

New species and new record of the genus *Amyntas* Kinberg, 1867 (Oligochaeta: Megascolecidae) from Sulawesi, Indonesia

Rizki Amaliah^{1,2,3}, F. Fahri^{2,3*} & Anh D. Nguyen^{4,5}

Abstract. A new *Amyntas* species belonging to the *Amyntas sieboldi* group is described from the central part of Sulawesi, namely, *A. triatmowidii*, new species. In addition, a new record of *A. castaneus* has been reported from Lore Lindu National Park Central Sulawesi, the first since 1899. *Amyntas triatmowidii*, new species, is diagnosed by simple male pores, absence of genital markings, spermathecal pores lateroventrally paired in 6/7/8/9, holandry and simple and smooth intestinal caeca.

Key words. *Amyntas*, biodiversity, caecate earthworms, Lore Lindu National Park, Sulawesi, taxonomy

INTRODUCTION

The earthworm genus *Amyntas* Kinberg, 1867, can be recognised by their cylindrical bodies, intestinal caeca originating in xxvii, absence of nephridia on spermathecal ducts and absence of copulatory pouches (Sims & Easton, 1972). This genus is known to have more than 600 described species (Bantaowong et al., 2023). The genus *Amyntas* is widely distributed in Asia, and has been reported from the Philippines (James, 2004; Aspe, 2016; Aspe & James, 2016, 2017; Aspe et al., 2021), Thailand (Blakemore, 2002, 2011; Bantaowong et al., 2011, 2014, 2015, 2020; Chanabun et al., 2023), Korea (Hong, 2007; Blakemore et al., 2012, 2013), Taiwan (Tsai et al., 2001, 2002, 2007, 2010; Shen et al., 2002, 2003, 2013, 2014, 2015, 2016, 2019; James et al., 2005; Chang et al., 2007; Shen, 2012, 2014, 2018), China (Sun et al., 2013, 2015, 2016; Zhao et al., 2013, 2018; Dong et al., 2018), Laos (Hong, 2019), Vietnam (Nguyen et al., 2016), and Japan (Shen, 2018).

Sulawesi, formerly known as Celebes, is one of the largest islands of Indonesia. This island contains both biodiversity and complex geology elements from Asia and Australia

(Nugraha & Hall, 2018). Thus, it is believed that Sulawesi has a rich biodiversity (Myers et al., 2000), which is caused by evolutionary processes generated by environmental dynamics (Herrera-Alsina et al., 2021). However, the knowledge of earthworms on this island is very limited. To date, a total of nine genera have been reported from Sulawesi, i.e., *Polypheretima* Michaelsen, 1934 with eight species (Michaelsen, 1896, 1899; Gates, 1972; Sim & Easton, 1972; Easton, 1976, 1979; Fahri et al., 2017), *Pontodrilus* Perrier, 1874 with a single species (Michaelsen, 1899), *Glyphidrilus* Horst, 1889 with a single species (Horst, 1889, 1894), *Planapheretima* Michaelsen, 1934 with two species (Michaelsen, 1899; Easton, 1979), *Pithemera* Sim & Easton, 1972 with two species (Fahri et al., 2018), *Metaphire* Sim & Easton, 1972 with two species (Michaelsen, 1896, 1899; Gates, 1972; Fahri et al., 2018), *Pheretima* Kinberg, 1867 with two species (Michaelsen, 1896, 1899), *Dichogaster* Beddard, 1888 with one species (Michaelsen, 1899), and *Amyntas* Kinberg, 1867.

Amyntas species from Sulawesi were originally described by Benham in 1896, who originally described a total of six species, namely *A. bonthainensis*, *A. digitatus*, *A. hexathecus*, *A. jampeanus*, *A. purpureus*, and *A. zebrus*, all of which were collected from the southern part of the main island of Sulawesi (Bonthain peak) and the small island of Jampea to the south of the main island (known as Tanah Tjampea Island). In addition, one species of *Amyntas* from Tomohon, North Sulawesi was originally described by Beddard & Fedarb (1895), namely *A. padasensis*, and ten more species of *Amyntas* from the Sulawesi were originally described by Michaelsen (1896, 1899, 1934), namely *A. castaneus*, *A. culminis*, *A. dorous*, *A. fissiger*, *A. juloides*, *A. kalaenensis*, *A. lompopatangensis*, *A. minahassae*, *A. sarasinorum*, and *A. semifasciatus*. Those ten species were collected from either South (Bonthain, Lompobatang), North (Bone-Thai, Buol, Minahasa and Mating-Katte) or Central (Poso) Sulawesi (Table 1).

Accepted by: Ng Ting Hui

¹Graduate School of Animal Bioscience, IPB University, Bogor, 16680, West Java, Indonesia.

²Department of Biology, Faculty of Mathematics and Natural Sciences, Tadulako University, Jalan Raya Soekarno–Hatta, Tondo, Palu, 94117, Central Sulawesi, Indonesia; Email: fahribadjeber11@gmail.com (*corresponding author)

³Zoological Community of Celebes (ZCC), Jalan Kamboja, Palu, 94118, Central Sulawesi, Indonesia.

⁴Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology, 18, Hoangquocviet Rd., Cau Giay District, Hanoi, Vietnam.

⁵Graduate University of Science and Technology, Vietnam Academy of Science and Technology, 18, Hoangquocviet Rd., Cau Giay District, Hanoi, Vietnam.

Table 1. Earthworms reported from Sulawesi, Indonesia

Species	Distribution in Sulawesi	Endemic or Cosmopolitan	References
<i>Amyntas bonthainensis</i>	Bonthain peak (Bantaeng), South Sulawesi	Endemic	Benham, 1896
<i>A. castaneus</i>	Matinang-Kette, North Sulawesi	Endemic	Michaelsen, 1899
<i>A. culminis</i>	Bonthain peak (Bantaeng), Lompobatang, South Sulawesi	Endemic	Michaelsen, 1899
<i>A. dorous</i>	Poso, Central Sulawesi	Endemic	Michaelsen, 1934
<i>A. digitatus</i>	Jampea island, South Sulawesi	Endemic	Benham, 1896
<i>A. fissiger</i>	Bonthain peak (Bantaeng), Lompobatang, South Sulawesi	Endemic	Michaelsen, 1899
<i>A. hexathecus</i>	Bonthain peak (Bantaeng), South Sulawesi	Endemic	Benham, 1896
<i>A. jampeanus</i>	Jampea island, South, North and Central Sulawesi	Endemic	Benham, 1896
<i>A. juloides</i>	Bone-Thal, Buol, Sulawesi	Endemic	Michaelsen, 1899
<i>A. kalaenensis</i>	Kalaena (Luwu), South Sulawesi	Endemic	Michaelsen, 1899
<i>A. lompobatensis</i>	Bonthain peak (Bantaeng), Lompobatang, South Sulawesi	Endemic	Michaelsen, 1899
<i>A. minahassae</i>	Minahassa, Lokon, Gipfel Dua Sudara, Masarang, Sulawesi	Endemic	Michaelsen, 1899
<i>A. padasensis</i>	Tomohon, North Sulawesi	Endemic	Beddard & Fedarb, 1895
<i>A. purpureus</i>	Bonthain peak (Bantaeng), South Sulawesi	Endemic	Benham, 1896
<i>A. sarasinorum</i>	North Sulawesi (Matinang-Kette) and Central Sulawesi (Poso)	Endemic	Michaelsen, 1899
<i>A. semifasciatus</i>	Matinang-Kette, North Sulawesi	Endemic	Michaelsen, 1899
<i>A. triatmowidii</i> , new species	Natural/primary forest near Lake Kalimpa'a in Lore Lindu NP, Sulawesi	Endemic	Present study
<i>A. zebrus</i>	Bonthain peak (Bantaeng), South Sulawesi	Endemic	Benham, 1896
<i>Dichogaster corticis</i>	Masarang-Kette, North Sulawesi	Endemic	Michaelsen, 1899
<i>Glyphidrilus weberi</i>	Luwu, South Sulawesi	Cosmopolitan	Horst, 1889
<i>Metaphire posthuma</i>	South Sulawesi	Cosmopolitan	Vaillant, 1868
<i>M. ferdinandii</i>	Sangihe, North Sulawesi	Endemic	Michaelsen, 1891
<i>M. rusedii</i>	Natural forest of Mt. Torompupu, Sulawesi	Endemic	Fahri, Amaliah & Nguyen, 2018
<i>Pheretima darnleiensis</i>	North Sulawesi	Cosmopolitan	Fletcher, 1886
<i>Ph. sangirensis</i>	Sangir, Minahassa, Kema, Rurukan, Matinang-Kette, North Sulawesi	Endemic	Michaelsen, 1891
<i>Pitheclimella suwastikai</i>	Lomba village, Banggai district	Endemic	Fahri, Amaliah & Atmowidi, 2018

Species	Distribution in Sulawesi	Endemic or Cosmopolitan	References
<i>Pi. tadulako</i>	Natural forest, secondary forest near Lake Kalimpa'a in Lore Lindu NP	Endemic	Fahri Amaliah & Atmowidi, 2018
<i>Planapheretima subulata</i>	Kalaena (Luwu), Takalekadjo, Sulawesi	Endemic	Michaelsen, 1899
<i>Pl. celebensis</i>	Takalekadjo, Sulawesi	Endemic	Michaelsen, 1899
<i>Polypheretima cokelat</i>	Tongoa village, Lore Lindu National Park, Sulawesi	Endemic	Fahri & Amaliah, 2017
<i>Po. elongata</i>	Salibabu island, Buton, Bolano-Lambunu, Kepulauan Talaud, Sulawesi	Cosmopolitan	Perrier, 1872
<i>Po. elongatoides</i>	Secondary forest, Pangli Binangga Nature Reserve, Sulawesi	Endemic	Fahri & Nguyen, 2017
<i>Po. everetti</i>	Minahasa, Klabat, Uangkahulu valley or Buol, Bone valley, Koro valley	Cosmopolitan	Beddard & Fedarb, 1895
<i>Po. kalimpapaensis</i>	Tongoa village, Lore Lindu NP, Sulawesi	Endemic	Fahri & Amaliah, 2017
<i>Po. phacellotheca</i>	Masarang or Tomohon, Ogotumubu Barat village, Sulawesi	Endemic	Michaelsen, 1899
<i>Po. sahlani</i>	Tongoa village, Lore Lindu NP, Sulawesi	Endemic	Fahri & Amaliah, 2017
<i>Po. stelleri</i>	Sangihe, Kepulauan Talaud, Matinang range, Bone valley, Sulawesi	Endemic	Michaelsen, 1891
<i>Pontodrilus littoralis</i>	Pare-Pare, South Sulawesi	Cosmopolitan	Michaelsen 1899

Recent surveys have revealed more new species and contributed to a better understanding of the earthworm diversity in Sulawesi (Fahri et al., 2017, 2018). These discoveries focused on only three genera, *Polypheretima*, *Metaphire*, and *Pithemera*, but not *Amyntas*. Continuing our work on earthworm diversity of Sulawesi, this paper provides the description of a new *Amyntas* species from Sulawesi. In addition, an identification key to "caecate" pheretimoid earthworms from Sulawesi is also provided.

MATERIAL AND METHODS

Earthworm specimens were collected from primary forests (01°19'35.27"S, 120°18'36.71"E) near Lake Kalimpa'a, Lore Lindu National Park, South Kulawi, Central Sulawesi Province, Indonesia, on 1–3 November 2016 (Fig. 1).

Earthworms were killed in 2% formaldehyde, transferred to 4% formaldehyde for fixation for approximately 24 hours, and then transferred to new 4% formaldehyde for long-term preservation and morphological studies. Specimens were dissected from the dorsal side for internal observation. Both external and internal morphology were observed under a Nikon type 104 C-LEDS stereo microscope.

The holotype of the new species is deposited in Museum Zoologicum Bogoriense (MZB) Bogor, Indonesia. Other specimens are deposited in Tadulako University (UNTAD), Palu, Indonesia.

TAXONOMY

Family Megascolecidae Rosa, 1891

Genus *Amyntas* Kinberg, 1867

Amyntas triatmowidii, new species (Table 1–2, Fig. 2)

Material examined. Holotype: Clitellate (MZB. Oli 0067), primary forest, near Lake Kalimpa'a, Lore Lindu National Park (01°19'35.27"S, 120°18'36.71"E), elevation of 1,674 m asl, South Kulawi, Central Sulawesi Province, Indonesia, leg. Rizki Amaliah et al., 1 November 2016. Paratype. One mature (UNTAD. Oli 012), same data as for holotype.

Diagnosis. Small worms, length 67–98 mm, diameter 1.5–2.0 mm, and segments 67–115. Prostomium epilobous. First dorsal pore in 12/13. Setal numbers: 25–37 in v, 28–44 in vii, 35–41 in viii, 31–52 in xxv, and 8–10 between male porophores in xviii. Three pairs of spermathecal pores in lateroventral 6/7/8/9. Male pores simple, paired in xviii. Genital markings absent. Septa 8/9/10 absent. Spermathecal ampulla oval-shaped, duct enlarged, about 1/2 as long as ampulla. Diverticulum cylindrical, stalk coiled, about 3/4 as long as ampulla, attached to duct. Holandric, prostate glands paired in xvi–xx. Intestinal caeca simple and smooth, paired in xxvii.

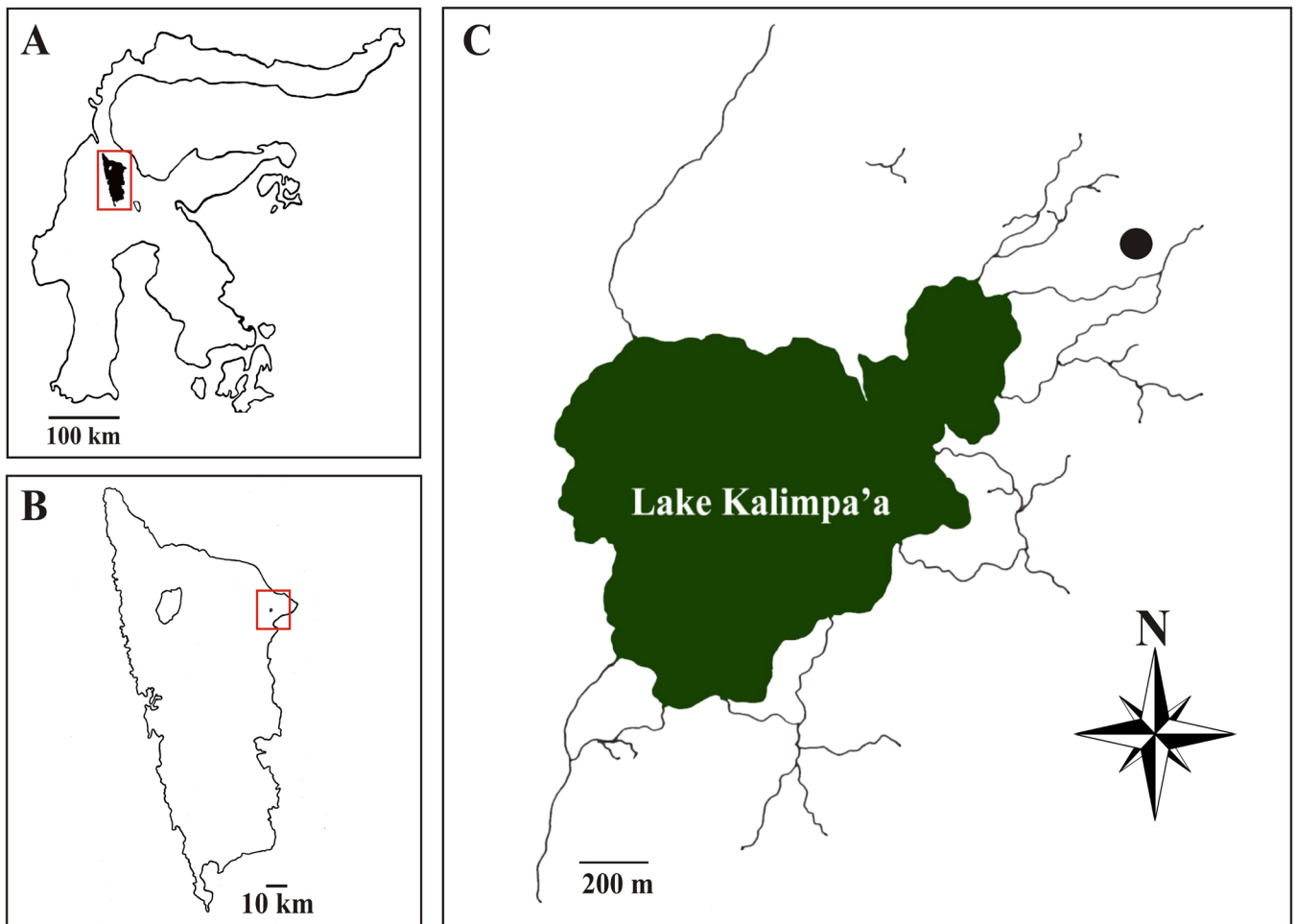


Fig. 1. The map of Lake Kalimpa'a in Lore Lindu National Park, Sulawesi (a solid circle indicates the sampling locality).

Description. External characters. Body generally cylindrical, small-sized, length 67–98 mm ($n=2$), diameter 1.5–2.0 mm, and segments 67–115. For living specimens, colouration dark brown on dorsum and light brown on ventrum. For fixed specimens, colouration yellowish light brown on ventrum.

Prostomium epilobous. First dorsal pore in 12/13. Perichaetine, setal numbers: 25–37 in v, 28–44 in vii, 35–41 in viii, and 31–52 in xxv and 8–10 between male porophores in ventral xviii; setal distance: aa=ab, zz=1–2zy. Clitellum annular, within xiv–xvi, smooth without setae and dorsal pores. Female pore single, mid-ventral in xiv.

Spermathecal pores small, lateroventrally paired in 6/7/8/9, distance between spermathecal pores about 0.35x body circumference ventrally (Fig. 2A). Male pores simple on setal ring (Fig. 2D), paired in xviii, distance between male pores about 0.25x body circumference ventrally. Genital markings absent in both spermathecal and male pore regions (Fig. 2A, D).

Internal characters. Septa 3/4–7/8 thick, 8/9/10 absent, 10/11–12/13 thin. Oesophageal gizzard large in viii–x. Oesophageal hearts paired in xi–xiii. Intestine enlarged from xv; intestinal caeca paired in xxvii, extending anteriorly to xxv (Fig. 2E), simple and smooth. Typhlosole simple.

Spermathecae large, paired in vii–ix (Fig. 2B). Ampulla oval, duct enlarged, about 1/2 as long as ampulla. Diverticulum cylindrical, stalk coiled, about 3/4 as long as ampulla, attached to duct. No spermathecal accessory glands.

Holandric. Testes sacs yellowish, small, ventrally paired but separated in x–xi. Seminal vesicles well-developed in xi–xii. Ovaries paired in xiii; ovisacs paired in xiii. Prostate glands racemose, paired in xvi–xx (Fig. 2C); prostatic duct C-shaped. No prostatic accessory glands.

Etymology. This species is named after Prof. Dr. Tri Atmowidi, Chairman of the Animal Biosciences Study Program in IPB University for his great encouragement to reveal the diversity and ecology of earthworms and insect fauna in Indonesia, including Sulawesi Island. He is supervisor of RA and FF and also a colleague and partner of the Discovery Earthworms Project at Sulawesi in 2017–2023.

Habitat and ecology. Specimens were collected in primary forest near Lake Kalimpa'a, Lore Lindu National Park, South Kulawi, Central Sulawesi at the elevation of 1,674 m asl. This species was found at the depth of 15–20 cm in moist and sandy soils around rocks and decayed wood.

Remarks. This new species belongs to the *A. sieboldi* group characterised by three pairs of spermathecal pores in

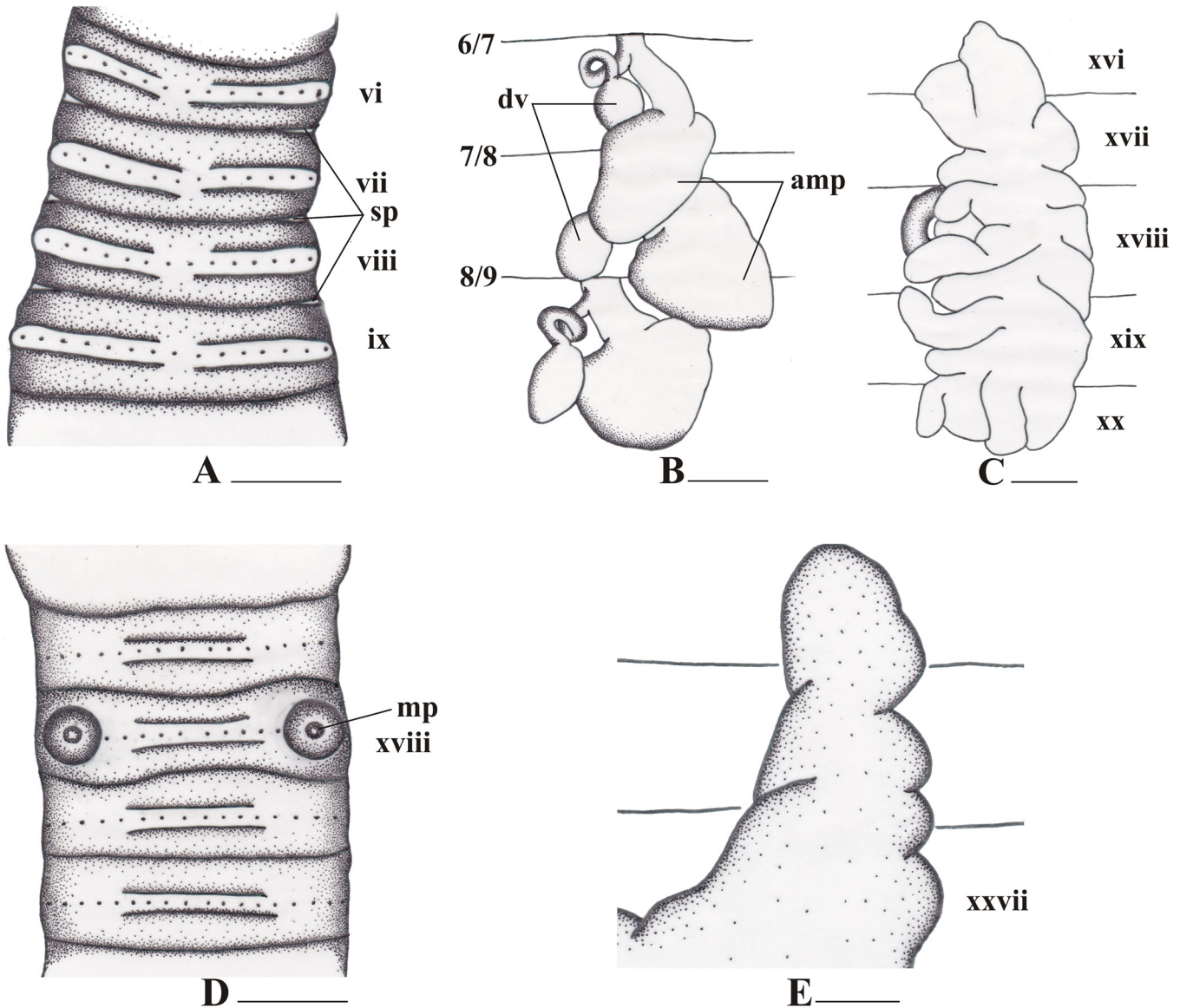


Fig. 2. *Amyntas triatmowidii*, new species, holotype, MZB. Oli 0067. A, spermathecal pores (sp) B, spermathecae, right side in vii–ix (amp = ampulla; dv = diverticulum) C, prostate gland D, male pore region (mp = male pore) E, intestinal caecum. Scale bars = 1 mm.

intersegments 6/7–8/9 and a holandric male sexual system (Sims & Easton, 1972; James et al., 2005). Previously, the *A. sieboldi* group was renamed the *A. aelianus* group (James, 2005) and the name has been adopted by Bantaowong et al. (2014, 2015, 2023). However, owing to the lack of clarity regarding the defining character of the *A. aelianus* group and pending resolution of its phylogeny, we follow Aspe et al. (2021) in recognising the *A. sieboldi* group, along with the majority of earthworm taxonomists, e.g., Zhao et al. (2013, 2018), Shen et al. (2014), Dong et al. (2018), and Hong (2019).

This new species is similar to *A. aelianus* (Rosa, 1892) from Bua-Bua, Enggano (Sumatra) in characters such as the absence of genital markings and body length. However, they differ in the number of segments (67–115 vs. 115–120), shape of ampulla (ampulla oval, duct enlarged, about 1/2 as long as ampulla vs. oval sac with slender short ducts), diverticula shape (diverticula cylindrical, about 3/4 as long as ampulla, duct looks like a circular vs. slender diverticula

and longer than spermathecae), intestinal caeca (xxv–xxvii vs. xxiii–xxvii), and prostate position (xvi–xx vs. xvii–xix) (Table 2).

This new species is similar to *A. udei* (Rosa, 1896) from Mt. Si-Rambe, Sumatra and *A. dammermani* (Michaelsen, 1924) from Mt. Krakatau, Sumatra, in the absence of genital markings, as well as small and simple male pores. However, these three species are different in prostate position (five segments on xvi–xx vs. one segment in *A. udei* vs. three segments in xvii–xix in *A. dammermani*), diverticulum (stalk coiled as a circle, about 3/4 as long as ampulla in *A. triatmowidii*, new species vs. short, straight stalk with an oval seminal chamber in *A. udei* vs. long, coiled, spiral-shaped stalk and more than twice as long as the ampulla in *A. dammermani*) (Table 2).

When compared with species from Java, this new species is similar to *A. buitendijki* (Michaelsen, 1922) from Sukabumi, Java in colour, absence of genital markings, five prostate

Table 2. The character comparison among species of *Amyntas* in Sulawesi region and some regions in Indonesia and Asia: *A. sieboldi* group and *A. aelianus* group without genital markings.

Characters	<i>A. aelianus</i> , (Rosa, 1892)	<i>A. udei</i> , (Rosa, 1896)	<i>A. dammermani</i> , (Michaelsen, 1924)	<i>A. magnaprostata</i> (Aspe et al., 2021)	<i>A. triatmowidii</i> , new species
Body length (mm)	80–100	66	45–110	105	67–98
Number of segments	115–120	90	83–90	110	67–115
Prostomium	?	?	½ epilobous	?	epilobous
Spermathecal pores	6/7/8/9	6/7/8/9	6/7/8/9	6/7/8/9	6/7/8/9
Distance between spermathecal pores	2 mm	?	0.3	3.3–4 mm (0.26–0.28)	0.35
First dorsal pore	12/13	12/13	12/13	12/13	12/13
Preclitellar setal number	74 in xiii(?)	40 in vii	42 in v, 50 in xiii	51–56 in vii, 56–65 in xx	28–44 in vii
Setae between male pores	?	8	?	0	8–10
Distance between male pores	2 mm	?	0.3	3.2–3.4 mm (0.23–0.25)	0.25
Genital markings	absent	absent	absent	lacking	absent
Septa 8/9/10	absent	8/9 present, 9/10 absent	absent	8/9 thin, 9/10 lacking	absent
Spermathecae	ampulla oval sac with slender short duct; slender diverticula and longer than spermathecae	ampulla oval, duct as long as ampulla; diverticulum with a short, straight stalk and an oval seminal chamber	ampulla sack-shaped, duct short; diverticulum long, coiled, spiral-shaped, more than twice as long as the ampulla	ovate ampulla with sausage-shape apex, slender and muscular duct, and single stalked diverticulum	ampulla oval, duct enlarged, about 1/2 as long as ampulla; diverticulum cylindrical, stalk coiled as a circle, about 3/4 as long as ampulla, duct with looks like a circular
Intestinal caeca	xxiii–xxvii	?	xxiv–xxvii	xxi–xxvi	xxv–xxvii
Male sexual system	?	holandric	holandric	holandric	holandric
Prostate glands	xvii–xix	xviii, transverse oblong-shaped	xvii–xix	xiv–xxi	xvi–xx

segments in xvi–xx, and simple male pores on setal ring. However, these two species are different in number of setae (less than 60 in *A. triatmowidii*, new species vs. more than 60 in *A. buitendijki*), ventral distance between spermathecal pores (0.35x vs. 0.3x body circumference) and shape of spermathecae (oval ampulla with an enlarged duct and a diverticulum coiled as a circle in *A. triatmowidii*, new species vs. elongated, sack-shaped ampulla with a short duct and a long, heavily coiled diverticulum in *A. buitendijki*). This new species is also different from *A. buitendijki* in the development of intestinal caeca (three segments vs. more than four segments) (Table 2).

The new species is also similar to *A. dongyinensis* Shen, 2014 from Dongyin, Matsu, Taiwan in spermathecal pores in

6/7/8/9, holandry, absence of genital markings, setal numbers, and distance between male pores (0.25x vs 0.26–0.3x body circumference). However, those two species are different in the spermathecal shape (oval ampulla with an enlarged duct and a diverticulum coiled as a circle in *A. triatmowidii*, new species vs. round, peach- or elongated oval-shaped ampulla with a stout duct and a diverticulum with a straight stalk and an oval- or rod-shaped seminal chamber in *A. dongyinensis*), and the male sexual system (yellowish, small, ventrally paired testes sacs, but separated in x–xi vs. two pairs of large, oval testes in ventrally joined sacs in x and xi) (Table 2).

This new species also resembles *A. magnaprostata* Aspe et al., 2021 from Palawan, Philippines by having spermathecal pores in 6/7/8/9, holandry male system, and

Table 2. (Continued)

Characters	<i>A. apapillatus</i> , (Zhao & Qiu, 2013)	<i>A. eumorphus</i> , (Qiu & Zhao, 2018)	<i>A. dongyinensis</i> , (Shen, 2014)	<i>A. buitendijki</i> , (Michaelsen, 1922)
Body length (mm)	120	221–300	49–91	78
Number of segments	83	100–145	91–113	85
Prostomium	epilobous	½ epilobous	epilobous	½ epilobous
Spermathecal pores	6/7/8/9	6/7/8/9	6/7/8/9	6/7/8/9
Distance between spermathecal pores	0.4	0.33	0.28–0.31	0.3
First dorsal pore	11/12	10/11	12/13	12/13
Preclitellar setal number	32 in v, 44 in viii	26–38 in v, 44–58 in viii	38–54 in vii	63 in xi
Setae between male pores	12	8–10	7–9	?
Distance between male pores	0.4	0.33	0.26–0.3	0.3
Genital markings	absent	absent	absent	absent
Septa 8/9/10	absent	8/9 thin, 9/10 threadlike	absent	absent
Spermathecae	ampulla elongated ovoid with duct stout; diverticulum about 0.67 of main pouch and coiled, enlarged, serving as the seminal chamber	ampulla heart-shaped with duct half as long as ampulla; diverticulum in vii and ix equals to spermathecal duct, terminal half enlarged as a sharp-pointed seminal chamber	ampulla rounded, peach-shaped or elongated oval-shaped, surface wrinkled, with a stout spermathecal; diverticulum with an iridescent, oval- or rod-shaped seminal chamber	ampulla elongated, sack-shaped, duct short; diverticulum long, heavily coiled diverticulum
Intestinal caeca	xxv–xxvii	xxiv–xxvii	xxii or xxiii–xxvii	xxiii–xxvii
Male sexual system	holandric	holandric	holandric	holandric
Prostate glands	xvii–xviii	xvi–xviii	xvi–xxi	xvi–xx

absence of genital markings. However, those two species are different in size (67–98 mm, diameter 1.5–2.0 mm in *A. triatmowidii*, new species vs. 105 mm, diameter 4–4.5 mm in *A. magnaprostata*), the number of setae in vii (28–44 setae in *A. triatmowidii*, new species vs. 51–56 setae in *A. magnaprostata*), the position of intestinal caeca (originating in xxvii, extending anteriorly to xxv in *A. triatmowidii*, new species vs. originating in xxvi, extending anteriorly to xxi in *A. magnaprostata*), and the spermathecal shape (oval ampulla with an enlarged duct and a diverticulum coiled as a circle in *A. triatmowidii*, new species vs. ovate ampulla with sausage-shape apex, slender and muscular duct, and single stalked diverticulum in *A. magnaprostata*) (Table 2).

Amyntas castaneus (Michaelsen, 1899)

(Table 1, Fig. 3)

Amyntas [sic] *castaneus* Michaelsen, 1899: 56–58 (type locality: Matinang-Kette, North Celebes).

Material examined. 2 clitellates (UNTAD. Oli 0013), primary forests, near Lake Kalimpa'a, Lore Lindu National Park (01°19'35.27"S, 120°18'36.71"E), elevation of 1,674 m asl, South Kulawi, Central Sulawesi province, Indonesia, leg. Rizki Amaliah et al., 3 November 2016.

Description. Small-sized worm, length 56–64 mm (n=2), diameter 1.5–2.0 mm, and segments 72–83. Prostomium epilobous. First dorsal pore in 12/13. Setal numbers: 28–31 in v, 32–38 in vii, 29–36 in viii, 34–38 in xxv, and 10–12 between male porophores in ventral xviii. Three pairs of spermathecal pores in lateroventral 6/7/8/9, distance between spermathecal pores about 0.35x body circumference ventrally (Fig. 3A). Male pores simple, distance between male pores about 0.2x body circumference ventrally. Genital markings present, small, widely paired in pre- and post-setal xvii, and pre-setal xviii–xix (Fig. 3D). Septa 8/9/10 absent. Spermathecae large, paired in vii–ix (Fig. 3B). Spermathecal ampulla rounded, duct enlarged, about 2/5 as long as ampulla. Diverticulum cylindrical, about 1/2 as long as ampulla,

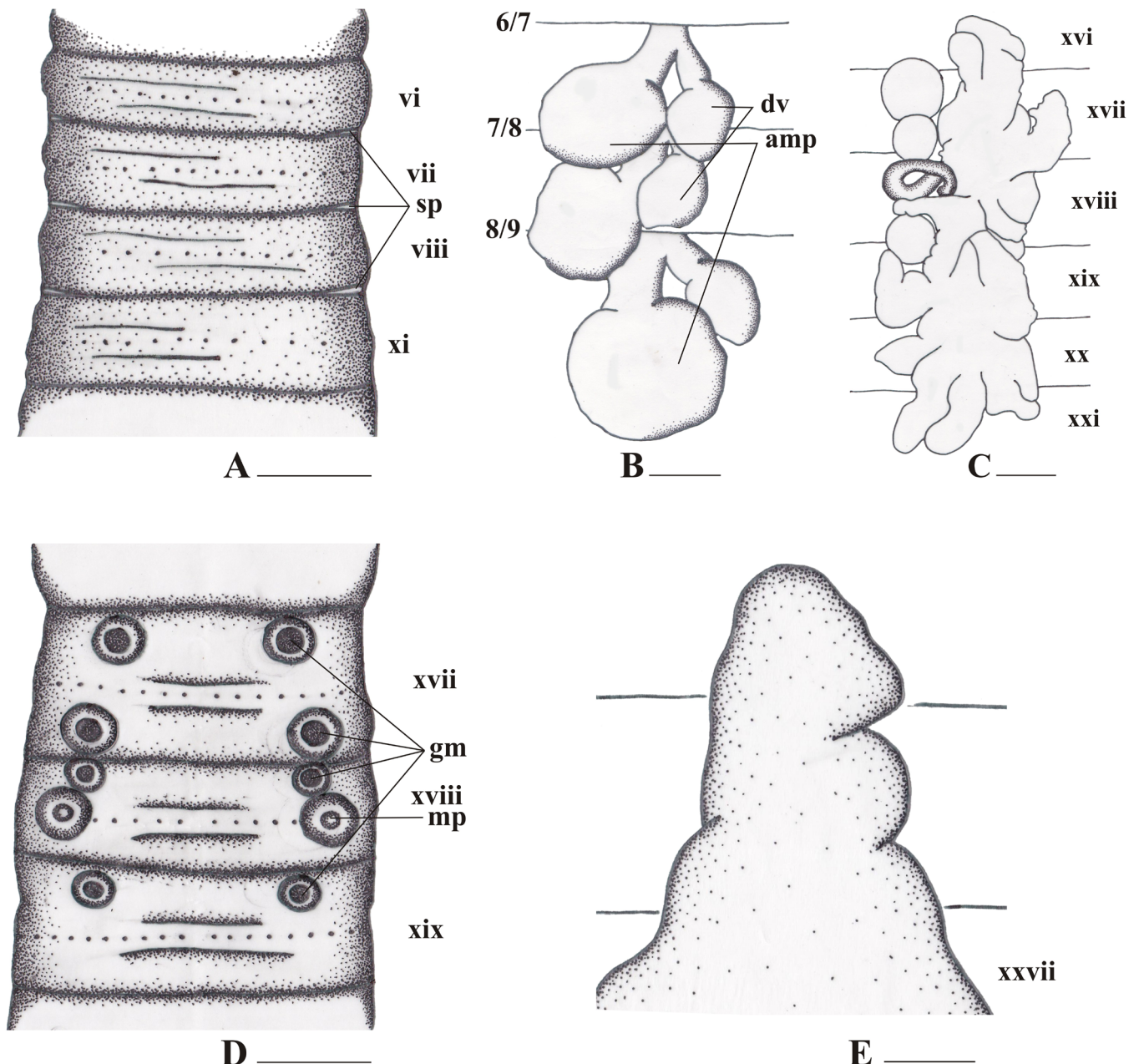


Fig. 3. *Amynthus castaneus* from Lore Lindu National Park, Central Sulawesi (UNTAD. Oli 0014). A, spermathecal pores (sp) B, spermathecae, right side in vii–ix (amp = ampulla; dv = diverticulum) C, prostate gland D, male pore region (mp = male pore, gm = genital markings) E, intestinal caecum. Scale bars = 1 mm.

attached to ducts. Holandric. Prostatic duct C-shaped. Accessory gland present, stalked. Oesophageal gizzard large in viii–x. Oesophageal hearts paired in xi–xiii. Intestine beginning in xv; caeca originating from xxvii extending anteriorly to xxv (Fig. 3E), paired laterally. Typhlosole simple. Testes sacs yellowish, small, ventrally paired but separated in x–xi. Seminal vesicles in xi–xii. Ovaries paired in xiii; ovisacs paired in xiii. Prostate glands racemose, paired (Fig. 3C).

Habitat and ecology. Specimens were collected in primary forest near Lake Kalimpa'a, Lore Lindu National Park, South Kulawi, Central Sulawesi at the elevation of 1,674 m asl. This species was found at the depth of 15–20 cm in moist and sandy soils around rocks and decayed wood.

Remarks. This is the second record since it was first described by Michaelsen (1899) from Matinang-Kette, North Sulawesi. Specimens described by Michaelsen are slightly different from the present material in having diverticulum with slender stalk and an elongated rod-shaped seminal chamber.

Key to *Amynthus* species recorded in Sulawesi, Indonesia

1. Spermathecal pores absent (not visible).....*Amynthus bonthainensis*
- Spermathecal pores present.....2
2. First spermathecal pores at 4/5.....*A. hexathecus*
- First spermathecal pores behind 4/5.....3
3. First spermathecal pores at 5/6.....4
- First spermathecal pores behind 5/6.....5

4. One thecal segment *A. lompopatangensis*
- More than one thecal segment *A. padasensis*
5. First spermathecal pores at 6/7 6
- First spermathecal pores at 7/8 10
6. Genital markings absent *A. triatmowidii*, new species
- Genital markings present 7
7. More than 40 setae in each segment v–viii 8
- Less than 40 setae in each segment v–viii 9
8. Ampulla sac-shaped *A. juloides*
- Ampulla almost spherical-shaped *A. minahassae*
9. Ampulla pear-shaped to sac-shaped, with narrow, short, and a slender duct *A. kalaenensis*
- Ampulla sack-shaped, rounded, with enlarged duct *A. castaneus*
10. One thecal segment 11
- Two thecal segment 12
11. Ampulla pyriform-shaped, with defined duct *A. zebrus*
- Ampulla sack-shaped, short, and wide, with barely visible duct *A. culminis*
12. Genital markings absent 13
- Genital markings present 15
13. Spermathecae with a short diverticulum duct *A. sarasinorum*
- Spermathecae with a long undulating diverticulum duct 14
14. Ampulla pyriform sac-shaped *A. digitatus*
- Ampulla nearly spherical-shaped *A. jampeanus*
15. Intestinal caeca extending to xxv 16
- Intestinal caeca extending to xxvi 17
16. Ampulla globular with a narrow duct and a long, club-shaped diverticulum *A. purpureus*
- Ampulla irregular sack-shaped with a thick, spindle-shaped duct, and a twisted diverticulum *A. dorous*
17. Ampulla sack-shaped with an enlarged duct and a twisted diverticulum *A. fissiger*
- Ampulla sack with flat-shaped, elongated, distally widened, with cylindrical duct *A. semifasciatus*

ACKNOWLEDGEMENTS

We would like to thank Prof. Dr. Tri Atmowidi (IPB University) and Dr. Andy Darmawan (Institut Teknologi Sumatera) for their comments that improved the paper. Also, we would like to express our gratitude to Prof. Darmawati Darwis, Ph.D and Dr. Annawaty (Tadulako University) for her support to discover earthworms in Sulawesi. We would also like to thank the head of the Lore Lindu National Park, Ir. Sudayatna, for permission to collect samples. We also thank the Department of Biology students for their assistance during fieldwork. Finally, we would like to express our thanks to reviewers for their great comments and suggestions. The research was partially supported by the project “Penelitian Pembinaan” and “Penelitian Unggulan”, funded by DIPA Faculty of Science, Tadulako University in 2021 and 2022. Our thanks to the Center for Education Financial Services (Pusat Layanan Pembiayaan Pendidikan), Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia and Indonesia Endowment Funds for Education (Lembaga Pengelola Dana Pendidikan), Ministry of Finance of the Republic of Indonesia through Indonesian Education Scholarship (Basiswa Pendidikan Indonesia) for a scholarship to the first author.

LITERATURE CITED

- Aspe NM (2016) The geographic distribution of the genera in the *Pheretima* complex in eastern Asia and the Pacific region. *Kaiyo Monthly*, Japan, 48: 39–45. In Japanese: 東アジア及び太平洋地域における広義フトミズ属の地理的分布. 月刊海洋「環形動物の分類学」, 48: 39–45 (2016).
- Aspe NM & James SW (2016) New species of *Pheretima*, *Amyntas*, *Polypheretima*, and *Pithemera* (Clitellata: Megascolecidae) from Mindanao and associated islands, Philippines. *Zoological Studies*, 55: 8.
- Aspe NM & James SW (2017) Pheretimid earthworms (Clitellata: Megascolecidae) from Mt. Apo, Mindanao Island, Philippines with description of eight new species. *Raffles Bulletin of Zoology*, 65: 357–372.
- Aspe NM, Manasan RE, Manlavi AB, Patiluna MLE, Sebido MAB, Obusan MCM, Simbahan JF & James SW (2021) The earthworm fauna of Palawan, Philippines with description of nineteen new pheretimid species (Clitellata: Megascolecidae). *Journal of Natural History*, 55: 733–797.
- Bantaowong U, Chanabun R, Tongkerd P, Sutcharit C, James SW & Panha S (2011) New earthworm species of the genus *Amyntas* Kinberg, 1867 from Thailand (Clitellata, Oligochaeta, Megascolecidae). *Zookeys*, 90: 35–62.
- Bantaowong U, Somniyam P, Sutcharit C, James SW & Panha S (2014) Four new species of the earthworm genus *Amyntas* Kinberg, 1867, with redescription of the type species (Clitellata: Megascolecidae). *Raffles Bulletin of Zoology*, 62: 655–670.
- Bantaowong U, James SW & Panha S (2015) Three new earthworm species of the genus *Amyntas* Kinberg, 1867 from Thailand (Clitellata: Megascolecidae). *Tropical Natural History*, 15: 167–178.
- Bantaowong U, Chanabun R & Panha S (2020) *Amyntas whitteni*, a new species of earthworm from Mawlamyine, Myanmar (Clitellata: Megascolecidae). *Raffles Bulletin of Zoology*, Supplement 35: 17–21.
- Bantaowong U, Chanabun R & Inkhavilay K (2023) Two new species of terrestrial earthworms of the genus *Amyntas* Kinberg, 1867 (Clitellata, Oligochaeta, Megascolecidae) from Northern Laos. *Tropical Natural History*, 7: 165–172.
- Beddard FE (1888) On certain points in the structure of *Urochaeta*, E.P., and *Dichogaster*, nov. gen., with further remarks on the nephridia of earthworms. *Quarterly Journal of Microscopical Science*, 29: 235–282.
- Beddard FE & Fedarb SM (1895) On some Perichaetidae from the Eastern Archipelago collected by Mr. Everett. *Annals and Magazine of Natural History*, Series 6, 16: 69–73.
- Benham WB (1896) Some earthworms from Celebes. *The Annals and Magazine of Natural History*, Series 6, 18: 429–448.
- Blakemore RJ (2002) *Cosmopolitan Earthworms—an Eco-Taxonomic Guide to the Peregrine Species of the World*. CD-ROM Monograph, Verm Ecology, Canberra. 506 pp.
- Blakemore RJ (2011) Description of a new *Amyntas* earthworm (Megascolecidae sensu stricto) from Thailand. *Bulletin of the National Museum of Nature and Science*, Series A, 37(1): 9–13.
- Blakemore RJ, Park TS & Seo H (2012) A new Korean earthworm (Oligochaeta: Megadrilacea: Megascolecidae). *Zootaxa*, 3368: 256–262.
- Blakemore RJ, Lee S, Lee W & Seo HY (2013) Two new Korean earthworms (Annelida, Oligochaeta, Megadrilacea, Megascolecidae). *Zookeys*, 307: 35–44.
- Chanabun R, Aonkum A, Seesamut T, Bantaowong U & Panha S (2023) Four new terrestrial earthworm species from the northeast Thailand (Oligochaeta, Megascolecidae). *ZooKeys*, 1176: 195–219.

- Chang CH, Lin YH, Chen IH, Chuang SC & Chen JH (2007) Taxonomic re-evaluation of the Taiwanese Montane Earthworm *Amyntas wulinensis* Tsai, Shen & Tsai, 2001 (Oligochaeta: Megascolecidae): Polytypic species or species complex? *Organisms. Diversity and Evolution*, 7(3): 231–240.
- Dong Y, Yuan Z, Jiang J, Zhao Q & Qiu J (2018) Two new species of earthworms belonging to the genus *Amyntas* (Oligochaeta: Megascolecidae) from Guangxi Province, China. *Zootaxa*, 4496(1): 259–268.
- Easton EG (1976) Taxonomy and distribution of the *Metapheretima elongate* species-complex of Indo-Australian earthworms (Megascolecidae: Oligochaeta). *Bulletin of the British Museum (Natural History) Zoology*, 30(2): 29–53.
- Easton EG (1979) A revision of the ‘acaecate’ earthworms of the *Pheretima* group (Megascolecidae: Oligochaeta): *Archipheretima*, *Metapheretima*, *Planapheretima*, *Pleionogaster* and *Polypheretima*. *Bulletin of the British Museum (Natural History) Zoology*, 35: 1–126.
- Fahri, Amaliah R, Annawaty & Nguyen AD (2017) The earthworm genus *Polypheretima* Michaelsen, 1934 (Annelida: Clitellata: Megascolecidae) from Sulawesi, Indonesia, with descriptions of four new species. *Raffles Bulletin of Zoology*, 65: 559–573.
- Fahri F, Amaliah R, Suryobroto B, Atmowidi T & Nguyen AD (2018) Three new “caecate” earthworm species from Sulawesi, Indonesia (Oligochaeta, Megascolecidae). *ZooKeys*, 805: 1–14.
- Fletcher J (1886) Notes on Australian Earthworms. Part III. *Proceedings of the Linnean Society of New South Wales*, 2(2): 377–402.
- Gates GE (1972) Burmese earthworms, an introduction to the systematics and biology of megadrile oligochaetes with special reference to the Southeast Asia. *Transactions of the American Philosophical Society*, 62: 1–326.
- Herrera-Alsina L, Algar AC, Bocedi G, Gubry-Rangin C, Lancaster L, Mynard P, Osborne OG, Papadopoulos AS, Creer S, Nangoy M, Fahri F, Lupiyaningdyah P, Sudiana IM, Juliandi B & Travis MJM (2021). Ancient geological dynamics impact neutral biodiversity accumulation and are detectable in phylogenetic reconstruction. *Global Ecology and Biogeography*, 30: 1633–1642.
- Hong Y (2007) Some new earthworms of the genus *Amyntas* (Oligochaeta: Megascolecidae) with male discs from Bogildo Island, Korea. *Revue suisse de zoologie*, 114: 721–728.
- Hong Y (2019) New earthworm species of *Amyntas* (Clitellata: Megascolecidae) from Nam Phou in National Protected Area, Laos. *Journal of Asia-Pacific Biodiversity*, 12: 353–356.
- Horst R (1889) Over een nieuwe sort onder de Lumbricinen door Prof. Max Weber uit Nederl. Indie medegebracht. *Tijdschrift de Nederlandsche Dierkundige Vereeniging*, 2: 77.
- Horst R (1894) Earthworms from the Malay Archipelago. In: Weber M (ed), *Zoologische Ergebnisse einer Reise in Niederländisch Ost-Indien*, 3: 28–77.
- James SW (2004) New species of *Amyntas*, *Pheretima*, *Pleionogaster* (Oligochaeta: Megascolecidae) of the Mt. Kitanglad Range, Mindanao Island, Philippines. *Raffles Bulletin of Zoology*, 52: 289–313.
- James SW (2005) New genera and species of pheretimoid earthworms (Clitellata: Megascolecidae) from southern Luzon, Philippines. *System Biodivers*, 2(3): 271–279.
- James SW, Shih HT & Chang HW (2005) Seven new species of *Amyntas* (Clitellata: Megascolecidae) and new earthworms record from Taiwan. *Journal of Natural History*, 39(14): 1007–1028.
- Kinberg JGH (1867) *Annulata nova. Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar*, 23(4): 97–103.
- Michaelsen W (1891) Oligochaeten des Naturhistorischen Museum in Hamburg. IV. *Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten*, 8: 1–42.
- Michaelsen W (1896) Oligochaeten. *Kükenthal, Ergebnisse einer Zoologischen Forschungsreise in den Molukken und in Borneo. Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, 23: 193–243.
- Michaelsen W (1899) Terricolen von verschiedenen Gebieten der Erde. *Mittheilungen aus dem Naturhistorischen Museum in Hamburg*, 16: 1–122.
- Michaelsen W (1922) Oligochaeten aus dem Rijks Museum van Natuurlijke Historie zu Leiden. *Capita Zoologica*, 1: 1–72.
- Michaelsen W (1924) Oligochaeten von Niederländisch-Indien. *Treubia*, 5: 379–401.
- Michaelsen W (1934) Oligochaeten von Niederländisch-Indien. *Archives Néerlandaises de Zoologie, Leiden*, 1: 100–117.
- Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB & Kent J (2000) Biodiversity hotspots for conservation priorities. *Nature*, 403: 853–858.
- Nugraha AMS & Hall R (2018) Late Cenozoic palaeogeography of Sulawesi, Indonesia. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 490: 191–209.
- Nguyen TT, Lam DH & Nguyen AD (2016) On the giant pheretimoid earthworms from Vietnam (Clitellata: Megascolecidae), with descriptions of three new species. *Zoological Studies*, 55(52): 1–13.
- Perrier E (1872) Recherches pour servir à l’histoire des *Lombriciens terrestres*. *Nouvelles Archives du Muséum d’Histoire Naturelle*, 8: 5–198.
- Perrier E (1874) Sur un nouveau genre indigène des Lombriciens terrestres (*Pontodrilus marionis* E.P.). *Compte rendu hebdomadaire des séances de l’Académie de Sciences Paris*, 78: 1582–1586.
- Rosa D (1891) Die exotischen Terricolen des k. k. naturhistorischen Hofmuseums. *Annalen des K. K. naturhistorischen Hofmuseums, Wien*, 6: 379–406.
- Rosa D (1892) I Lombrichi Raccolti nell’isola di Engano dal Dottore Elio Modigliani. *Annali del Museo Civico di Storia Naturale di Genova*, 12: 542–548.
- Rosa D (1896) I Lombrichi raccolti a Sumatra dal dott. Elio Modigliani. *Annali del Museo Civico di Storia Naturale Giacomo Doria*, 16: 502–532.
- Shen HP (2012) Three new earthworms of the genus *Amyntas* (Megascolecidae: Oligochaeta) from eastern Taiwan with redescription of *Amyntas hongyehensis* Tsai and Shen, 2010. *Journal of Natural History*, 46: 2259–2283.
- Shen HP (2014) Five new earthworm species of the genera *Amyntas* and *Metaphire* (Megascolecidae: Oligochaeta) from Matsu, Taiwan. *Journal of Natural History*, 48: 495–522.
- Shen HP (2018) Biogeography meets taxonomy: Distribution-based inferences on the accuracy of identification and synonymization of East Asian earthworms. *Zootaxa*, 4496(1): 313–336.
- Shen HP, Tsai CF & Tsai SC (2002) Description of a new earthworm belonging to the genus *Amyntas* (Oligochaeta: Megascolecidae) from Taiwan and its infraspecific variation in relation to elevation. *Raffles Bulletin of Zoology*, 50(1): 1–8.
- Shen HP, Tsai CF & Tsai SC (2003) Six new earthworms of the genus *Amyntas* (Oligochaeta: Megascolecidae) from Central Taiwan. *Zoological Studies*, 42(4): 479–490.
- Shen HP, Chang CH, Li CL, Chih WJ & Chen JH (2013) Four new species of the genus *Amyntas* (Oligochaeta: Megascolecidae) from Kinmen, Taiwan. *Zootaxa*, 3599: 471–482.
- Shen HP, Chang CH & Chih WJ (2014) Five new earthworm species of the genus *Amyntas* and *Metaphire* (Megascolecidae: Oligochaeta) from Matsu, Taiwan. *Journal of Natural History*, 48: 495–522.
- Shen HP, Chang CH & Chih WJ (2015) Earthworms from Matsu, Taiwan with descriptions of new species of the genera *Amyntas* (Oligochaeta: Megascolecidae) and *Drawida* (Oligochaeta: Moniligastridae). *Zootaxa*, 3973(3): 425–450.

- Shen HP, Chang CH & Chih WJ (2016) Four new earthworm species of the genus *Amyntas* (Megascolecidae: Oligochaeta) from southwestern Taiwan with re-description of *Amyntas tungpuensis* Tsai, Shen and Tsai, 1999. *Journal of Natural History*, 50(29–30): 1889–1910.
- Shen HP, Chang CH & Chih WJ (2019) Two new earthworm species of the genus *Amyntas* (Oligochaeta: Megascolecidae) from central Taiwan, with comments on some recent species assignments in *Amyntas* and *Metaphire*. *Zootaxa*, 4658(1): 101–123.
- Sims RW & Easton EG (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(3): 169–268.
- Sun J, Zhao Q, Jiang J & Qiu J (2013) New *Amyntas* species (Oligochaeta: Megascolecidae) from south and central Hainan Island, China and estimates of evolutionary divergence among some *corticis*-group species. *Journal of Natural History*, 47: 1143–1160.
- Sun J, Jiang J, Zhao Q & Qiu J (2015) New earthworms of the *Amyntas morrisi*-group (Oligochaeta, Megascolecidae) from Hainan Island, China. *Zootaxa*, 4058(2): 257–266.
- Sun J, Jiang J, Hu F & Qiu J (2016) Four new earthworms of the genus *Amyntas* (Oligochaeta: Megascolecidae) from Mount Emei, Sichuan Province, China. *Journal of Natural History*, 50: 2499–2513.
- Tsai CF, Shen HP & Tsai SC (2001) Some new earthworms of the genus *Amyntas* (Oligochaeta: Megascolecidae) from Mt. Hohuan of Taiwan. *Zoological Studies*, 40(4): 276–288.
- Tsai CF, Shen HP & Tsai SC (2002) A new athecate earthworm of the genus *Amyntas* Kinberg (Megascolecidae: Oligochaeta) from Taiwan with discussion on phylogeny and biogeography of the *A. illotus* species-group. *Journal of Natural History*, 36: 757–765.
- Tsai CF, Shen HP, Tsai SC & Lee HH (2007) Four new species of terrestrial earthworms belonging to the genus *Amyntas* (Megascolecidae: Oligochaeta) from Taiwan with discussion on speculative synonyms and species delimitation in oligochaete taxonomy. *Journal of Natural History*, 41(5–8): 357–379.
- Tsai CF, Shen HP & Tsai SC (2010) Four new species of *Amyntas* earthworms (Oligochaeta: Megascolecidae) from the Central Mountain Range of Southern Taiwan. *Journal of Natural History*, 44: 1251–1267.
- Vaillant L (1868) Note sur l'anatomie de deux espèces du genre *Perichaeta* et essai de classification des Annélides Lombricine. *Annales des Sciences Naturelles*, 10: 225–256.
- Zhao Q, Sun J, Jiang J & Qiu J (2013) Four new species of genus *Amyntas* (Oligochaeta: Megascolecidae) from Hainan Island, China. *Journal of Natural History*, 47: 2175–2192.
- Zhao Q, Yao X, Lan Y, Xu J & Qiu J (2018) New earthworm species of the genus *Amyntas* from Hainan Island, China (Megascolecidae, Clitellata). *Zootaxa*, 4496(1): 279–286.