae exhibit various life styles. These include inhabiting mud or sand tubes on soft bottom, the fouling of different hard substrata, and boring into sponges and various calcareous structures. Boring and non-boring or tube-dwelling species are generally recognized on the basis of their boring activity. However, no structural adaptation distinguishes the boring from non-boring forms, thus the life style of a species cannot be ascertained from its morphology. Despite the considerable economic implications of polydorid infestations in commercially important molluscs and the consequent numerous investigations on borers, details of the boring mechanism have yet to be thoroughly understood (see Blake and Evans 1973, Lauckner 1983, Sato-Okoshi and Okoshi 1993 1996). The ability of a species to manifest both shell-boring and tube-dwelling life styles is accepted by some authors (Blake 1971 1996) while others believe in species-specific habitat preference (Sato-Okoshi and Okoshi 1997). In fact, the existence of 2 or more life styles by the same species has never been demonstrated conclusively. Thus, we could not morphologically distinguish between boring and non-boring forms of *P. triglanda*, and therefore we report the species as inhabiting both mud tubes on soft bottoms and boring into oyster shells. Further molecular investigation should be undertaken to

clarify the identity of these forms. Future investigation in this area is especially crucial since a series of sibling species has been revealed among *Polydora* species (Manchenko and Radashevsky 1993 1994 1998). Nevertheless, we still consider habitat preference as a major characteristic in polydorid diagnostics (see Tables 1, 2).

Most boring polydorids are associated with various gastropod and bivalve molluscs, and only 10 species have been reported to bore into corals (see Martin and Britayev 1998). These include 2 species of *Dipolydora*, *D. armata* Langerhans (Blake and Evans 1973) and *D. tridenticulata* (Woodwick 1964), 5 species of *Polydora*, *P. pacifica* (Takahashi 1937), *P. allopors* (Light 1970a), *P. wobberi* (Light 1970b), *P. kaneohe*, and *P. pilikia* (Ward 1981), and 3 species of *Pseudopolydora*, *P. corallicola*, *P. pigmentata*, and *P. reishi* (Woodwick 1964). *Polydora villosa* described herein is now the 6th species of *Polydora* associated with corals. The burrow architecture, boring mechanisms, and the host specificity of polydorids on commercially important molluscs have received considerable study and discussion, whereas those associated with corals have drawn little attention. Two of the 11 coral-boring species, *Dipolydora armata* and *Polydora pacifica*, have also been reported to bore into mollusc shells. All the others are known only to be associated with corals from the original descriptions. The relationship between polydorid and coral species as well as the mechanism of burrow formation in coral skeletons have yet to be thoroughly explained.

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## 臺灣才女蟲多毛類

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才女蟲屬(*Polydora*)海稚蟲(多毛綱,海稚蟲科)是海域底棲群聚中最常見的一群多毛類,然而臺灣附近海域才女蟲的種類組成卻未曾有詳細的分類報導。本研究報告描述了分布於臺灣北部、西南部與金門淺海海域的5種才女蟲多毛類。這5種分別為*Polydora* cf. *agassizi*, *P. cornuta*以及三個新種*P. fusca*, *P. triglanda*和*P. villosa*。*Polydora* cf. *agassizi*築泥質管,棲息在鬻的甲殼上;*P. cornuta*和*P. fusca*棲息於軟底質的泥管中;*P. villosa*則在活珊瑚骨骼裡鑽穴而居。*Polydora triglanda*既能在貝類硬殼上鑽穴而居,亦能在泥地築管而居;棲息在兩種不同環境的個體,形態上沒有差異。本文製作了上述5種的分類檢索表,以提供種的鑑定之用。本報告並對相近的數十種才女蟲做了形態上的比較。

**關鍵詞**: 海稚蟲多毛類,才女蟲屬,系統分類,形態。

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