

On the Giant Pheretimoid Earthworms From Vietnam (Clitellata: Megascolecidae), with Descriptions of Three New Species

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Tung T. Nguyen, Dang H. Lam, and Anh D. Nguyen (2016) The giant earthworms from Vietnam are being reviewed to consist of six species, *Amynthas dangi* (Thai, 1984), *A. munglonganus* (Thai & Tran, 1986) comb. nov., *A. ghilarovi* (Thai, 1982), and three new, *A. munglongoides* sp. nov., *A. antoanensis* sp. nov. and *A. konkakinh* sp. nov. All six species have lengths ranging 300-680 mm, diameter ca. 16-20 mm, and without copulatory pouches. The new species, *A. munglongoides* sp. nov. is characterised by three pairs of spermathecal pores in intersegment 5/6/7/8, genital markings paired in vii, viii and xviii. *A. antoanensis* sp. nov. is distinguished by four pairs of spermathecal pores in 5/6/7/8/9, genital marking paired in viii, ix, and xviii. *A. konkakinh* sp. nov. is recognised by four pairs of spermathecal pores in 5/6/7/8/9, genital marking single in viii, paired in xviii. In addition, a key to all six gigantic species in Vietnam is also provided.

Key words: Annelida, Megascolecidae, Pheretimoids, Gigantic earthworms, Vietnam.

BACKGROUND

Pheretimoid earthworms have been known to be the largest group in the family Megascolecidae, with about 930 valid species from more than 1,400 nominal names in 15 genera (Sims and Easton 1972; Easton 1979; Blakemore 2007). This group is mainly found in the Oriental region, e.g. Vietnam, Taiwan, Philippines (Blakemore et al. 2006; Aspe and James 2016; Nouven et al. 2016). Almost all species are smaller than 400 mm in length, and 8 mm in diameter. Only five pheretimoid species are longer than 500 mm including Amynthas mekongianus (Cognetti, 1922) (= Pheretima fluvialis Gates, 1939) from Thailand and Laos (length = 500-2,900 mm), Metaphire musica (Horst, 1883) from Java island (length = 570 mm), Metaphire magna (Chen, 1938) from Hainan island (length = 700 mm), Metapheretima jocchana (Cognetti, 1911) from New Guinea (length

= 670 mm), and *Metaphire taiwanensis* Tsai, Tsai & Shen, 2004 from Taiwan (length = 637-655 mm) (Tsai et al. 2004). Although Vietnamese earthworms are very diverse with 213 known species (Nguyen et al. 2016), only three, *Amynthas dangi dangi* (Thai, 1984), *A. dangi munglonganus* (Thai et Tran, 1986) and *Amynthas ghilarovi* (Thai, 1982) are longer than 300 mm. More large earthworms are expected to be discovered in Vietnam due to habitat diversity and specific geographical locations in the tropical region. The study herein contributes to our knowledge of Vietnamese earthworm through descriptions of three new species of gigantic earthworms.

MATERIALS AND METHODS

Specimens were collected from various parts of Vietnam and deposited in the Laboratory of

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Zoology, Cantho University (= CTU), Cantho City, Vietnam. All specimens are preserved permanently in 4% formalin.

RESULTS

Taxonomy

Family Megascolecidae Rosa, 1891 Genus *Amynthas* Kinberg, 1867

Amynthas dangi (Thai, 1984) (Fig. 1, Table 1)

Pheretima dangi Thai, 1984: 1325, fig. 4B. Amynthas dangi dangi - Blakemore 2007: 27; Nguyen et al. 2016

Material examined: 1 mature (CTU-EW.078.01) Ba Vi Mt., Hanoi, 9/1992, coll. Khiem; 1 mature (CTU-EW.078.03) the temple of Hung Vuong King, Doan Hung District, Phu Tho province, 29/4/2007, coll. Vu Quang Manh.

Diagnosis: Large-size worm, length > 300 mm, diameter ca. 13-17 mm. First dorsal pore in 11/12. Prostomium epilobous. Spermathecal pores ventrally paired in intersegmental furrows 7/8/9. Male pores located in xviii, without copulatory pouches. Genital makings absent on spermathecal region, but three pairs in xviii and xix. Holandric. Spermathecal ampulla egg-shaped, duct absent. Testis sacs separated. Intestinal caeca manicate. Septa 8/9/10 absent.

Distribution: Phu Tho (Doan Hung); Vinh Phuc (Tam Dao NP); Lang Son (Huu Lung); Hanoi (Soc Son) (Thai 1984; Le 1995; Nguyen et al. 2016).

Remarks: An endemic species to Vietnam.

Amynthas munglonganus (Thai et Tran, 1986) comb. nov.

(Fig. 2, Table 1)

Pheretima dangi munglongana Thai et Tran, 1986: 9, fig. 3B. *Amynthas dangi munglonganus* - Blakemore 2007: 27; Nguyen et al. 2016

Material examined: 3 matures (CTU-EW.078.02) bamboo forest, Thuong Tien NR, Kim Boi, Hoa Binh, 7/8/2005, coll. Anh D. Nguyen.

Diagnosis: Large-size worm, length 320-355 mm, diameter ca. 14-18 mm. First dorsal pore in 12/13. Prostomium epilobous. Spermathecal pores ventrally paired in intersegmental furrows 5/6/7/8. Male pores located in xviii,

without copulatory pouches. Genital makings 5-6 pairs in front of spermathecal pores in v, vi and viii; and only one pair closely next to male pores. Holandric. Spermathecal ampulla oval-shaped, duct short. Testis sacs separated. Intestinal caeca manicate. Septa 8/9/10 absent.

Distribution: Nghe An (Ky Son); Quang Binh (Minh Hoa); Hoa Binh (Kim Boi) (Thai and Tran 1986; Nguyen 1994; Nguyen et al. 2016).

Remarks: The species was originally described as the subspecies *Pheretima dangi munglongana* Thai & Tran, 1986. However, it is different from its congener, *A. dangi* (Thai, 1984) by having three spermathecal pores in 5/6/7/8 (two pairs in 7/8/9 in *A. dangi*), presence of genital markings in both spermathecal and male pore regions, and a spermathecal ampulla duct short, while in *A. dangi* genital markings are absent in the spermathecal region, and the ampulla duct is almost absent. These differences lead to raising *A. dangi munglonganus* to full species rank.

An endemic species to Vietnam.

Amynthas ghilarovi (Thai, 1982) (Fig. 3, Table 1)

Pheretima ghilarovi Thai, 1982: 826, fig. 2D. Amynthas ghilarovi - Blakemore 2007: 41; Nguyen et al. 2016

Diagnosis: Large-size worm, length 370 mm, diameter ca. 13 mm. First dorsal pore in 12/13. Prostomium epilobous. Spermathecal pores ventrally paired in intersegmental furrows 6/7/8/9. Male pores located in xviii, without copulatory pouches. Genital makings paired closely behind spermathecal pores in vii, viii and ix; and two pairs in front of and behind male pores. Holandric. Spermathecal ampulla egg-shaped, duct short and stout. Testis sacs separated. Intestinal caeca manicate. Septa 8/9/10 absent.

Distribution: Ninh Binh (Cuc Phuong NP) (Thai 1982; Nguyen et al. 2016).

Remarks: An endemic species to Vietnam.

Amynthas munglongoides Nguyen, Lam & Nguyen sp. nov.

lsid:zoobank.org:act:F669ACC7-13D2-40FA-AB7A-FC01EE1918CA (Fig. 4, Table 1)

Material examined: Holotype: One mature (CTU-EW037-h01) Vietnam, Ha Giang province, Vi Xuyen District, Cao Bo commune, elevation of 1,492 m a.s.l., 22°47'33,9"N - 104°52'07,9"E; 07/2008, coll. Nguyen Hoang Ngoc.

Paratype: One mature (CTU-EW037-p01) together with holotype.

Diagnosis: Large-size worm, length ca. 252-318 mm, diameter ca. 15.5-16.0 mm. First dorsal pore in 11/12. Prostomium epilobous.

Spermathecal pores round and small, ventrally paired in intersegmental furrows 5/6/7/8. Male pores located in xviii, without copulatory pouches. Genital makings present on both spermathecal and male pore regions (on vii, viii, and xviii). Holandric.



Fig. 1. *Amynthas dangi* (Thai, 1984) from Phu Tho (CTU-EW.078.03). A, E: Male pore region, ventral view (mp = male pore; gm = gential markings); B: Spermathecal region, ventral view (sp = spermathecal pore); C, G: Spermathecae (amp = ampulla; dv = diverticula); D, I: Prostatic gland (ag = accessory gland); F, H: Intestinal caeca. Scale bar = 1 mm.

Spermathecal ampulla egg-shaped, duct almost reduced. Testis sacs separated. Intestinal caeca manicate. Septa 8/9/10 absent.

Etymology: "*munglongoides*" is an adjective in apposition to emphasize its similarity to the species, *A. munglonganus* (Thai & Tran, 1986)

Description: External characters: Body cylindrical, large size; length 252-318 mm, diameter 15.5-16.0 mm, weight 18.62-37.86 g; 98-116 segments. Body uniformly whitish grey. Prostomium 1/3 epilobous. First dorsal pore large, in 11/12. Setae perichaetine, short; pre-clitellar setae stouter and sparser than post-clitellar setae, 66-76 in v, 84-98 in viii, 94-99 in x, 91-94 in xx, 106 in xxv, 105-107 in xxx, 20-35 between male porophores in xviii; setal distance aa = 1.5-2.0 ab, zz = 1.5-2.0 zy. Clitellum annular, xiv-xvi, darkish brown, smooth and without setae and dorsal pores. Female pore single, mid-ventral in xiv. Spermathecal pores round and small, ventrally paired in intersegmental furrows 5/6/7/8. Two pairs of round genital markings ventrally

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Characters	A. munglongoides	A. antoanensis	A. konkakinh	A. dangi	A. munglonganus
Length (mm)	252-318	685	670	>300	320-355
Diameter (mm)	15.5-16	19	16.5	13-17	14-18
Segments	98-116	335	204	>160	130-133
Setae between male pores	20-35	55	50	38	26
First dorsal pore	11/12	12/13	12/13	11/12	12/13
Prostomium	epilobous	epilobous	epilobous	epilobous	epilobous
Spermathecal pores	5/6/7/8	5/6/7/8/9	5/6/7/8/9	7/8/9	5/6/7/8
Copulatory pouches	Absent	Absent	Absent	Absent	Absent
GM in spermathecal region	Present, paired in vii, viii	Present, paired in l viii, ix	Present, only one in ventral viii	Absent	Present
GM in male pore region	Present, three pairs in xviii, and one pair next to male pores	Present, two pairs in mid-ventral xviii	Present, one pair in front of male pores	Three pairs in xv and xix	iii Present
Spermathecal ampulla	Large, Egg-shaped	Oval-shaped	Cylindrial-shaped	Egg-shaped	Oval-shaped
Ampulla duct	Almost absent	Short	Short	Almost absent	Short
Spermathecal diverticula	Coiled	Coiled	Coiled	-	Folded
Septa 8/9/10	Absent	Absent	Absent	Absent	Absent
Intestinal caeca	Manicate	Simple	Simple	Manicate	Manicate
Testis sacs	Holandric	Holandric	Holandric	Holandric	Holandric
Characters	A. ghilarovi	A. mekongianu	s M. tai	wanensis	M. magna
Length (mm)	370	500-2,900	63	7-655	700
Diameter (mm)	10.5-13	4-10	16.	1-17.2	-
Segments	151	370-580	18	3-228	184
Setae between male pores	14	-	1	5-24	20
First dorsal pore	12/13	11/12 or 12/13	12/13	or 13/14	
Prostomium	epilobous		pro	lobous	Pro-epilobous
Spermathecal pores	6/7/8/9	4/5/6/7/8 or 5/6/7/	/8/9 5/6	6/7/8/9	7/8/9
Copulatory pouches	Present	Absent	Pr	resent	Present
GM in spermathecal region	Present, behind spermathecal pore	Absent	al	bsent	3-6 near pore
GM in male pore region	Two sub-semicircular in front of and behind male pores	Absent	Present, A pads in from	pair of genital (t of male pores	One inside from pore
Spermathecal ampulla	Egg-shaped	Heart-shaped	Oval or h	eart-shaped	-
Ampulla duct	Large	Stout, short	s	short	-
Spermathecal diverticula	Not coiled	Not coiled	C	oiled	coiled
Septa 8/9/10	Absent	8/9 thicked, 9/10 at	osent A	bsent	-
Intestinal caeca	Manicate	Simple	S	imple	-
Testis sacs	Holandric	Holandric	Pro	pandric	Holandric



Fig. 2. *Amynthas munglonganus* (Thai & Tran, 1986) from Hoa Binh (CTU-EW.078.02). A, J: Male pore region, ventral view (mp = male pore; gm = gential markings); B, I: Spermathecal region, ventral view (sp = spermathecal pore); C, F: Spermathecae (amp = ampulla; dv = diverticula; ag = accessory gland); D, H: Prostatic gland (ag = accessory gland); E, G: Intestinal caeca. Scale bar = 1 mm.

present in front of setal rings on vii and viii; ventral distance between genital markings about 0.25x body circumference. Male pores directly opened in xviii, without copulatory pouches; ventral distance between male porophores about 0.35x body circumference. Three pairs of genital markings present in xviii: one pair bean-shaped closing to male porophore; two pairs crescentic in front of and behind setal ring of xviii, the anterior pair larger than posterior one.

Internal characters: Septa 5/6/7/8 thickened, 8/9/10 absent, 10/11/12/13 thickened. Oesophageal gizzard within viii-x. Intestinal origin at xv; caeca manicate, originating at xxvii and extending anteriorly to xxiv or xxii. Last hearts in xiii. Pharyngeal micronephridia developed in 4/5/6. Lymph glands present from xvi. Typhlosole simple, lamelliform, poorly developed. Spemathecae paired ventrally, in vi-viii. Spermathecal ampulla large, egg-shaped, yellowish white; duct extremely short, almost absent. Diverticula very short, opalescent, directly attached to body wall, close to ampulla duct. Two pairs of accessory glands opalescent in vii and viii. Holandric. Testis sacs separated, in x and xi. Seminal vesicles well developed within xi-xii, and a pseudoseminal vesicle large in 13/14. Oviduct on septum 12/13 posteriorly; ovaries well developed in 12/13. Prostate glands deeply racemose, paired in xvi-xix; prostatic ducts U-shaped, slightly bigger distally. Accessory glands absent in male region.

Habitat: The new species was found in very high elevation, ca. 1,500 m a.s.l. It can be epigeic species because it was collected from soil surface.

Remarks: The new species can be classified into the *hawayanus* species group characterised by holandric and three pairs of spermathecal pores in intersegments 5/6/7/8 (Sims and Easton 1972). It can be distinguished by its large size and pattern of genital markings on the spermathecal and male regions.

When compared with the large species found in Vietnam, the new species is similar to *Amynthas dangi* (Thai, 1984), *Amynthas munglonganus*



Fig. 3. *Amynthas ghilarovi* (Thai, 1982) from Cuc Phuong, redrawn from Thai (1982). A: Male pore region, ventral view; B: Spermathecal pore; C: Spermathecae; D; Intestinal caeca; E: Prostatic gland. Scale bar = 1 mm.

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Fig. 4. *Amynthas munglongoides* sp. nov., holotype. A: Male pore region, ventral view (mp = male pore; gm = gential markings); B, G: Spermathecae and accessory gland (amp = ampulla; dv = diverticula; ag = accessory gland); C, E: Intestinal caeca; D; Prostatic gland; F; Male pore region, ventral view; H: Spermathecal region, ventral view (sp = spermathecal pore). Scale bar = 1 mm.

Thai & Tran, 1986), and Amynthas ghilarovi (Thai, 1982) by its large size, epilobous prostomium, septa 8/9/10 absent, intestinal caeca manicate, last hearts in xiii, and copulatory pouches absent (Table 1). However, Amynthas dangi differs from the new species in having two pairs of spermathecal pores in 7/8/9, a genital marking closed to the male pore and an additional three pairs of genital markings on ventral xviii and xix. Amynthas munglonganus is distinguished from the new species by the first dorsal pore in 12/13, three pairs of small genital markings located closely to the spermathecal pores, a medium genital marking next to the male pore, and different shape of the spermathecal ampulla. The other large species, Amynthas ghilarovi (Thai, 1982), is slightly smaller than the new species, and has three pairs of spermathecal pores in 6/7/8/9, small, round genital markings located behind spermathecal pores, two pairs of sub-semicircular genital markings located in front of and behind the male pore, and presence of copulatory pouches. The other large species, A. mekongianus (Cognetti, 1922) differs from the new species by having longer length (up to 2.900 mm) and smaller diameter (less than 10 mm), four pairs of spermathecal pores in 4/5/6/7/8 or 5/6/7/8/9, and no genital markings in both spermathecal and male regions.

In comparison to *M. taiwanensis*, the new species shares the large size (more than 16 mm in diameter). *M. taiwanensis* differs from the new species in first dorsal pore in 12/13 or 13/14, four pairs of spermathecal pores in 5/6/7/8/9, genital markings oval-shaped, located in front of porophores, male pores located inside copulatory pouches, and proandric. A character comparison among large pheretimoid species is presented in the Table 1.

Amynthas antoanensis Nguyen, Lam & Nguyen sp. nov.

lsid:zoobank.org:act:56BBD3F7-9F6C-4E3A-AC59-2A21E3B72ABE (Fig. 5, Table 1)

Material examined: Holotyp: One mature (CTU-EW038-h01) forest, An Toan commune, Binh Dinh province, 29/12/2006, coll. Pham Hoai Vu.

Diagnosis: Large-size worm, length ca. 685 mm, diameter ca. 19 mm. First dorsal pore in 12/13. Prostomium epilobous. Spermathecal pores round and small, ventrally paired in intersegmental furrows 5/6/7/8/9. Male pores located in xviii, without copulatory pouches. Genital makings present on both spermathecal and male pore regions (on viii, ix, and xviii). Holandric. Spermathecal ampulla oval-shaped, duct short; diverticula coiled. Testis sacs separated. Intestinal caeca simple. Septa 8/9/10 absent.

Etymology: Named after the type locality, An Toan commune.

Description: External characters: Body cylindrial, length 685 mm, diameter 19 mm (20 mm/ viii, 21 mm/xvi, 18 mm/xviii, 17 mm/xxx), weight 97.66 g, 335 segments,. Dorsa blackish grey, but ventra paler. Prostomium 1/3 epilobous. First dorsal pore large, in 12/13. Setae perichaetine, short; pre-clitellar setae stouter and sparser than post-clitellar setae, 126 in v, 137 in viii, 149 in x, 177 in xx, 228 in xxv, 249 in xxx, 55 between male porophores in xviii; setal distance aa = 2.0ab, zz = 1.0-2.0zy. Clitellum annular, xiv-1/2xvii, blackish brown, smooth and without setae and dorsal pores. Female pore single, mid-ventral in xiv. Spermathecal pores very small, ventrally paired in intersegmental furrows 5/6/7/8/9, hardly visible externally. Genital markings ventrally paired present on viii and ix: three pairs behind setal rings on viii, and two pairs in front of setal ring on ix. Male pores directly opened in xviii, without copulatory pouches; ventral distance between male porophores about 0.35x body circumference. Two pairs of genital markings present between male porophores, behind setal ring of xviii; the anterior pair slightly more medial to male pores compared to posterior pair.

Internal characters: Septa 4/5/6/7/8 very thickened, 8/9/10 absent, 10/11/12/13 thin. Oesophageal gizzard within viii-x. Intestinal origin at xv; caeca simple, originating at xxvii and extending anteriorly to xxiv. Last hearts in xiii. Pharyngeal micronephridia developed in 5/6/7. Lymph glands present from 31/32. Typhlosole simple, lamelliform, poorly developed. Spemathecae paired ventrally in vi- ix. Spermathecal ampulla oval-shaped; duct extremely short, not distinct from ampulla. Diverticula very short, opalescent, coiled, directly attached to base of ampulla. Accessory glands present in viii and ix. Holandric. Testis sacs separated, in x and xi. Seminal vesicles poorly developed within xixii. Oviduct poorly developed on septum 12/13 posteriorly; ovaries developed in 13/14. Prostate glands racemose, paired within xviii; prostatic ducts strong, slightly bigger distally. Two pairs of accessory glands present.

Habitat: The species was found in the rich forest of An Toan commune. It can be epigeic



Fig. 5. *Amynthas antoanensis* sp. nov., holotype. A, G: Male pore region, ventral view (mp = male pore; gm = gential markings); B, I: Spermathecal region (sp = spermathecal pore; gm = gential markings); C, D: Spermathecae (amp = ampulla; dv = diverticula); E, H: Intestinal caeca; F: Prostatic gland. Scale bar = 1 mm.

species because it was collected from soil surface.

Remarks: The new species can be classified into the *diffringens* species group characterised by holandric and four pairs of spermathecal pores in intersegments 5/6/7/8/9 (Sims and Easton 1972). However, it can be distinguished by its large size and pattern of genital markings in spermathecal and male regions.

The new species is fairly similar to the other large Amynthas earthworms from Vietnam, Amynthas dangi (Thai, 1984) and Amynthas munglonganus (Thai & Tran, 1986), by the very large size, holandric, prostomium epilobous, septa 8/9/10 absent, last hearts in xiii, and copulatory pouches absent (Table 1). However, Amynthas dangi differs from the new species in having two pairs of spermathecal pores in 7/8/9, a genital marking close to the male pore and an additional three pairs of genital markings on ventral xviii and xix. Amynthas munglonganus is distinguished from the new species by the first dorsal pore in 12/13, three pairs of small genital markings located closely to the spermathecal pores in 5/6/7/8, a medium genital marking next to the male pore, and different shape of spermathecal ampulla.

The new species is also fairly similar to the other large *Metaphire* species, *M. taiwanensis* Tsai, Tsai & Shen, 2004, by having four pairs of spermathecal pores in 5/6/7/8/9, septa 8/9/10 absent, intestine originating from xv, and caeca simple. However, *M. taiwanensis* differs from the new species in the first dorsal pore in 12/13 or 13/14; genital markings absent in the spermathecal region, but oval-shaped, located anteriorly next to porophores; male pores located inside copulatory pouches.

Amynthas konkakinh Nguyen, Lam & Nguyen sp. nov.

lsid:zoobank.org:act:833AA0A9-E3EF-4AE4-9F87-9C75E84696A7 (Fig. 6, Table 1)

Material examined: Holotype: One mature (CTU-EW038-p01) primary forest, southwestern part of Kon Ka Kinh National Park, Gia Lai province, Vietnam, 20/10/2010, coll. Pham Thi Mai.

Diagnosis: Large-size worm, length ca. 670 mm, diameter ca. 16.5 mm. First dorsal pore in 12/13. Prostomium epilobous. Spermathecal pores round and small, ventrally paired in intersegmental furrows 5/6/7/8/9. Male pores located in xviii, without copulatory pouches. Genital makings present on both spermathecal and male regions (on viii and xviii). Holandric. Spermathecal ampulla cylindrical-shaped, duct short; diverticula coiled. Testis sacs separated. Intestinal caeca simple. Septa 8/9/10 absent.

Etymology: *"konkakinh"* is a noun in apposition to emphasize the type locality.

Description: External characters: Body cylindrial, length 670 mm, diameter 16.5 mm (20 mm/viii, 15 mm/xvi, 16 mm/xviii, 15 mm/xxx), segments 204, weight 119.68 g. Dorsa blackish grey, but ventra paler. Prostomium epilobous. First dorsal pore large, in 12/13. Setae perichaetine, short; pre-clitellar setae stouter and sparser than post-clitellar setae, 131 in v, 144 in viii, 187 in x, 219 in xx, 226 in xxv, 208 in xxx, 50 between male porophores in xviii; setal distance aa = ab, zz = 1.0-2.0zy. Clitellum annular, xiv-1/2xvii, blackish brown, smooth and without setae and dorsal pores. Female pore single, mid-ventral in xiv. Spermathecal pores very small, ventrally paired in intersegmental furrows 5/6/7/8/9, hardly visible externally. A genital marking ventrally present on viii. Male pores directly opened in xviii; ventral distance between male porophores about 0.35x body circumference. A pair of genital markings present in front of setal ring of xviii, slightly medial to male pores.

Internal characters: Septa 4/5/6/7/8 very thickened, 8/9/10 absent, 10/11/12/13 thin. Oesophageal gizzard within viii-x. Intestinal origin at xv; caeca simple, originating at xxvii and extending anteriorly to xxii. Last hearts in xiii. Pharyngeal micronephridia developed in 5/6/7. Lymph glands present from 32/33. Typhlosole simple, lamelliform, poorly developed. Spermathecae paired ventrally in vi- ix. Spermathecal ampulla cylindrical-shaped; duct short, about 1/3 ampulla length. Diverticula very shorter than ampulla, opalescent, coiled, directly attached to base of ampulla. Accessory glands absent. Holandric. Testis sacs separated, in x and xi. Seminal vesicles whitish yellow, poorly developed within xi-xii. Oviduct poorly developed on septum 12/13 posteriorly; ovaries developed in 13/14. Prostate glands racemose, paired within xviii; prostatic ducts strong, slightly getting smaller distally. A pair of accessory glands present.

Habitat: The species was collected from soil surface or litter layer in the rich forest. It can be epigeic species.

Remarks: The new species can be classified into the *diffringens* species group characterised by holandric and four pairs of spermathecal pores in intersegments 5/6/7/8/9 (Sims and Easton 1972).



Fig. 6. *Amynthas konkakinh* sp. nov., holotype. A, F: Male pore region, ventral view (mp = male pore; gm = gential markings); H: Spermathecal region (sp = spermathecal pore; gm = gential markings); C, E: Spermathecae (amp = ampulla; dv = diverticula); D, G: Intestinal caeca; B: Prostatic gland (ag = accessory gland). Scale bar = 1 mm.

However, it can be distinguished by its large size and pattern of genital markings in spermathecal and male regions.

Amynthas konkakinh sp. nov. is especially similar to A. antoanensis sp. nov. by having large size, first dorsal pore in 12/13, four pairs of spermathecal pores in 5/6/7/8/9, intestinal caeca simple, septa 8/9/10 absent, and prostomium epilobous (Table 1). However, A. antoanensis sp. nov. can be recognized from A. konkakinh sp. nov. by having four pairs of genital markings in viii and ix, and two pairs of genital markings in mid-ventral xviii.

The new species is also fairly similar to the other large Amynthas earthworms from Vietnam, Amynthas dangi (Thai, 1984) and A. munglonganus (Thai & Tran, 1986), by its very large size, holandric, prostomium epilobous, septa 8/9/10 absent, last hearts in xiii, and copulatory pouches absent. However, A. dangi differs from the new species in having two pairs of spermathecal pores in 7/8/9, a genital marking closed to the male pore and an additional three pairs of genital markings on ventral xviii and xix. A. munglonganus is distinguished from the new species by the first dorsal pore in 12/13, three pairs of small genital markings located closely to spermathecal pores in 5/6/7/8, a medium genital marking next to the male pore, and different shape of spermathecal ampulla.

Key to large earthworms in Vietnam

1.	Four pairs of spermathecal pores in 5/6/7/8/9 2
-	Only two or three pairs of spermathecal pores
2.	Genital markings paired in viii, ix, and mid-ventral xviii.
	Spermathecal ampulla oval-shaped A. antoanensis
-	Genital markings single in viii, and paired in front of male
	pores in xviii. Spermathecal ampulla cylindrical
	A. konkakinh
3.	Two pairs of spermathecal pores in 7/8/9 A. dangi
-	Three pairs of spermathecal pores in 5/6/7/8 or 6/7/8/9
4.	Spermathecal pores in 6/7/8/9 A. ghilarovi
-	Spermathecal pores in 5/6/7/8 5
5.	Genital markings absent in both spermathecal and male
	pore regions A. munglonganus
-	Genital markings present in both spermathecal and male
	pore regions A. munglongoides

DISCUSSION

Nguyen et al. (2016) reported 212 earthworm species recorded from Vietnam, but more species are awaiting discovery from this country due to its specific location and habitat diversity in the tropical region. Almost all species are smaller than 300 mm in length and 8 mm in diameter. Only six species are larger than 300 mm in length and 10 mm in diameter.

All six gigantic species have only been collected from the top soil layer or litter layer in rich forest. They have never been recorded from cultivated lands or hilly soils. Presumably, the giant species are very sensitive to environs of the forest, and easily affected by human activities. It is recommended that the giant species be used as a bio-indicator for forest environments in Vietnam.

The relationship between body size and segment numbers of gigantic eathworms was informed by Tsai et al. (2004). There are two ways to increase the body length. First, earthworms can increase their body length by increasing segment length. Five gigantic earthworms belonging to this group are Metaphire taiwanensis Tsai, Tsai & Shen, 2004, M. magna (Chen, 1938), M. musica (Horst, 1883), A. antoanensis sp. nov., and A. konkakinh sp. nov. The second group, which consists of only Metapheretima jocchauna (Cognetti, 1911) from New Guinea, increases the body size by development of segment number. However, the relationship between body diameter, length and segment numbers has not been clearly studied. It is suggested to have further and in-dept research on the evolutionary trend and relationship among these characters.

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