

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

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**Vasily I. Radashevsky and Hwey-Lian Hsieh (2000)** *Pseudopolydora* (Polychaeta: Spionidae) species from Taiwan. *Zoological Studies* 39(3): 218-235. Eight species of the genus *Pseudopolydora* (Polychaeta: Spionidae) are reported from the shallow waters of Taiwan and off mainland China, including *P. diopatra* Hsieh, 1992, *P. cf. kempji japonica* Imajima and Hartman, 1964, *P. paucibranchiata* (Okuda, 1937), and 5 species new to science: *P. achaeta*, *P. corniculata*, *P. gigeriosa*, *P. reticulata*, and *P. vexillosa*. All species inhabit muddy-sand tubes in soft bottoms; *P. diopatra* occurred also on the tube-caps of the onuphid polychaete *Diopatra sugokai* and shells of the oyster *Crassostrea gigas*. All species are described and illustrated, and a key is provided for their identification.

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

In recent studies of macrobenthic communities, we collected many spionids from the west coast of Taiwan and from Kinmen Island, near mainland China (Fig. 1). Five *Polydora* species found in these investigations have been described (Radashevsky and Hsieh 2000). The present paper deals with 8 *Pseudopolydora* species from this region; all are described and illustrated, and a key is provided for their identification. The types and representative materials have been 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 sample data are given under the "Materials" paragraph for each species in the "Systematic Account" below. Unless otherwise indicated, the samples were collected by H.L. Hsieh. The number of specimens in a sample is given in parentheses following the museum abbreviation and registration number.

### **SYSTEMATIC ACCOUNT**

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

1. Prostomium T-shaped anteriorly, with 2 pointed antero-lateral processes; caruncle reaching middle of segment 6; parapodial lamellae of segment 1 long, cirriform; notochaetae of segment 2 longer than those of following segments .....  
..... *P. corniculata*  
Prostomium bilobed, incised or rounded anteriorly, without antero-lateral processes; caruncle usually not extending beyond segment 5; parapodial lamellae of segment 1 short; notochaetae of segment 2 as long as those of following segments ..... 2
2. Segment 5 greatly modified, larger than segments 4 or 6; median antenna absent; 2 rows of black spots present on ventral side of anterior segments ..... *P. diopatra*  
Segment 5 slightly modified or the same as segments 4 or 6; median antenna present; 2 rows of black spots absent on ventral side of anterior segments (except *P. reticulata*) .... 3
3. Gizzardlike structure in digestive tract present; posterior row major spines on segment 5 with bristles on subdistal part .....  
..... *P. gigeriosa*  
No gizzardlike structure in digestive tract; posterior row major spines on segment 5 without bristles on subdistal part ... 4
4. Prostomium rounded anteriorly; pygidium without dorso-lateral extensions; anterior row major spines on segment 5 with subdistal constriction; glandular pouches single throughout ..... 5  
Prostomium incised or bilobed anteriorly; pygidium with dorso-lateral extensions; anterior row major spines on segment 5 without subdistal constriction; glandular pouches paired in segments 6 and 7 ..... 6
5. Anterior row notochaetae on middle segments slender capillaries ..... *P. paucibranchiata*

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- Anterior row notochaetae on segments from 7 up to 19 pennoned capillaries with short, pointed main stem and enlarged semicircular limb tapering to a long tip ..... *P. vexillosa*
6. Neurochaetae of segment 1 short hairlike capillaries; major spines of segment 5 arranged in a straight or slightly curved vertical row ..... *P. achaeta*  
Neurochaetae of segment 1 winged capillaries; major spines of segment 5 arranged in a J-shaped vertical row ..... 7
7. Caruncle not extending beyond segment 3; small black spot usually present on caruncle behind the median antenna; two rows of black spots present on dorsal side of segments 3 up to 15; ventral pigmentation absent ..... *P. cf. kempi japonica*  
Caruncle reaching end of segment 5; black narrow band present along caruncle from median antenna to about segment 3; no spots but black reticulated pigment present on dorsal side of anterior segments; two rows of small melanophores present on ventral side of anterior segments ..... *P. reticulata*

**Genus *Pseudopolydora* Czerniavsky, 1881**  
***Pseudopolydora diopatra* Hsieh, 1992**  
(Figs. 2, 11E)

*Pseudopolydora* sp.: Hsieh and Chang, 1991: 331-339.  
*Pseudopolydora diopatra* Hsieh, 1992: 630-634, figs. 1-10; 1994: 205-214, figs. 1-12.

**Materials:** Hsinchu Co., Hsiangshan, 24°50'N, 120°54'E, intertidal, sandflat, from tube-caps of the onuphid *Diopatra sugokai* Izuka: Nov. 1990, ASIZW 001 (**holotype**); May 1990, ASIZW 002 (23 paratypes); Nov. 1990, ASIZW 003 (14 paratypes); May 1991, ASIZW 004 (10 paratypes, SEM preparations); 23 May 1990, ASIZW 84 (20); 29 Oct. 1990, ASIZW 82 (200+); 27 Nov. 1990, ASIZW 81 (500+); 21 Feb. 1991, ASIZW 85 (100+); 21 Feb.

1991, IMBV 817 (45); coll. V.I. Radashevsky, 19 July 1999, IMBV 3393 (24); intertidal, from the shell surface of the oyster *Crassostrea gigas* (Thunberg), coll. V.I. Radashevsky, 19 July 1999, IMBV 3392 (8). Miaoli Co., Tunghsiao, 24°30'N, 120°37'E, intertidal, sandflat, from tube-caps of the onuphid *Diopatra sugokai* Izuka: June 1988, ASIZW 005 (20 paratypes); Sept. 1991, ASIZW 006 (15 paratypes). Taipei Co., Tanshui R. estuary, 25°10'N, 121°27'E: 5 m, mud, 21 May 1997, ASIZW 86 (5); st. K-11, intertidal + shallow subtidal, mud, 14 Aug. 1998, USNM 186528 (23); st. K-10, 8 m, tubes on aggregation of

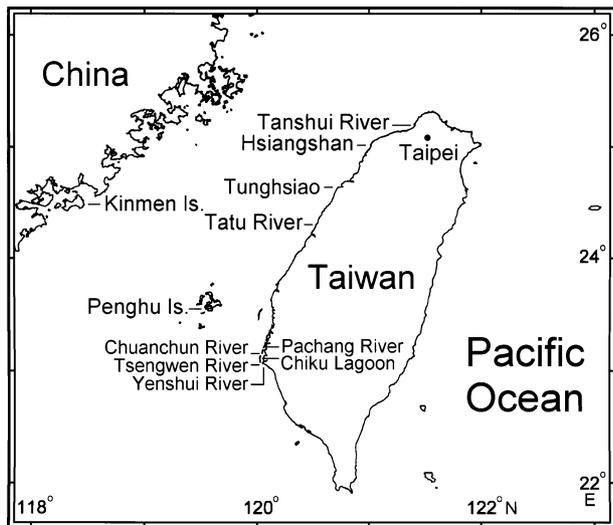


Fig. 1. Map showing localities mentioned in the text.

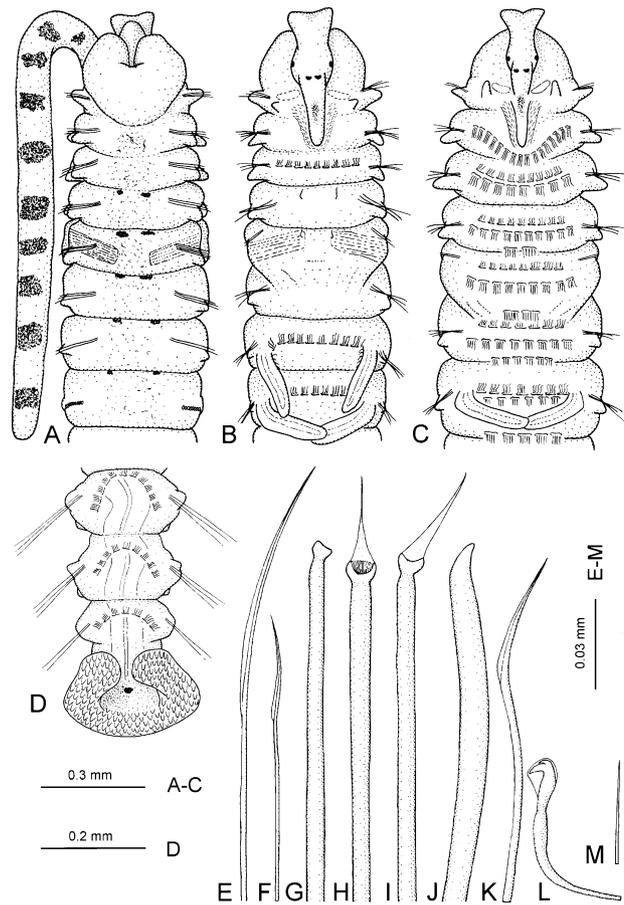


Fig. 2. *Pseudopolydora diopatra* Hsieh, 1992.  
(A) Anterior end, female, ventral view; (B) the same, dorsal view; (C) anterior end, male, dorsal view; (D) posterior end, dorsal view; (E) dorsal superior capillary of segment 4; (F) dorsal superior capillary of segment 5; (G-I) anterior row notochaetae of segment 5 (major spines); (G) older broken spine from upper position; (H, I) newly developed larger spines from lower position, from posterior and lateral view; (J) posterior row notochaeta of segment 5 (major spine); (K) neuropodial capillary of segment 5; (L) neuropodial hairlike bidentate hooded hook of segment 8; (M) neuropodial hairlike capillary alternating with hooded hooks in segment 8.  
A-M: IMBV 3393.

the mussel *Mytilopsis sallei* (Recluz) on muddy bottom, 14 Aug. 1998, ASIZW 87 (3); st. K-12, 5 m, mud, 14 Aug. 1998, ASIZW 83 (1); st. K-12, intertidal, tube on the surface of oyster *Crassostrea gigas* (Thunberg), coll. V.I. Radashevsky, 29 Apr. 1999, IMBV 3394 (1).

*Description:* Largest individual measuring 4.3 mm long and 0.5 mm wide at segment 7 for 34 segments. Small paired melanophores always present on ventral side along anterior margin of segments from 4 to 10-13 (Fig. 2A); scattered black pigmentation present on the caruncle and on ventral and dorso-lateral sides of 9-13 anterior segments; black pigmentation may disappear after fixation. Up to 21 branched yellow chromatophores present on palps in live individuals as transverse bars or rounded spots (Fig. 2A); all disappear after fixation. Prostomium usually incised or bifurcated anteriorly, with 2 rounded lobes, occasionally blunt or rounded. Four black eyes always present. Caruncle extending posteriorly to end of segment 2. Median antenna absent on caruncle (Fig. 2B, C). Palps extending posteriorly for 10-15 segments.

Segment 1 with well-developed noto- and neuropodial lamellae; notochaetae absent but short capillary neurochaetae present. Posterior notopodia with a few long alimbated capillaries. Hooded hooks in neuropodia from segment 8; hooks bidentate with upper tooth closely applied to main fang and with constriction on upper part of shaft; lower part of shaft bent at right angle (Fig. 2L); hooks numbering up to 16 in a series. In anterior segments, hooks alternating with very fine and short capillaries, latter almost completely embedded into body (Fig. 2M).

Segment 5 modified, larger than segments 4 or 6, with dorsal musculature slightly overlapping segment 6; notopodial lamellae absent but neuropodial postchaetal lamellae present; dorsal superior capillaries (Fig. 2F) numbering 2 or 3 in a fascicle, shorter (1.5-3 times), thinner, and fewer in number than those on segments 4 or 6 (Fig. 2E); ventral capillaries (Fig. 2K) the same in shape and number as those on segments 4 or 6. Two kinds of major spines arranged in a curved oblique or almost horizontal double row. Lower (anterior row) spines pennoned, with pointed tip, and subdistal constriction (Fig. 2G-I); the distal tip often broken in older anterior spines (Fig. 2G); spines numbering up to 10 in a series. Upper (posterior row) spines simple falcate with elongated rounded curved tips (Fig. 2J), numbering up to 7 in a series.

Branchiae from segments 7 up to 14, free from notopodial postchaetal lamellae, with flattened surfaces oriented laterally; some few large oval cells ar-

ranged inside posterior edge of branchiae.

In all females, and most males, nototrochs present on segment 3 and from segment 7 onwards, shortest on segment 3. Additionally, one or 2 pairs of short cirri usually present on segments 4 and 5. Nototrochs arrayed in single, continuous transverse rows of cilia running to tips of gills on all branchial segments (Fig. 2B). Complex dorsal ciliation observed in 4 of 15 living males examined from Hsiangshan, including medial transverse nototrochs from segment 2 onwards, plus an additional intersegmental ciliary row from segment 3 (Fig. 2C). Cilia of nototrochs longer than those of intersegmental rows.

Pygidium small and fleshy, disclike or cup-shaped, usually with only dorsal gap or incision (Fig. 2D); additional ventral notch or incision occasionally present; numerous fusiform mucous cells present inside pygidium giving it a whitish appearance.

Glandular pouches from segment 1, single throughout. No gizzardlike structure in digestive tract.

Pregonadal excretory nephridia from segment 4; female paired gonoducts terminating externally into 1 middorsal nephridiopore in fertile segments except the 1st one.

*Reproduction:* *Pseudopolydora diopatra* is a gonochoristic species. Nine males and 13 females were noted in a sample collected in the Tanshui River estuary (14 August 1998); fifteen males and 20 females in a sample collected in Hsiangshan (19 July 1999). Gametes were present from segments 12 to 21-29 in both females and males.

In males, spermatids are gathered in 8-cell clusters (octads); the spermatozoa measured as acrosome  $1.2 \pm 0.5 \mu\text{m}$ , nucleus  $5.3 \pm 0.5 \mu\text{m}$ , middlepiece  $2.8 \pm 0.5 \mu\text{m}$ , and flagellum  $34 \pm 1 \mu\text{m}$ . In females, oocytes develop in clusters attached to the segmental blood vessels on either side of a fertile segment. Up to 10 oocytes were found in each cluster; thus, up to 20 oocytes developed in each fertile segment. Females deposit 150-300 eggs into 10-18 capsules joined in a string on the inside of the tube. Each egg capsule is attached to the tube wall by a single thin stalk and contains 5-20 eggs. Eggs are of ca.  $100 \mu\text{m}$  in diameter. All the eggs develop into larvae, suggesting the absence of nurse eggs. The larvae develop in capsules until the 3 segment stage, after which they enter the plankton. Larvae measured 190-200  $\mu\text{m}$  long at release, and all had 3 pairs of black eyes; black pigmentation included dorsal faint unpaired median melanophores on the posterior edge of the head and on the pygidium, and paired melanophores on segments 2 and 3; grasping

cilia were present on segment 3. Newly released larvae actively swim and feed in the plankton until settlement and metamorphosis. Newly settled 13-segment juveniles measuring about 950  $\mu\text{m}$  long were found crawling on onuphid tube-caps. The 1st yellow spots on palps appear when an individual reaches 14-15 segments and measures about 1.1 mm long. Worms become mature after reaching 22-23 segments, at a length of about 2.5 mm. The smallest female with egg capsules in its tube had 24 segments. While early larvae were in the egg capsules, the female had a new generation of vitellogenic oocytes measuring about 45  $\mu\text{m}$  in diameter developing in segments 12-21. This species reproduces several times in a prolonged reproductive season (Hsieh 1994).

**Habitat:** *Pseudopolydora diopatra* inhabits mud tubes in marine and brackish-water environments. It occurs intertidally and shallow subtidally both in soft muddy bottoms and on various hard substrata. In the type locality, Hsiangshan, the species predominantly inhabits the above-ground tube-caps of the onuphid *Diopatra sugokai* and shell surface of the oyster *Crassostrea gigas*. Both organisms provide a good shelter for small organisms such as *P. diopatra*. The worms are rare in sediment substrates in the same area (Hsieh and Chang 1991).

**Remarks:** *Pseudopolydora diopatra* is unique

among presently known *Pseudopolydora* species in the extensive modification of segment 5: it is larger than segments 4 or 6; notopodial lamellae are lacking; dorsal superior capillaries are shorter, thinner, and fewer in number than those chaetae on segments 4 or 6; and major spines are arranged in a curved oblique or almost horizontal row (Fig. 11E). In addition, the major spines of neither the anterior nor posterior rows resemble the simple falcate and pennoned spines which are characteristic of most other *Pseudopolydora* species (e.g., see below *P. paucibranchiata*, *P. reticulata*).

For living specimens, *Pseudopolydora diopatra* can be distinguished easily from other *Pseudopolydora* species by the presence of yellow bands on the palps and paired black spots on the ventral side of the anterior segments.

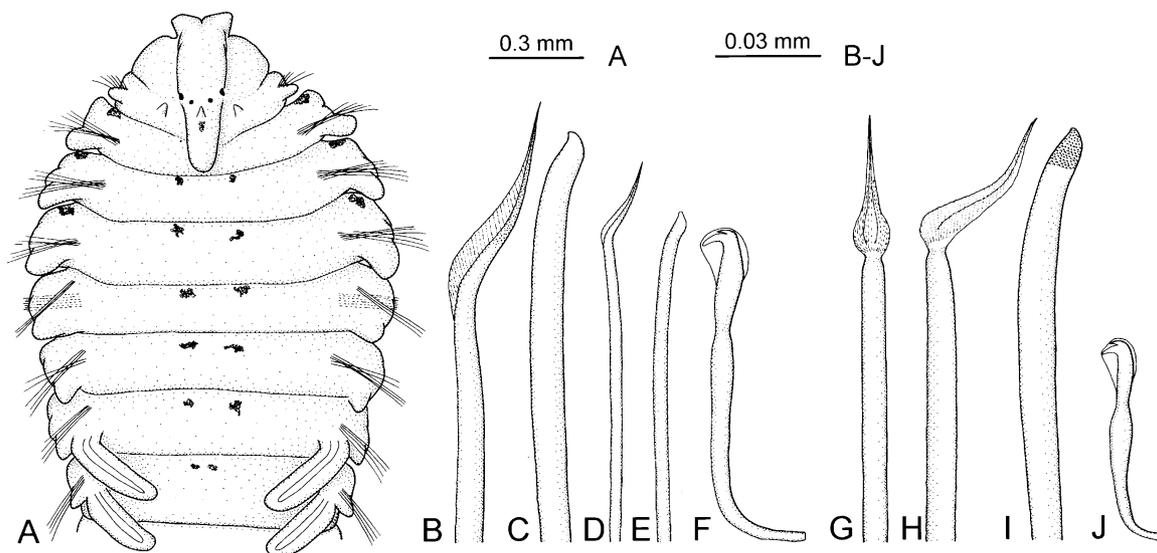
**Distribution:** Taiwan.

***Pseudopolydora* cf. *kempi japonica* Imajima and Hartman, 1964**  
(Fig. 3A-F)

*Polydora* (*Carazzia*) *kempi* var. Okuda, 1937: 233-236, figs. 13, 14.

*Pseudopolydora kempi japonica* Imajima and Hartman, 1964: 287.

**Materials:** Tainan Co., lagoon at Chiku, 23°08'N, 120°04'E, < 2 m, mud, 14 May 1996: st. 9, ASIZW 89



**Fig. 3.** *Pseudopolydora* cf. *kempi japonica* Imajima and Hartman, 1964 (A-F) and *Pseudopolydora paucibranchiata* (Okuda, 1937) (G-J).

(A) Anterior end, dorsal view; (B, D) anterior row notochaetae of segment 5; (C, E) posterior row notochaetae of segment 5 (major spines); (B, C) newly developed larger notochaetae from lower position; (D, E) older smaller notochaetae from upper position; (F) neuropodial bidentate hooded hook of segment 8; (G) anterior row notochaeta of segment 5 (major spine), posterior view; (H) the same, lateral view; (I) posterior row notochaeta of segment 5 (major spine); (J) neuropodial bidentate hooded hook of segment 8.

A-F: ASIZW 93; G-J: ASIZW 112.

(5); st. 10, ASIZW 90 (12); Tsengwen R. estuary, 23°04'N, 120°05'E, st. 1S, < 2 m, mud, 26 May 1995, ASIZW 91 (3). Fujian Prov., Tzu Lake of Kinmen Is., 24°28'N, 118°18'E, < 2 m, mud or fine sand: st. 1, 28 Feb. 1996, ASIZW 88 (4); st. 1, 30 May 1996, ASIZW 92 (15); st. 2, 28 Feb. 1996, ASIZW 93 (9); st. 2, 30 May 1996, ASIZW 94 (38); st. 3, 28 Feb. 1996, ASIZW 95 (2); st. 3, 30 May 1996, ASIZW 96 (10); st. 4, 28 Feb. 1996, ASIZW 97 (5); st. 4, 30 May 1996, IMBV 3396 (17); st. 5, 28 Feb. 1996, ASIZW 98 (2); st. 5, 30 May 1996, ASIZW 99 (15); st. 6, 30 May 1996, ASIZW 100 (5); st. 7, 28 Feb. 1996, ASIZW 101 (2); st. 7, 30 May 1996, IMBV 3397 (36); st. 8, 30 May 1996, ASIZW 102 (20); st. 9, 28 Feb. 1996, ASIZW 103 (2); st. 9, 30 May 1996, USNM 186530 (50); st. 9, 14 Nov. 1996, ASIZW 104 (1); st. 10, 28 Feb. 1996, ASIZW 105 (9); st. 10, 30 May 1996, ASIZW 106 (19); st. 11, 28 Feb. 1996, ASIZW 107 (1); st. 11, 30 May 1996, ASIZW 108 (21); st. 12, 28 Feb. 1996, ASIZW 109 (1); st. 12, 30 May 1996, ASIZW 110 (30); st. 12, 14 Nov. 1996, ASIZW 111 (1).

*Description:* Largest specimen measuring 10.0 mm long and 0.8 mm wide at segment 7 for 53 segments. Two rows of black spots present on dorsal side of segments from 3 up to 15; black spots or narrow transverse bands present on antero-lateral edges of anterior segments beginning from segment 2; small middorsal black spot usually present on caruncle, behind median antenna. Dorsal pigmentation occasionally absent, probably as a result of fixation; pigmentation on palps and on ventral side of segments absent. Prostomium incised on anterior margin, with 2 short lobes. Four black eyes present. Caruncle extending posteriorly usually to end of segment 2, occasionally to middle of segment 3. Short median antenna present on caruncle (Fig. 3A). Palps extending posteriorly for 10-20 segments.

Segment 1 with short notopodial lamellae and well-developed neuropodial lamellae; notochaetae absent but winged capillary neurochaetae present. Anterior row notochaetae of segments 3-6 modified in shape and arrangement as compared with those notochaetae of neighboring segments; notochaetae of segment 5 exhibiting the greatest modification. Posterior notopodia with a few long alimbate capillaries. Hooded hooks in neuropodia from segment 8; hooks bidentate with upper tooth closely applied to main fang and with constriction on upper part of shaft; lower part of shaft bent at right angle (Fig. 3F); hooks numbering up to 22 in a series.

Segment 5 not modified, similar in size and shape to segments 4 or 6; noto- and neuropodial postchaetal lamellae present; dorsal superior and

ventral capillaries the same in shape and number as those chaetae on segments 4 or 6. Two kinds of major spines arranged in a vertical J-shaped double row; newly developed spines in lower part of both rows (Fig. 3B, C) larger than older spines in upper rows (Fig. 3D, E). Anterior (outer) row spines pennoned, with curved pointed tips, without subdistal constriction (Fig. 3B, D), numbering up to 18 in a series; posterior (inner) row spines simple falcate (Fig. 3C, E), numbering up to 16 in a series.

Branchiae from segment 7 up to 20, free from notopodial postchaetal lamellae, with flattened surfaces oriented laterally; some few large oval cells arranged inside along posterior edge.

Pygidium a large flaring disc with wide dorsal gap and dorso-lateral processes, white colored.

Glandular pouches from segment 1, largest and paired in segments 6 and 7, single in other segments. No gizzardlike structure in digestive tract.

Gonochoristic, gametes present in females from segments 12-14 to 26-30.

*Habitat:* *Pseudopolydora* cf. *kempi japonica* inhabits mud tubes in soft bottoms of brackish-water environments. The species has been found in the same samples as *Polydora cornuta* Bosc, *Polydora fusca* Radashevsky and Hsieh, and *Pseudopolydora achaeta* (see below).

*Remarks:* The stem species, *Pseudopolydora kempi*, was described by Southern (1921) from India. The original description was brief and there is no evidence as to whether the type material of the species still exists. *Pseudopolydora* specimens similar to *P. kempi* were found in both the northwestern and northeastern Pacific. Okuda (1937) compared his samples with Southern's (1921) description and apparently assumed that a variety of the stem species existed in Japan. Imajima and Hartman (1964) subsequently established a new subspecies, *P. kempi japonica*, for the Japanese population (probably based only on Okuda's description). Light (1969) also established a new subspecies, *P. kempi californica*, for the Californian population. However, Blake and Woodwick (1975), Light (1978), and Blake (1996) considered these subspecies to be invalid due to a poor original description of *P. kempi* (and the lack of type material). Moreover, the description of *P. kempi japonica* was much too abbreviated, and Okuda (1937) apparently did not deposit any types. Clearly, further investigations are required to clarify the status of Indian, Japanese, and Californian populations. Pending such studies, we tentatively identify our Taiwan materials as *P. cf. kempi japonica*, which fit previous descriptions by Okuda (1937) and Imajima and Hartman (1964).

*Distribution:* Taiwan; Kinmen Is. off mainland China.

***Pseudopolydora paucibranchiata* (Okuda, 1937)**  
(Figs. 3G-J, 11C)

*Polydora* (*Carazzia*) *paucibranchiata* Okuda, 1937: 231-233, figs. 11-12.

*Pseudopolydora paucibranchiata* Imajima and Hartman 1964: 288; Radashevsky 1993: 50-53, fig. 27.

*Material:* Taiwan Strait, Penghu Co., Chitou, Penghu Is., 23°38'N, 119°36.2'E, intertidal, sand, 5 July 1997, ASIZW 112 (4).

*Description:* Largest complete individual measuring 5.5 mm long and 0.4 mm wide at segment 7 for 48 segments. Body and palp pigmentation absent (preserved individuals). Prostomium rounded on anterior margin. Four black eyes present. Caruncle extending posteriorly to end of segment 3. Short median antenna present on caruncle. Palps extending posteriorly for 15-25 segments.

Segment 1 with short noto- and neuropodial lamellae; notochaetae absent but capillary neurochaetae present. Notochaetae of segments 4 and 6 winged capillaries, with no modification. Posterior notopodia with a few long alimbate capillaries. Hooded hooks in neuropodia from segment 8; hooks bidentate with upper tooth closely applied to main fang and with constriction on upper part of shaft; lower part of shaft bent at right angle (Fig. 3J); hooks numbering up to 10 in a series.

Segment 5 almost the same in size as segments 4 or 6, without notopodial postchaetal lamellae but with neuropodial ones; dorsal superior capillaries and ventral capillaries almost the same in shape and length or slightly shorter than those chaetae on segments 4 or 6. Two kinds of major spines arranged in a vertical J-shaped double row; anterior (outer) row spines pennoned, with geniculate distal tips, and subdistal constriction (Fig. 3G, H), numbering up to 9 in a series; posterior (inner) row spines simple falcate (Fig. 3I), with tilelike structure on distal end visible on high magnification only, numbering up to 6 in a series.

Branchiae from segments 7 up to 18, free from notopodial postchaetal lamellae, with flattened surfaces oriented laterally; a few large oval cells arranged inside along posterior edge.

Pygidium small disc or cup with dorsal gap.

Glandular pouches from segment 1, single throughout.

*Habitat:* *Pseudopolydora paucibranchiata* inhabits mud tubes in soft bottoms.

*Remarks:* The species is reported herein for the first time from Taiwan.

*Distribution:* Sea of Japan, Yellow Sea, Sakhalin Is., Kunashir Is. of the southern Kurile Islands, Japan's Inland Sea, Taiwan Strait, California, ? Australia, and ?New Zealand.

***Pseudopolydora achaeta* sp. nov.**  
(Figs. 4, 5, 11A)

*Diagnosis:* A moderate-sized gonochoristic *Pseudopolydora* species inhabiting mud tubes in soft bottoms. Dorsal, lateral and ventral transverse bands of black diffuse pigment usually present on anterior segments. Prostomium incised or blunt anteriorly. Four black eyes present. Caruncle reaching end of segment 2. Median antenna present on caruncle. Segment 1 with short hairlike neurochaetae. Segment 5 not modified, with noto- and neuropodial lamellae; two kinds of major spines arranged in an almost straight vertical double row. Pygidium flaring disc with dorso-lateral processes. Glandular pouches from segment 1, largest and paired in segments 6 and 7.

*Type materials:* Taipei Co., Tanshui R. estuary, 25°10'N, 121°27'E: st. K-11, intertidal, mud, 21 May 1997, ASIZW 113 (6); st. K-11, 5 m, fine sand, 21 May 1997, ASIZW 114 (3); st. K-11, 5 m, mud, 11 Aug. 1997, ASIZW 115 (1); st. K-11, 5 m, fine sand, 14 Aug. 1998, ASIZW 116 (8); st. K-12, 5 m, very fine sand, 5 Mar. 1998, ASIZW 117 (2). Tainan Co., Tsengwen R. estuary, 23°04'N, 120°05'E, < 2 m, mud: st. 1M, 18 Oct. 1994, ASIZW 118 (131); st. 1N, 18 Oct. 1994, ASIZW 119 (152); st. 1S, 18 Oct. 1994, ASIZW 120 (66); st. 1S, 18 Oct. 1994, ASIZW 121 (**holotype**); st. 1S, 18 Oct. 1994, USNM 186524 (142); st. 2M, 26 May 1995, ASIZW 122 (13); st. 2M, 18 Oct. 1994, IMBV 3401 (135); st. 2M, 18 Oct. 1994, USNM 186525 (195); st. 2N, 18 Oct. 1994, ASIZW 123 (9); st. 2S, 18 Oct. 1994, ASIZW 124 (118); st. 2S, 18 Oct. 1994, USNM 186526 (121); st. 3M, 18 Oct. 1994, ASIZW 125 (36); st. 3N, 18 Oct. 1994, ASIZW 126 (61); st. 3S, 18 Oct. 1994, ASIZW 127 (12); st. 4M, 18 Oct. 1994, ASIZW 128 (1); st. 4N, 18 Oct. 1994, ASIZW 129 (3). Fujian Prov., Tzu Lake of Kinmen Is., 24°28'N, 118°18'E, < 2 m, mud or fine sand: st. 1, 28 Feb. 1996, ASIZW 130 (9); st. 1, 30 May 1996, ASIZW 131 (4); st. 2, 28 Feb. 1996, ASIZW 132 (12); st. 2, 30 May 1996, ASIZW 133 (14); st. 2, 14 Nov. 1996, ASIZW 134 (1); st. 3, 30 May 1996, ASIZW 135 (1); st. 3, 14 Nov. 1996, ASIZW 136 (2); st. 4, 28 Feb. 1996, ASIZW 137 (1); st. 4, 30 May 1996, ASIZW 138 (1); st. 7, 14 Nov. 1996, ASIZW 139 (1); st. 9, 14 Nov. 1996, ASIZW 140 (1); st. 10, 28 Feb. 1996, ASIZW 141 (3); st. 10, 30 May 1996, ASIZW 142 (2); st. 11, 28 Feb. 1996,

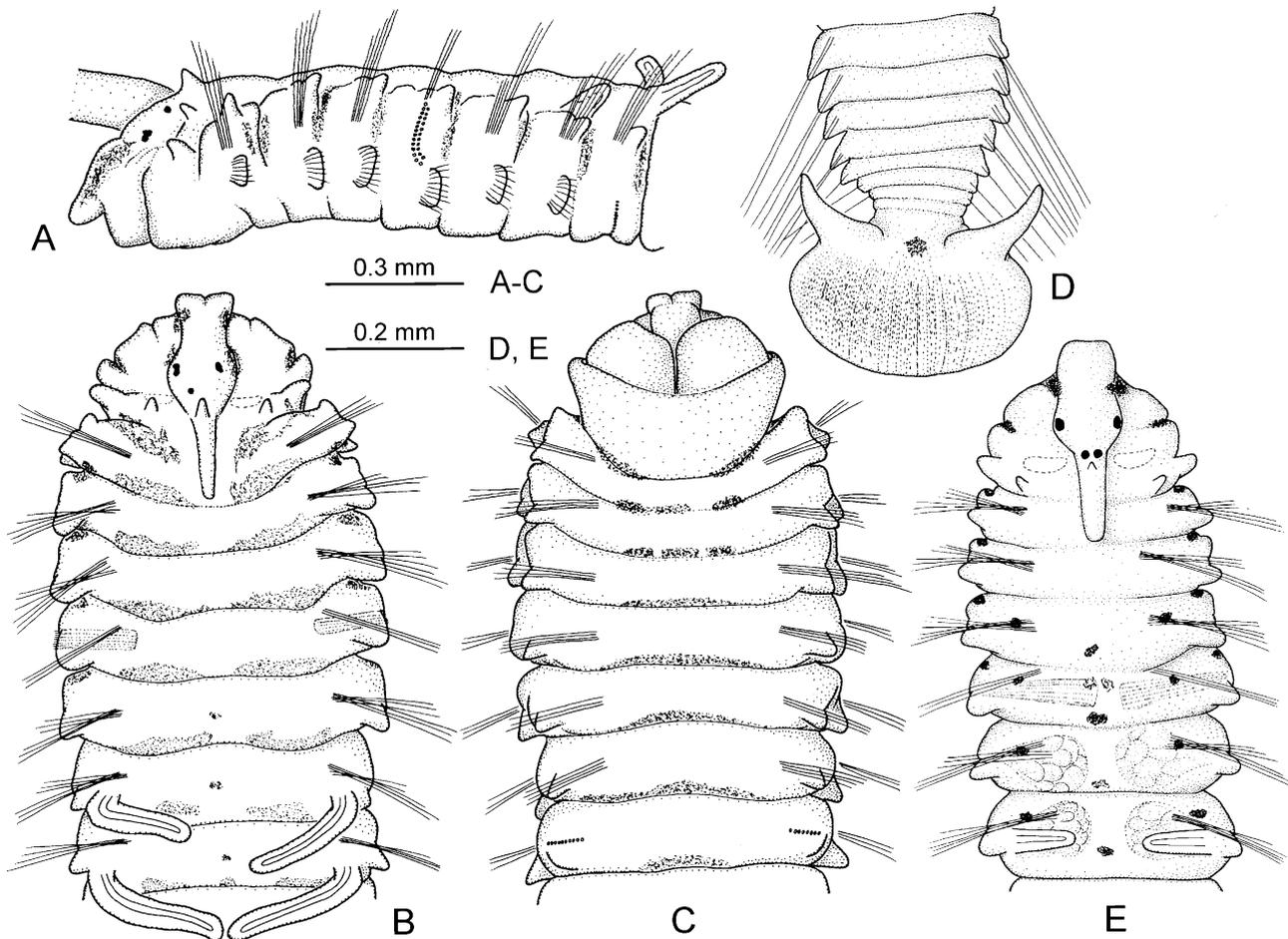
ASIZW 143 (2).

**Holotype:** Complete 75-segment individual measuring 10.4 mm long and 0.7 mm wide at segment 7. The head and 10-11 anterior segments with diffuse black pigment: aggregations of pigment present on either side of the prostomium, laterally between segments, and on dorsal and ventral side of segments along posterior edges; small spots present on segments 6-10 middorsally. Prostomium incised on anterior margin. Low transverse fold present along midline of ventral and lateral sides of peristomium (Fig. 4C). Three black eyes present. Caruncle extending posteriorly to end of segment 2. Short median antenna present on the caruncle (Fig. 4A, B). Right palp extending posteriorly for about 15 segments; left palp lost.

Segment 1 reduced, weakly separated from the peristomium, with small notopodial and well-devel-

oped neuropodial lamellae; notochaetae absent; approximately 10 very fine, hairlike neurochaetae present (Fig. 5A); those hairs measuring 125-140  $\mu\text{m}$  long and 10-15  $\mu\text{m}$  wide. Neurochaetae of segment 2 winged capillaries measuring 250-300  $\mu\text{m}$  long, 30-40  $\mu\text{m}$  wide in middle part and up to 55  $\mu\text{m}$  wide in basal part (Fig. 5B), numbering about 25 in a series. Anterior row notochaetae of segment 4 (Fig. 5C) intermediate in shape between winged capillaries of segment 3 and pennoned spines of segment 5. Posterior notopodia with a few long alimbate capillaries. Hooded hooks in neuropodia from segment 8; hooks bidentate with upper tooth closely applied to main fang and with constriction on upper part of shaft; lower part of shaft bent at right angle (Fig. 5F); hooks numbering up to 16 in a series.

Segment 5 not modified, the same in size and shape as segments 4 or 6; noto- and neuropodial



**Fig. 4.** *Pseudopolydora achaeta* sp. nov.

(A) Anterior end, lateral view; (B) the same, dorsal view; (C) the same, ventral view; (D) posterior end, dorsal view; (E) anterior end of a 35-segment individual, dorsal view.

A-D: ASIZW 121, holotype; E: IMBV 3401, paratype.

postchaetal lamellae present; dorsal superior and ventral capillaries the same in shape and number as those chaetae on segments 4 or 6. Two kinds of major spines arranged in a vertical slightly curved double row; newly developed spines in lower rows larger than older spines in upper rows. Anterior row spines pennoned, with curved pointed tip, without subdistal constriction (Fig. 5D), numbering 15 in a series; posterior row spines simple falcate (Fig. 5E), numbering 11 in a series.

Branchiae on segments 7-18, free from notopodial postchaetal lamellae, with flattened surfaces oriented laterally; some few large oval cells arranged inside along posterior edge.

Pygidium a flaring disc with wide dorsal gap and dorso-lateral processes, white colored because of large number of fusiform mucous cells (Fig. 4D).

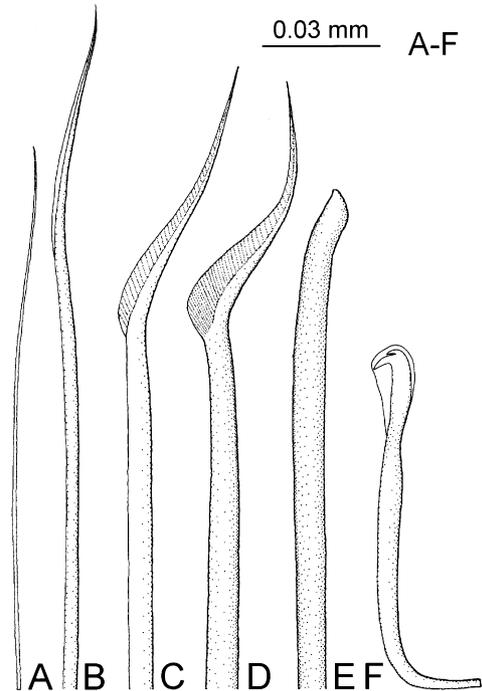
Glandular pouches from segment 1, largest and paired in segments 6 and 7, single in other segments. No gizzardlike structure in digestive tract.

Female, small oocytes present in segments 19 to 44. Paired gonoducts terminating externally into 1 gonopore on middorsal side of segments 20 to 47.

**Variability:** The largest individual measures 24 mm long and 0.9 mm wide for 93 segments. Ventral, lateral, and paired dorsal transverse bands are usually positioned along the posterior edge of segments 1 up to 15; wide paired dorsal bands are usually most conspicuous on 3 anterior segments; small middorsal spots are usually present on segments 4-6 up to 12; the pigmentation may be faint or completely absent after fixation. Small individuals have no wide paired dorsal bands or narrow ventral bands of diffused pigment; instead, they retain larval pigmentation as small black spots on the dorsal side of anterior segments (Fig. 4E). Prostomium is weakly incised, notched, or blunt on the anterior margin. The midline transverse fold on the peristomium is conspicuous. Four black eyes are usually present. Caruncles extend posteriorly usually to end of segment 2. Neurochaetae of segment 1 are always fine and hairlike. They are difficult to observe under low magnification giving the segment an achaetous appearance. Major spines of segment 5 are arranged in the characteristic long, straight, or slightly curved vertical row. Branchiae begin from segment 7 and continue up to segment 21. The species is gonochoristic, and gametes are present in females and males from segments 18-19 to 35-53.

**Habitat:** *Pseudopolydora achaeta* inhabits mud tubes in soft bottoms of brackish-water environments. The species has been found together with *P. cf. kempi japonica*, *P. reticulata* (see below), and *P. vexillosa* (see below).

**Differential diagnosis:** *Pseudopolydora achaeta* is very similar to *Pseudopolydora glandulosa* Blake and Kudenov, 1978, described from Australia. Both species have diffuse black pigmentation on dorsal and ventral sides of the body, caruncle of the same length, and major spines of similar shape. Both species are unique among presently known *Pseudopolydora* species in having a transverse midline fold on the peristomium. However, both species (holotype G2899 and 6 paratypes G2900 of *P. glandulosa* deposited in the National Museum of Victoria, Australia, were examined) differ in pigmentation patterns, morphology of neurochaetae of segment 1, and major spine arrangement. In *P. achaeta*, the prostomium is pigmented only laterally, paired dorsal black bands are positioned on posterior margins of segments, and transverse black bands of segment 3 are separated and not joined into a complete band; neurochaetae of segment 1 are short hairlike capillaries, numbering up to 10 in a series; major spines of segment 5 number up to 17 in a row, and the row is either straight or slightly curved vertically. In *P. glandulosa*, the prostomium is intensively pigmented dorsally, paired black bands are positioned on ante-



**Fig. 5.** *Pseudopolydora achaeta* sp. nov.

(A) Neurochaeta of segment 1; (B) neurochaeta of segment 2; (C) anterior row notochaeta of segment 4; (D) anterior row notochaeta of segment 5 (major spine); (E) posterior row notochaeta of segment 5 (major spine); (F) neuropodial bidentate hooded hook of segment 8.

A-F: ASIZW 120, paratype.

rior margins of segments, and a complete narrow transverse black band is present on segment 3; neurochaetae of segment 1 are slender capillaries, numbering up to 25 in a series; major spines of segment 5 number up to 25 in a row, and the row is either J- or U-shaped. In addition, the dorsal anterior edge of segment 3 in *P. glandulosa* is elevated creating a low transverse ridge. In *P. achaeta*, however, such elevation is absent.

*Pseudopolydora achaeta* is characterized by the arrangement of major spines in nearly straight vertical rows instead of J- or U-shaped rows on segment 5. The species can be distinguished from other related species by its characteristic pigmentation pattern.

**Etymology:** The Greek species name is composed of the negative prefix *a*, and *cháité*, chaeta, referring to the characteristic achaetous appearance of segment 1.

**Distribution:** Taiwan; Kinmen Is. off mainland China.

***Pseudopolydora corniculata* sp. nov.**

(Fig. 6)

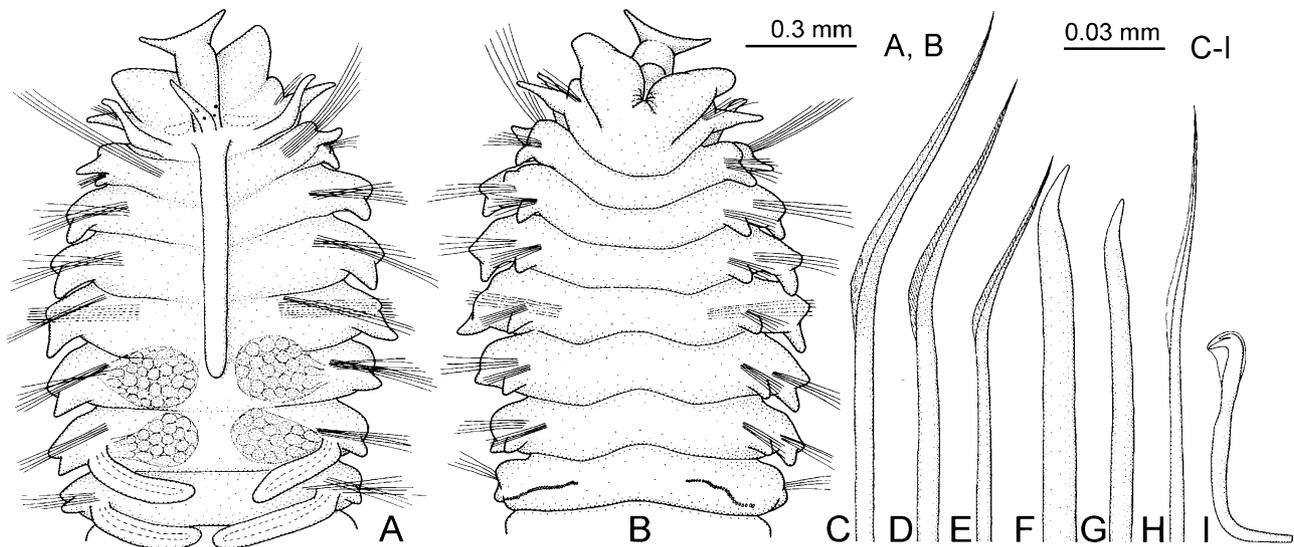
**Diagnosis:** A moderate-sized, gonochoric *Pseudopolydora* species inhabiting mud tubes in soft bottoms of brackish-water environments. Body pigmentation absent. Prostomium T-shaped anteriorly,

with 2 pointed antero-lateral processes. Four black eyes present. Caruncle reaching middle of segment 6. Median antenna present on caruncle. Segment 1 with long cirriform postchaetal lamellae and winged capillary neurochaetae. Segment 5 not modified, with noto- and neuropodial lamellae; anterior row notochoetae slightly different from those chaetae on neighboring segments. Glandular pouches largest and paired in segments 6 and 7.

**Type materials:** Tainan Co., coast off Pachang R.: 23°20'N, 120°03'E, st. 3, 14 m, mud, 7 Sept. 1994, ASIZW 144 (**holotype**); coast off Chuanchun R., 23°15'N, 120°04'E, st. 18, 11 m, fine sand, 5 Sept. 1994, ASIZW 145 (1); 23°07'N, 120°01'E, st. 41, 11 m, fine sand, 9 Sept. 1994, USNM 186527 (2).

**Holotype:** An anterior 30-segment fragment, measuring 4.0 mm long and 0.5 mm wide at segment 7. Body and palp pigmentation absent. Prostomium T-shaped anteriorly, with 2 pointed antero-lateral processes. Four black eyes present. Caruncle extending posteriorly to middle of segment 6. Long cirriform median antenna present on the caruncle between palps. Peristomium consisting of 2 flaring lobes (Fig. 6A, B). Palps extending posteriorly for 15-20 segments.

Segment 1 well separated from the peristomium; long cirriform noto- and neuropodial postchaetal lamellae, both twice as longer as those on following segments; notochoetae absent but winged



**Fig. 6.** *Pseudopolydora corniculata* sp. nov.

(A) Anterior end, dorsal view; (B) the same, ventral view; (C) anterior row notochoeta of segment 4; (D, E) anterior row notochoetae of segment 5; (F, G) posterior row notochoetae of segment 5 (major spines); (D, F) newly developed larger notochoetae from lower position; (E, G) older smaller notochoetae from upper position; (H) anterior row notochoeta of segment 6; (I) neuropodial bidentate hooded hook of segment 8.

A, B: ASIZW 144, holotype; C-I: ASIZW 145, paratype.

capillary neurochaetae present. Notochaetae of segment 2 directed antero-laterally, 1.5 times longer than notochaetae of following segments. Posterior notopodia with a few long alimbate capillaries. Hooded hooks in neuropodia from segment 8; hooks bidentate with upper tooth closely applied to main fang and with constriction on upper part of shaft; lower part of shaft bent at right angle (Fig. 6I); hooks numbering up to 36 in a series.

Segment 5 the same in appearance as segments 4 or 6; noto- and neuropodial postchaetal lamellae well developed; dorsal superior and ventral capillaries the same in shape and number as those chaetae on segments 4 or 6. Two kinds of notochaetae arranged in a vertical double row; lower part of row weakly curved to J-shaped. Anterior row notochaetae winged capillaries (Fig. 6D, E), similar in shape but slightly shorter than those chaetae on segments 4 (Fig. 6C) or 6 (Fig. 6H), numbering 13 in a series; posterior row notochaetae simple falcate spines with slightly bent tips (Fig. 6F, G), numbering 10 in a series.

Branchiae on segments 7-20, free from notopodial postchaetal lamellae, with flattened surfaces oriented laterally; large oval cells with striated contents arranged inside branchial edges.

Glandular pouches largest and paired in segments 6 and 7, pouches not evident in other segments. No gizzardlike structure in digestive tract.

Female, small oocytes present from segment 12 to end of the fragment. Paired gonoducts terminating externally into 1 gonopore on middorsal side from segment 13 onwards.

**Variability:** The type material includes 4 anterior fragments. Glandular pouch arrangement and pygidium morphology are unknown.

**Habitat:** *Pseudopolydora corniculata* inhabits mud tubes in soft bottoms of brackish-water environments.

**Differential diagnosis:** *P. corniculata* is unique among presently known *Pseudopolydora* species in the shape of the prostomium, peristomium, and long cirriform postchaetal lamellae on segment 1. The species is also remarkable in that the anterior row notochaetae on segment 5 are the least modified among known members of the genus and are similar in shape and number to anterior row winged capillaries on neighboring segments.

*Pseudopolydora corniculata* is also similar to *P. corallicola* Woodwick, 1964 in that the caruncle extends over segment 6, notochaetae are longest on segment 2, and large paired glandular pouches are present in segments 6 and 7. In addition to the shape of the prostomium and postchaetal lamellae

on segment 1, *P. corniculata* differs from *P. corallicola* in morphology of notochaetae on segment 5 and in their arrangement in a weak J-shaped almost vertical row instead of a distinct U-shaped row (see Woodwick 1964).

**Etymology:** The species name, feminine for Latin *corniculatus* (horned), refers to the morphology of its anterior end with its horn-like antero-lateral processes on the prostomium, long cirriform median antenna on the caruncle, and long cirriform notopodial lamellae on segment 1. These structures give a horned appearance to the worms.

**Distribution:** Taiwan.

### ***Pseudopolydora gigeriosa* sp. nov.**

(Fig. 7)

**Diagnosis:** A moderate-sized gonochoristic *Pseudopolydora* species inhabiting mud tubes in soft bottoms. Body pigmentation absent; narrow black bands usually marking food groove on palps. Prostomium rounded anteriorly. Four black eyes present. Caruncle reaching end of segment 2. Median antenna present on caruncle. Segment 1 with winged capillary neurochaetae. Segment 5 not modified, with noto- and neuropodial lamellae; two kinds of major spines arranged in an almost straight vertical double row. Pygidium a small disc with dorsal gap. No gizzardlike structure in digestive tract.

**Type materials:** Tainan Co., northern coast of Tsengwen R., 23°03'N, 120°02'E, st. N-1, intertidal, fine sand: 5 July 1995, ASIZW 146 (5); 20 Sept. 1995, ASIZW 147 (**holotype**); 20 Sept. 1995, ASIZW 148 (7); 4 Dec. 1995, ASIZW 149 (8); 15 July 1996, ASIZW 150 (2); 17 July 1996, ASIZW 151 (1); 10 Sept. 1996, ASIZW 152 (20); 25 Nov. 1996, ASIZW 153 (1); 23°07'N, 120°02'E, st. N-2, 10 Sept. 1996, ASIZW 154 (2); southern coast of Tsengwen R., 23°03'N, 120°03'E, st. S-1, intertidal, fine sand: 17 July 1996, ASIZW 155 (4); 10 Sept. 1996, ASIZW 156 (4); 11 Sept. 1996, ASIZW 157 (7); 5 Dec. 1995, ASIZW 158 (17); 5 Dec. 1995, USNM 186529 (10); 5 Dec. 1995, IMBV 3398 (57); 23°02'N, 120°05'E, st. S-2, intertidal, fine sand: 5 Dec. 1995, ASIZW 159 (4); 26 Nov. 1996, ASIZW 160 (4); Tsengwen R. estuary, 23°04'N, 120°05'E, st. 3N, < 2 m, mud, 18 Oct. 1994, ASIZW 161 (1).

**Holotype:** Complete 56-segment individual measuring 9.0 mm long and 0.5 mm wide at segment 7. Body pigmentation absent; narrow longitudinal black bands marking food groove on palpi. Prostomium narrowing anteriorly, rounded on anterior margin. Four black eyes present including 1 anterior pair and 1 posterior pair; the posterior eyes appar-

ently joined and looking like 1 eye. Caruncle extending posteriorly to end of segment 2. Median antenna present on caruncle (Fig. 7A). Left palp extending posteriorly for 14 segments; right palp lost.

Segment 1 with noto- and neuropodial lamellae; notochaetae absent but winged capillary neurochaetae present. Anterior row notochaetae of segments 3-6 slightly modified (Fig. 7C-E, H), shorter and wider than those chaetae on neighboring segments; anterior row notochaetae of segment 5 exhibiting greater modification but still not much different from common capillaries. Posterior notopodia with a few long alimbate capillaries. Hooded hooks in neuropodia from segment 8; hooks bidentate with upper tooth closely applied to main fang and with constriction on upper part of shaft; lower part of shaft bent at right angle (Fig. 7I); hooks numbering 19 in a series on middle segments, and up to 25 on posterior segments.

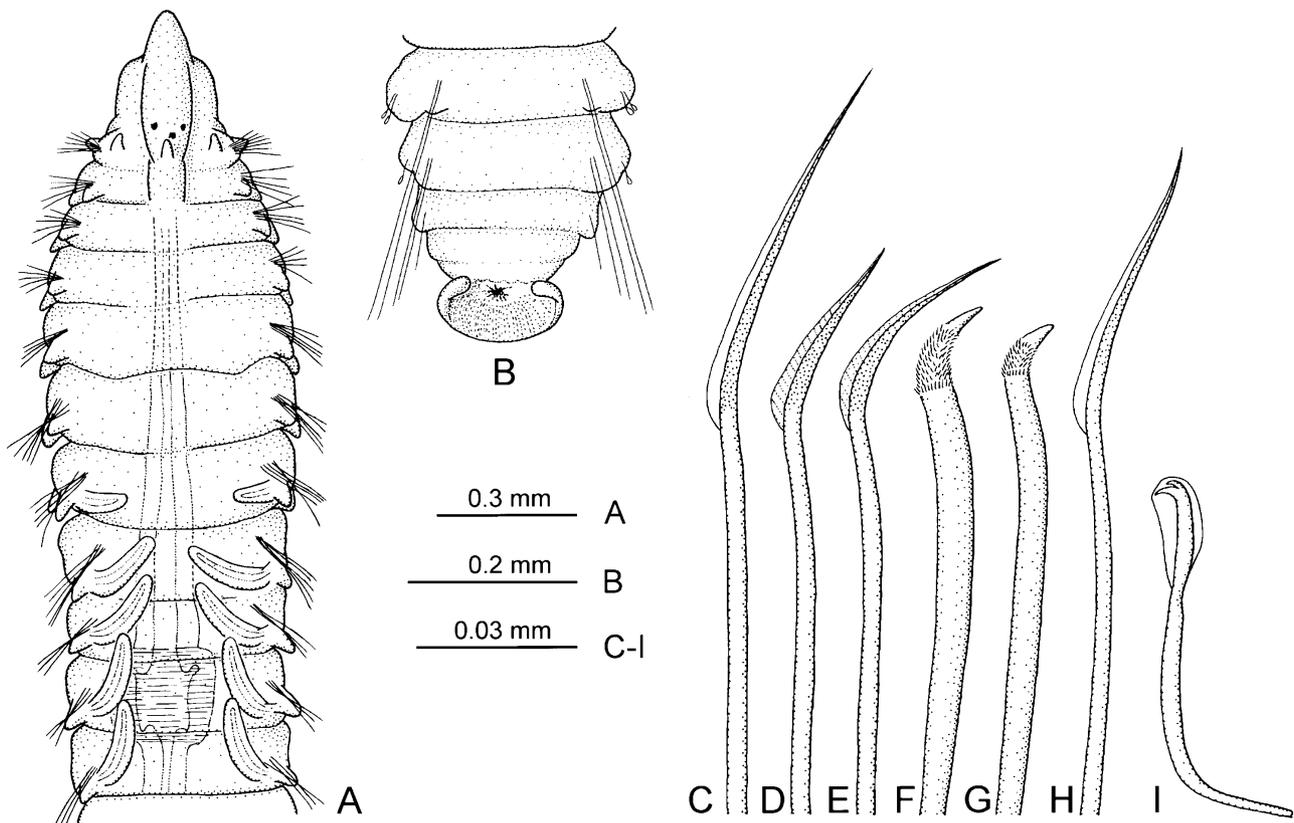
Segment 5 not modified, the same in appearance as segments 4 or 6; noto- and neuropodial

postchaetal lamellae well developed; dorsal superior and ventral chaetae the same in shape and number as those chaetae on segments 4 or 6; neurochaetae including anterior and posterior vertical rows of 11 wide capillaries in each and 2 slender inferior capillaries positioned below the vertical rows. Anterior and posterior rows of notochaetae arranged vertically. Anterior row notochaetae winged capillaries, similar in shape but slightly shorter than those chaetae on segments 4 or 6 (Fig. 7D, E), numbering 9 in a series; posterior row notochaetae falcate spines with fine bristles on curved subdistal part (Fig. 7F, G), numbering 5 in a series.

Branchiae on segments 7-28, full-sized from segment 8, free from notopodial postchaetal lamellae, with flattened surfaces oriented laterally; with a few large oval cells arranged along the anterior and posterior edges.

Pygidium a small disc with dorsal gap (Fig. 7B).

Gizzardlike structure present in segment 10, positioned between esophagus and stomach (Fig. 7A).



**Fig. 7.** *Pseudopolydora gigeriosa* sp. nov.

(A) Anterior end, dorsal view; (B) posterior end, dorsal view; (C) anterior row notochaeta of segment 4; (D, E) anterior row notochaetae of segment 5; (F, G) posterior row notochaetae of segment 5 (major spines); (H) anterior row notochaeta of segment 6; (I) neuropodial bidentate hooded hook of segment 8.

A-I: ASIZW 147, holotype.

Glandular pouches present but their arrangement not revealed.

Male, sperm present in segments 15–43.

**Variability:** The largest complete individual measures 14 mm long and 0.7 mm wide for 65 segments. Body pigmentation is absent but narrow black bands are usually present along food grooves on palps. The prostomium is elongated and tapering, conical anteriorly, with a rounded anterior margin. Four eyes are usually present, occasionally there are 3. The caruncle extends posteriorly to the middle or up to the end of segment 2. A cirriform median antenna is present on the caruncle. Segment 5 is unmodified; anterior row notochaetae are similar in shape but slightly shorter than those chaetae on segments 4 or 6. The major spines of segment 5 are arranged in a short, straight, vertical row. Branchiae begin from segment 7 and continue up to segment 35. The branchiae are full-sized from segments 8–10 but those on segment 7 are 1/2 the size of those on the following segments. The pygidium is a small disc with a dorsal gap and without dorso-lateral extensions. A gizzardlike structure is usually positioned in segment 10; it apparently consists of only a muscular part, a secretory structure was not observed. Glandular pouches are present but their arrangement is difficult to discern. They are very small and not evident in anterior segments and are apparently single throughout wherever present.

The species is gonochoristic. Gametes are present in females and males from segments 14–16 to 34–42. The paired gonoducts of females terminate externally into 1 middorsal gonopore.

**Habitat:** *Pseudopolydora gigeriosa* inhabits tubes in intertidal muddy bottoms of brackish-water environments.

**Differential diagnosis:** *P. gigeriosa* is unique among presently known species of the genus in having bristled falcate spines on segment 5, and a gizzardlike structure in the digestive tract. Posterior row falcate spines with subdistal bristles have been reported for *Carazziella* species, and the gizzardlike structure is characteristic of some *Dipolydora* and *Carazziella* species (see Blake and Kudenov 1978, Blake 1996). Other features of *P. gigeriosa*, such as hooded hook and pygidium morphology, branchiae beginning from segment 7 and hooks from segment 8, and the absence of notochaetae on segment 1, are consistent with diagnostic features of the genus *Pseudopolydora*. The generic status of this species will be confirmed pending clarification of glandular pouches and nephridia arrangements.

*Pseudopolydora gigeriosa* can be distinguished from other *Pseudopolydora* species by the absence

of body pigmentation, fine black bands along the palps, and the presence of a gizzardlike structure which is readily seen through the transparent body wall at the level of segment 10.

**Etymology:** The species name refers to the presence of a gizzardlike structure (Latin *gigerium*, gizzard) in the digestive tract, a feature which is presently unique among members of the genus *Pseudopolydora*.

**Distribution:** Taiwan.

### ***Pseudopolydora reticulata* sp. nov.**

(Figs. 8, 9, 11B)

**Diagnosis:** A moderate-sized gonochoristic *Pseudopolydora* species inhabiting mud tubes in soft bottoms. Black reticulated pigment present on dorsal side of anterior segments; paired black spots arranged on ventral side of anterior segments; narrow black band present on caruncle. Prostomium bifurcate anteriorly. Four black eyes present. Caruncle usually reaching end of segment 5. Median antenna present on caruncle. Segment 5 not modified, with noto- and neuropodial lamellae; two kinds of major spines arranged in a vertical J-shaped double row. Pygidium disclike with dorso-lateral processes. Glandular pouches from segment 1, largest and paired in segments 6 and 7.

**Type materials:** Tainan Co., lagoon at Chiku, 23°08'N, 120°04'E, < 2 m, mud, 14 May 1996: st. 6, ASIZW 162 (1); st. 11, ASIZW 163 (1); st. 12, ASIZW 164 (1); Tsengwen R. estuary, 23°04'N, 120°05'E, < 2 m, mud: st. 1M, 18 Oct. 1994, ASIZW 165 (10); st. 1N, 18 Oct. 1994, ASIZW 166 (6); st. 1S, 18 Oct. 1994, ASIZW 167 (19); st. 2N, 18 Oct. 1994, ASIZW 168 (**holotype**); st. 2N, 18 Oct. 1994, IMBV 3400 (18); st. 2N, 18 Oct. 1994, USNM 186531 (58); st. 2S, 18 Oct. 1994, ASIZW 169 (1); coast off Chuanchun R., 23°13'N, 120°04'E, st. 23, 6 m, fine sand, 26 Sept. 1994, ASIZW 170 (1); coast off Yenshui R., 22°59'N, 120°07'E, st. 78, 10 m, mud, 26 Apr. 1995, ASIZW 171 (1); southern coast of Tsengwen R., 23°03'N, 120°03'E, st. S-1, intertidal, fine sand: 26 Sept. 1994, ASIZW 172 (2); 7 July 1995, ASIZW 173 (1); 17 July 1996, ASIZW 174 (1). Changhua Co., Tatu R. estuary, 24°10'N, 120°27'E, st. D2, intertidal, fine sand, coll. Y.H. Wang, 30 May 1995, ASIZW 175 (1). Taipei Co., Tanshui R. estuary, 25°10'N, 121°27'E, st. K-12, 5 m, mud, 14 Aug. 1998, ASIZW 176 (6).

**Holotype:** Complete 32-segment individual measuring 9.0 mm long and 0.95 mm wide at segment 7. Black reticulated pigment present on dorsal side of segments from 2 to 15; small paired black

spots present on ventral side along posterior edge of segments from 4 to 8; narrow black bands or spots present on antero-lateral edges of segments 2 and 3; narrow longitudinal black band present along midline of caruncle from median antenna to segment 3 (Fig. 8A, B). Prostomium bifurcate, with 2 short flaring lobes. Four black eyes present. Caruncle extending posteriorly to 1/3 of segment 5. Long median antenna present on caruncle (Fig. 8A). Palps extending posteriorly for about 10 segments.

Segment 1 with small notopodial lamellae and well-developed neuropodial lamellae; notochaetae absent but winged capillary neurochaetae present. Anterior row notochaetae of segments 3, 4, 6, and 7 slightly modified, yellowish-brown, arranged in weak J-shaped rows resembling the arrangement of notochaetae on segment 5. The shape, color, and arrangement of anterior row notochaetae gradually changing from segments 3 to 7 with the greatest modification on segment 5 (Fig. 9A-F). Hooded hooks in neuropodia from segment 8; hooks bidentate with upper tooth closely applied to main fang and with constriction on upper part of shaft; lower part of shaft bent at right angle (Fig. 9H, I); hooks numbering up to 31 in a series.

Segment 5 unmodified, similar in appearance to segments 4 or 6; noto- and neuropodial postchaetal lamellae well developed; dorsal superior and ventral capillaries the same in shape and number as those

chaetae on segments 4 or 6. Two kinds of major spines arranged in a vertical J-shaped double row. Anterior row (outer) spines pennoned, without subdistal constriction (Fig. 9D), numbering 21 in a series; posterior row (inner) spines simple falcate (Fig. 9G), numbering 16 in a series. Both kinds of spines increasing in size from upper to lower position; newly developed spines largest, positioned at lower part of rows.

Branchiae on segments 7-17, free from notopodial postchaetal lamellae, with flattened surfaces oriented laterally.

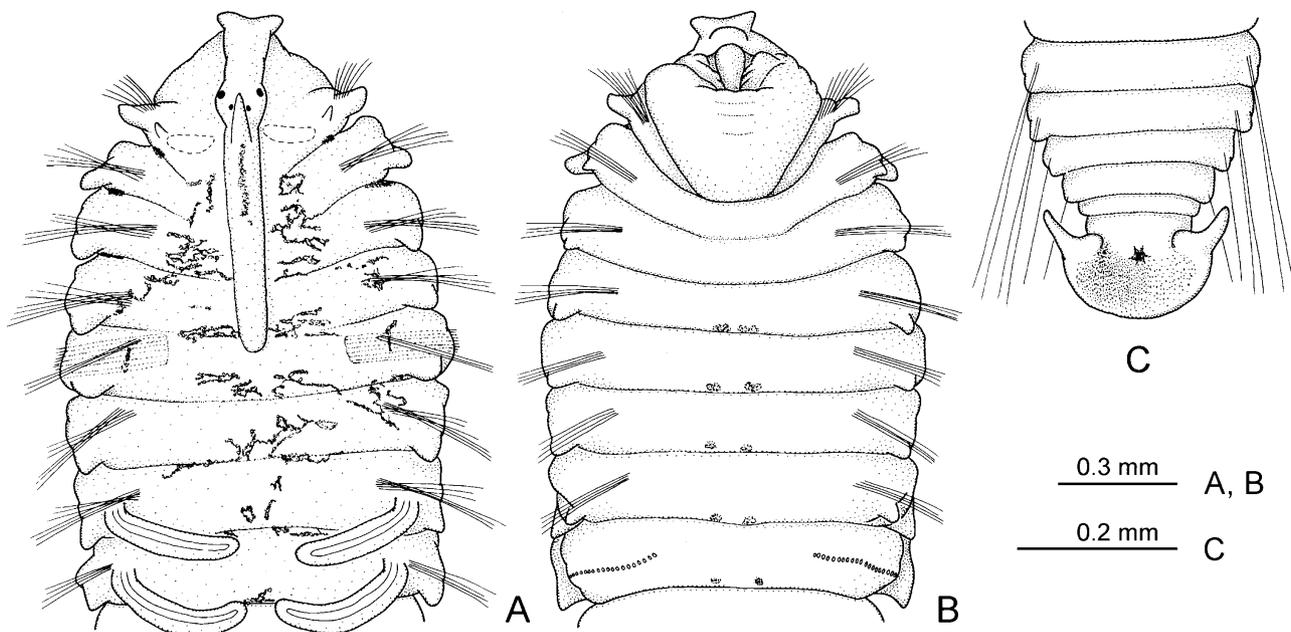
Pygidium disclike with dorsal gap and dorso-lateral processes (Fig. 8C).

Glandular pouches from segment 1, paired and largest in segments 6 and 7, single in other segments. No gizzardlike structure in digestive tract.

Female, paired gonoducts terminating externally into 1 middorsal gonopore on segments 13-22.

*Variability*: The largest complete 38-segment individual measures 14 mm long and 1.0 mm wide at segment 7. The black pigmentation is rather fragile and can be easily lost after fixation. The black band on the caruncle is usually present on fixed individuals. The caruncle extends posteriorly usually to end of segment 5; one individual had a caruncle extending to the middle of segment 6; individuals with less than 25 segments have shorter caruncles.

The species is gonochoric; gametes are



**Fig. 8.** *Pseudopolydora reticulata* sp. nov.

(A) Anterior end, dorsal view; (B) the same, ventral view; (C) posterior end, dorsal view.

A-C: ASIZW 168, holotype.

present in both females and males beginning from segment 12.

**Habitat:** *Pseudopolydora reticulata* inhabits muddy-sand tubes in soft bottoms of brackish-water environments. The species has been found in the same samples with *P. achaeta* (see above), *P. diopatra*, and *P. vexillosa* (see below).

**Differential diagnosis:** *P. reticulata* is very close to *Pseudopolydora bassarginensis* (Zachs, 1933). The latter species was originally described by Zachs (1933) from Peter the Great Bay (Sea of Japan). The original description was very brief, and the status of the species remained uncertain (Radashevsky unpubl.). Both species have characteristic netlike black pigmentation on the dorsal side of anterior segments, a narrow black band along the caruncle, similar major spines on segment 5, similar glandular pouches, and pygidium. They differ, however, in that *P. reticulata* has a longer caruncle, extending to the end of segment 5; even small, 25-segment individuals have caruncles extending beyond segment 4. Moreover, black paired spots are present on the ventral side of anterior segments. In *P. bassarginensis*, the caruncle extends posteriorly usually up to middle of segment 4 but rarely up to end of segment 4; black ventral pigmentation is always absent.

*Pseudopolydora reticulata* can be distinguished from the other related species by the presence of the black band on the caruncle and by the reticulate, netlike pigmentation on the dorsal side of anterior segments.

**Etymology:** The species name, feminine for Latin *reticulatus* (netlike, netted, reticulate) refers to the characteristic pattern of black pigmentation on the dorsal side of anterior segments.

**Distribution:** Taiwan.

### *Pseudopolydora vexillosa* sp. nov.

(Figs. 10, 11D)

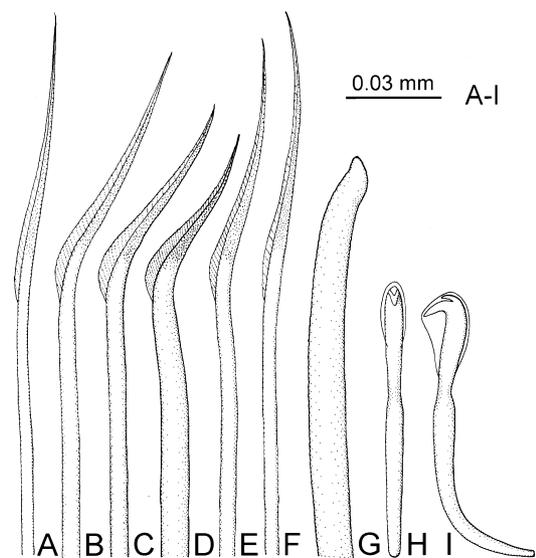
**Diagnosis:** A moderate-sized gonochoric *Pseudopolydora* species inhabiting mud tubes in soft bottoms. Body pigmentation absent. Prostomium rounded anteriorly. Four black eyes present. Caruncle reaching end of segment 4. Median antenna present on caruncle. Segment 1 with winged capillary neurochaetae. Anterior row notochaetae on segments from 7 up to 19 pennoned capillaries with shortly pointed main stem and enlarged semicircular limb tapering to a long tip. Segment 5 slightly modified; two kinds of major spines arranged in a straight oblique or in almost a vertical J-shaped double row. Pygidium a small disc with dorsal gap. Glandular pouches from segment 1, single through-

out.

**Type materials:** Tainan Co., lagoon at Chiku, 23°08'N, 120°04'E, < 2 m, mud, 14 May 1996: st. 10, ASIZW 177 (6), USNM 186532 (6); st. 11, ASIZW 178 (2); Tsengwen R. estuary, 23°04'N, 120°5'E, mud or fine sand: st. 1M, 18 Oct. 1994, ASIZW 179 (**holotype**); st. 1N, 18 Oct. 1994, ASIZW 180 (1); st. 2M, 18 Oct. 1994, ASIZW 181 (1); st. 2N, 18 Oct. 1994, ASIZW 182 (1); st. 2M, 26 May 1995, IMBV 3399 (2); st. 2N, 26 May 1995, ASIZW 183 (1); coast off Pachang R., 23°20'N, 120°02'E, st. 3, 14 m, mud, 7 Sept. 1994, ASIZW 184 (1). Taipei Co., Tanshui R. estuary, 25°10'N, 121°27'E, st. K-12, 5 m, mud, 14 Aug. 1998, ASIZW 185 (1).

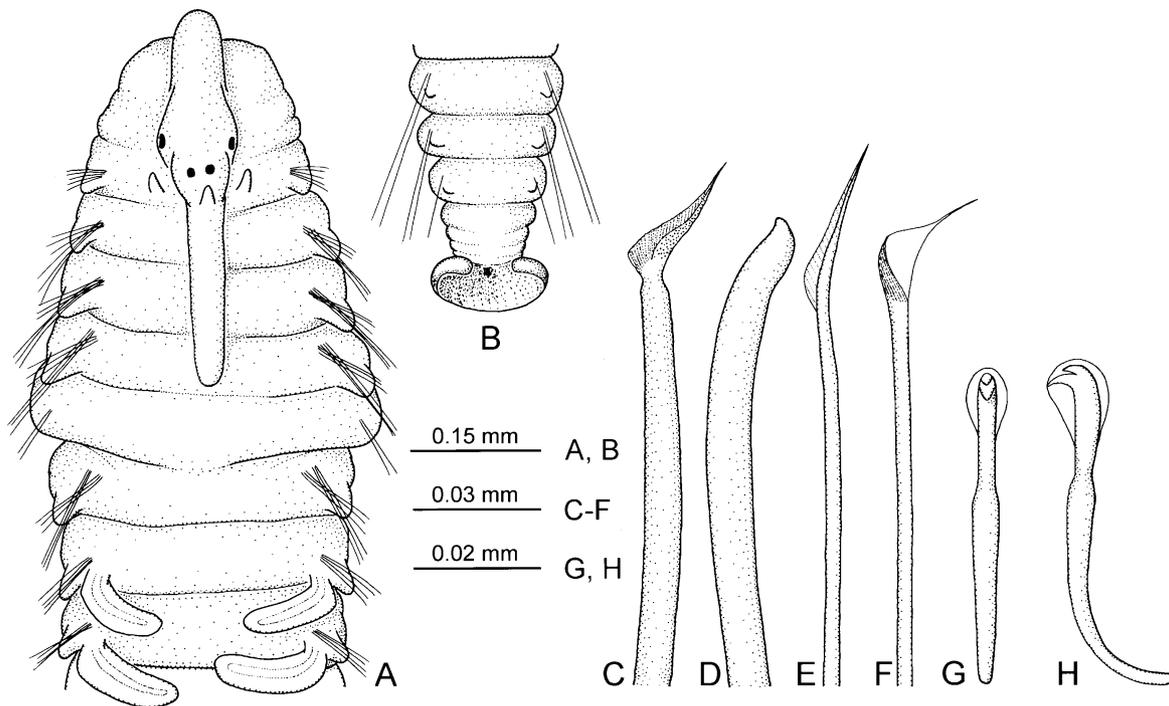
**Holotype:** Complete 50-segment individual measuring 5.2 mm long and 0.33 mm wide at segment 7. Body pigmentation absent. Prostomium rounded on anterior margin. Four black eyes present. Caruncle extending posteriorly to end of segment 4 (Fig. 10A). Short median antenna present on caruncle. Palps lost.

Segment 1 with small notopodial lamellae and well-developed neuropodial lamellae; notochaetae absent but winged capillary neurochaetae present. Notochaetae of segments 4 and 6 common winged capillaries with long, gradually tapering stem and



**Fig. 9.** *Pseudopolydora reticulata* sp. nov.

(A) Anterior row notochaeta of segment 2; (B) anterior row notochaeta of segment 3; (C) anterior row notochaeta of segment 4; (D) anterior row notochaeta of segment 5 (major spine); (E) anterior row notochaeta of segment 6; (F) anterior row notochaeta of segment 7; (G) posterior row notochaeta of segment 5 (major spine); (H) neuropodial bidentate hooded hook of segment 8, frontal view; (I) the same, lateral view. A-I: USNM 186531, paratype.



**Fig. 10.** *Pseudopolydora vexillosa* sp. nov.

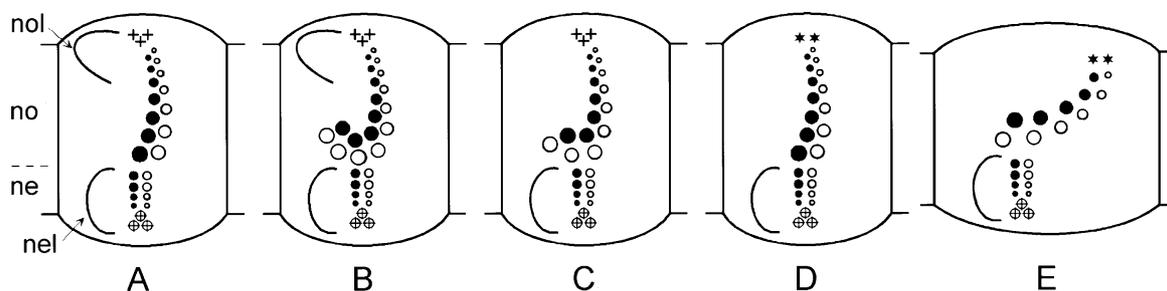
(A) Anterior end, dorsal view; (B) posterior end, dorsal view; (C) anterior row notochaeta of segment 5 (major spine); (D) posterior row notochaeta of segment 5 (major spine); (E) anterior row notochaeta of segment 6; (F) anterior row notochaeta of segment 7; (G) neuropodial bidentate hooded hook of segment 8, frontal view; (H) the same, lateral view.

A–B: ASIZW 179, holotype; C–H: ASIZW 177, paratype.

narrow limbation (Fig. 10E). Anterior row notochaetae on segments 7-17 modified pennoned capillaries with short pointed main stem and enlarged semicircular limbation tapering to a long tip (Fig. 10F); pennoned capillaries numbering up to 5 in a series; posterior row and superior notochaetae on these segments common slender winged capillaries.

Posterior notopodia with only a few long alimbate capillaries. Hooded hooks in neuropodia from segment 8; hooks bidentate with upper tooth closely applied to main fang and with constriction on upper part of shaft; lower part of shaft bent at right angle (Fig. 10G, H); hooks numbering up to 12 in a series.

Segment 5 slightly modified, almost the same in



**Fig. 11.** Schematic chaetal arrangement in segment 5 of *Pseudopolydora* species.

All the schemes show the right side of the body: dorsal side is up; the anterior is to the right. Newly developed chaetae are depicted by larger circles.

(A) *P. achaeta*; (B) *P. reticulata*; (C) *P. paucibranchiata*; (D) *P. vexillosa*; (E) *P. diopatra*.

no: notochaetae; ne: neurochaetae; nol: notopodial postchaetal lamellae; nel: neuropodial postchaetal lamellae; +: dorsal superior unmodified capillaries (the same as on segment 4 or 6); \*: dorsal superior modified capillaries (shorter and fewer in number than on segment 4 and 6); O: anterior row chaetae; ●: posterior row chaetae; ⊕: ventral inferior unmodified capillaries.

size as segments 4 or 6; notopodial postchaetal lamellae absent but small neuropodial lamellae present; dorsal superior capillaries shorter, thinner, and fewer in number than those chaetae on segments 4 or 6; ventral capillaries almost the same in shape and number as those chaetae on segments 4 or 6. Two kinds of notopodial major spines arranged in an almost straight, slightly oblique double row. Anterior row (outer) spines pennoned, with subdistal constriction (Fig. 10C), numbering 10 in a series; posterior row (inner) spines simple falcate with bent distal end (Fig. 10D), numbering 6 in a series.

Branchiae on segments 7-20, free from notopodial postchaetal lamellae, with flattened surfaces oriented laterally; with few large oval cells along posterior edge.

Pygidium a small disc with dorsal gap, without dorso-lateral processes (Fig. 10B).

Glandular pouches from segment 1, single throughout. No gizzardlike structure in digestive tract.

**Variability:** The largest individual measures 18.0 mm long and 0.5 mm wide for 71 segments. Body and palp pigmentation is absent in all paratypes. The prostomium is rounded anteriorly. Four black eyes and median antenna are present. The caruncle extends posteriorly to the end of segment 3, and extends up to the end of segment 4. Palps extend posteriorly for 15-20 segments. Anterior row noto-chaetae are modified pennoned capillaries on segments 7 to 17-19. Hooded hooks number up to 16 per neuropodium. Segment 5 is weakly modified. It is almost the same size or slightly larger than segments 4 or 6; dorsal superior capillaries are always shorter and fewer in number than those chaetae on segments 4 or 6; major spines are arranged in a straight oblique or in an almost vertical weakly J-shaped double row. Branchiae always begin from segment 7 and continue up to segment 21. The pygidium is a small disc without dorso-lateral processes.

**Habitat:** *Pseudopolydora vexillosa* inhabits mud tubes in soft bottoms of brackish-water environments. The species has been found together with *Dipolydora tentaculata*, *P. achaeta* (see above), *P. cf. kempii japonica*, and *P. reticulata* (see above).

**Differential diagnosis:** *P. vexillosa* is unique among presently known *Pseudopolydora* species in having modified pennoned capillaries in the notopodia of some middle segments.

**Etymology:** The species name, feminine for Latin *vexillosus* (flag-like, pennoned) refers to the characteristic shape of the modified noto-chaetae in middle segments.

**Distribution:** Taiwan.

## DISCUSSION

The *Pseudopolydora* species are among the least modified members of the polydorid complex of spionids, which have been identified as having a modified 5th segment (see Blake 1996). In most *Pseudopolydora* species, segment 5 is only slightly modified or the same in appearance as segments 4 or 6, usually with well-developed noto- and neuropodial postchaetal lamellae. Dorsal superior and ventral capillaries on this segment are often the same in shape and number as those chaetae on neighboring segments; thus, only anterior and posterior rows of noto-chaetae are modified (see Radashevsky and Fauchald 2000 for the chaetal arrangement and homology in spionids). In some *Pseudopolydora* species, even anterior row noto-chaetae on the 5th segment are similar in shape and number to winged capillary noto-chaetae on neighboring segments (e.g., *P. corniculata*). Such a trait may be considered to represent a plesiomorphic condition for polydorids. Posterior row noto-chaetae of *Pseudopolydora* species are always modified compared to noto-chaetae on neighboring segments. Generally they are simple falcate spines, similar in shape in most known species (e.g., *P. achaeta*, *P. kempii japonica*, *P. paucibranchiata*, *P. reticulata*, and *P. vexillosa*).

It is noteworthy that anterior row noto-chaetae are modified not only on segment 5 but also on neighboring segments in some *Pseudopolydora* species (e.g., *P. achaeta*, *P. gigeriosa*, *P. kempii japonica*, and *P. reticulata*). Such species show a gradation of noto-chaetal morphology from segments 4 to 6 or even from segments 3 to 7 whereby the spines are more modified on segment 5. Posterior row noto-chaetae do not demonstrate such gradation, and modification is always restricted to the 5th segment.

Another peculiarity of some *Pseudopolydora* species is the vertical J-shaped arrangement of modified spines on segment 5. This feature is traditionally considered to be a diagnostic characteristic of the genus. In other polydorids, the modified spines of the 5th segment are usually arranged in an oblique or almost straight horizontal row. The spine arrangement was assumed to be correlated to the elongation of the 5th segment (Radashevsky and Fauchald 2000). Thus, species with no elongated 5th segment (most *Pseudopolydora* members) have modified spines arranged vertically, the same as un-

modified notochaetae on neighboring segments (Fig. 11A-D). *Pseudopolydora diopatra* is unique among known species of the genus in having segment 5 elongated. Although the notochaetae in unmodified segments are arranged vertically, modified spines in segment 5 of *P. diopatra* are arranged in a curved, oblique, or almost horizontal row (Fig. 11E).

The J-shaped arrangement of modified spines in *Pseudopolydora* species is probably correlated with the spine number and their location. New spines appear in the lower part of the row near the neuropodium. They are larger than older superior spines. In species that have the same number of spines as capillaries on neighboring segments, the spines are both thicker and arranged in a comparatively longer row. In such cases, the vertical row appears reflected in a dorsal direction where it approaches the neuropodium, forming a J- or U-shaped row (e.g., *P. corniculata*, *P. kempii japonica*, *P. paucibranchiata*, and *P. reticulata*, Fig. 11B, C). If, however, the number of spines is low, the spines are arranged in a slightly curved or almost straight vertical row between the noto- and neuropodium (e.g., *P. achaeta*, *P. gigeriosa*, and *P. vexillosa*, Fig. 11A, D).

The morphology of *Pseudopolydora* species demonstrates that the definition of the polydorid complex needs to be clarified, and synapomorphies for polydorids (if they constitute a monophyletic group) should be established. A non-specific 'modification' of segment 5 cannot be considered to be a principal diagnostic feature of the complex because of the ambiguity of the precise nature of the 'modification'. As shown above, segment 5 is the same in appearance as neighboring segments in some *Pseudopolydora* species. Therefore, we suggest segment 5 should be distinguished in terms of the modification of both postchaetal lamellae and each group of noto- and neurochaetae (anterior, posterior, and superior or inferior). This approach would make it possible to code a series of characters for a cladistic analysis and to analyze relationships between polydorids and other spionid taxa.

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## 臺灣偽才女蟲多毛類

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本報告討論臺灣淺海及鄰近中國大陸海域 8 種偽才女蟲屬 (*Pseudopolydora*) 的海稚蟲多毛類 (Polychaeta: Spionidae)。這些種類包括了 *P. diopatra* Hsieh, 1992, *P. cf. kempii japonica* Imajima & Hartman, 1964, *P. paucibranchiata* Okuda, 1937, 及 5 種新種: *P. achaeta*, *P. corniculata*, *P. gigeriosa*, *P. reticulata* 和 *P. vexillosa*。這些種類都棲息於軟底質的泥沙質棲管中, 而 *P. diopatra* 也會出現於歐努菲蟲巢沙蠶 (*Diopatra sugokai*) 的彎曲管口上或牡蠣 (*Crassostrea gigas*) 殼的表面。本報告詳細地描述這些種類, 並製成檢索表以為鑑定之用。

**關鍵詞**: 海稚蟲多毛類, 偽才女蟲屬, 系統分類, 形態。

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