

## Six New Earthworms of the Genus *Amyntas* (Oligochaeta: Megascolecidae) from Central Taiwan

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(Accepted May 30, 2003)

**Huei-Ping Shen, Chu-Fa Tsai and Su-Chen Tsai (2003)** Six new earthworms of the genus *Amyntas* (Oligochaeta: Megascolecidae) from central Taiwan. *Zoological Studies* 42(4): 479-490. This paper describes 6 new species of terrestrial earthworms belonging to the genus *Amyntas* (Oligochaeta: Megascolecidae) from the Central Mountain Range of Taiwan at elevations of 700 to 2300 m. They are *Amyntas uvaglandularis* sp. nov., *Amyntas penpuensis* sp. nov. and *Amyntas nanshanensis* sp. nov. of the octothecal *corticis*-group; *Amyntas tantulus* sp. nov. and *Amyntas fenestrus* sp. nov. of the sixthecal *sieboldi*-group; and *Amyntas wangi* sp. nov. of the *gracilis*-group. <http://www.sinica.edu.tw/zool/zoolstud/42.4/479.pdf>

**Key words:** Earthworms, New species, *Amyntas*, Megascolecidae, Taiwan.

In 1999 and 2000, we conducted an earthworm survey in the central region of Taiwan along Highways 14 and 14A on the western slopes of the Central Mountain Range, and described 8 new forms. They were *Amyntas exiguus aquilonius*, *Amyntas wulinensis*, *Amyntas catenus*, *Amyntas proasacceus*, and *Amyntas hohuanmontis* (Tsai et al. 2001 2002) at elevations of 2300 to 3200 m; *Amyntas tessellatus tessellatus* and *A. tessellatus paucus* (Shen et al. 2002) at elevations of 700 to 3200 m; and *Metaphire taiwanensis* at elevations of 1800 to 2100 m (Tsai et al. 2003). This paper describes 6 new species from the remaining specimens collected at elevations of 700 to 2300 m in the survey. They are the octothecal *Amyntas uvaglandularis* sp. nov., *Amyntas penpuensis* sp. nov., and *Amyntas nanshanensis* sp. nov.; and the sixthecal *Amyntas tantulus* sp. nov., *Amyntas fenestrus* sp. nov., and *Amyntas wangi* sp. nov. With an addition of these new species, there are a total of 49 species of terrestrial earthworms known from Taiwan.

The earthworms collected were fixed in a 10% formalin-water solution and preserved in a 70% ethyl alcohol-water solution. They are pre-

served at Taiwan Endemic Species Research Institute, Chichi, Nantou, Taiwan. Scale bars equal 1 mm in all figures.

### *Amyntas uvaglandularis* sp. nov.

**Type materials:** Holotype: 1 mature (clitellate) specimen (93 mm, dissected) collected 18 Nov. 1999 from Rueyen Creek Nature Reserve (elevation 2300 m) by CF Tsai, SC Tsai, HP Shen, and CT Yao (coll. no. 1999-24-Shen). Paratypes: 6 mature and 3 immature specimens (same collection data as for holotype).

**Other materials:** 17 mature (2 dissected) and 36 immature specimens collected 19 Oct. 1999 at the National Taiwan University's High-altitude Horticulture Experimental Station at Meifeng (elevation 2100 m), Nantou by CF Tsai, SC Tsai, HP Shen, TJ Lin, and CY Chang (coll. no. 1999-16B-Shen); 22 mature (1 dissected) and 6 immature specimens collected 8 Dec. 1999 at Mt. Beidongyan (elevation 1800 m), Nantou by CF Tsai, SC Tsai, HP Shen, and PH Ho (coll. no. 1999-29-Shen).

**External characters:** Length (mature) 62-113

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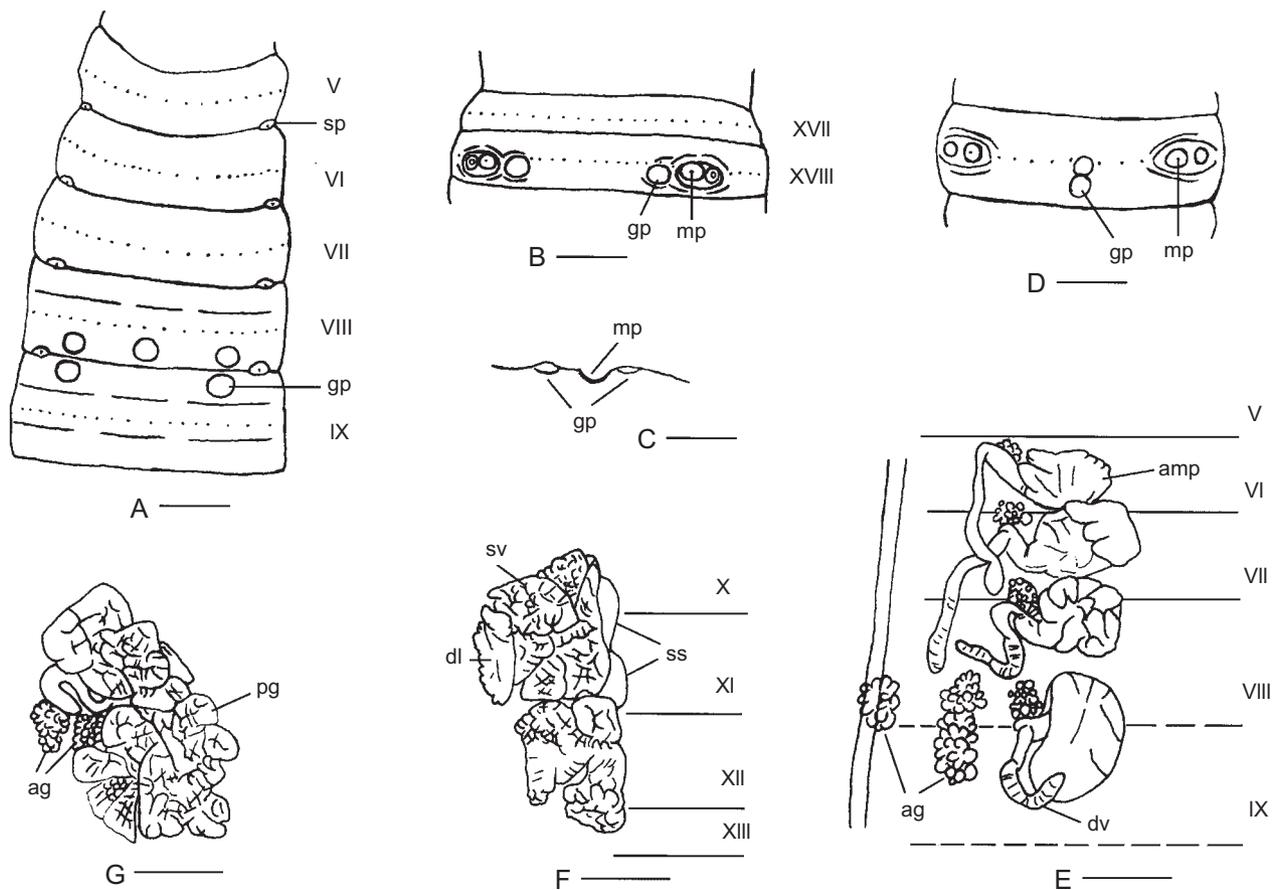
mm, clitellum width 2.95-3.26 mm. Prostomium epilobous. Segments numbering 75-115. First dorsal pore 10/11. Number of incomplete annulets 2-3 per segment in VIII-XIII. Setal number 33-44 in VII, 38-48 in XX, 11-13 between male pores in XVIII. Clitellum XIV-XVI, smooth, setae absent, dorsal pores absent, length 2.46-3.62 mm.

Four pairs of spermathecal pores in 5/6-8/9, ventrolateral, each on a papilla-like porophore in segmental furrow, distance between paired pores 0.31-0.35 body circumferences apart. Genital papillae postsetal, widely paired, latero-ventral in VIII, and presetal in IX, about 8 to 9 intersetal distances apart, occasionally with a papilla in medio-ventrum (Fig. 1A). For 10 type specimens examined, in VIII, presetal papillae absent from 9 specimens, 1 on left in 1 specimen, and postsetal papillae 1 pair in 9 specimens, 1 pair with an additional papilla in medio-ventrum in 1 specimen; in IX, pre-

setal papillae 1 pair in 9 specimens, 1 pair with a papilla in medio-ventrum in 1 specimen. Each papilla round, center flat or slightly concave, 0.3-0.37 mm in diameter, surrounded by a white rim. Female pore single, medioventral in XIV.

Male pores paired in XVIII, latero-ventral, minute, on a depressed porophore (Fig. 1C), with a small papilla adjacent laterally (Fig. 1B), both surrounded by 2 or 3 circular folds, distance between pores 0.25-0.30 circumferences apart. Two postsetal genital papillae in XVIII, each adjacent medially to male pore and close to setal line (Fig. 1B), about 10 or 11 intersetal distances apart, or 2 closely arranged in middle between the 2 male pores (Fig. 1D). Each papilla round, similar in structure to those in spermathecal region.

Preserved specimens dark brown on dorsum, light brown on ventrum, dark brown around clitellum.



**Fig. 1.** *Amynthus uvaglandularis* sp. nov. holotype (93 mm). (A) Ventral view of the preclitellar region (gp, genital papilla; sp, spermathecal porophore); (B) ventral view of male pores (mp) and postclitellar genital papillae (gp); (C) depressed male pore porophore and adjacent genital papillae; (D) ventral view of male pores (mp) and postclitellar genital papillae in mid-ventrum for 3 specimens from Mt. Beidongyan; (E) spermathecae (amp, ampulla; dv, diverticulum) and accessory glands (ag); (F) right sperm sacs (ss) and seminal vesicles (sv) (dl, dorsal lobe); (G) right prostate gland (pg) and accessory glands (ag).

**Internal characters:** Septa 8/9/10 absent, 11/12-13/14 thickened. Gizzard round in IX and X. Intestine enlarged from XV. Intestinal caeca paired in XXVII, each simple, surface slightly wrinkled, extending anteriorly to XXIV-XXIII. Esophageal hearts enlarged in XI-XIII.

Four pairs of spermathecae in VI-IX (Fig. 1E). Ampulla oval, 1.27-1.54 mm long, 0.67-1.09 mm wide, duct stout, 0.36-0.41 mm long. Diverticulum long and slender, 1.15-1.62 mm long, with or without distal oval seminal chamber. Accessory glands sessile, each in the form of a grape-like follicular mass, about 0.65 mm long and 0.45 mm wide, corresponding to each of the external genital papillae. At base of each spermathecal duct with an accessory gland in a mass of smaller follicles.

**Holandry:** Sperm sacs paired in X and XI, large, round. Seminal vesicles paired in XI and XII, large, each occupying 1.5 to 2 segments, follicular, yellow, with a large granulated dorsal lobe (Fig. 1F). Prostate glands paired in XVIII, large, lobed, extending from XVI to XX or XXI, prostatic duct C-shaped, distal end enlarged. Accessory glands similar in structure to those in spermathecal region (Fig. 1G); large (about 0.75 mm long) gland corresponding to genital papilla medial to male pore, while small (about 0.6 mm in length) one at base of prostatic duct corresponding to papilla lateral to male pore. Both about 0.4 mm wide.

**Locality and habitat:** In Rueyen Creek Nature Reserve (a natural broadleaf forest) and at Mt. Beidongyan, *A. uvaglandularis* sp. nov. was found entangled in grass roots in soil on wet mountain slopes. At the National Taiwan University's High-altitude Horticulture Experimental Station, Meifeng, this species was collected from ditches. The above 3 sites are located at elevations of 1800 to 2300 m.

**Remarks:** *Amyntas uvaglandularis* sp. nov. has 4 pairs of spermathecae in VI-IX, and belongs to the *corticis* (= *diffringens*) species-group (Sims and Easton 1972). Its porophore structure resembles that of *A. silvestrii* (Cognetti 1909) from Hawaii of the same species-group. However, the median papilla is larger and lateral papilla smaller in *A. uvaglandularis*. Also, *A. uvaglandularis* has long diverticula and large prostate glands, whereas *A. silvestrii* has short diverticulum stalks and small prostate glands.

The name "*uvaglandularis*" is given with reference to the grape-like accessory glands of the earthworm.

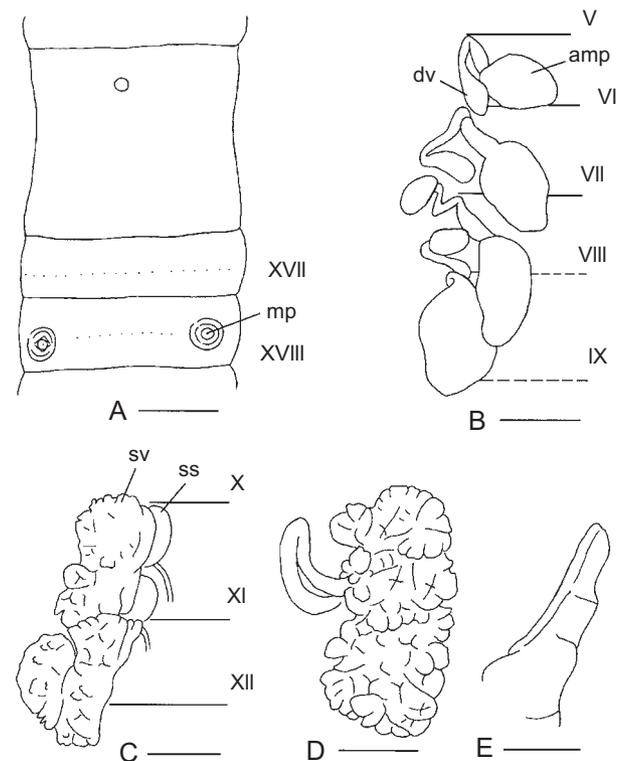
***Amyntas penpuensis* sp. nov.**

**Type materials:** Holotype: 1 mature (clitellate) specimen (94 mm, dissected) collected 10 Nov. 1999 on a mountain slope along Penpu Creek (elevation 700-800 m), Jenai Township, Nantou by CF Tsai, SC Tsai, JW Luo, HP Shen, MH Shen, JL Lai, and CY Chang (coll. no. 1999-21-Shen). Paratypes: 32 mature and 1 immature specimens (same collection data as for holotype).

**Other materials:** 9 mature (1 dissected) and 3 immature specimens collected 10 Nov. 1999 on a mountain slope along Nanshan Creek (elevation 800-900 m), Jenai Township, Nantou by the same collectors of holotype (coll. no. 1999-20-Shen).

**External characters:** Length (mature) 55-104 mm, clitellum width 2.22-3.21 mm. Prostomium epilobous. Segments numbering 62-104. First dorsal pore 5/6 or 6/7. Number of incomplete annulets 2-3 per segment in VIII-XIII. Setal number 27-37 in VII, 36-46 in XX, 8-11 between male pores in XVIII. Clitellum XIV-XVI, smooth, setae absent, dorsal pores absent or marked with shallow depression, 2.07-2.82 mm long.

Spermathecal pores 5/6-8/9, not visible exter-



**Fig. 2.** *Amyntas penpuensis* sp. nov. holotype (94 mm). (A) Ventral view of the male pore (mp) region; (B) right spermathecae (amp, ampulla; dv, diverticulum); (C) right sperm sacs (ss) and seminal vesicles (sv); (D) right prostate gland; (E) right intestinal caecum.

nally. Female pore single, medioventral in XIV. Male pores paired in XVIII, 0.25-0.28 body circumferences ventrally apart, porophore round, 0.25-0.30 mm in diameter, surrounded by 2 to 4 slight circular or diamond-shaped folds (Fig. 2A). No genital papillae in either preclitellar or postclitellar regions.

Preserved specimens gray on dorsum, whitish gray on ventrum, light brown around clitellum.

*Internal characters:* Septa 8/9/10 absent, 6/7/8 and 11/12-13/14 thick. Gizzard round in IX and X. Intestine enlarged from XVI. Intestinal caeca paired in XXVII, each simple, surface slightly wrinkled, extending anteriorly to XXV-1/2XXIV (Fig. 2E). Esophageal hearts enlarged in XI-XIII.

Four pairs of spermathecae in VI-IX (Fig. 2B). Ampulla peach-shaped, 0.96-1.31 mm long, 0.73-0.93 mm wide, duct stout, about 0.4 mm long. Diverticulum stalk slender, straight or curved, 0.44-0.56 mm long, seminal chamber oval-shaped, 0.42-0.5 mm long.

*Holandry:* Two pairs of sperm sacs in XI, round. Seminal vesicles paired in XI and XII, 2nd pair larger than 1st pair, occupying 1.5 to nearly 2 segments, fairly smooth, yellow (Fig. 2C). Prostate glands paired in XVIII, extending from XVII to XX, prostatic duct slender, U-shaped (Fig. 2D).

*Locality and habitat:* *Amyntas penpuensis* sp. nov. occurs on mountain slopes wetted by water seeping from underground at elevations of 700 to 900 m along Nanshan and Penpu Creeks.

*Remarks:* *A. penpuensis* sp. nov. has 4 pairs of spermathecae in VI-IX, and belongs to the *corticis* species-group (Sims and Easton 1972). It is fairly similar in structure to *Amyntas fornicatus* (Gates) of Sichuan, China, by having a simple male pore structure without genital papillae. However, *A. fornicatus* has larger, disk-shaped or square male porophores and higher setal numbers (Gates 1935, Chen 1936), while *A. penpuensis* has small round porophores and lower numbers of setae (Table 1). Also, spermathecal pores are not visible externally on *A. penpuensis*, whereas they are visible externally on the papillae (porophores) on *A. fornicatus*. In addition, the 1st dorsal pore is in 5/6 or 6/7 for *A. penpuensis* whereas it is in 11/12 or 12/13 for *A. fornicatus*. The name "*penpuensis*" is given with reference to the type locality on the mountain slope along Penpu Creek.

#### *Amyntas nanshanensis* sp. nov.

*Type materials:* Holotype: 1 mature (clitellate) specimen (75 mm, dissected) collected 10 Nov. 1999 on a mountain slope along Nanshan Creek (elevation 800-900 m), Jenai Township, Nantou by

**Table 1.** A comparison of characters between *Amyntas penpuensis* sp. nov. of Taiwan and *A. fornicatus* (Gates) of Sichuan, China

Character	<i>Amyntas penpuensis</i> sp. nov.	<i>Amyntas fornicatus</i> (Gates, 1935)
Body length (mm)	55-104	78-94 <sup>a</sup>
Clitellum width/diameter (mm)	2.2-3.2	4-6
Segment number	62-104	90-105 <sup>b</sup>
First dorsal pore	5/6 or 6/7	11/12 or 12/13 <sup>a</sup>
Prostomium	Epilobous	Epilobous <sup>b</sup>
Setal number		
VII	27-37	43-50 (VI) <sup>b</sup>
VIII	-	46-52 <sup>b</sup>
XII	-	42-52 <sup>b</sup>
XX	36-46	56
XXV	-	45-55 <sup>b</sup>
between male pores	8-11	9-14
Spermathecal pores	Not visible	4 pairs (5/6-8/9) on the porophores
Number of spermathecae	4 pairs (VI, VII, VIII, IX)	4 pairs (VI, VII, VIII, IX)
Male porophore	Small, round	Large, disk-shaped or square
Genital papillae	Absent	Absent
Seminal vesicle	Large	Small and elongate <sup>b</sup>

<sup>a</sup>Data of Gates (1935) and Chen (1936) combined.

<sup>b</sup>Data of Chen (1936).

CF Tsai, SC Tsai, JW Luo, HP Shen, MH Shen, JL Lai, and CY Chang (coll. no. 1999-20-Shen). Paratypes: 68 mature and 2 immature specimens (same collection data as for holotype).

*Other materials:* 3 mature specimens (1 dissected) collected 8 Dec. 1999 at Mt. Beidongyan (elevation 1800 m), Nantou by CF Tsai, SC Tsai, HP Shen, and PH Ho (coll. no. 1999-29-Shen).

*External characters:* Length (mature) 41-89 mm, clitellum width 2.19-3.02 mm. Prostomium epilobous. Segments numbering 50-104. First dorsal pore 5/6. Number of incomplete annulets 2-3 per segment in IX-XIII. Setal number 28-36 in VII, 34-44 in XX, 8-12 between male pores in XVIII. Clitellum XIV-XVI, smooth, setae absent, dorsal pores absent, 1.94-3.23 mm long.

Spermathecal pores 5/6-8/9, 0.33-0.34 body circumferences ventrally apart. Genital papillae in VII-IX, number and position variable among specimens. For 71 type specimens examined, in VII, presetal papilla absent from 70 specimens, single median in 1 specimen; in VIII, presetal absent from 8 specimens, single median (Fig. 3B) in 18 specimens, 2 closely adjacent median papillae in 1 specimen, 2 papillae about 7 intersetal distances apart in 6 specimens, single median with 1 on right or left in 10 specimens, single median with 1 on both sides (Fig. 3A) in 21 specimens, 2 median with 1 on either side in 5 specimens, 6 papillae in 2 specimens, and postsetal absent from 56 specimens, 2 postsetal papillae 7 or 8 intersetal distances apart (Fig. 3C) in 10 specimens, 1 on right or left in 5 specimens; in IX, presetal absent from 63 specimens, 2 papillae 7 or 8 intersetal distances apart in 7 specimens, 1 on left in 1 specimen. Each papilla round, center concave, 0.22-0.35 mm in diameter. Female pore single, medioventral in XIV.

Male pores paired in XVIII, 0.24-0.29 body circumferences ventrally apart, each with a lateral papilla closely adjacent, both male pore and papilla surrounded by 2 or 3 slight circular folds (Fig. 3D). Genital papillae widely paired, presetal in XVIII and XIX slightly medial to male pores. For 71 type specimens examined, in XVIII, absent from 44 specimens, paired in 24 specimens, 1 on right or left in 3 specimens; in XIX, absent from 15 specimens, paired in 42 specimens, 1 on right or left in 14 specimens. Each papilla round, center concave, about 0.2 mm in diameter, similar in structure to those in spermathecal region.

Preserved specimens purplish brown on dorsum, light gray on ventrum, yellowish gray around clitellum.

*Internal characters:* Septa 8/9/10 absent, 5/6-7/8 and 10/11-13/14 thickened. Gizzard round in IX and X. Intestine enlarged from XIV or XV. Intestinal caeca paired in XXVII, each simple, surface slightly wrinkled, short, extending anteriorly to XXV (Fig. 3H). Esophageal hearts enlarged in XI-XIII.

Four pairs of spermathecae in VI-IX (Fig. 3E). Ampulla peach-shaped, 0.98-1.45 mm long, 0.62-1.47 mm wide, duct stout, 0.45-0.53 mm long. Diverticulum stalk slender, about 0.5 mm long, seminal chamber oval-shaped, about 0.45 mm long. Accessory glands large, round, about 0.46 mm in diameter, stalk short, about 0.24 mm long, corresponding to external genital papillae.

*Holandry:* Two pairs of sperm sacs in XI, round. Seminal vesicles paired in XI and XII, large, each occupying about 1.5 segments, follicular, yellow, dorsal lobe follicular (Fig. 3F). Prostate glands paired in XVIII, extending from XVII to XX, prostatic duct C-shaped. Accessory glands smaller than those in preclitellar region, slightly lobed, stalk 0.1-0.3 mm long, head 0.1-0.3 mm long (Fig. 3G). No gland associated with papilla lateral to male pore.

*Locality and habitat:* *Amyntas nanshanensis* sp. nov. occurs on mountain slopes wetted by seeping water at elevations of 800-900 m along Nanshan Creek and in wet gravel substrate at Mt. Beidongyan at an elevation of 1800 m.

*Remarks:* *A. nanshanensis* sp. nov. is an octothecal earthworm belonging to the *corticis* species-group of the genus *Amyntas* (Sims and Easton 1972). It has a small round porophore immediately adjacent lateral to a small genital papilla without an accessory gland, and also has widely paired genital papillae with stalked accessory glands in both spermathecal and male pore regions. These characters are easily distinguishable from those of the other 3 species of the *corticis* species-group that have been described from Taiwan: *Amyntas penpuensis* sp. nov., *A. uvaglandularis* sp. nov., and *A. wulinensis* (Tsai et al. 2001). *A. penpuensis* has no genital papillae, and *A. wulinensis* has no papillae in the spermathecal region, but has widely paired papillae with sessile accessory glands in the male pore region (Tsai et al. 2001). *A. uvaglandularis* has large sessile folliculate accessory glands associated with papillae adjacent to each of the male porophores and also paired genital papillae in both spermathecal and male pore regions, whereas *A. nanshanensis* has stalked accessory glands. Based on the position of the genital papillae, *A. nanshanensis*

sis is more closely related to *A. uvaglandularis* than to *A. wulinensis* or *A. penpuensis*.

The characters of a genital papilla closely adjacent to the male pore and the presence of paired presetal papillae in XVIII for *A. nanshanensis* of Taiwan are fairly similar to those of *Amyntas youngtai* of Korea (Hong and James 2001). However, *A. nanshanensis* is smaller and has lower segment and setal numbers than *A. youngtai*. Also, the former has stalked accessory glands, while the latter has sessile accessory glands (Table 2).

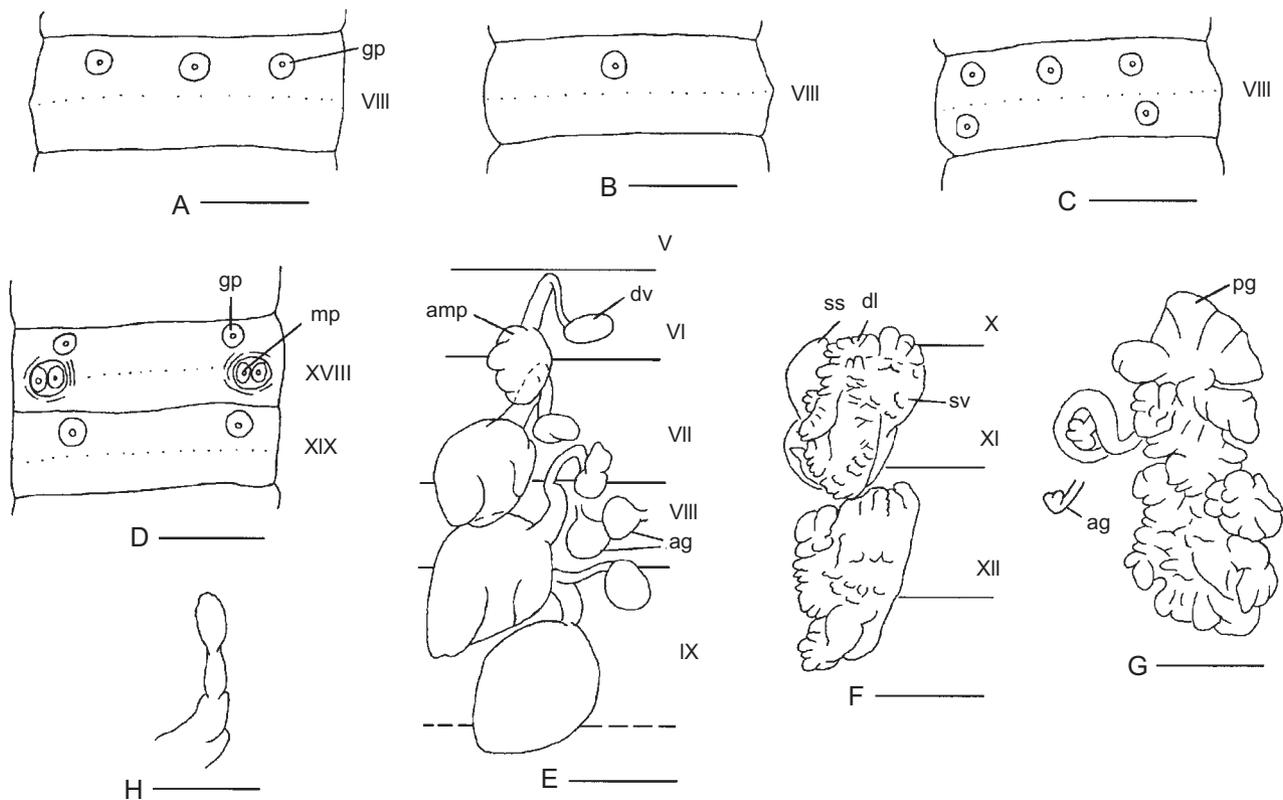
*Amyntas carnosus* was first described by Goto and Hatai (1899) as a species with 3 pairs of spermathecae, and thus Sims and Easton (1972) assigned it to the *gracilis* (= *hawayanus*) species-group. However, Ohfuchi (1937) made a detailed examination of the species and indicated that 4 pairs of spermathecae are the typical form of *A. carnosus*, and thus *A. carnosus* should be placed within the *corticis* species-group as *A. nanshanensis*.

When *A. carnosus* of Japan described by Ohfuchi (1937) is compared with *Amyntas sangyeoli* of Korea described by Hong and James (2001), it is clear that they share similar characters (Table 2). Accordingly, *A. sangyeoli* Hong and James, 2001 is synonymous to *A. carnosus* (Goto and Hatai 1899).

The name "*nanshanensis*" is given with reference to the type locality on the mountain slope along Nanshan Creek.

### *Amyntas tantulus* sp. nov.

*Type materials*: Holotype: 1 mature (clitellate) specimen (51 mm, dissected) collected 18 Nov. 1999 from Rueyen Creek Nature Reserve (elevation 2300 m), Nantou Co. by CF Tsai, SC Tsai, HP Shen, and CT Yao (coll. no. 1999-24-Shen). Paratypes: 12 mature (1 dissected) and 6 immature specimens (same collection data as for holotype).



**Fig. 3.** *Amyntas nanshanensis* sp. nov. holotype (75 mm). (A) Ventral view of the preclitellar region (gp, genital papilla); (B) ventral view of the preclitellar region of a 69-mm paratype; (C) ventral view of the preclitellar region of a 60-mm paratype; (D) ventral view of the male pore (mp) region with postclitellar genital papillae; (E) left spermathecae (amp, ampulla; dv, diverticulum) and accessory glands (ag); (F) right sperm sacs (ss) and seminal vesicles (sv) (dl, dorsal lobe); (G) right prostate gland (pg) and accessory gland (ag); (H) right intestinal caecum.

*External characters:* Small earthworm, length (mature) 32-58 mm, clitellum width 1.74-2.15 mm. Prostomium epilobous. Segments numbering 65-90. First dorsal pore 5/6. Number of incomplete annulets 2-3 per segment in VIII-XI. Setal number 26-35 in VII, 28-35 in XX, 8-10 between male pores in XVIII. Clitellum XIV-XVI, smooth, setae absent, with or without dorsal pore markings, 1.63-2.45 mm long.

Three pairs of spermathecal pores in 6/7-8/9, ventrolateral in depressed furrow, distance between paired pores 0.3-0.36 body circumferences ventrally apart. Genital papillae presetal, closely paired in mid-ventral regions in IX-XII, number variable among specimens and segments (Fig. 4A). For 19 specimens examined, in IX, presetal papillae absent from 16 specimens, 1 on left in 1 specimen, 1 pair in 2 specimens; in X, 1 pair in 17 specimens, 1 on left in 1 specimen, absent from 1 specimen; in XI, absent from 12 specimens, 1 on right in 2 specimens, 1 on left in 2 specimens, 1 pair in 3 specimens; in XII, absent from 18 specimens, 1 on left in 1 specimen. Each papilla small, round, flat-topped or slightly concave, about 0.15 mm in diameter. Female pore single, medioventral in XIV.

Male pores paired in XVIII, latero-ventral, distance between pores 0.26-0.31 circumferences apart. For 19 type specimens examined, male aperture minute in a round porophore of about 0.25 mm in diameter, surrounded by 3 or 4 slight circular or diamond-shaped folds (Fig. 4B) in 14 specimens, and the male pore with a small, less distinctly marked genital papilla pad adjacent laterally (Fig. 4C) in 5 specimens. Genital papillae presetal, closely paired in mid-ventral portion in XVIII-XX. For 19 specimens examined, in XVIII, 1 pair of presetal papillae in 18 specimens, 1 on left in 1 specimen; in XIX, 1 pair in 17 specimens, absent from 1 specimen, 1 on right in 1 specimen; in XX, 1 pair in 3 specimens. Each papilla small, round, center concave, size and arrangement similar to those in spermathecal region.

Preserved specimens dark reddish brown on dorsum, light gray on ventrum, light orange brown around clitellum.

*Internal characters:* Septa 8/9/10 absent, 5/6-7/8 and 10/11-12/13 thickened. Gizzard round in IX and X. Intestine enlarged from XV. Intestinal caeca paired in XXVII, each simple, short, stocky, surface slightly wrinkled, extending anteriorly to XXV (Fig. 4H). Esophageal hearts enlarged in XI-

**Table 2.** A comparison of characters among *Amyntas nanshanensis* sp. nov., *A. carnosus* (Goto and Hatai), *A. sangyeoli* Hong and James, and *A. youngtai* Hong and James within the *corticis* species-group of the genus *Amyntas* Kinberg

Character	<i>A. nanshanensis</i> sp. nov.	<i>A. youngtai</i> Hong and James, 2001	<i>A. carnosus</i> (Goto and Hatai, 1899) <sup>a</sup>	<i>A. sangyeoli</i> Hong and James, 2001
Locality	Taiwan	Korea	Japan	Korea
Elevation (m)	800-1800	—	—	—
Length (mm)	41-89	165-190	155-192	165-186
Segments	50-104	110-123	107-135	118-126
First dorsal pore	5/6	12/13	12/13	12/13
Setal number				
VII	28-36	39	35-43	35
XX	34-44	64	62-69	50
between male pores	8-12	16-17	16-19	18-21
Genital papillae				
papilla adjacent to male pore	One lateral	One posterior	Absent	Absent
preclitellar	1-8 in VIII	Paired presetal in IX	Paired presetal in VIII, IX	Paired presetal in VIII, IX
postclitellar	Paired presetal in XVIII and XIX	Paired presetal in XVIII	Paired presetal and postsetal in XVIII	Paired presetal and postsetal in XVIII
Seminal vesicles	Large	Small	Small	Small
Prostate glands	Large	Small	Large	Large
Prostatic ducts	C-shaped	U-shaped	C-shaped	U-shaped
Accessory glands	Stalked, round or lobed	Sessile, large in XVIII	Sessile, round, granular mass	Sessile

<sup>a</sup>*A. carnosus* was first described by Goto and Hatai (1899), but the description of Ohfuchi (1937) was more detailed and used in this study.

## XIII.

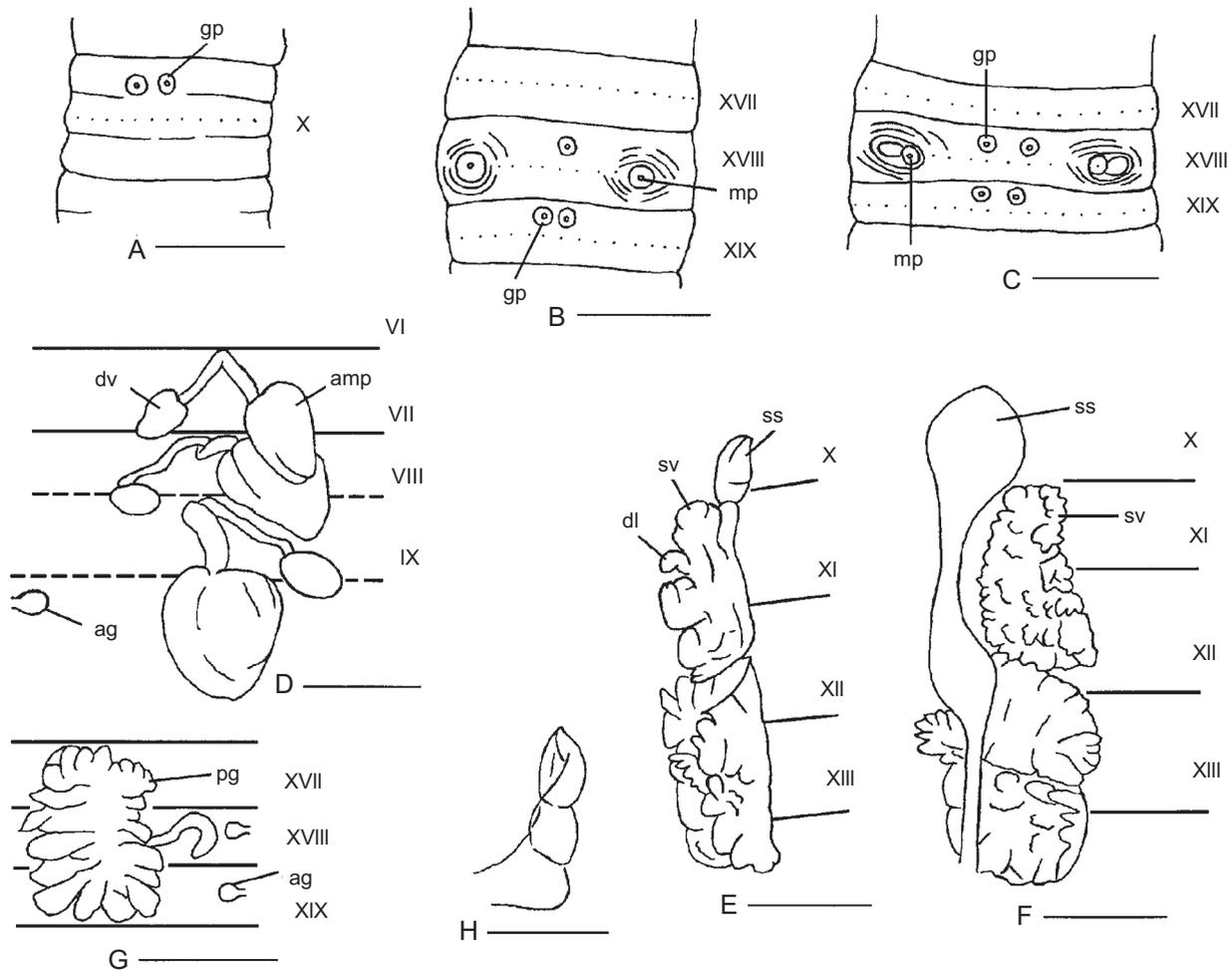
Three pairs of spermathecae in VII-IX (Fig. 4D). Ampulla peach-shaped, 2nd and 3rd pairs larger than 1st pair, 0.65-1.06 mm long, 0.51-0.77 mm wide; stalk 0.38-0.52 mm long. Diverticulum stalk straight or slightly bent, 0.38-0.68 mm long; seminal chamber oval-shaped, 0.3-0.4 mm long. Accessory glands round, flat, with extremely short stalk, corresponding to external genital papillae.

*Holandry*: First pair of sperm sacs large in X, connected with posterior pair of lesser enlargement in XII (Fig. 4F). Seminal vesicles large, extending between segments XI and XIII or XI and XIV, surface wrinkled, follicular, creamy (Fig. 4E, F). Prostate glands paired in XVIII, wrinkled, occupying 3 to 4 segments in XVI-XX; prostatic duct C-shaped. Accessory glands similar in size and struc-

ture to those in spermathecal region (Fig. 4G).

*Locality and habitat*: *Amyntas tantulus* was commonly found in soil mixed with gravel on wet mountain slopes in Rueyen Creek Nature Reserve at an elevation of 2300 m.

*Remarks*: *A. tantulus* sp. nov. is sixthecal and belongs to the *sieboldi*-group (Sims and Easton 1972). Its small size, large seminal vesicles, segment and setal numbers, and the position of the 1st dorsal pore are fairly similar to those of *Amyntas dactylicus* (Chen, 1946) of Sichuan, China (Table 3). However, *A. tantulus* has short stalked accessory glands and preclitellar genital papillae, whereas *A. dactylicus* has sessile accessory glands and no preclitellar genital papillae. The 2 species also have different spermathecal structures. The name "*tantulus*" is given with ref-



**Fig. 4.** *Amyntas tantulus* sp. nov. holotype (51 mm). (A) Ventral view of the preclitellar region (gp, genital papilla); (B) ventral view of male pores (mp) and postclitellar genital papillae; (C) ventral view of male pores (mp) and postclitellar genital papillae of a 41-mm paratype; (D) right spermathecae (amp, ampulla; dv, diverticulum; ag, accessory gland); (E) dorsal view of the right sperm sacs (ss) and seminal vesicles (sv) (dl, dorsal lobe); (F) ventral view of sperm sacs (ss) and seminal vesicles (sv); (G) left prostate gland (pg) and accessory gland (ag); (H) right caecum.

erence to the small size of this species.

***Amyntas fenestrus* sp. nov.**

*Type materials:* Holotype: 1 mature (clitellate) specimen (71 mm, dissected) collected 18 Nov. 1999 from Rueyen Creek Nature Reserve (elevation 2300 m), Nantou Co. by CF Tsai, SC Tsai, HP Shen, and CT Yao (coll. no. 1999-24-Shen). Paratypes: 7 mature (3 dissected) specimens (same collection data as for holotype).

*Other materials:* 1 mature (clitellate, 70 mm, dissected) and 1 immature specimens collected 8 Dec. 1999 at Mt. Beidongyan (elevation 1800 m), Nantou by CF Tsai, SC Tsai, HP Shen, and PH Ho (coll. no. 1999-29-Shen).

*External characters:* Body length (mature) 60-73 mm, clitellum width 2.58-2.92 mm. Prostomium

epilobous. Segments numbering 83-103. First dorsal pore 5/6 or 6/7. Number of incomplete annulets 2-3 per segment in IX-XIII, XVII, and XVIII. Setal number 30-36 in VII, 33-43 in XX, 8-10 between male pores in XVIII. Clitellum XIV-XVI, smooth, setae and dorsal pores absent, length 2.22-3.37 mm.

Three pairs of spermathecal pores in 6/7-8/9, ventrolateral in depressed furrow, distance between paired pores 0.31-0.34 body circumferences ventrally apart. Genital papillae presetal, widely paired in IX, close to intersegmental furrow, 5 or 6 intersetal distances apart (Fig. 5A). Each papilla large, round, concave, about 0.34 mm in diameter. Female pore single, medioventral in XIV.

Male pores paired in XVIII, latero-ventral, distance between pores 0.26-0.3 circumferences

**Table 3.** A comparison of characters among *Amyntas fenestrus* sp. nov. and *A. tantulus* sp. nov. of Taiwan and *A. dactylicus* (Chen) of Sichuan, China

Character	<i>Amyntas fenestrus</i> sp. nov.	<i>Amyntas tantulus</i> sp. nov.	<i>Amyntas dactylicus</i> (Chen)
Elevation (m)	1800-2300	2300	1829-2439
Body length (mm)	60-73	32-58	35-70
Segment number	83-103	65-90	65-108
First dorsal pore	5/6 or 6/7	5/6	4/5
Prostomium	Epilobous	Epilobous	Epilobous
Setal number			
VII	30-36	26-35	-
IX	-	-	35
XIX	-	-	34
XX	33-43	28-35	-
XXV	-	-	36
between male pores	8-10	8-10	10-12
Spermathecal pores	3 pairs (6/7/8/9)	3 pairs (6/7/8/9)	3 pairs (6/7/8/9)
Number of spermathecae	3 pairs (VII, VIII, IX)	3 pairs (VII, VIII, IX)	3 pairs (VII, VIII, IX)
Spermathecae	Ampulla peach-shaped, 0.65-1.06 mm in length, diverticulum with oval seminal chamber	Ampulla peach-shaped, about 1 mm in length, diverticulum with oval seminal chamber	Ampulla large, about 2 mm in length, diverticulum with dactyloid and pointed seminal chamber
Genital papillae			
preclitellar	Presetal, widely paired, latero-ventrum of IX	Presetal, paired, medio-ventrum of IX-XII	Absent
postclitellar	Absent or paired, presetal, medial to male pores, and absent to paired, postsetal, medio-ventrum of XVIII	Presetal, paired, medio-ventrum of XVIII-XX	One or two medial to male pore, and presetal, paired, medio-ventrum of XVIII
Seminal vesicle	Large	Large	Large
Intestine enlarged from	XV	XV	XV
Prostate gland	3 to 4 segments in XVI-XX	3 to 4 segments in XVI-XX	Large, XVI-XXIV
Prostatic duct	C-shaped	C-shaped	V-curve
Accessory glands	Preclitellar glands large, oval or lobed, short-stalked; postclitellar glands round, sessile or stalked	Small, round, short-stalked	Sessile

apart. One round, blackish gray papilla adjacent laterally to each male pore (Fig. 5B). For 8 type specimens examined, 1 specimen with 2 papillae lateral to each male pore (Fig. 5C). Other genital papillae number and position highly variable: excluding 1 damaged specimen, in XVIII, large presetal papillae widely paired immediately posterior to 17/18 in 3 specimens, absent from 4 specimens, and large postsetal papillae closely paired in medio-ventrum in 1 specimen, 1 on right in 1 specimen, 1 on left in 1 specimen, absent from 4 specimens. Each papilla round, center concave, about 0.3 mm in diameter.

Preserved specimens brownish gray on dorsum, light gray on ventrum, light brownish gray around clitellum.

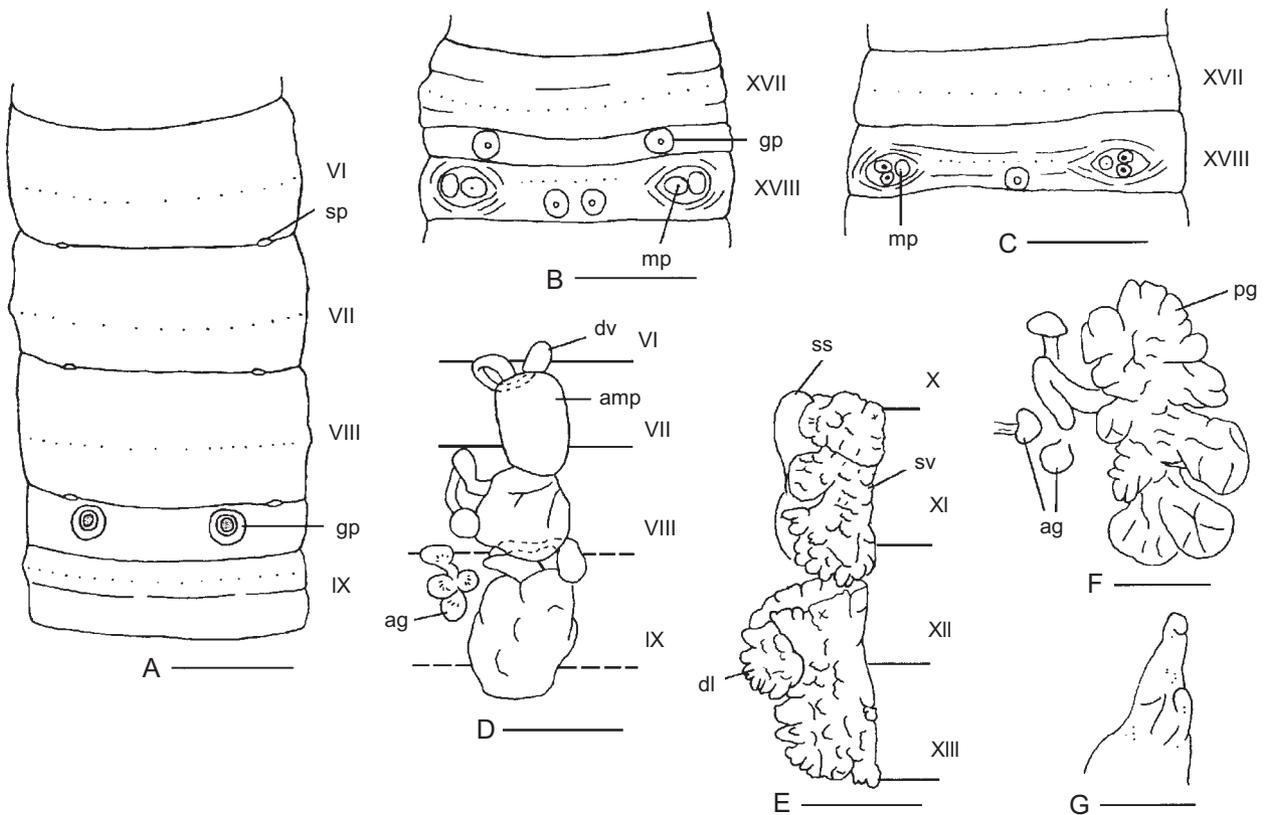
*Internal characters:* Septa 8/9/10 absent, 5/6-7/8 and 10/11-12/13 thickened. Gizzard round in IX and X. Intestine enlarged from XV. Intestinal caeca paired in XXVII, each simple, short, stocky, surface slightly wrinkled, extending anteriorly to

XXV or XXIV (Fig. 5G). Esophageal hearts enlarged in XI-XIII.

Three pairs of spermathecae in VII-IX (Fig. 5D). Ampulla peach-shaped, about 1.0 mm long and 0.9 mm wide, stalk stout, 0.4-0.5 mm long. Diverticulum stalk slightly bent or curved, 0.45-0.7 mm long, seminal chamber oval-shaped, 0.4 mm long. Accessory glands large, oval-shaped or divided into 3 or 4 round lobes, each lobe 0.25-0.45 mm long, stalk short, corresponding to external genital papillae.

*Holandry:* Two pairs of sperm sacs in XI, round. Seminal vesicles large, extending between segments XI and XIII, surface wrinkled, follicular, creamy, each with a large dorsal lobe with folliculated surface (Fig. 5E). Prostate glands paired in XVIII, wrinkled, occupying 3 to 4 segments in XVI-XX, prostatic duct C-shaped. Accessory glands round, sessile or with stalk 0.24-0.28 mm long (Fig. 5F).

*Locality and habitat:* In Rueyen Creek Nature



**Fig. 5.** *Amynthus fenestrus* sp. nov. holotype (71 mm). (A) Ventral view of the preclitellar region (gp, genital papilla; sp, spermathecal pore); (B) ventral view of male pores (mp) and postclitellar genital papillae (gp); (C) ventral view of male pores and postclitellar genital papillae of a 73-mm paratype; (D) right spermathecae (amp, ampulla; dv, diverticulum) and accessory glands (ag); (E) right sperm sacs (ss) and seminal vesicles (sv) (dl, dorsal lobe); (F) right prostate gland (pg) and accessory gland (ag); (G) right caecum.

Reserve, *A. fenestrus* sp. nov. was commonly found in soil mixed with gravel on wet mountain slopes at an elevation of 2300 m. At Mt. Beidongyan (1800 m in elevation), it occurred in shallow soil with gravel substrate underneath.

**Remarks:** *Amyntas fenestrus* has 3 pairs of spermathecal pores in 6/7-8/9 and thus belongs to the *sieboldi*-group (Sims and Easton 1972). This species is fairly similar to *A. tantulus* sp. nov. except for the size and arrangements of the genital papillae and the structure of the accessory glands (Table 3). *A. fenestrus* is larger, and has comparatively higher segment and setal numbers, larger pre- and postclitellar genital papillae, and larger accessory glands than *A. tantulus*. The name “*fenestrus*” is given to this species to indicate the window-like, paired genital papillae in the preclitellar region.

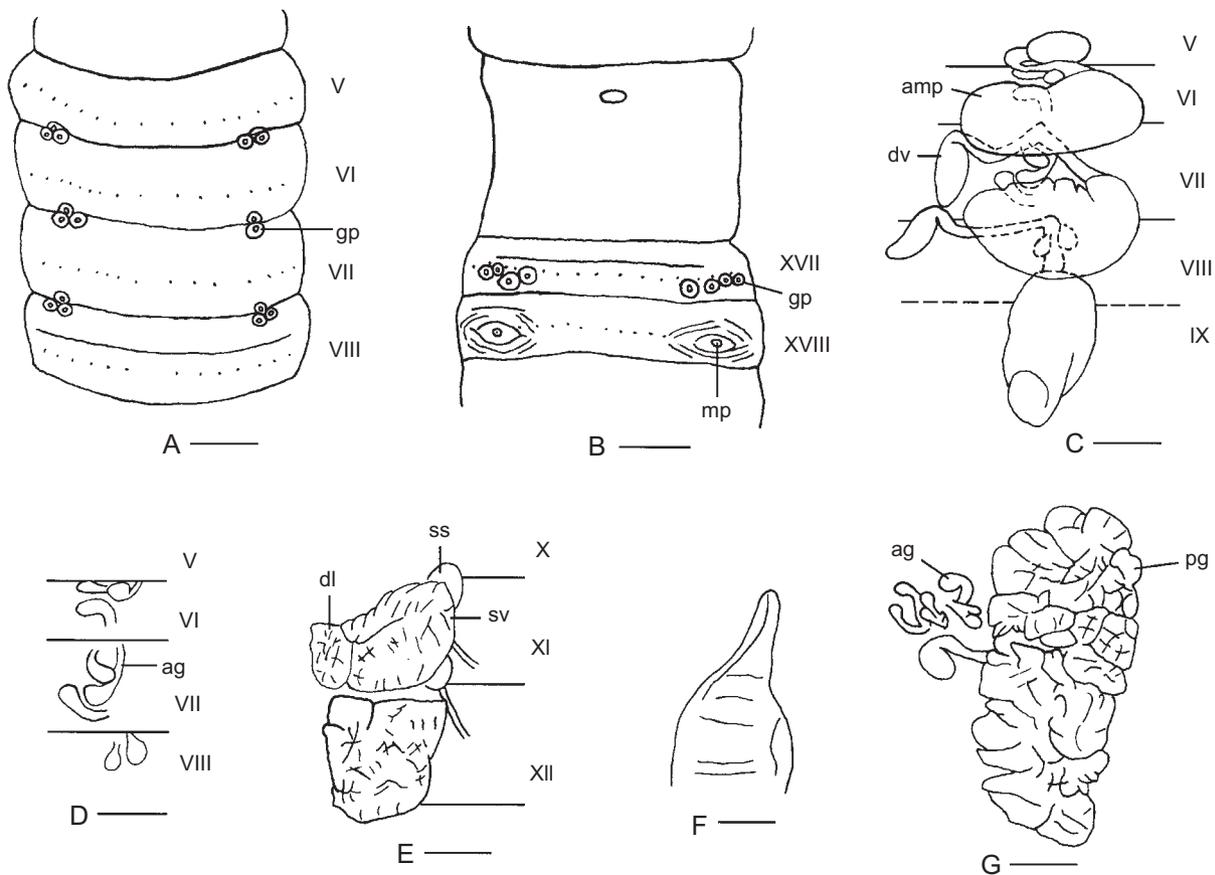
***Amyntas wangi* sp. nov.**

**Type material:** Holotype: 1 mature (clitellate), amputated specimen (62+ mm, dissected) collected 18 Nov. 1999 from Rueyen Creek Nature Reserve (elevation 2300 m), Nantou Co. by CF Tsai, SC Tsai, HP Shen, and CT Yao (coll. no. 1999-24-Shen).

**External characters:** Length 62+ mm, clitellum width 3.42 mm. Prostomium epilobous. Segments numbering 70. First dorsal pore 11/12. Number of incomplete annulets 2-3 per segment in VIII-XIII and XVII. Setal number 34 in VII, 36 in XX, 10 between male pores in XVIII. Clitellum XIV-XVI, smooth, setae and dorsal pores absent, 2.65 mm long.

Spermathecal pores 5/6-7/8, about 0.3 body circumferences ventrally apart, each surrounded by a genital papilla anteriorly and 1 or 2 papillae posteriorly (Fig. 6A). Each papilla round, center concave, about 0.2 mm in diameter. Female pore single, medioventral in XIV.

Male pores paired in XVIII, about 0.28 body



**Fig. 6.** *Amyntas wangi* sp. nov. holotype (62+ mm). (A) Ventral view of the preclitellar region (gp, genital papilla); (B) ventral view of male pores (mp) and postclitellar genital papillae (gp); (C) right spermathecae (amp, ampulla; dv, diverticulum); (D) accessory glands (ag) in the spermathecal region; (E) right sperm sacs (ss) and seminal vesicles (sv) (dl, dorsal lobe); (F) right caecum; (G) right prostate gland (pg) and accessory gland (ag).

circumferences ventrally apart, male aperture minute, in a transversely oval porophore of about 0.5 mm in diameter, surrounded by a few slight oval folds (Fig. 6B). Postsetal genital papillae in a horizontal row in right and left latero-ventral regions of XVII, each row with 4 papillae adjacent to setal line. Each papilla round, center concave, 0.2-0.25 mm in diameter. Breadth of the 4 papillae about 0.87 mm.

Preserved specimens whitish olive on dorsum, whitish gray on ventrum, light brown around clitellum.

*Internal characters:* Septa 8/9/10 absent, 5/6-7/8 and 10/11-12/13 thickened. Gizzard round in IX and X. Intestine enlarged from XV. Intestinal caeca paired in XXVII, each simple, surface slightly wrinkled, short, extending anteriorly to entire segment of XXIV (Fig. 6F). Esophageal hearts enlarged in XI-XIII.

Three pairs of spermathecae in VI-VIII (Fig. 6C). Ampulla large, elongated oval, 2.18-2.86 mm long, 1.16-1.5 mm wide, duct 0.87-1.36 mm long. Diverticulum stalk slender, 0.78-1.13 mm long, seminal chamber oval-shaped, 0.8-1.05 mm long. Accessory glands stalked, 0.25-0.65 mm long, corresponding to each of the papillae around spermathecal pores (Fig. 6D).

*Holandry:* Sperm sacs paired in X and XI, small, round. Seminal vesicles paired in XI and XII, large (Fig. 6E), creamy, yellowish white. Prostate glands paired in XVIII, extending from XVI to XXI, creamy, lobed, prostatic duct C-shaped, distal end enlarged. Accessory glands stalked, 1 large gland or paired small glands associated with each of the genital papillae, stalk about 0.2 mm and head 0.1-0.2 mm long (Fig. 6G).

*Locality and habitat:* *Amyntas wangi* sp. nov. was found entangled in grass roots in soil on wet mountain slopes in Rueyen Creek Nature Reserve at an elevation of 2300 m.

*Remarks:* *A. wangi* sp. nov. has 3 pairs of spermathecae in VI-VIII, and belongs to the *gracilis* (= *hawayanus*) species-group (Sims and Easton 1972). The genital papillae arrangements around the spermathecal pores and in XVII, and the paired accessory glands in XVII are unique characters that are easily distinguishable from other species in the *gracilis* species-group.

The name "*wangi*" is given to this species in honor of Dr. Yuhsi Wang, late professor and head

of the Department of Zoology, National Taiwan University between 1955 and 1973, who made great contributions to the early taxonomy of millipedes and centipedes of Taiwan.

**Acknowledgments:** We are grateful to C. T. Yao, P. H. Ho, J. W. Luo, M. H. Shen, J. L. Lai, T. J. Lin, H. P. Chen, and C. Y. Chang who assisted in field collections.

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