

DESCRIPTION OF A NEW EARTHWORM BELONGING TO THE GENUS *AMYNTHAS* (OLIGOCHAETA: MEGASCOLECIDAE) FROM TAIWAN AND ITS INFRASPECIFIC VARIATION IN RELATION TO ELEVATION

H. P. Shen, C. F. Tsai and S. C. Tsai

*Habitat and Ecosystem Division, Taiwan Endemic Species Research Institute,
Chichi, Nantou, Taiwan*

ABSTRACT. - This paper describes the sixthelical earthworm *Amyntas tessellatus*, new species, from the Central Mountain Range of Taiwan. It shows wide ranges of vertical (altitude) variation in the characters of reproductive organs, such as the number and location (segment) of genital papillae, the stalk length of accessory glands, the spermathecal stalk length/ampullar length ratio, and the diverticular stalk length/seminal chamber length ratio. Based on genital papillae and accessory glands, *A. tessellatus* consists of two distinctive geographical populations; *Amyntas tessellatus tessellatus*, new subspecies, at high elevations of 1000 m to 3200 m, and *Amyntas tessellatus paucus*, new subspecies, at low elevations of 700 m to 1100 m. In the postclitellar region, *A. tessellatus tessellatus* has genital papillae with sessile accessory glands in XVII, XVIII and XIX, whereas *A. tessellatus paucus* has genital papillae with stalked accessory glands in XVIII.

KEY WORDS. - Taiwan, earthworm, *Amyntas*, Megascolecidae, new species.

INTRODUCTION

Taiwan is a mountainous island located in the humid subtropical region of Northeast Asia. It has the steep Central Mountain Range running almost along its longitudinal axis with the highest peak (Mt. Jade, Yushan) of nearly 4000 m in elevation, and being divided by many deep valleys and rivers. These complicated topography and geomorphology have resulted in the formation of highly diverse habitat for terrestrial animals including the megadrile earthworms (Oligochaeta).

Up to date most of the nominal species of native terrestrial earthworms in Taiwan belong to the genera *Amyntas* and *Metaphire*. They are reported mostly from peripheral hills and mountains, where the environments remain natural, or more or less undisturbed by man (Tsai et al., 2000a). In the peripheral hills (elevations less than 500 m) around the Central Mountain Range where the samplings have been frequently made, several native earthworms have been reported. They are *Amyntas formosae* (Michaelsen, 1922), *Amyntas polyglandularis* (Tsai, 1964), *Amyntas*

hsinpuensis (Kuo, 1995), *Metaphire paiwana* (Tsai, Tsai & Liaw, 2000b), *Amyntas binoculatus*, *Amyntas sexpectatus* and *Amyntas tayalis* (Tsai, Shen & Tsai, 1999). In the mountains where the samplings have been occasionally made, also several native species have been reported. They are *Amyntas tungpuensis* (Tsai, Shen & Tsai, 1999) at elevations of 1000 m to 2000 m, *Metaphire bununa* (Tsai, Tsai & Liaw, 2000b) from peripheral hills to 3000 m (Tsai et al., 2000a), *Metaphire yeni* (Tsai, Shen & Tsai, 2000c) at elevation of 1000 m, and *Amyntas exiguus aquilonius*, *Amyntas catenus*, *Amyntas proasacceus*, and *Amyntas wulinensis* (Tsai, Shen & Tsai, 2001) at elevations of 2300 m to 3200 m. There is a strong indication that occurrence and distribution of the native earthworms in hills and mountains of Taiwan are somewhat related to elevation.

This paper describes *Amyntas tessellatus*, new species, from the Central Mountain Range of Taiwan at elevations between 700 m (temperate climate) to 3200 m (cold climate), and examines its infraspecific variation and subspecific differentiation.

MATERIALS AND METHODS

The earthworms collected were anesthetized in 20% ethyl-alcohol solution, fixed in 10% formalin water solution, and preserved in 75% ethyl-alcohol solution. They are deposited at the Taiwan Endemic Species Research Institute, Chichi, Nantou, Taiwan.

TAXONOMY

Amyntas tessellatus, new species

(Fig. 1)

Material examined. - Holotype - 1 mature (clitellate) specimen (dissected)(coll. no. 1999-24-Shen) collected in the Rueyen Nature Reserve at the elevation of 2300 m, Nantou Prefecture, central Taiwan, coll. C. F. Tsai, S. C. Tsai, H. P. Shen & C. T. Yao, 18 Nov.1999.

Paratypes - 6 mature and 1 immature specimens, same data as holotype.

Others - 1 mature specimen (dissected)(coll. no. 1999-9-Shen) collected from Mt. Hohuan along Rt. 14A in Hualien Prefecture near the border to Nantou Prefecture, central Taiwan, coll. C. F. Tsai, S. C. Tsai, H. P. Shen, R. C. Jang, H. P. Chen, and C. Y. Chang, 8 Jul.1999; 1 mature specimen (dissected)(coll. no. 1999-16-Shen) collected on Rt. 14A at Wulin, Nantou, central Taiwan, coll. C. F. Tsai, S. C. Tsai, H. P. Shen, T. J. Lin, and C. Y. Chang, 19 Oct.1999; 1 mature specimen (coll. no. 1999-17-Shen) collected along Rt. 14A in Mt. Hohuan, central Taiwan, coll. C. F. Tsai, S. C. Tsai, H. P. Shen, T. J. Lin, and C. Y. Chang, 20 Oct.1999; 19 mature specimens (one dissected)(coll. no. 1999-20-Shen) collected in the mountain slope along Nanshan Creek, Jen-ay Hsiang, Nantou, central Taiwan, coll. C. F. Tsai, S. C. Tsai, H. P. Shen, J. W. Luo, M. H. Shen, J. L. Lai & C. Y. Chang, 10 Nov.1999; 2 mature specimens (one dissected)(coll. no. 1999-21-Shen) collected in the mountain slope along Benbuh Creek, Jen-ay Hsiang, Nantou, central Taiwan, coll. C. F. Tsai, S. C. Tsai, H. P. Shen, J. W. Luo, M. H. Shen, J. L. Lai & C. Y. Chang, 10 Nov.1999; 31 mature (two dissected) and 1 immature specimens (coll. no. 1999-29-Shen) collected from Mt. North-Dongyan, Nantou, central Taiwan, coll. C. F. Tsai, S. C. Tsai, H. P. Shen & P. H. Ho, 8 Dec.1999; 1 mature specimen (dissected)(coll. no. 2000-4-Shen) collected at Meichi, Nantou, central Taiwan, coll. C. F. Tsai, S. C. Tsai, H. P. Shen, H. P. Chen & T. J. Lin, 14 Feb.2000; 1 mature specimen (dissected)(coll. no. 2000-5-Shen) collected at Wanta near the Wanta Lake near Wushe, Nantou, central Taiwan, coll. C. F. Tsai, S. C. Tsai, H. P. Shen, H. P. Chen & T. J. Lin, 14 Feb.2000.

Description. - Length 52-85 mm, clitellum width 2.5-3.4 mm. Prostomium epilobous. Segment number 66-114. Setae 32-35 in VII, 38-42 in XX, eight to 10 between male pores. First dorsal pore in 11/12.

Clitellum XIV-XVI, length 1.7-2.9 mm, smooth, setae absent.

Spermathecal pores invisible. Patches of small, round presetal and postsetal genital papillae present ventromedially with number highly variable. For holotype, presetal papillae 23 in VIII, 10 in IX, and postsetal papillae absent (Fig. 1A). For six (matures) paratypes, presetal papillae one to three in VI for three specimens, and three to 13 in VII, 16-24 in VIII, two to 19 in IX for five specimens; postsetal papillae one to three in VIII for two specimens, one in IX for one specimen. Female pore single, medio-ventral in XIV.

Male pores paired in XVIII, porophore simple, round, papillar-like, surrounded by two or three incomplete circular folds, about 0.28 body circumference ventrally apart. For holotype, presetal genital papillae patched in the medio-ventral position, 20 in XVII, 22 in XVIII, 16 in XIX; postsetal papillae two in XIX (Fig. 1B). For paratypes, presetal papillae 11-21 in XVII, 14-25 in XVIII, 10-25 in XIX for all specimens, one to 16 in XX for three specimens, three in XXI for one specimen; postsetal papillae one to two in XIX for three specimens, one in XX for two specimens. The shape and arrangement of the papillae similar to those in the spermathecal region.

Preserved specimens whitish olive dorsum, olive-gray ventrum, dark brown clitellum.

Septa 5/6-7/8 thickened, 8/9 and 9/10 absent, 10/11-13/14 greatly thickened. Gizzard in IX-X, round, yellowish white in color. Intestine enlarged from XVI. Dorsal typhlosole from XXVII, its height about one third of that of intestine. Intestinal caeca paired in XXVII, each simple, extending anteriorly to XXIII with white distal end (Fig. 1F). Esophageal hearts XI-XIII. Meronephridial, bush-like mass in intersegmental spaces, anteriorly to 6/7.

Spermathecae three pairs in VI-VIII, ampulla oval-shaped, about 1.27 mm long, 0.89 mm wide, with a stout stalk of about 0.9 mm long (Fig. 1C). Diverticulum with a white, oval-shaped seminal chamber of about 0.6 mm long and a slender stalk of about 1.1 mm long (Fig. 1C).

Holandry: first and second pairs of testis sacs leant each other closely in XI, light yellow. Seminal vesicles paired in XI and XII, light yellow, each with a round dorsal lobe (Fig. 1D). Prostate glands paired in XVIII, large, follicular, smooth surface, yellowish white in color, extending anteriorly to XVI and posteriorly to XX. Prostatic duct U-shaped with the

slender proximal end connecting to prostate gland and the enlarged distal end connecting to male pore (Fig. 1E).

Accessory glands in presetal and postsetal areas in the spermathecal and male pore regions, round, mostly sessile on body wall, few with very short stalks of about 0.21 mm long (Figs. 1C, E), number much less than that of genital papillae in the corresponded segments (Figs. 1B, E). The above differences in

number of accessory glands as compared to that of genital papillae suggest that some of the genital papillae have no accessory glands, and the sessile glands might have ducts mounted in the body wall to connect to the genital papillae.

Etymology. - The name "*tessellatus*" is given to this new species to express the character of the "mosaic formation" of its genital papillae in both spermathecal and male pore regions.

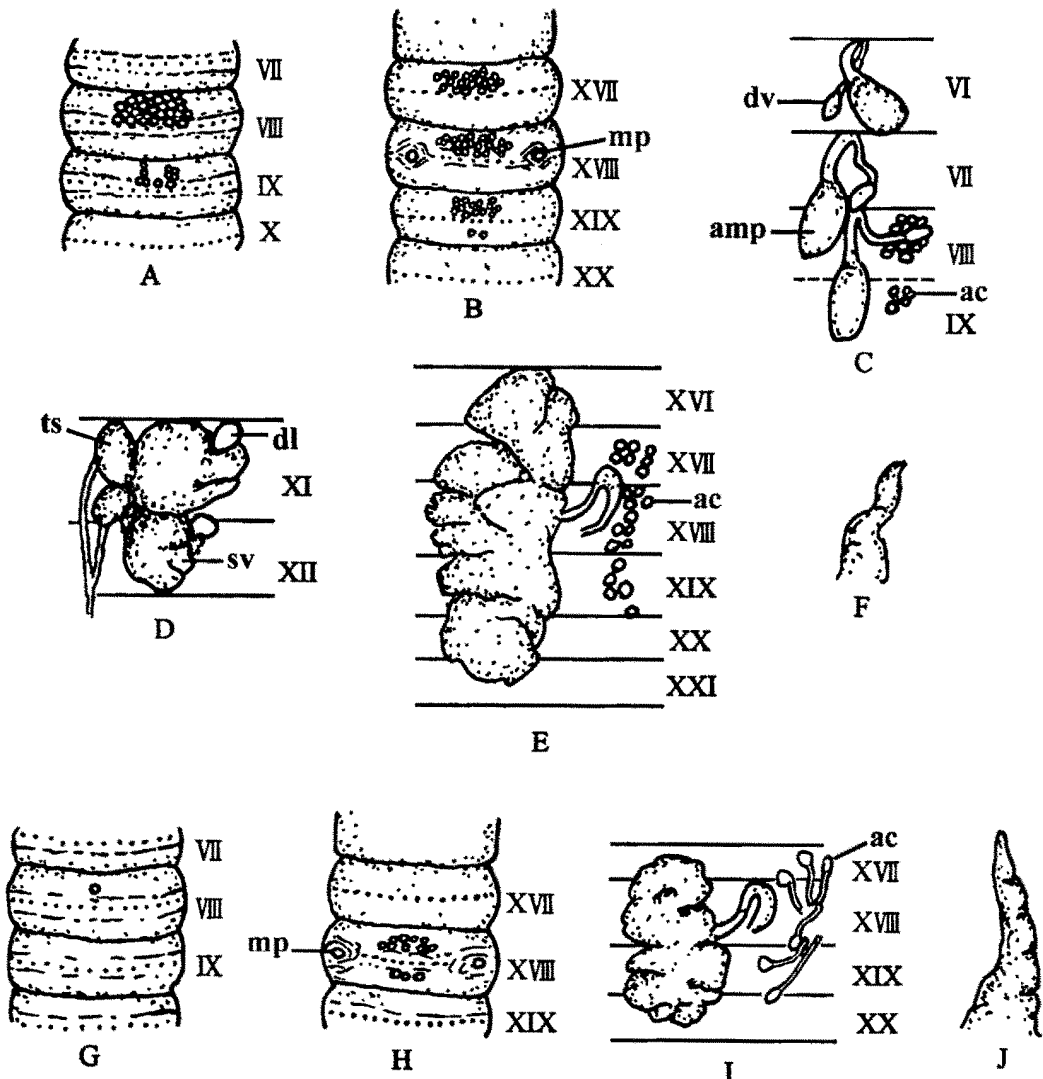


Fig. 1. *Amynthus tessellatus*, new species (= *Amynthus tessellatus tessellatus*, new subspecies), holotype (85 mm): (A) ventral view of the spermathecal pore region with genital papillae in VIII and IX, (B) ventral view of the male pore (mp) region with genital papillae in XVII-XIX, (C) dorsal view of left spermathecae (amp, ampulla; dv, diverticulum; ac, sessile accessory glands), (D) dorsal view of left testis sacs (ts) and seminal vesicles (sv) with small dorsal lobe (dl), (E) left prostate gland and sessile accessory glands (ac), (F) left intestinal caecum. *Amynthus tessellatus paucus*, new subspecies, holotype (109 mm): (G) ventral view of the spermathecal region with a presetal papilla in VIII, (H) ventral view of the male pore region with genital papillae in XVIII, (I) left prostate gland with stalked accessory glands (ac), and (J) left intestinal caecum.

Remarks. - *Amyntas tessellatus*, new species, is a holandric and sexthecal earthworm, belonging to the *hawayanus* species-group of the genus *Amyntas* (Sims & Easton, 1972). It is closely related to *Amyntas papulosus papulosus* (Rosa, 1896) of Sumatra, Malay Peninsula (Beddard, 1900), Burma (Gates, 1972), Thailand (Gates, 1939) and Yunnan of China (= *Pheretima composita* Gates, 1932), and *Amyntas papulosus sauteri* (Michaelsen, 1922) of Taiwan. Both *A. tessellatus* and *A. papulosus* share the fairly similar characters in body size, segment number, propophore structure, thickness of septa 5/6-12/13, papillae in the spermathecal and male pore regions.

However, *A. tessellatus* has distinctly less number of setae, clitellum smooth without setae, and genital papillae irregularly densely patched, whereas *A. papulosus* has higher number of setae, clitellum with a few setae on each of the three segments, and genital papillae arranged in transverse row(s) (Table 1). Testis sacs are small and both pairs are in XI for *A. tessellatus*, but anterior pair in X and posterior pair in XI for *A. papulosus*. *A. tessellatus* has larger prostate glands in XVI-XX like that of *A. papulosus papulosus* of Southeast Asia (Rosa, 1896; Gates, 1972) than that of *A. papulosus sauteri* of Taiwan, which has small prostate glands in XVIII (Michaelsen, 1922).

Table 1. A comparison of characters among *Amyntas tessellatus*, new species, *A. papulosus papulosus*, and *A. papulosus sauteri*.

Character	<i>A. tessellatus</i> new species	<i>A. p. papulosus</i> (Rosa, 1896)	<i>A. p. sauteri</i> (Michaelsen, 1922)	<i>A. papulosus</i> (Gates, 1932)	<i>A. papulosus</i> (Gates, 1972)
Locality	Taiwan	Sumatra	Taiwan	Burma, Yunnan	Burma
Body length (mm)	42-109	45-50	52	52-78	45-78
Segment number	66-114	110-115	90	97-119	96-119
Setal number					
V	28-34	54	54	-	54-60
VII	30-40	-	-	-	-
X	34-40	-	61	-	-
XIII	35-44	66	62	-	62-66
XIV (clitellum)	0	2	few	0-2	usually present
XV (clitellum)	0	4	few	0-2	usually present
XVI (clitellum)	0	4-5	few	6-11	4-6
XIX	-	-	56	-	56-62
XX	35-48	-	-	57-67	57-67
XXVII	38-48	-	53	-	-
between male pores	5-11	-	19	11-14	11-15
Diverticular stalk	slender	slender, zigzag in the terminal portion	slender	slender, looped in a zigzag fashion	short, slender
Prostate glands	XVI-XX	XVI-XXI	small in XVIII	XVI-XIX	XVI-XXI
Genital papillae (number)					
Presetal					
VI	0-3	0	0	0	0
VII	0-21	0	0	0 or 1 transverse row	transverse row(s)
VIII	1-32	0	0	1 transverse row	transverse row(s)
IX	0-19	0	0	0 or 1 transverse row	transverse row(s)
XVII	0-22	2 transverse rows	1 transverse row	2 or 3 transverse rows	patches of 2-3 rows
XVIII	5-25	1 transverse row	1 transverse row	0 or 1 transverse row	transverse row(s)
XIX	0-25	1 transverse row	1 transverse row	1 transverse row	transverse row(s)
XX	0-16	0	0	0	0
XXI	0-3	0	0	0	0
XXII	0-2	0	0	0	0
Postsetal					
VII	0-5	0	0	0 or 1 transverse row	transverse row(s)
VIII	0-12	0	0	1 transverse row	transverse row(s)
IX	0 or 1	0	0	0	transverse row(s)
XVII	0-6	2 transverse rows	1 transverse row	2 or 3 transverse rows	patches of 2-3 rows
XVIII	0-8	0	0	0 or 1 transverse row	transverse row(s)
XIX	0-5	0	0	0	0
XX	0-2	0	0	0	0
XXI	0	0	0	0	0
XXII	0 or 1	0	0	0	0

Densely patched small genital papillae with associated accessory glands of *A. tessellatus* are the characters fairly similar to those of *Amyntas polyglandularis* (Tsai, 1964) of Taiwan, and *Amyntas yunoshimensis* (Hatai, 1930) and *Pheretima purpurata* (Ishizuka, 1999) of Japan. However, their arrangements are species specific and differ from that of *A. tessellatus*, and moreover, the three species are quadrithecal.

HABITAT AND DISTRIBUTION

At the 11 sampling stations, *A. tessellatus*, new species, is found at eight stations in the Central Mountain Range. They are Benbuh at the elevations of

700-800 m, Nanshan at 800-900 m, Wanta at 1100 m, Meichi at 1000 m, North Dongyan at 1800 m, Rueyen at 2300 m, Hohuan at 3000 m, and Wulin at 3200 m (Fig. 2). Benbuh, Nanshan and Meichi are at mountain slopes in the headwater areas of Mei River, while North Dongyan, Rueyen and Wulin are at the mountain slopes in the headwater areas of PeiKan River. Both rivers are the tributaries to the Whu River. Wanta is located at the mountain slope near the Jwoshui River, and Hohuan is at the headwater area of Hohuan Creek, a tributary to the Tachia River, but close to Wulin at the headwater area of PeiKan River. *A. tessellatus* is not found at the three stations: Meifeng at 2000 m, Dongyan at 1000 m at the headwater tributary areas of the Mei River, and Wushe at 1200 m at mountain slopes along the Jwoshui River.

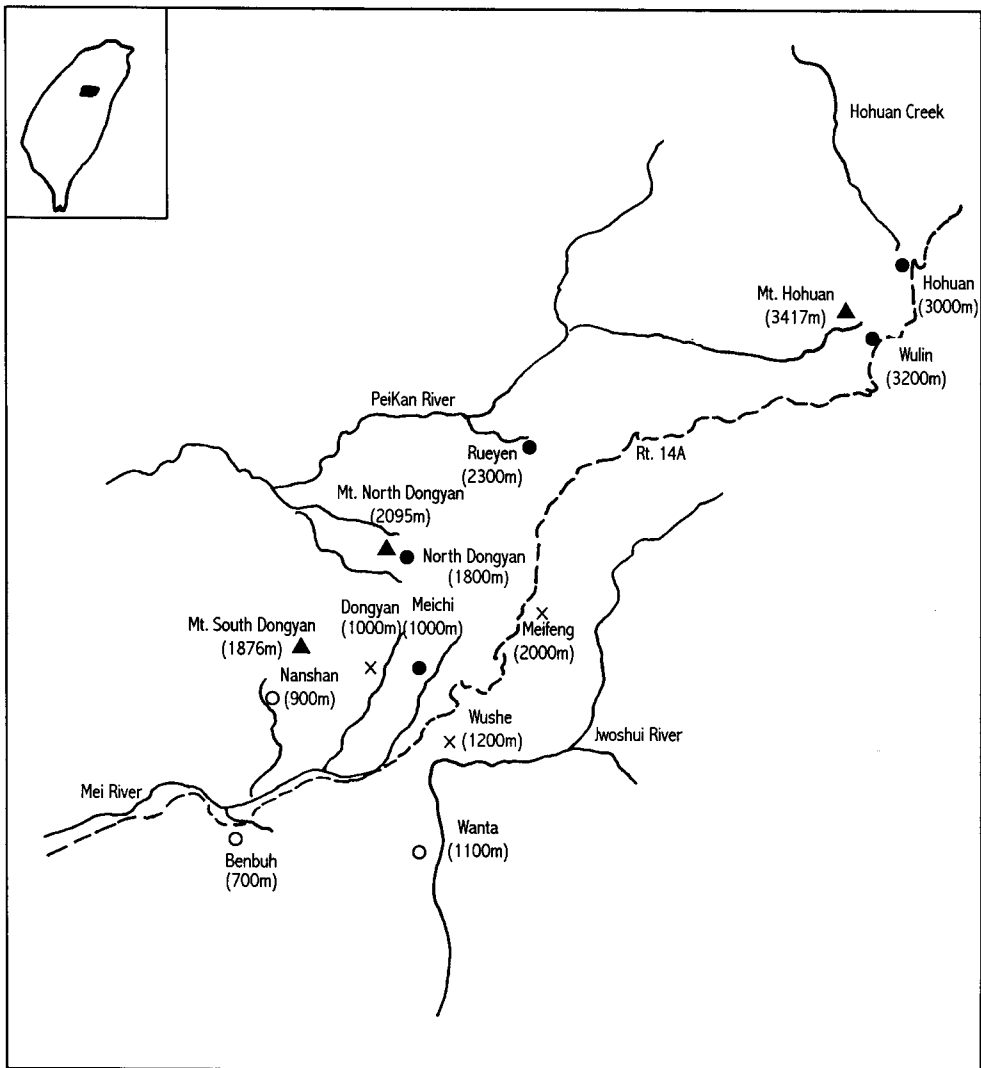


Fig. 2. Distribution of *Amyntas tessellatus tessellatus*, new subspecies, (solid circles) and *Amyntas tessellatus paucus*, new subspecies, (open circles) in the Central Mountain Range of central Taiwan (crosses, the stations where no *A. tessellatus* is collected; solid line, drainage; dashed line, Rt. 14A).

Amyntas tessellatus is a small earthworm with feeble movement, and lives in the mountain slopes wetted by seepage of mountain (underground water) water, or in wetted areas along small ditches. The distribution of *A. tessellatus* seems to show association with elevation.

MORPHOMETRIC VARIATION

Table 2 shows a comparison of the characters of *A. tessellatus* collected at the eight stations. Body length, segment number and setal number show no

obvious difference among the stations, suggesting the fairly conservative nature of these morphometric characters. In contrast, the reproductive organs, such as spermathecae, genital papillae and accessory glands are highly variable among the stations.

Spermathecae. - For spermathecae, the stalk length/ampullar length ratio is the highest (0.82) at Benbuh (elevations of 700-800 m). The ratio decreases to 0.30 at Hohuan (3000 m). In other words, there is a linear vertical (altitude) cline in the length of spermathecal stalk, whose length decreases with the increase in elevation.

Table 2. A comparison of characters of *Amyntas tessellatus tessellatus*, new subspecies, and *Amyntas tessellatus paucus*, new subspecies, collected at the eight sampling areas in central Taiwan, July-December 1999 and February 2000.

Character	<i>tessellatus</i>					<i>paucus</i>		
	Wulin (3200 m) ^{1/}	Hohuan (3000 m)	Rueyen (2300 m)	North Dongyan (1800 m)	Meichi (1000 m)	Wanta (1100 m)	Nanshan (800-900 m)	Benbuh (700-800 m)
Body length (mm)	82	60-93	52-85	68-103	55	99	42-109	63-83
Segment number	89	95-100	66-114	72-110	86	102	68-107	89-105
Setal number								
VII	36	32-36	32-35	30-40	33	31	33-40	33-34
XX	47	42-48	38-42	35-44	42	46	40-45	36-38
between male pores	9	5-7	8-10	8-11	10	10	9-11	9-10
Spermathecal stalk length /ampulla length	0.43	0.30	0.71	0.69	0.70	0.67	0.66	0.82
Diverticular stalk length /seminal chamber length	1.29	1.17	1.88	2.13	2.58	2.21	1.67	1.03
Preclitellar genital papillae								
Presetal								
VI	0	0	1-3(42.9) ^{2/}	0	3(100)	2(100)	0	0
VII	0	2(50)	3-13(71.4)	2-21(90)	6(100)	11(100)	0	5(50)
VIII	3(100)	11-16(100)	16-24(71.4)	9-32(100)	6(100)	15(100)	1(50)	2-12(100)
IX	4(100)	5-12(100)	2-19(71.4)	1(20)	0	0	0	0
Postsetal								
VII	0	0	0	1-5(80)	1(100)	0	0	0
VIII	0	0	1-3(28.6)	1-12(100)	0	0	0	0
IX	0	0	1(14.3)	0	0	0	0	0
Postclitellar genital papillae								
Presetal								
XVII	12(100)	13-17(100)	11-21(100)	7-22(100)	8(100)	0	0	0
XVIII	8(100)	12-14(100)	14-25(100)	9-20(90)	14(100)	18(100)	5-11(100)	8-11(100)
XIX	4(100)	4(50)	10-25(100)	2-21(100)	7(100)	0	0	0
XX	0	1(50)	1-16(42.9)	1(20)	0	0	0	0
XXI	0	0	3(14.3)	1(10)	0	0	0	0
XXII	0	0	0	2(10)	0	0	0	0
Postsetal								
XVII	0	0	0	3-6(100)	3(100)	0	0	0
XVIII	0	0	0	1-4(80)	1(100)	8(100)	1-4(100)	1-4(100)
XIX	0	0	1-2(57.1)	2-5(90)	2(100)	0	0	0
XX	0	0	1(28.6)	1-2(30)	0	0	0	0
XXI	0	0	0	0	0	0	0	0
XXII	0	0	0	1(10)	0	0	0	0
Accessory glands								
Sessile	All	All	Most	Most	Most	None	None	None
Stalked	None	None	Rare	Rare	Rare	All	All	All
Stalk length (mm)	0	0	0.21	0.23	0.13	0.91	0.95-1.38	0.65-0.89

1/ Elevation.

2/ Percentage of samples with genital papillae in the total samples examined.

For diverticula, the stalk length/seminal chamber length ratio is the highest (2.58) at Meichi (1000 m). The ratio decreases to 1.03 at Benbuh and 1.17 at Hohuan. Unlike the spermathecal stalk length/ampullar length ratio, the diverticular stalk length/seminal chamber length ratio shows a V-shaped vertical cline.

Postclitellar Genital Papillae. - Genital papillae of *A. tessellatus* have a wide range of variation in number and location. In the male pore region, presetal genital papillae are always present in XVII, XVIII and XIX at Meichi, North Dongyan, Rueyen, Hohuan and Wulin. Their number is high at North Dongyan and Rueyen and low at Meichi, Hohuan and Wulin. Also, the papillae are occasionally present in XX, XXI and XII at North Dongyan and in XX and XXI at Rueyen. On the other hand, at Wanta, Nanshan and Benbuh the postclitellar genital papillae are restricted to XVIII with the number much less than those at North Dongyan and Rueyen.

Also, postsetal papillae occur in XVII, XVIII and XIX at Meichi and North Dongyan and occasionally in XX at North Dongyan, in XIX and XX at Rueyen, and absent at Hohuan and Wulin. Their number is much less than that of the presetal genital papillae. On the other hand, the postsetal genital papillae occur only in XVIII at Wanta, Nanshan and Benbuh.

Preclitellar Genital Papillae. - Presetal genital papillae in the spermathecal region usually occur in VI, VII and VIII at Meichi, in VII and VIII and occasionally in IX at North Dongyan, in VII, VIII and IX and occasionally in VI at Rueyen, and then in VIII and IX and occasionally in VII at Hohuan and Wulin. At these five stations, the presetal genital papillae shift their locations from VII and VIII to VIII and IX with the increase in elevation. On the other hand, at Wanta, Nanshan and Benbuh presetal genital papillae are found in VIII and occasionally also in VI and VII with less number than those in the higher elevations.

For postsetal genital papillae, a few occur in VII at Meichi, in VII and VIII at North Dongyan, in VIII and IX at Rueyen, and become absent at Hohuan and Wulin. They are also absent in Wanta, Nanshan and Benbuh.

Accessory Glands. - Accessory glands in earthworms collected from Wanta, Nanshan and Benbuh have long stalks (Fig. 11). Their lengths ranged between 0.65 and 1.38 mm. On the other hand, at Meichi, North Dongyan and Rueyen, most of the accessory

glands are sessile (glands sit on the inner surface of body wall without stalks) (Figs. 1C, E), occasionally mixing with a few glands with very short stalks with the length of 0.13-0.23 mm. At Hohuan and Wulin all accessory glands are sessile.

Amyntas tessellatus, new species, has the obvious vertical (altitude) differences in the spermathecal stalk length, the diverticular stalk length, the accessory gland stalk length, and the number and segment location of genital papillae. Based on the characters of genital papillae and accessory glands, *A. tessellatus* may be divided into following two subspecies (Table 2):

***Amyntas tessellatus tessellatus*, new subspecies**
(Figs. 1A-F)

Material examined. - Holotype and paratypes similar to those for *A. tessellatus*, new species, collected at Rueyen, Nantou Prefecture, central Taiwan (coll. no. 1999-24-Shen), 18 Nov.1999.

Remarks. - *Amyntas tessellatus tessellatus*, new subspecies, represents a population of *A. tessellatus*, new species, at the high elevations between 1000-3200 m at Meichi, North Dongyan, Rueyen, Hohuan and Wulin in the Central Mountain Range of Taiwan. It inhabits at mountain slopes of the headwater areas of Mei River and Peikan River, tributaries to the Whu River (Fig. 2). It has the patches of genital papillae in VIII and usually in VII and IX in the preclitellar region and in XVII, XVIII, and XIX in the postclitellar region (Fig. 1A, B). Accessory glands are sessile or mostly sessile mixing with a few with very short stalks (Table 2 and Figs. 1C, E).

***Amyntas tessellatus paucus*, new subspecies**
(Figs. 1G-J)

Material examined. - Holotype - 1 mature (clitellate) specimen (dissected)(coll. no. 1999-20-Shen) collected from the mountain slope along Nanshan Creek (elevation 800-900 m), Jen-ay Hsiang, Nantou, central Taiwan, coll. C. F. Tsai, S. C. Tsai, H. P. Shen, J. W. Luo, M. H. Shen, J. L. Lai, and C. Y. Chang, 10 Nov.1999.

Paratypes - 18 mature specimens, same data as holotype.

Remarks. - *Amyntas tessellatus paucus*, new subspecies, is distinguishable from *A. tessellatus tessellatus*, new subspecies, by having patches of both presetal and postsetal genital papillae only in XVIII in the postclitellar region, and accessory

glands with long, slender stalks (Table 2 and Fig. 11). It occurs at the mountain slopes at the elevations of 700 m to 1100 m along Nanshan and Benbuh creeks, the headwater areas of Mei River, and also at the mountain slope along the Jwoshui River (Fig. 2).

The name "*paucus*" is given to this subspecies due to its "less degree" of the mosaic formation for the patch of the genital papillae, as compared to that for *A. tessellatus tessellatus*, new subspecies.

ACKNOWLEDGEMENTS

We are grateful to Messrs. R. C. Jang, H. P. Chen, J. W. Luo, M. H. Shen, J. L. Lai, T. J. Lin, C. Y. Chang, P. H. Ho, and C. T. Yao who assisted in field collections. Ms. F. F. Li assisted in drawing the figures.

LITERATURE CITED

- Beddard, F. E., 1900. On the earthworms collected during the "Skeat Expedition" to the Malay Peninsula, 1899-1900. *Proceedings of the Zoological Society of London*, **1900**: 891-911.
- Gates, G. E., 1932. The earthworms of Burma III. The Megascolecidae. *Records of the Indian Museum*, **34**: 357-549.
- Gates, G. E., 1939. Thai earthworms. *The Journal of the Thailand Research Society*, **12**: 65-114.
- Gates, G. E., 1972. Burmese earthworms: an introduction to the systematics and biology of megadrile oligochaetes with special reference to Southeast Asia. *Transactions of the American Philosophical Society*, **62**(7): 1-326.
- Hatai, S., 1930. Note on *Pheretima agrestis* (Goto & Hatai), together with the description of four new species of the genus *Pheretima*. *Science Report of the Tohoku University*, **5**: 651-667.
- Ishizuka, K., 1999. New species of the genus *Pheretima* s. lat. (Annelida, Oligochaeta, Megascolecidae) from Tokyo, Japan-species with manicate intestinal caeca. *Bulletin of the National Science Museum. Series A: Zoology*, **25**(1): 33-57.
- Kuo, T. C., 1995. Ultrastructure of genital markings in some species of *Pheretima*, *Bimastos* and *Perionyx* in northern Taiwan. *National Hsinchu Teacher's College Journal*, **8**: 181-199.
- Michaelsen, W., 1922. Oligochaten aus dem Rijks Museum van Natuurlijke Historie zu Leiden. *Capita Zoologica*, **1**(3): 1-68.
- Rosa, D., 1896. I Lombrichi raccolti a Sumatra dal Dott. Elio Modigliani. *Annali del Museo Civico di Storia Naturale di Genova Serie 2.^a*, **16**: 502-532.
- Sims, R. W. & E. G. Easton, 1972. A numerical revision of the earthworm genus *Pheretima* auct. (Megascolecidae: Oligochaeta) with the recognition of new genera and an appendix on the earthworms collected by the Royal Society North Borneo Expedition. *Biological Journal of the Linnean Society*, **4**: 169-268.
- Tsai, C. F., 1964. On some earthworms belonging to the genus *Pheretima* Kinberg collected from Taipei area in North Taiwan. *Quarterly Journal of the Taiwan Museum*, **17**(1&2): 1-35.
- Tsai, C. F., H. P. Shen & S. C. Tsai, 1999. On some new species of the pheretimoid earthworms (Oligochaeta: Megascolecidae) from Taiwan. *Journal of the National Taiwan Museum*, **52**(2): 33-46.
- Tsai, C. F., H. P. Shen & S. C. Tsai, 2000a. Native and exotic species of the terrestrial earthworms (Oligochaeta) in Taiwan with reference to Northeast Asia. *Zoological Studies*, **39**(4): 285-294.
- Tsai, C. F., S. C. Tsai & G. J. Liaw, 2000b. Two new species of protandric pheretimoid earthworms belonging to the genus *Metaphire* (Megascolecidae: Oligochaeta) from Taiwan. *Journal of Natural History*, **34**: 1731-1741.
- Tsai, S. C., H. P. Shen & C. F. Tsai, 2000c. A new pheretimoid earthworm with latero-dorsal genital papillae. *Journal of the National Taiwan Museum*, **53**(1): 7-13.
- Tsai, C. F., H. P. Shen & S. C. Tsai, 2001. Some new earthworms of the genus *Amyntas* (Oligochaeta: Megascolecidae) from Mt. Hohuan of Taiwan. *Zoological Studies*, **40**(4): 276-288.