

Some New Earthworms of the Genus *Amyntas* (Oligochaeta: Megascolecidae) from Mt. Hohuan of Taiwan

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Chu-Fa Tsai, Huei-Ping Shen and Su-Chen Tsai (2001) Some new earthworms of the genus *Amyntas* (Oligochaeta: Megascolecidae) from Mt. Hohuan of Taiwan. *Zoological Studies* 40(4): 276-288. This paper describes 1 new subspecies and 3 new species of terrestrial earthworms belonging to the genus *Amyntas* (Oligochaeta: Megascolecidae) from Mt. Hohuan on the subtropical island of Taiwan from a region at elevations of 2300 to 3200 m with a cold-temperate climate. They are *Amyntas exiguus aquilonius* subsp. nov., *A. catenus* sp. nov., *A. proasacceus* sp. nov., and *A. wulinensis* sp. nov. Of these 4 new forms, *A. exiguus aquilonius* is conspecific to *A. exiguus exiguus* (Gates) of Burma, while *A. catenus* and *A. proasacceus* are closely related, respectively, to *A. monoserialis* (Chen) and *A. asacceus* (Chen) of Hainan Island, China. The endemic terrestrial earthworm fauna in this cold-temperate mountain region of Taiwan is apparently more closely related to those of tropical southern China and Southeast Asia than to that of cold-temperate central China. <http://www.sinica.edu.tw/zool/zoolstud/40.4/276.pdf>

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

Since Goto and Hatai (1898) described 2 new species of terrestrial earthworms, the earthworm fauna of Taiwan has been studied by Michaelsen (1922), Kobayashi (1938a b c), Gates (1959), Tsai (1964), Kuo (1995), and Chen and Shih (1996), and recently by Tsai et al. (1999 2000b c 2001) and Shen et al. (2001). A total of 37 species, including 14 native species and 23 exotic species, have been reported mostly from the coastal plains with some from the peripheral hills and mountains at elevations of less than 1000 m (Tsai et al. 2000a).

In 1999 to early 2000 we conducted an earthworm survey in central Taiwan along Rts. 14 and 14A on the western slope of the Central Mountain Range. From the materials collected from Mt. Hohuan at an elevation of 3000 m, two new species of the genus *Amyntas* were described. They are the athecal *A. hohuanmontis* (Tsai et al. 2001) and the sixthcal *A. tessellatus* (Shen et al. 2001). The former species shows a close relation to *A. sheni* (Chen 1935) of Hong Kong Island (Tsai et al. 2001). This paper describes 4 remaining new forms of the genus *Amyntas* collected at elevations of 2300 to 3200 m

from the Ruyey Nature Reserve, Mt. Hohuan and the Wulin Natural Scenery Observatory, representing a cold-temperate climate region (cool summer and snowing winter) in the mountain range of this subtropical island. They are *Amyntas exiguus aquilonius* subsp. nov., *A. catenus* sp. nov., *A. proasacceus* sp. nov., and *A. wulinensis* sp. nov. For these 4 new forms, *A. exiguus aquilonius* is conspecific to *A. exiguus exiguus* (Gates 1930 1932 1939 1972) of Burma and Thailand, while *A. catenus* and *A. proasacceus* are, respectively, closely related to *A. monoserialis* and *A. asacceus* (Chen 1938) of Hainan I., China. The endemic terrestrial earthworm fauna in this cold-temperate mountain region of the island was found to be more closely related to those of tropical southern China and Southeast Asia than to that of cold-temperate central China.

The earthworms collected were fixed in a 15% formalin/water solution and preserved in a 70% ethyl alcohol/water solution. They are preserved at the Taiwan Endemic Species Research Institute, Chichi, Nantou County, Taiwan.

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***Amyntas exiguus aquilonius* subsp. nov.**

Type materials: Holotype: 1 mature (clitellate) specimen (50 mm, dissected) collected 7 July 1999 from Mt. Hohuan (elev. 3000 m), Hualien Co., along Rt. 14A near the border with Nantou Co. by CF Tsai, SC Tsai, HP Shen, RC Jang, HP Chen, and CY Chang (coll. no. 1999-8-Shen). Paratypes: 10 mature specimens (38-63 mm, 1 dissected) collected 18 Nov. 1999 from the Rueyen Nature Reserve below Mt. Hohuan (elev. 2300 m) by CF Tsai, SC Tsai, HP Shen and CT Yao (coll. no. 1999-24-Shen).

Other material: 1 specimen (dissected) collected 19 Oct. 1999 at the same locality of the holotype by CF Tsai, SC Tsai, HP Shen, TJ Lin, and CY Chang (coll. no. 1999-16-Shen).

External characters: Small earthworm, length (mature) 39-63 mm, clitellum width 1.9-2.6 mm, weight 0.15-0.17 g. Prostomium probolous or epilobous. Segments numbering 70-84. First dorsal pore 6/7. Segments not annulated (no secondary segmentation), but setal line clearly elevated in pre-clitellar region. Setal number 26-35 in VII, 28-38 in XX, 5-9 between male pores in XVIII. Clitellum XIV-XVI, smooth, dorsal pore absent, setae absent, length 1.96-3.23 mm.

Spermathecal pores 4 pairs in 5/6-8/9, ventrolateral, each in depressed furrow, distance between paired pores about 0.45 body circumferences apart. Genital papillae presetal and postsetal, widely paired in VII, VIII, and IX, in longitudinal rows slightly medial to spermathecal pores, number highly variable among specimens and segments (Fig. 1A). For 11 type specimens examined, in VII, presetal absent from 5 specimens, one on right and none or 3 on left for 2 specimens, one to 2 pairs for 3 specimens, three to 4 on each side for 1 specimen; postsetal absent from 6 specimens, one or 2 on right for 2 specimens, one pair for 3 specimens. In VIII, presetal 1 to 2 pairs for 9 specimens, one on right and 2 on left for 1 specimen, five on right and 4 on left for 1 specimen; postsetal absent from 5 specimens, one pair for 5 specimens, two on right for 1 specimen. In IX, presetal absent from 1 specimen, one on either right or left for 5 specimens, one to 2 pairs for 3 specimens, two on right and 1 or 6 on left for 2 specimens; postsetal absent from 10 specimens, one on right for 1 specimen. Besides the above widely paired genital papillae, an additional presetal papilla in the medio-ventral position in VIII and IX for 1 specimen, and 1 papilla immediately behind each spermathecal pore in 5/6-7/8 for 1 specimen. Each papilla small, round, tubercle-like, surrounded by a circular fold, its size about 1/3 to 1/4 distance be-

tween setal line and segmental furrow. Female pore single, medio-ventral in XIV.

Male pores paired in XVIII, latero-ventral, distance between pores 0.23-0.30 circumferences apart, porophore large, round, smooth, slightly elevated, with a male aperture inconspicuous on lateral concave area (Fig. 1B). Genital papillae presetal and postsetal, widely paired in XVII, XVIII, and XIX, in 2 longitudinal rows fairly similar to arrangement in spermathecal region, number highly variable among specimens and segments. For 11 type specimens, in XVII, presetal absent from 7 specimens, one on either right or left for 4 specimens; postsetal 1 to 2 pairs for 7 specimens, one on right and 3 on left for 1 specimen, two on right and none or 1 on left for 2 specimens, three to 5 on each side for 1 specimen. In XVIII, presetal and postsetal 1 pair each for 8 specimens (each papilla slightly medial to male pore), two to 6 and 1 to 4 on each side above and below setal line, respectively, for 3 specimens, an additional postsetal papilla in the medio-ventral position for 1 specimen. In XIX, presetal 1 to 2 pairs for 5 specimens, one on right and 2 on left for 1 specimen, two on right and 1 or 3 on left for 3 specimens, three to 6 on each side for 2 specimens; postsetal absent from 1 specimen, one pair for 9 specimens, two on right and 1 on left for 1 specimen. In XX, one pair of presetal papillae for 1 specimen. Each papilla small, round, center flat or slightly concave, 0.21-0.27 mm in diameter, about 1/2 distance between setal line and segmental furrow, surrounded by a circular fold.

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

Internal characters: Septa 8/9/10 absent, 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, extending anteriorly to XXIV-XXII (Fig. 1F). Esophageal hearts enlarged in XI-XIII.

Spermathecae 4 pairs in VI-IX (Fig. 1C). Ampulla peach-shaped, stalk straight, much shorter than ampullar length. Diverticulum vestigial, short, seminal chamber rudimentary or absent, length shorter to slightly longer than spermathecal stalk, straight or slightly bent, originating 1/3 distance from spermathecal pore to ampulla. Accessory glands present, each round, stalked, corresponding to each genital papilla. In addition, an accessory gland is present at proximal end of spermathecal stalk near spermathecal pore, indicating presence of a genital papilla submerged within each spermathecal pore, but undetectable outside. For 11 specimens exam-

ined such papillae detected externally for only 1 specimen.

Holandry: Sperm sacs paired in X and XI, small, round. Seminal vesicles paired in XI and XII, large, surface wrinkled, follicular, yellow, each having a white dorsal lobe with a granulated surface (Fig. 1D). Prostate glands paired in XVIII, large, wrinkled, extending to XVI and XX, prostatic duct C-shaped, distal end enlarged. Accessory glands present, similar in structure to those in spermathecal region (Fig. 1E).

Locality and habitat: At Mt. Hohuan, this new subspecies was collected from a ditch along Rt. 14A. The earthworm was apparently washed down with rainwater from the mountain slope. In the Rueyen Nature Reserve, consisting of a natural broadleaf forest, this earthworm was commonly found in soil mixed with gravel on wet mountain slopes. The

above 2 sites are located at elevations of 2300 to 3000 m.

Remarks: *Amyntas exiguus* (Gates) is a small holandric, octothecal earthworm belonging to the *corticus* species-group (Sims and Easton 1972). It was first described as *Pheretima minuta* by Gates (1929) from specimens collected from Lashio, Burma. Because "*minuta*" was preoccupied by *A. minutus* Beddard in 1900, Gates (1930) renamed it *P. exigua* nom. nov. Gates (1932) divided this species into 2 subspecies, the northern form *P. exigua exigua* and the southern form *P. exigua austrina*, based on the position of the spermathecal pores and the structure and arrangement of the genital papillae. Gates (1936) raised the subspecies *austrina* to the species level and called it *P. austrina*. However, Gates later (1972) again dropped it back to the subspecies level.

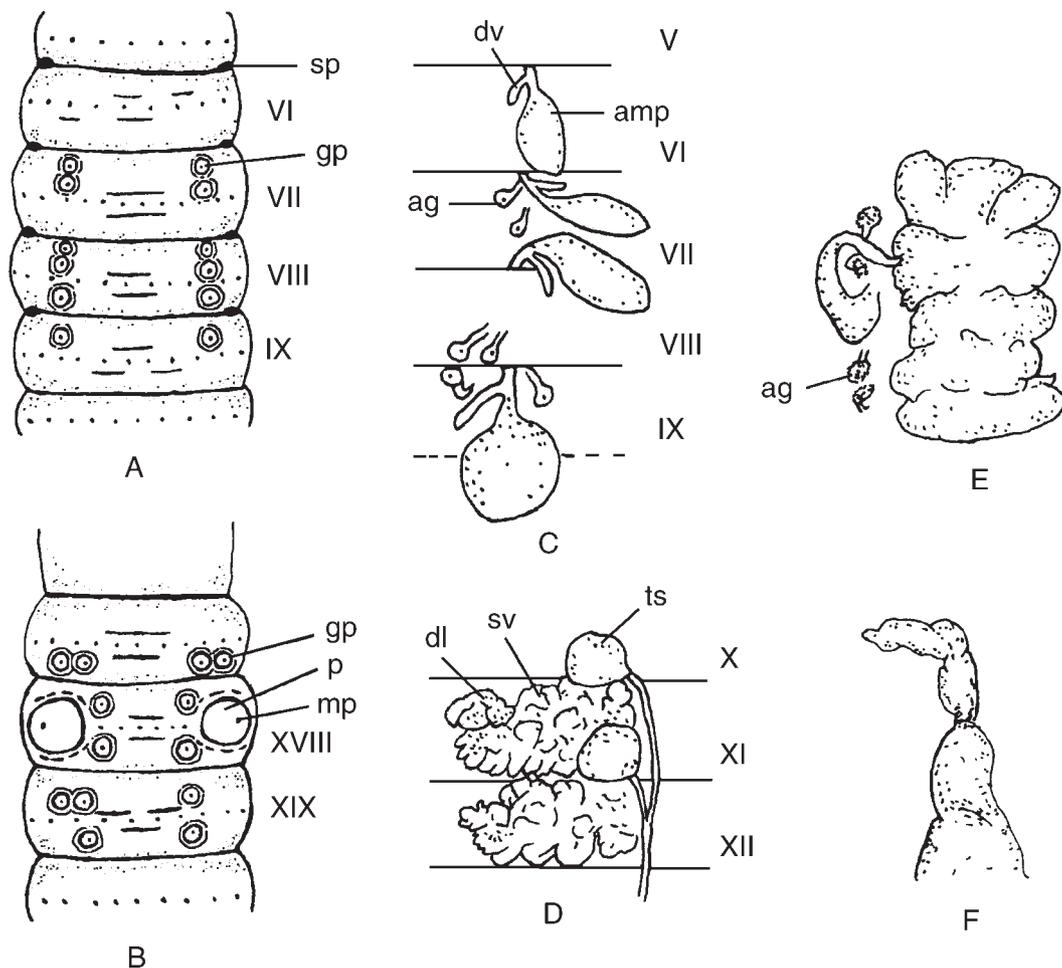


Fig. 1. *Amyntas exiguus aquilonius* subsp. nov. holotype (50 mm): A, ventral view of preclitellar region (gp, genital papilla; sp, spermathecal pore); B, ventral view of male pores (mp) and postclitellar genital papillae (p, porophore); C, ventral view of right spermathecae (amp, ampulla; dv, diverticulum; ag, accessory gland); D, right testis sacs (ts) and seminal vesicles (sv) (dl, dorsal lobe); E, right prostate gland; F, left caecum.

Table 1 compares the characters of the 3 subspecies, *aquilonius* from Taiwan in this study, and *exiguus* and *austrina* from Burma described by Gates (1972). *A. exiguus aquilonius* has fewer setae and much shorter diverticula as compared to those of *exiguus*. It has small, usually widely paired pre-setal and/or postsetal papillae in both preclitellar and postclitellar regions. In contrast *exiguus* has no postsetal papillae, but has closely paired or median pre-setal papillae in the preclitellar region, and closely or widely paired ones in some segments in the postclitellar region. Both subspecies have spermathecal pores in intersegmental furrows and have stalked accessory glands. *A. exiguus austrina* differs greatly from the above 2 subspecies by having intrasegmental spermathecal pores just behind the segmental furrows. It has large, closely paired postsetal papillae usually in the 18/19 furrow from the setal line in XVIII to near the setal line in XIX. Such large intersegmental furrow papillae occasionally occur in 17/18 and 19/20. Also, its accessory glands are sessile.

The name “*aquilonius*” is given to this subspecies in Taiwan as a geographical population north of *A. exiguus exiguus* (Gates), as compared to another subspecies *A. exiguus austrina* (Gates) located to

the south of *exiguus* in Burma and Thailand (Gates 1972).

Amyntas catenus sp. nov.

Type materials: Holotype: 1 mature (clitellate) specimen (dissected) collected 20 Oct. 1999 at Mt. Hohuan on the borders of Hualien and Nantou Cos. in central Taiwan by CF Tsai, SC Tsai, HP Shen, TJ Lin, and CY Chang (coll. no. 1999-17-Shen). Paratypes: 3 mature specimens (1 dissected, same collection data as for holotype).

Other materials: 8 mature specimens (7 dissected) collected 7 July 1999 from Mt. Hohuan at the type locality by CF Tsai, SC Tsai, HP Shen, RC Jang, HP Chen, and CY Chang (coll. no. 1999-8-Shen; the collection was lost in the 21 Sept. 1999 earthquake).

External characters: Length 61-106 mm, clitellum width 2.7-4.2 mm. Prostomium epilobous. Segments numbering 85-103. Three annulets per segment in IX-XIII, occasionally in X-XIII or VIII-XIII. Setae minute, numbering 20-27 in III, 29-38 in VII, 41-47 in XX, and 7-10 between male pores. First dorsal pore in 11/12 or 12/13. Clitellum XIV-XVI, setae absent, dorsal pore absent.

Table 1. Comparison of characters among *Amyntas exiguus aquilonius* subsp. nov. of Taiwan, and *A. exiguus exiguus* (Gates) and *A. exiguus austrina* (Gates) of Burma (Gates 1972)

Character	<i>aquilonius</i> Taiwan ^a 2300-3000 m ^b	<i>exiguus</i> Burma ^a Lowlands to 1300 m ^b	<i>austrina</i> Burma ^a Lowlands to 400 m ^b
Body length (mm)	39-63	24-48	33-57
Clitellum width (mm)	1.9-2.6	2-3	2-3
Segment number	70-84	86-91	73-103
Setal number in VII	26-35	32-40 (VIII)	24-33
XX	28-38	35-46	24-38
between male pores	5-9	9-15	6-10
Spermathecal pores	intersegmental furrows 5/6-8/9	intersegmental furrows 5/6-8/9	intrasegments VI-IX just behind furrows 5/6-8/9
Diverticulum	short, vestigial	long	long
Genital papillae			
Pre-setal	small, usually widely paired in VII-IX, XVIII, and XIX	small, usually closely paired in VII, VIII, and XIX, and widely paired in XVII-XX	small, paired or median in IX
Postsetal	small, usually widely paired in VII-IX and XVII-XX	absent	large, paired in 17/18-19/20
Accessory glands	long stalk	long stalk	sessile

^aLocality.

^bElevation.

Spermathecal pores, ventro-lateral, number highly variable: for holotype and paratypes (coll. no. 1999-17-Shen) no pore; for other material (coll. no. 1999-8-Shen) examined, three pairs in 5/6-7/8 for 4 specimens, three pairs but lacking a right pore in 7/8 for 1 specimen, lacking a right pore in 6/7 and a left pore in 7/8 for 1 specimen, only a single left pore in 6/7 for 1 specimen, and pore absent from 1 specimen. Distance between spermathecal pores about 0.22 body circumferences ventrally apart. Genital

papillae arranged in a longitudinal series like a chain on the medio-ventral line in V-IX, number of papillae and segment location highly variable: three presetal papillae in VI-VIII and 2 postsetal papillae in VII and VIII for holotype (Fig. 2A), 0 to 9 in V-IX in other specimens (Table 2). Generally, one presetal papilla and/or 1 postsetal papilla in a segment, each occupying the entire width of an annulet adjacent to intersegmental furrow. Occasionally, two papillae joined closely in an annulet. Each papilla rounded with a

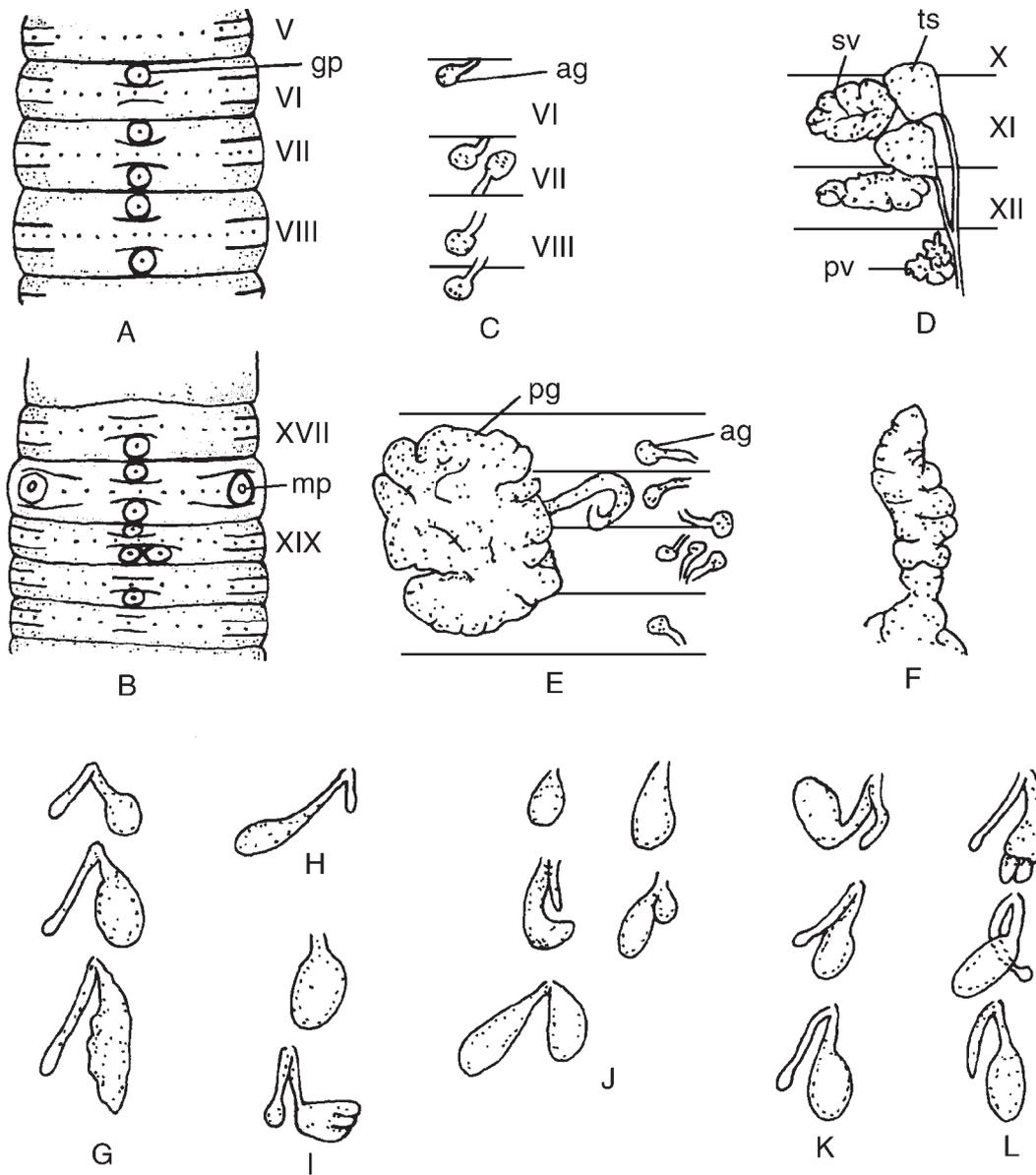


Fig. 2. *Amynthus catenus* sp. nov. holotype (66 mm): A, ventral view of preclitellar genital papillae (gp, genital papilla); B, ventral view of male pores (mp) and postclitellar genital papillae; C, accessory glands (ag) in the spermathecal region; D, right testis sacs (ts) and seminal vesicles (sv) (pv, pseudovesicle); E, left prostate gland (pg) and accessory gland; F, left intestinal caecum; G-L, various sizes and structures of spermathecae (G, specimen no. 3 [denoted in Table 2, coll. no. 1999-8-Shen], 96 mm; H, no. 2, 97 mm; I, no. 4, 92 mm; J, no. 6, 85 mm; K, no. 7, 81 mm; L, no. 8, 64 mm).

concave center. Female pore single, medio-ventral in XIV.

Male pores paired, ventral in XVIII, each porophore round, circular tubercle on setal annulet, distance between pores 0.23 body circumferences ventrally apart. Genital papillae arranged in a longitudinal series at the medio-ventral position in XVII-XXI, like those in preclitellar region, number and segment highly variable: seven from XVII to XX for holotype (Fig. 2B), and 3 to 9 for other specimens (Table 2). The position and arrangement of the papillae similar to those in spermathecal region (Fig. 2A-B).

Preserved specimens whitish purple on dorsum, whitish gray on ventrum, light grayish tan on clitellum.

Internal characters: Septa 5/6-7/8 thickened, 8/9 and 9/10 absent, 10/11-13/14 greatly thickened. Nephridial tufts paired in V and VI. Gizzard in VIII-X, large, cylindrical, white. Intestine enlarged from XVI or XV. Intestinal caeca paired in XXVII, simple, extending anteriorly to XXII (XX for 1 specimen). Esophageal hearts enlarged in XI-XIII.

Spermathecae vestigial or absent, number highly variable in VI-VIII: for 9 specimens dissected, six spermathecae (in 3 pairs) for 3 specimens, five spermathecae for 1 specimen, four spermathecae for 1 specimen, one spermatheca for 1 specimen, and spermathecae absent from 3 specimens (Table 2). When spermathecae present, size and structure of ampulla, spermathecal duct, and diverticulum

highly variable (Fig. 2G-L): ampulla large to small, round to irregularly shaped with or without stalk; diverticulum has normal seminal chamber with long straight stalk, or no seminal chamber with vestigial stalk, or diverticulum absent (Fig. 2G-L). For spermathecae examined, 21.4% lacking diverticulum and 22.7% of diverticula lacking seminal chambers.

Holandry: Testis sacs paired in XI, large, light yellow. Seminal vesicles paired in XI and XII, light yellow, small, irregularly shaped, follicular (Fig. 2D). Occasionally, small vestigial seminal vesicles (pseudovesicles) in XIII. Prostate glands paired in XVIII, large, racemose, yellowish white, occupying 3 to 4 segments in XVI-XXI. Prostatic duct hook-shaped (Fig. 2E). Prostate glands asymmetric in position and size between left and right (Table 2). Prostate glands absent from 2 specimens, but prostatic ducts present.

Each genital papilla in both spermathecal and male pore regions associated with a white, round, stalked accessory gland (Fig. 2C, E).

Locality and habitat: Specimens were collected in roadside ditches and on slopes at Mt. Hohuan (elev. 3000 m) in central Taiwan. The areas were being wetted by water dripping down the rocky slope.

Remarks: The arrangement of genital papillae of *Amyntas catenus* sp. nov. from Taiwan is fairly similar to that of *A. monoserialis* (Chen 1938) of Hainan I. However, both species are easily distinguishable by the characters of the spermathecae, setal number, and accessory glands (Table 3).

Table 2. Individual variations in spermathecae, genital papillae, and prostate glands of *Amyntas catenus* sp. nov.

Specimen	Spermathecae		Genital papillae		Prostate glands	
	left	right	preclitellar	postclitellar	left	right
Coll. no. 1999-17-Shen						
1 (holotype)	0	0	VI-VIII (5)	XVII-XX (7)	XVII-XX	XVI-XX
2 (paratype)	0	0	VIII (1)	XVII-XX (9)	absent ^b	absent ^b
3 (paratype)	—	—	VI-VIII (5)	XVIII-XIX (3)	—	—
4 (paratype)	—	—	VII (2)	XVIII-XIX (3)	—	—
Coll. no. 1999-8-Shen ^a						
1	—	—	VII-VIII (4)	XVII-XX (6)	—	—
2	VII (1)	0	VI-IX (7)	XVII-XXI (8)	XVIII-XX	XVI-XVIII
3	VI-VIII (3)	VI-VIII (3)	VII-VIII (2)	XVI-XIX (7)	XVII-XIX	XVII-XIX
4	VI-VII (2)	VI-VIII (2)	VII-VIII (4)	XVIII-XIX (3)	XVI-XIX	XVIII-XXI
5	0	0	V-IX (9)	XVII-XX (7)	XVII-XX	XVIII-XX
6	VI-VIII (3)	VI-VII (2)	VI-VIII (4)	XVIII-XX (6)	absent ^b	absent ^b
7	VI-VIII (3)	VI-VIII (3)	VIII (1)	XVII-XXI (9)	XVI-XIX	XVII-XIX
8	VI-VIII (3)	VI-VIII (3)	0	XVII-XXI (8)	XVI-XX	XIX-XX

^aThe collection was lost in the earthquake of 21 Sept. 1999.

^bProstatic ducts normal.

—: specimens not dissected; number of spermathecae and genital papillae in parentheses.

from the same locality as the holotype by CF Tsai, SC Tsai, HP Shen, RC Jang, HP Chen, and CY Chang; 2 mature specimens (1 dissected) collected 18 Nov. 1999 from the Rueyen Nature Reserve (elev. 2300 m), Nantou Co. by CF Tsai, SC Tsai, HP Shen, and CT Yao (coll. no. 1999-24-Shen).

External characters: Length (mature) 39-76 mm, clitellum width 2.9-3.99 mm. Prostomium with a large mouth opening surrounded by a small, soft, thick, white semicircular dorsal lip and a large, thick, white ventral lip (Fig. 3B-D). Segments numbering 57-106, three annulets per segment after III in preclitellar region. Setae minute, 33-40 in VII, 43-51

in XX, 6-9 between male pores. First dorsal pore in 11/12. Clitellum XIV-XVI, length 1.4-2.5 mm, shorter than width.

Spermathecal pores not visible. No genital papillae in preclitellar region. Female pore single, medio-ventral in XIV.

Male porophores paired in XVIII, 0.22-0.28 body circumferences ventrally apart, each round or oval, surface smooth, slightly convex with or without a shallow horizontal slit (depression) in middle, surrounded by 2 or 3 circular folds (Fig. 3A). Male aperture not visible. No genital papillae in postclitellar region.

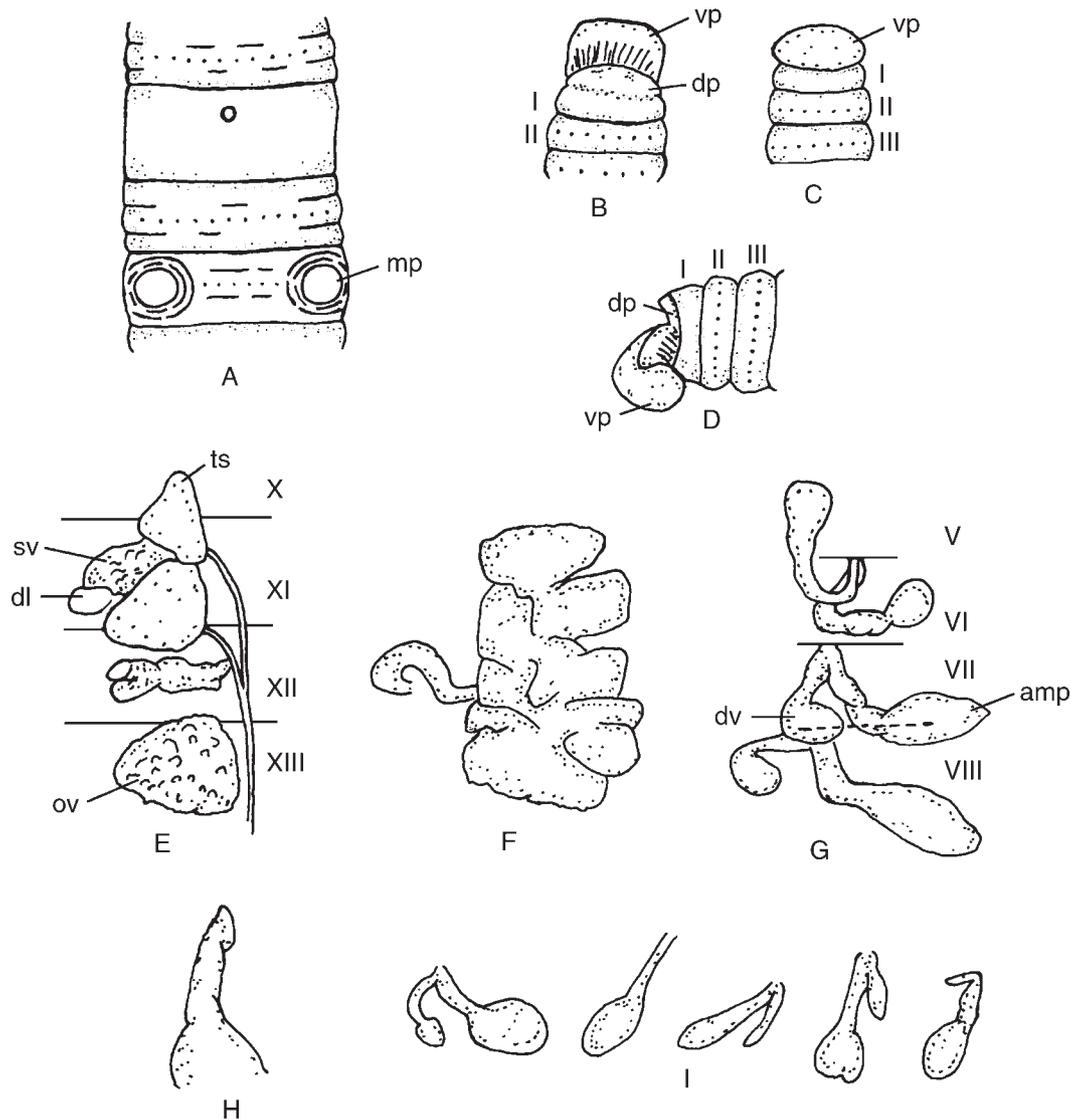


Fig. 3. *Amynthus proasaccus* sp. nov. holotype (67 mm): A, ventral view of the male porophore (mp) region; B, dorsal view of prostomium (dp, dorsal lip; vp, ventral lip); C, ventral view of prostomium; D, lateral view of prostomium; E, right testis sacs (ts) and seminal vesicles (sv) (dl, dorsal lobe; ov, ovary); F, right prostate gland; G, right spermathecae (amp, ampulla; dv, diverticulum); H, right intestinal caecum; I, various forms of spermathecae from normal to vestigial.

Preserved specimens whitish pink on dorsum, whitish gray on ventrum, light grayish tan on clitellum.

Internal characters: Septa 5/6-7/8 thickened, 8/9 and 9/10 absent, 10/11-13/14 thickened. Gizzard in VIII-X, cylindrical, white. Intestine enlarged from XV. Intestinal caeca paired in XXVII, simple, extending anteriorly to XX, XXI, or XXIII. Esophageal hearts enlarged in XI-XIII.

Spermathecae in VI-VIII, number and structure highly variable (normal, vestigial, or absent): for 13 specimens dissected, six spermathecae (in 3 pairs) for 9 specimens (including holotype) (Fig. 3G), five for 1 specimen, four for 2 specimens, and 2 for 1 specimen (Table 4). For normal spermathecae, ampulla oval-shaped, 0.83-1.4 mm long, with slender spermathecal stalk 0.86-1.3 mm long, diverticulum small with oval seminal chamber, about 0.25 mm long with a slender stalk about 0.55 mm long; for vestigial spermathecae, diverticula often lacking seminal chambers, stalk vestigial or absent (Fig. 3I). For spermathecae examined, 17.4% lacking diverticulum, and 47.4% of diverticula lacking seminal chambers. Ovaries paired in XIII, each large with follicular surface (Fig. 3E).

Holandry: Testis sacs 2 pairs in XI and partly in X or/and XII, each round or triangular, light yellow (Fig. 3E). Seminal vesicles paired in XI and XII, light yellow, each small, irregularly-shaped with a small, white, oval-shaped dorsal lobe (Fig. 3E). Prostate glands paired in XVIII, racemose (Fig. 3F), yellowish

white, occupying 3 to 6 segments in XVI-XXI (Table 4). Prostatic duct hook-shaped. One dissected specimen lacking prostate glands but with prostatic ducts.

Locality and habitat: At Mt. Hohuan, the type specimens were collected in roadside ditches and on slopes being wetted by water dripping down the rocky slope.

Remarks: *Amyntas proasacceus* sp. nov. of Taiwan shares similar external characters in body size, segment number, setal number, coloration, and genital papillae with *A. asacceus* (Chen 1938) of Hainan I. and *A. pusillus* (Ohfuchi 1956) (synonymous to *A. asacceus*) of the Ryukyu Is. The latter 2 species were found to be synonymous by Tsai et al. (2001). *A. proasacceus* and *A. asacceus* also share the occurrence of parthenogenetic degeneration but at different levels in the reproductive organs, such as spermathecae, seminal vesicles, and prostate glands. *A. proasacceus* usually has 3 pairs of spermathecae, but there is a trend of reduction in number (Table 4) and size, and also occurrence of structural deformation (Fig. 3I). These suggest that *A. proasacceus* was originally a sixthelcal earthworm. On the other hand, *A. asacceus* has no spermatheca, the most advanced (final) stage of spermathecal degeneration, and is a member of the athecal *illotus* species-group (Sims and Easton 1972, Easton 1981). Furthermore, *A. proasacceus* has a pair of large, circular porophores, but their edges do not reach the intersegmental furrows 17/18

Table 4. Variations in numbers and locations of spermathecae and prostate glands of *Amyntas proasacceus* sp. nov.

Specimen	Spermathecae		Prostate glands	
	left	right	left	right
Type material				
1 (holotype)	VI-VIII (3)	VI-VIII (3)	XVII-XIX	XVII-XIX
2 (paratype)	VI-VIII (3)	VI-VIII (3)	XVII-XIX	XVII-XIX
3 (paratype)	VI-VIII (3)	VI-VIII (3)	XVI-XXI	XVI-XXI
4 (paratype)	VI-VIII (3)	VI-VIII (3)	XVII-XX	XVII-XX
5 (paratype)	VI-VIII (3)	VI-VIII (3)	XVII-XIX	XVII-XIX
6 (paratype)	VI-VIII (3)	VI-VIII (3)	XVI-XXI	XVI-XXI
7 (paratype)	VI-VIII (3)	VII-VIII (2)	XVI-XXI	XVI-XXI
Other material				
1	VI-VIII (3)	VI-VIII (3)	XVI-XXI	XVI-XXI
2	VI-VIII (3)	VI-VIII (3)	XVI-XVIII	XVII-XX
3	VI-VII (2)	VII-VIII (2)	XVII-XX	XVII-XX
4	VII-VIII (2)	absent (0)	XVII-XX	XVII-XX
5	VIII (1)	VI-VIII (3)	XVII-XIX	XVIII-XX
6	VI-VIII (3)	VI-VIII (3)	absent ^a	absent ^a

^aProstatic ducts normal.

Number of spermathecae in parentheses.

and 18/19 (Fig. 3A), while those of *A. asacceus* (Chen 1938, Ohfuchi 1956) reach the furrows. The former is considered a more primitive character than the latter.

The above similarity and differences in characters between *A. proasacceus* sp. nov. of Taiwan and *A. asacceus* of Hainan and Ryukyu Is. (Chen 1938, Ohfuchi 1956) suggest that *A. proasacceus* may be an intermediate form which evolved from the sixthelical ancestor with bisexual reproduction to the present athecal form with parthenogenetic reproduction.

In addition, *A. proasacceus* has a unique structure of the prostomium with a large mouth opening surrounded by a small dorsal lip and a large ventral lip (Fig. 3B-D), easily distinguishable from other members of sixthelical and athecal earthworms in the genus *Amyntas*.

The name “*proasacceus*” is given to this new species to indicate that it is a species closely related to the ancestral form of *A. asacceus*.

Amyntas wulinensis sp. nov.

Type materials: Holotype: 1 mature (clitellate) specimen (dissected) collected 19 Oct. 1999 from a

ditch along the parking area of the Wulin Natural Scenery Observatory at an elevation of 3200 m, Nantou by CF Tsai, SC Tsai, HP Shen, TJ Lin, and CY Chang (coll. no. 1999-16A-Shen). Paratypes: 1 mature (dissected) and 7 immature (acitellate) specimens (same collection data as for holotype).

Other materials: 12 immature specimens (1 dissected) collected 19 Oct. 1999 at National Taiwan University's High-altitude Horticulture Experimental Station at Meifeng, Nantou by CF Tsai, SC Tsai, HP Shen, TJ Lin, and CY Chang (coll. no. 1999-16B-Shen); 41 mature specimens (63-110 mm, 2 dissected) collected 10 Nov. 1999 in Nanshan Creek near Puli, Nantou by CF Tsai, SC Tsai, JW Luo, HP Shen, MH Shen, JL Lai, and CY Chang (coll. no. 1999-20-Shen); 1 immature specimen collected 8 Dec. 1999 at Mt. Beidongyan, Nantou by CF Tsai, SC Tsai, HP Shen, and PH Ho (coll. no. 1999-29-Shen).

External characters: Length (mature) 128-174 mm (immature, 72-115 mm), clitellum width 5.6-6.1 mm. Prostomium epilobous. Segments numbering 93-123, three annulets per segment after VI. Setae 42-45 in VII, 55-69 in XX, 13 between male pores. First dorsal pore in 11/12. Clitellum XIV-XVI, length 5.48-5.82 mm, slightly shorter than width, smooth, dorsal pore absent, setae absent.

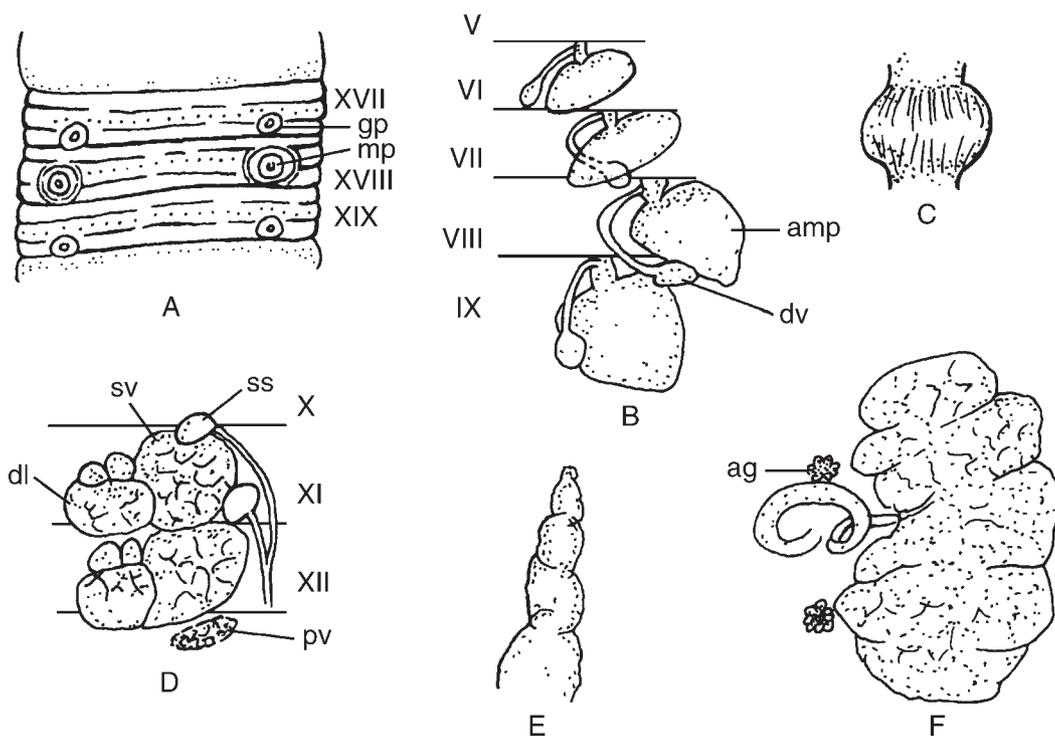


Fig. 4. *Amyntas wulinensis* sp. nov. holotype (174 mm): A, ventral view of the male pore (mp) region (gp, genital papilla); B, right spermathecae (amp, ampulla; dv, diverticulum); C, gizzard; D, right seminal vesicles (sv) (dl, dorsal lobe; ss, sperm sac); E, right intestinal caecum; F, right prostate gland (ag, accessory gland).

Table 5. Comparison of characters of *Amyntas wulinensis* sp. nov. collected at 4 locations with different elevations in central Taiwan

Character	Wulin 3200 m	Meifeng 2100 m	Mt. Beidongyan 1800 m	Nanshan Creek 800-900 m
Body length (mm)	128-174	87-95	69	63-110
Segment number	93-123	127-132	70	78-130
Setae in VII	42-45	32-34	38	28-37
in XX	55-69	41-42	46	33-48
between male pores	13	9-10	10	8-11

Spermathecal pores 4 pairs in 5/6-8/9, ventro-lateral, distance between pores about 0.29 body circumferences ventrally apart. No papillae in spermathecal region. Female pore single, medio-ventral in XIV, female aperture in middle of a round tubercle.

Male pores paired in XVIII, latero-ventral, distance between pores 0.24-0.28 body circumferences ventrally apart, each round or oval-shaped on setal line with depressed center (male aperture not visible) surrounded by 2 to 3 circular folds. Usually a pair of genital papillae slightly medial to male pore in each of XVII and XIX, each papilla oval-shaped with a depressed center, in posterior annulet between setal line and posterior intersegmental furrow (Fig. 4A), occasionally an additional pair or 1 papilla in XX, or missing one in XVII or XIX.

Preserved specimens light brown on dorsum, light yellow on ventrum, grayish tan around clitellum.

Internal characters: Septa 5/6-7/8 thickened, 8/9 and 9/10 absent, 10/11-13/14 greatly thickened. Gizzard small, round in X, white (Fig. 4C). Intestine enlarged from XV. Intestinal caeca paired in XXVII, simple, extending anteriorly to XXII or XX (Fig. 4E). Esophageal hearts enlarged in XI-XIII.

Spermathecae 4 pairs in VI-IX, each with a very short, stout stalk. Diverticulum with an oval, shining white seminal chamber and a slender, straight stalk originating from spermathecal stalk (Fig. 4B).

Holandry: Testis sacs paired in X and XI, each small, round, light yellow (Fig. 4D). Seminal vesicles paired in XI and XII, each large, light yellow, follicular, with a large, follicular dorsal lobe (Fig. 4D). Prostate glands paired in XVIII, large, racemose, follicular, yellowish white, extending anteriorly to XV and posteriorly to XX, prostatic duct coiled, hook-shaped (Fig. 4F). Accessory glands paired in XVII and XIX, each corresponding with external genital papillae, sessile (no stalk), flowery, yellowish white.

Locality and habitat: This species shows a wide distribution in the Central Mountain Range in central Taiwan at elevations from 800 m to the mountain ridge of 3200 m. It occurs in gravel substrate at

Wulin and Mt. Beidongyan and in soil substrate at Meifeng.

Remarks: *Amyntas wulinensis* sp. nov. is a holandric, octothecal earthworm belonging to the *corticus* species-group of the genus *Amyntas* (Sims and Easton 1972). It has simple, superficial porophores in the male pore region, and paired genital papillae in XVII and XIX, whose number, structure, location, and arrangement are fairly similar to those of *Metaphire posthuma* (Vaillant) of Burma (Gates 1932) and Taiwan (Tsai 1964) and *M. quadripapillata* (Michaelsen) of Sumatra (Beddard 1900) which have copulatory pouches. However, the genital papillae of *A. wulinensis* are located in the postsetal annulets close to the segmental furrows 17/18 and 19/20 (Fig. 4A), whereas the genital papillae of *M. posthuma* and *M. quadripapillata* are in the setal annulet (the middle annulet) in XVII and XIX.

The type specimens collected from Wulin at the mountain ridge (elev. 3200 m) are much larger, lighter in color, and have more setae than those from the lower elevations at Meifeng, Mt. Beidongyan, and Nanshan Creek (800-2100 m). These characters show vertical (elevation) variations (Table 5). Although the paired genital papillae are usually found in XVII and XIX, occasionally they also occur in XX. For 41 clitellate specimens collected at Nanshan Creek, eight have an additional pair of genital papillae and 4 have an additional one in XX.

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合歡山區之新種遠盲蚓

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本文描述 4 種產於合歡山區海拔 2300 至 3200 公尺的遠盲蚓；其中 1 種為亞種，另 3 種為新種。分別為 *Amyntas exiguus aquilonius* subsp. nov.、*A. catenus* sp. nov.、*A. proasacceus* sp. nov. 以及 *A. wulinensis* sp. nov.。 *A. exiguus aquilonius* 為產於緬甸的 *A. exiguus exiguus* (Gates) 之亞種，而 *A. catenus* 及 *A. proasacceus* 則分別與產於海南島的 *A. monoserialis* (Chen) 及 *A. asacceus* (Chen) 有密切相關。顯見臺灣本島高山地區之陸生蚯蚓相與南中國及東南亞之蚯蚓相有較密切的相關性，而與中國溫帶地區的種類不同。

關鍵詞：蚯蚓，新種，遠盲蚓屬，巨首蚓科，臺灣。

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