RAFFLES BULLETIN OF ZOOLOGY **65**: 559–573
Date of publication: 30 October 2017
http://zoobank.org/urn:lsid:zoobank.org:pub:9A17DED6-26FE-44F4-A414-E3C650B16D94

The earthworm genus *Polypheretima* Michaelsen, 1934 (Annelida: Clitellata: Megascolecidae) from Sulawesi, Indonesia, with descriptions of four new species

Fahri[1], Rizki Amaliah[1], Annawaty[1], Anh D. Nguyen[2,3*]

Abstract. The earthworm genus *Polypheretima* Michaelsen, 1934, from Sulawesi, Indonesia, is reviewed based on freshly collected material. A total of eight species are recorded in Sulawesi, including four new species, namely *P. cokelat*, new species, *P. sahlani*, new species, *P. elongatoides*, new species, and *P. kalimpaaensis*, new species. All new species belong to the *Polypheretima elongata* species-group, characterised by having spermathecal pores in 5/6 and/or 6/7, numerous spermathecae per battery, paired genital markings in xix and subsequent segments, in line with male porophores. In addition, an identification key to the species from Sulawesi is also provided.

Key words. earthworm, Megascolecidae, *Polypheretima*, new species, Central Sulawesi, Indonesia

INTRODUCTION

The genus *Polypheretima* Michaelsen, 1934, was established for pheretimoid earthworms characterised by the absence of intestinal caeca, absence of crescentic genital markings in front of or behind male pores, and numerous spermathecae per segment (Michaelsen, 1934). Easton (1979) revised and assigned 35 species to this genus. More new species have been recently described, e.g., *Polypheretima neglecta* Easton, 1984, from Fiji; *Polypheretima tamarae* Easton, 1984, from Papua New Guinea; *P. mekongmontis* Nguyen, Tran & Nguyen, 2014, *P. cattienensis* Nguyen, Tran & Nguyen, 2015, *P. militium* Nguyen, Tran & Nguyen, 2015, and *P. cordata* Nguyen, Tran & Nguyen, 2015, all from southern Vietnam; *P. mindanaoensis* Aspe & James, 2015, *P. bukidnonensis* Aspe & James, 2016, and *P. zamboangensis* Aspe & James, 2016 from the Philippines (Easton, 1984; Nguyen et al., 2014, 2015; Aspe & James, 2015, 2016). The genus *Polypheretima* is mainly distributed in Indo-Australian archipelago, for example, Indonesia, Malaysia, the Philippines, and southern Vietnam.

Sulawesi, formerly known as Celebes, is one of four largest islands in Indonesia, and 11th largest islands in the world (http://data.mongabay.com/profiles/sulawesi.html). Its territory is about 192,506 km^2, and mostly dominated by mountains. This island is a part of Wallacea; thus, it contains biological elements of both Asia and Australasia, which means that the biodiversity of Sulawesi could be very rich (Carstensen et al., 2012). To date, only four species of *Polypheretima* have been recorded from Sulawesi, namely *P. elongata* (Perrier, 1872) in southeast Sulawesi, *P. everetti* (Beddard & Fedarb, 1895) in north and west Sulawesi, *P. phacellotheca* (Michaelsen, 1899) in northeast Sulawesi and *P. stelleri* (Michaelsen, 1891) in Sulawesi (Bone valley and Matinang range) (Easton, 1976, 1979). This number may be far from reflecting the biodiversity of the genus *Polypheretima* from Sulawesi. Our work, therefore, contributes to the knowledge of this genus with descriptions of four new species.

MATERIAL AND METHODS

Fresh specimens were collected from cacao plantations and yards in Tongoa village (01°12′30.6″S–01°12′38.8″S, 120°10′02.0″E–120°10′04.6″E), from secondary forests near the Kalimpa'a lake (01°19′33″S, 120°18′29.6″E) of the Lore Lindu National Park, from secondary forests (0°42′56.4″S, 120°3′29.7″E) in the Pangi Binangga Nature Reserve; Ogotumubu village (0°30′39.5″N, 120°34′1.7″E), Margapura village (0°31′2.35″N, 120°57′45.15″E) in Central Sulawesi province (Indonesia) in April 25th 2016–January 21st 2017 (Fig. 1). The earthworms were killed in formalin 2%, transferred to formalin 4% for fixation for approximately 24 hours, and then transferred to new formalin 4% for long-term preservation and morphological studies. Specimens were dissected from dorsal side for internal observation. Both external and internal morphology were observed under a Carton DSZT44 stereo microscope. Holotypes and paratypes are deposited in the Museum Zoologicum Bogoriense (=MZB), Bogor, West Java, and Laboratory of Zoology, Tadulako University, Palu, Central Sulawesi (=UNTAD), Indonesia.

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ISSN 2345-7600 (electronic) | ISSN 0217-2445 (print)

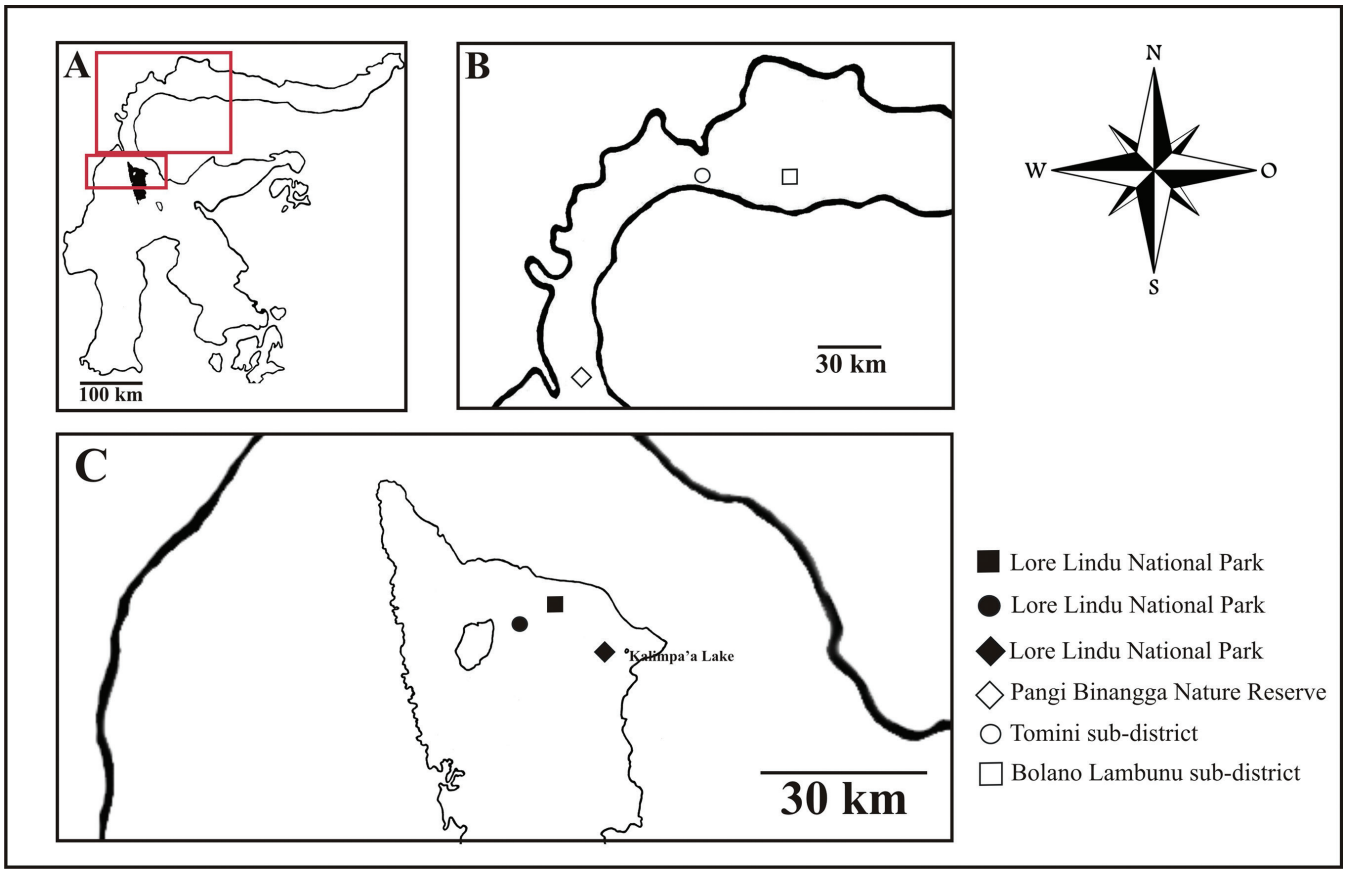

Fig. 1. Locations of collection sites in Sulawesi.

TAXONOMY

Family Megascolecidae Rosa, 1891

Genus *Polypheretima* Michaelsen, 1934

Polypheretima cokelat Fahri & Amaliah, new species

(Fig. 2)

Material examined. *Holotype*. Clitellate (MZB Oli. 0054), cacao plantation, (01°12′30.6″S, 120°10′02.0″E), elevation of 870 m asl, Tongoa village, Lore Lindu National Park, Sigi district, Central Sulawesi province, Indonesia, 26–27 October 2016, leg. Fahri, Rizki Amaliah, M. Syarif Indra Gunawan, Evans Madiono, Nurliana H Laewa, Ardiansyah, Adhi Pranata, Sahlan.

Paratypes. 4 clitellates (MZB Oli. 0055) and 3 clitellates (UNTAD Oli. 0001), same data as for holotype.

Diagnosis. Medium size, length 54–185 mm, diameter 4.5–6.0 mm, segments 169–214. Prostomiumprolobous. First dorsal pore in 12/13. Setae 43–61 in v, 52–63 in vii, 49–66 in viii, 46–62 in xxv, and 8–10 between male porophores in xviii. Spermathecal pores large, lateroventrally paired in 5/6/7. Spermathecae about 2–5 per battery. Male porophores highly elevated, large; male pores located inside copulatory pouches with crescentic openings in xviii. Genital markings large, on setal rings, paired (rarely unpaired) in xix–xxii, rarely xxiii. Holandric.

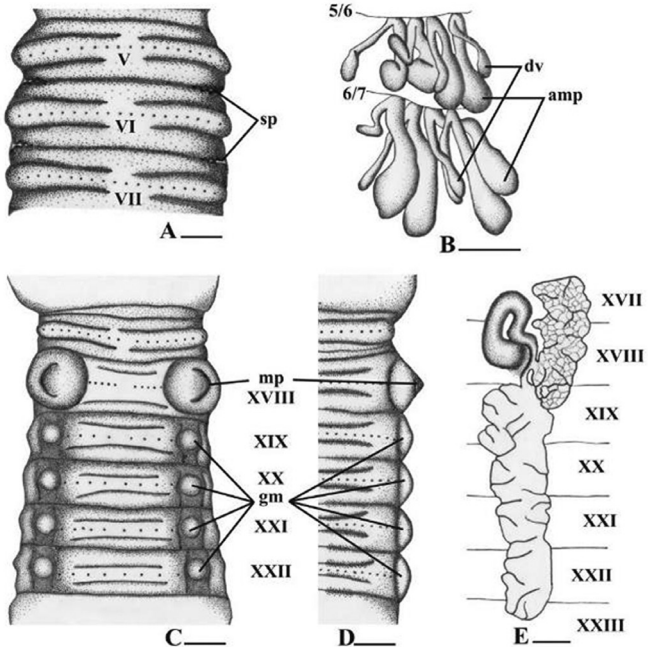

Fig. 2. *Polypheretima cokelat* sp. nov., Holotype. A, Spermathecal pores; B, Spermathecae (amp=ampulla, dv=diverticulum); C, Male pore region, ventral view (mp=opening of copulatory pouch, gm=genital markings); D, Male pore region, lateral view; E, Prostate gland. Scale bar = 1 mm.

Table 1. The number of genital markings, spermathecae, setae on vii, and prostate position of *Polypheretima cokelat*, new species.

No.	Specimen	Number of Genital Markings			Prostate Position	Number of Spermathecae				Setae on vii
		Left	Right	Total		Position	Left	Right	Total	
1	Holotype	4	4	8	17–23	vi	4	4	8	52
						vii	3	4	7	
2	Paratype 1	4	4	8	16–23	vi	4	4	8	57
						vii	4	4	8	
3	Paratype 2	4	4	8	17–22	vi	4	4	8	63
						vii	3	4	7	
4	Paratype 3	4	4	8	17–19	vi	4	5	9	58
						vii	5	5	10	
5	Paratype 4	4	4	8	17–24	vi	4	3	7	53
						vii	3	3	6	
6	Paratype 5	5	5	10	16–22	vi	4	3	7	56
						vii	2	2	4	
7	Paratype 6	5	4	9	16–23	vi	3	2	5	60
						vii	3	3	6	
8	Paratype 7	4	4	8	17–19	vi	4	5	9	62
						vii	5	4	9	

Etymology. Named after the local name "cokelat" for cacao trees.

Description. *External characters*. Body generally cylindrical, medium size, length 54–185 mm, diameter 4.5–6.0 mm at x and 5.0–5.5 mm at xx, segments 169–214. For living specimens, body pinkish brown on dorsum and ventrum, clitellum brown; for preserved specimens, colouration paler.

Prostomium prolobous. First dorsal pore in 12/13. Setae 43–61 in v, 52–63 in vii (Table 1), 49–66 in viii, 46–62 in xxv, and 8–10 between male porophores in xviii; setal distance aa=ab, zz=1–2.5zy. Clitellum annular, xiv–xvi, smooth, without setae and dorsal pores. Female pore single, mid-ventral in xiv.

Spermathecal pores large, lateroventrally paired in 5/6/7. Ventral distance between spermathecal pores about 0.4× body circumference. No genital markings in the spermathecal region.

Male porophores highly elevated, large; male pores located inside copulatory pouches in xviii. Ventral distance between male porophores about 0.4× body circumference. Genital markings large, on setal rings, paired (rarely unpaired) in xix–xxii, sometimes xxiii. Genital markings variable in specimens (Table 1).

Internal characters. Septa 3/4/5/6/7/8 thickened, 8/9/10 absent,10/11/12/13 thin. Gizzard large, round after viii. Last hearts in xiii. Intestinal origin at xv; caeca absent. Pharyngeal micronephridia well-developed on septum 6/7. Typhlosole simple, lamelliform. Lymph glands absent.

Spermathecae small, about 11–19 altogether: 5–9 in vi (3–4 on the left, and 2–5 on the right), 4–10 in vii (2–5 on the left, and 2–5 on the right). The number of spermathecae variable in specimens (Table 1). Ampulla claviform; duct relatively long, about 2/4–3/4 as long as ampulla. Diverticulum simple, shorter than ampulla, with a seminal chamber at distal end, attached to the base of duct. No accessory glands.

Holandric. Testes sacs paired in x–xi, small, separated, ventral, yellowish. Seminal vesicles in xi and xii. Ovaries and ovisacs paired in xiii. Prostate glands paired in xviii, racemose with the rough upper part and the smooth bottom part; two main branches extending variably in specimens (Table 1). Prostatic ducts U-shaped, distalend enlarged at xviii. No accessory glands.

Habitat and ecology. Specimens were collected in cacao plantations in Tongoa village, Lore Lindu National Park at 870 m asl. The species was found in sandy soils at depth of 0–30 cm. Soil surface was moist because of cacao leaf litter on the ground. The species was also found under decaying wood, and around the roots of cacao at depth of 10 cm.

Remarks. The new species can be keyed to the *Polypheretima elongata* species-complex (Easton, 1976, 1979) characterised by numerous spermathecal pores in paired batteries, lateroventral in intersegmental furrows 5/6 and/or 6/7; genital markings paired in xix and subsequent segments, in line with the male porophores. This group currently consists of seven species (excluding the new species described in this paper), namely *P. elongata* (Perrier, 1872), *P. everetti* (Beddard & Fedarb, 1895), *P. kinabaluensis* (Beddard & Fedarb, 1895), *P. phacellotheca* (Michaelsen, 1899), *P. stelleri* (Michaelsen,

1891), *P. mindanaoensis* Aspe & James, 2015, and *P. bukidnonensis* Aspe & James, 2016.

Polypheretima cokelat, new species, is particularly similar to *P. elongata* and *P. everetti* in having spermathecal pores in 5/6/7 and genital markings paired in xix and subsequent segments. However, it differs from those species in its smaller size (185 mm vs. 355 and 300 mm, respectively) (Easton, 1979). *Polypheretima elongata* has no more than three spermathecae per battery and 80–130 setae in vii (Easton, 1979); *P. everetti* and *P. kinabaluensis* have 6–12 spermathecae per battery and setal number in vii up to 130 for the former and less than 40 for the latter (Easton, 1979); *P. phacellotheca* has 9–12 spermathecae per battery and setae in vii 59–76 (Easton, 1976, 1979); *P. stelleri* has spermathecae up to 28 per battery and setal number in vii up to 130 (Easton, 1979); *P. mindanaoensis* has 0–5 spermathecae per battery and 41–53 setae in vii (Aspe & James, 2015); *P. bukidnonensis* has 7–11 spermathecae per battery and 39–45 setae in vii (Aspe & James, 2016) (Table 6). In contrast, *P. cokelat*, new species has 2–5 spermathecae per battery and 52–63 setae in vii (Table 1).

Polypheretima sahlani Fahri & Amaliah, new species
(Fig. 3)

Material examined. *Holotype*. Clitellate (MZB Oli. 0056), the yard (01°12′38.8″S, 120°10′04.6″E), elevation of 820 m asl, Tongoa village, Lore Lindu National Park, Poso district, Central Sulawesi province, Indonesia, 26–27 October 2016, leg. Fahri, Rizki Amaliah, M. Syarif Indra Gunawan, Evans Madiono, Nurliana H Laewa, Ardiansyah, Adhi Pranata, Sahlan.

Paratypes. 4 clitellates (MZB Oli. 0057) and 2 clitellates (UNTAD Oli. 0002), same data as for holotype.

Diagnosis. Medium size, length 152–195 mm, diameter 4.5–6.0 mm, segments 113–281. Prostomiumprolobous. First dorsal pore in 12/13. Setae 34–75 in v, 78–89 in vii, 71–91 in viii and 59–68 in xxv, and 8–10 between male porophores in xviii. Spermathecal pores absent or in 5/6. Male porophores highly elevated, large; male pores located inside copulatory pouches in xviii. Genital markings large, presetal, paired in xix–xxiii, sometimes xxiv, in line with male porophores. Metandric.

Etymology. The species is named after Sahlan, for his kind assistance in the fieldwork.

Description. *External characters*. Body generally cylindrical; medium size, length 152–195 mm, diameter 4.5–6.0 mm at x and 5.0–6.0 mm xx, segments 113–281. For living specimens, pre-clitellar region purplish pink, post-clitellar region purplish brown, clitellum brown; for preserved specimens, colouration paler.

Prostomium prolobous. First dorsal pore in 12/13. Setae 34–75 in v, 78–89 in vii (Table 2), 71–91 in viii and 59–68 in xxv, and 8–10 between male porophores in xviii; setal

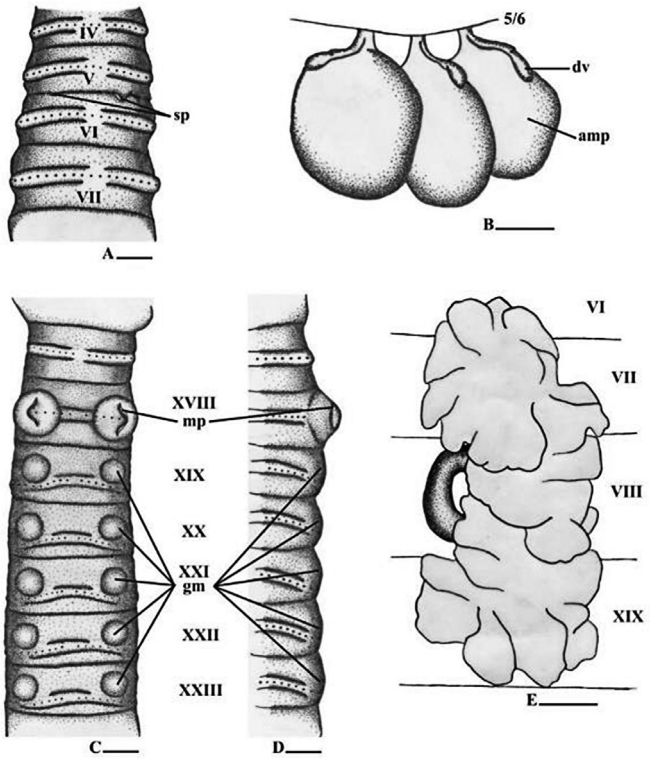

Fig. 3. *Polypheretima sahlani* sp. nov., Holotype. A, Spermathecal pores; B, Spermathecae (amp=ampulla, dv=diverticulum); C, Male pore region, ventral view (mp=opening of copulatory pouch, gm=genital markings); D, Male pore region, lateral view; E, Prostate gland. Scale bar = 1 mm.

distance aa=1–2ab, zz=1–2.5zy. Clitellum annular, xiv–xvi, smooth without setae and dorsal pores. Female pore single, mid-ventral in xiv.

Spermathecal pores absent or small, inconspicuous in ventral 5/6. Male porophores highly elevated, large; male pores located inside copulatory pouches with crescentic openings in xviii. Ventral distance between male porophores about 0.5× body circumference. Genital markings large, presetal, paired in xix–xxiii, sometimes xxiv, in line with the male porophores.

Internal characters. Septa 3/4/5/6/7/8 thickened, 8/9/10 absent, 10/11/12/13 thin. Gizzard large, round after viii. Last hearts in xiii. Intestinal origin at xv; caeca absent. Pharyngeal micronephridia well-developed on septum 6/7. Typhlosole simple. Lymph glands absent.

Spermathecae large, 0–3 altogether in vi: no spermathecae on the left, but 0–3 on the right. The number of spermathecae variable in specimens (Table 2). Ampulla large and globose; duct very short, about 1/6 as long as ampulla. Diverticulum simple, cylindrical, much shorter than ampulla, with a seminal chamber at distal end, attached to the base of duct. No accessory glands.

Metandric. Testes sacs paired in xi, small, separated, ventral, yellowish. Seminal vesicles in xii. Ovaries paired on xiii. Prostate glands paired in xviii, racemose, two main branches extending variably in specimens (Table 2). Prostatic ducts C-shaped, short and stout. No accessory glands.

Table 2. The number of genital markings, spermathecae, setae on vii, and prostate position of *Polypheretima sahlani*, new species.

No	Specimen	Number of Genital Markings			Prostate Position		Number of Spermathecae				Setae on vii
		Left	Right	Total	Left	Right	Position	Left	Right	Total	
1	Holotype	5	5	10	16–19	16–19	vi	0	3	3	85
2	Paratype 1	5	5	10	16–19	15–19	vi	0	0	0	78
3	Paratype 2	5	5	10	16–19	16–19	vi	0	0	0	85
4	Paratype 3	5	5	10	15–19	16–19	vi	0	0	0	89
5	Paratype 4	5	5	10	16–19	16–19	vi	0	0	0	82
6	Paratype 5	5	5	10	16–20	16–20	vi	0	1	1	83
7	Paratype 6	6	6	12	16–20	16–19	vi	0	0	0	80

Habitat and ecology. The species was found in the yard in Tongoa village, Lore Lindu National Park at 820 m asl. It was collected in sandy soils near water drainages at depth of 5–20 cm.

Remarks. The new species is fairly similar to *Polypheretima phacellotheca* by having spermathecal pores in 5/6, but differs in male sexual system (metandric vs. holandric), the number of spermathecae per battery (1–3 vs. 9–12), setae in vii (78–89 vs. up to 80), number of genital markings (xix–xxiii/xxiv vs. xix–xxii), and spermathecal ampulla (globose, duct short vs. oval, duct long) (Table 6).

Polypheretima elongatoides Fahri & Nguyen, new species

(Fig. 4)

Material examined. *Holotype*. Clitellate (MZB Oli. 0058), secondary forest, Pangi Binangga Nature Reserve (0°42′56.4″S, 120°3′29.7″E), elevation of 308 m asl, Parigi Moutong district, Central Sulawesi province, Indonesia, 7 May 2016, leg. Fahri, Rizki Amaliah, M. Syarif Indra Gunawan, Wanda Damayanti, Fitriana.

Paratypes. 2 clitellates (MZB Oli. 0059) and 4 clitellates (UNTAD Oli. 0003), same data as for holotype.

Diagnosis. Medium size, length 118–240 mm, diameter 4–8 mm, segments 97–153. Prostomium prolobous. First dorsal pore in 12/13. Setae 35–48 in v, 38–56 in vii, 41–53 in viii and 51–88 in xxv, 6–10 between male porophores in xviii. Spermathecal pores arranged in 5/6/7, about 3–9 spermathecae per battery. Ampulla irregular, oval, jagged, folded; diverticulum cylindrical, slightly twisted with a seminal chamber at distal end. Genital markings large, on setal rings, paired in xix–xxi, sometimes xix–xxii. Holandric.

Etymology. Named after the similarities to *Polypheretima elongata* (Perrier, 1872).

Description. *External characters*. Body generally cylindrical, but slightly bigger in segments iv–x. Medium size, length 118–240 mm, diameter 4–8 mm, number of segments 97–153. For living specimens, yellow brownish on dorsum and paler on ventrum, brown around clitellum; for preserved specimens, light brown pre and post clitellum, reddish brown in clitellum.

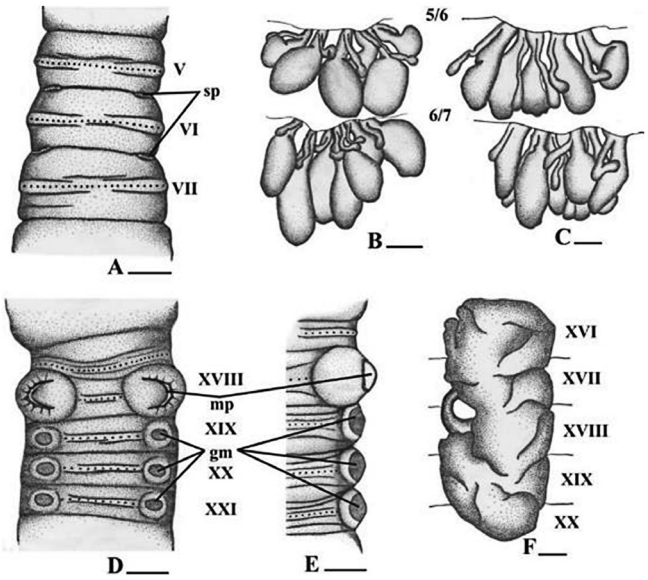

Fig. 4. *Polypheretima elongatoides* sp. nov., Holotype. A, Spermathecal pores; B, C, Spermathecae (amp=ampulla, dv=diverticulum); D, Male pores region (mp=opening of copulatory pouch, gm=genital marking, ventral view); E, Male pores region (lateral view); F, Prostate gland. Scale bar = 1 mm.

Prostomium prolobous. First dorsal pore in 12/13. Setae 35–48 in v, 38–56 in vii (Table 3), 41–53 in viii and 51–88 in xxv, 6–10 between male porophores in xviii; setae distance aa=1–2ab, zz=1–3zy. Clitellum annular, xiv–xvi, smooth without setae. Female pore single, mid-ventral in xiv.

Spermathecal pores large, lateroventrally in 5/6/7. Distance between spermathecal pores about 0.3× body circumference ventrally. No genital markings in the spermathecal region.

Male porophores highly elevated, large; male pores located deeply inside copulatory pouches each with a large, crescentic opening in xviii, ventral distance between openings about 0.4× body circumference. Genital markings large, on setal rings, paired in xix-xxi, sometimes xix-xxii and absent in spermathecal region. Genital markings variable in specimens (Table 3).

Table 3. The number of genital markings, spermathecae, setae on vii, and prostate position of *Polypheretima elongatoides*, new species.

No.	Specimen	Number of Genital Marking			Prostate Position	Number of Spermathecae				Setae on vii
		Left	Right	Total		Position	Left	Right	Total	
1	Holotype	3	3	6	17–19	vi	6	7	13	41
						vii	7	6	13	
2	Paratype 1	3	3	6	16–20	vi	5	6	11	48
						vii	7	7	14	
3	Paratype 2	3	3	6	16–19	vi	4	6	10	52
						vii	5	7	12	
4	Paratype 3	3	3	6	17–19	vi	6	7	13	56
						vii	7	9	16	
5	Paratype 4	3	3	6	16–20	vi	9	9	18	38
						vii	6	7	13	
6	Paratype 5	3	3	6	17–19	vi	7	7	14	46
						vii	7	7	14	
7	Paratype 6	4	4	8	17–19	vi	4	3	7	43
						vii	4	3	7	

Internal characters. Septa 3/4/5/6/7/8 thickened, 8/9/10 absent, 10/11/12/13 thin. Gizzard large, round after viii. Last heart in xiii. Intestine beginning at xv; caeca absent. Pharyngeal micronephridia well-developed on septum 6/7. Typhlosole simple. Lymph glands not seen.

Spermathecae small to large, 14–31 altogether: 7–18 in vi (4–9 on the left, and 3–9 on the right), 7–16 in vii (4–7 on the left, and 3–9 on the right). The number of spermathecae variable in specimens (Table 3). Ampulla irregular, oval, jagged, folded; duct about 1/2–1/3 as long as ampulla. Diverticulum cylindrical, much shorter than ampulla, distal end slightly expanded; stalk straight or slightly curved, attached to duct at base.

Holandric. Testes sacs paired in x–xi, small, separated, ventral, yellowish. Seminal vesicles in xi–xii. Ovaries paired in xiii and ovisacs developing in xiii. Prostate glands racemose, paired in xvi–xx (Table 3). Prostatic ducts C-shaped. No accessory glands.

Habitat and ecology. Specimens were collected in secondary forests in the Pangi-Binangga Nature Reserve at 308 m asl. This species was found in sandy soils at a depth about 0–10 cm.

The species was also found on the surface of the main road between two districts (Parigi Moutong and Donggala regency in Central Sulawesi) in Pangi Binangga Nature Reserve. We observed that the specimens were moving from a place covered by a narrow canopy and near a dry river to a lower place covered by shrubs and wider canopy.

Remarks. The new species can be keyed to the *P. elongata* species group. *Polypheretima elongatoides*, new species, is fairly similar to *P. elongata* in having spermathecal pores in 5/6/7, genital markings paired in xix–xxi. However, it differs from *P. elongata* in having more spermathecae per battery (3–9 vs. up to 3), smaller size (up to 240 mm vs. 300 mm), fewer setae in vii (38–56 vs. 80–130), and in the shape of the spermathecae (ampulla irregular, oval, jagged, folded vs. ampulla globose) (Perrier, 1872; Easton, 1982).

The new species also differs from its congeners in the number of spermathecae (about 3–9 per battery) and the number of setae (about 38–56 in vii). In contrast, *P. everetti* (Beddard & Fedarb, 1895) has 6–12 spermathecae per battery and up to 130 setae in vii (Easton, 1979); *P. phacellotheca* (Michaelsen, 1899) has 9–12 spermathecae per battery and up to 80 setae in vii (Easton, 1979); *P. stelleri* (Michaelsen, 1891) has up to 28 spermathecae per battery and up to 130 setae in vii (Easton, 1979); *P. kinabaluensis* (Beddard & Fedarb, 1895) has 6–12 spermathecae in each battery and less than 40 setae in vii (Easton, 1979); *P. mindanaoensis* Aspe & James, 2015 has 0–5 spermathecae in each battery and about 41–53 setae in vii; and *P. bukidnonensis* Aspe & James, 2016 has 7–11 spermathecae in each battery and about 39–45 setae in vii (Table 6).

Polypheretima kalimpaaensis Fahri & Amaliah, new species

(Fig. 5)

Material examined. *Holotype*. Clitellate (MZB Oli. 0051), Kalimpa'a Lake, Secondary Forest, Lore Lindu National Park (01°19′33″S, 120°18′29.6″E), elevation of 1,593 m asl., Central Sulawesi Province, Indonesia, 5 June 2016, leg. Fahri, Rizki Amaliah, Sahlan, Auni Ade Putri.

Paratypes. 5 clitellates (MZB Oli. 0053), same data as for holotype; 5 clitellates (MZB Oli. 0052), same locality as for holotype, 31 October 2016, leg. Fahri, Rizki Amaliah, Rika

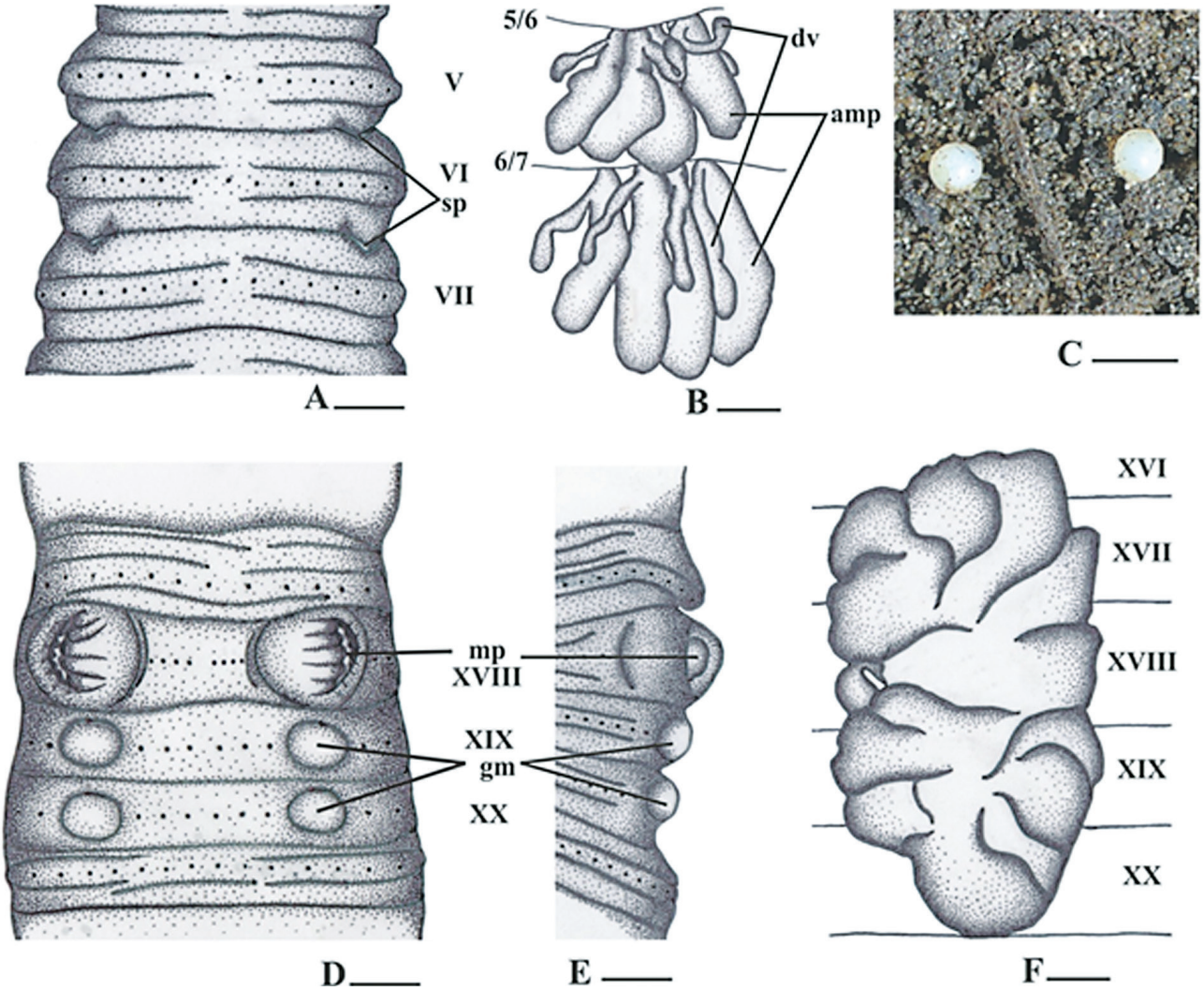

Fig. 5. *Polypheretima kalimpaaensis* sp. nov., Holotype. A, Spermathecal pores; B, Spermathecae (amp=ampulla, dv=diverticulum); C, Cocoon; D, Male pore region, ventral view (mp=opening of copulatory pouch, gm=genital marking); E, Male pore region, lateral view; F, Prostate gland. Scale bar = 1 mm (for A, B, D, E, F), 1 cm (for C).

Hafriani H, Evans Muhdiyono, Adhi Pranata, Ardiansyah, Sahlan; 10 clitellates (UNTAD Oli. 0004), same locality as for holotype, 31 October 2016, leg. Fahri, Rizki Amaliah, Rika Hafriani H, Evans Muhdiyono, Adhi Pranata, Ardiansyah, Sahlan.

Other material. 15 clitellates (UNTAD Oli. 0005), same locality as for holotype, 31 October 2016, leg. Fahri, Rizki Amaliah, Rika Hafriani H, Evans Muhdiyono, Adhi Pranata, Ardiansyah, Sahlan.

Diagnosis. Medium size, length 124–156 mm, diameter 3–5 mm, segments 150–223. Prostomium prolobous. First dorsal pore in 12/13. Setae 58–64 in v, 42–74 in vii, 69–85 in viii, 48–52 in xxv, and 8–10 between male porophores in xviii. Spermathecae arranged in two pairs of pores in 5/6/7, about 3–7 per battery. Genital markings large, on setal rings, paired (rarely unpaired) in xix-xx, sometimes xxi. Holandric.

Etymology. The new species is named after Lake Kalimpa'a, in Lore Lindu National Park, where the type material was found.

Description. *External characters*. Body generally cylindrical. Medium size, length 124–156 mm, diameter 3–5 mm, segments 150–223. For living specimens, pre-clitellum and post-clitellum somewhat purplish pink, and clitellum brownish pink; for preserved specimens, colouration paler.

Prostomium prolobous. First dorsal pore in 12/13. Setae 58–64 in v, 42–74 in vii, 69–85 in viii, 48–52 in xxv, and 8–10 between male porophores in xviii; setae distance aa=1–2ab, zz=1–2zy. The number of setae in vii variable in specimens (Table 4). Clitellum annular, xiv–xvi, smooth without setae and dorsal pores. Female pore single in mid-ventral xiv.

Spermathecal pores large, paired lateroventrally in 5/6/7. Ventral distance between spermathecal pores about 0.35× body circumference. Genital markings absent in the spermathecal region.

Male pores located deeply inside copulatory pouches in xviii; each copulatory pouch with a large, crescentic opening. Distance between the openings of copulatory pouches about 0.2× body circumference ventrally. Genital markings large, on setal rings, paired (rarely unpaired) in xix–xx (Table 4).

Table 4. The number of genital markings, spermathecae, setae on vii, and prostate position of *Polypheretima kalimpaaensis*, new species.

No.	Specimen	Number of Genital Marking			Prostate Position	Number of Spermathecae				Setae on vii
		Left	Right	Total		Position	Left	Right	Total	
1	Holotype	2	2	4	16–20	vi	5	4	9	68
						vii	4	4	8	
2	Paratype 1	2	2	4	16–20	vi	4	4	8	61
						vii	4	5	9	
3	Paratype 2	2	2	4	16–20	vi	4	5	9	63
						vii	4	5	9	
4	Paratype 3	2	2	4	16–20	vi	4	4	8	53
						vii	4	4	8	
5	Paratype 4	0	3	3	16–20	vi	5	5	10	51
						vii	4	4	8	
6	Paratype 5	2	2	4	16–20	vi	5	5	10	66
						vii	5	5	10	
7	Paratype 6	3	2	5	16–20	vi	5	4	9	61
						vii	5	4	9	
8	Paratype 7	2	2	4	16–20	vi	4	5	9	74
						vii	4	4	8	
9	Paratype 8	2	2	4	16–20	vi	5	4	9	64
						vii	5	4	9	
10	Paratype 9	2	2	4	16–20	vi	4	5	9	63
						vii	4	4	8	
11	Paratype 10	2	2	4	16–20	vi	5	4	9	64
						vii	5	4	9	
12	Paratype 11	2	2	4	15–19	vi	5	5	10	54
						vii	4	4	8	
13	Paratype 12	2	2	4	15–19	vi	4	4	8	63
						vii	3	3	6	
14	Paratype 13	2	2	4	15–19	vi	5	4	9	54
						vii	3	5	8	
15	Paratype 14	2	2	4	15–19	vi	4	6	10	55
						vii	4	4	8	
16	Paratype 15	2	2	4	15–19	vi	5	4	9	48
						vii	5	5	10	
17	Specimen 1	2	2	4	16–20	vi	5	4	9	61
						vii	4	5	9	
18	Specimen 2	2	2	4	16–20	vi	3	5	8	58
						vii	4	4	8	
19	Specimen 3	2	2	4	15–19	vi	4	5	9	58
						vii	4	4	8	
20	Specimen 4	2	2	4	15–19	vi	5	5	10	60
						vii	4	4	8	
21	Specimen 5	2	2	4	15–19	vi	5	4	9	61
						vii	7	5	12	
22	Specimen 6	2	2	4	16–20	vi	4	6	10	61
						vii	4	4	8	

No.	Specimen	Number of Genital Marking			Prostate Position	Number of Spermathecae				Setae on vii
		Left	Right	Total		Position	Left	Right	Total	
23	Specimen 7	2	2	4	16–20	vi	3	4	7	42
						vii	4	4	8	
24	Specimen 8	2	1	3	17–19	vi	5	5	10	63
						vii	4	5	9	
25	Specimen 9	2	2	4	16–20	vi	3	4	7	62
						vii	5	5	10	
26	Specimen 10	2	2	4	16–20	vi	4	5	9	59
						vii	5	5	10	
27	Specimen 11	2	2	4	16–20	vi	5	4	9	65
						vii	4	5	9	
28	Specimen 12	2	2	4	16–20	vi	5	4	9	57
						vii	4	4	8	
29	Specimen 13	1	2	3	16–20	vi	4	4	8	56
						vii	5	5	10	
30	Specimen 14	2	2	4	16–20	vi	5	5	10	55
						vii	5	5	10	
31	Specimen 15	2	2	4	15–19	vi	5	5	10	56
						vii	5	4	9	
32	Specimen 16	2	2	4	15–19	vi	4	4	8	49
						vii	5	5	10	
33	Specimen 17	2	2	4	16–20	vi	5	6	11	60
						vii	4	5	9	
34	Specimen 18	2	2	4	16–20	vi	4	5	9	61
						vii	5	5	10	
35	Specimen 19	2	2	4	16–20	vi	4	5	9	62
						vii	5	4	9	
36	Specimen 20	2	2	4	15–19	vi	4	4	8	63
						vii	4	5	9	

Internal characters. Septa 3/4/5/6/7/8 thick, 8/9/10 absent, 10/11/12/13 thin. Gizzard large, round after viii. Last hearts in xiii. Intestinal origin at xv; caeca absent. Pharyngeal micronephridia well-developed on septum 4/5. Typhlosole simple, lamelliform. Lymph glands absent.

Spermathecae small, 16–20 altogether in vi–vii: 8–10 in each of segment vi and vii (3–7 in each side of segment vi and vii, respectively). The number of spermathecae variable in specimens (Table 4). Ampulla more or less subcylindrial; duct very short. Diverticulum cylindrical, much shorter than ampulla, slightly expanded at distal end; stalk attached to duct at base.

Holandric. Testes sacs paired in x and xi, small, separated, ventral, yellowish. Seminal vesicles in xi and xii. Ovaries paired in xiii and ovisacs developing in xiii. Prostate gland racemose, paired in xvi–xx. Prostatic ducts C-shaped. No accessory glands.

Habitat and ecology. Specimens were found in secondary forests near Kalimpa'a Lake at 1,593 m asl. They live just under rotten woods in sandy soils, and we did not find them in other habitats (sandy soils without rotting woods near the lake, and sandy soils with rich litters but not rotting woods). Besides worms, several beetle larvae were also found. We also found its cocoons in the collecting area. Cocoons are white, oval-shaped with a diameter of 4 mm.

Remarks. *Polypheretima kalimpaaensis*, new species, is keyed to the *P. elongata* species group. The species is fairly similar to almost all species in the *elongata* group, except *P. phacellotheca* and *P. sahlani*, in having spermathecal pores in 5/6/7 (Table 6). However, the species is clearly different from its congeners in having 3–7 spermathecae in each battery and 42–74 setae in vii.

Table 5. The number of genital markings and spermathecae of *Polypheretima phacellotheca* (Michaelsen, 1899).

No.	Specimen	Number of Genital Marking			Number of Spermathecae		
		Left	Right	Total	Left	Right	Total
1	Specimen 1	5	5	10	11	11	22
2	Specimen 2	3	4	7	9	10	19
3	Specimen 3	4	4	8	10	10	20
4	Specimen 4	4	4	8	11	11	22
5	Specimen 5	4	4	8	11	11	22
6	Specimen 6	4	4	8	11	11	22
7	Specimen 7	4	4	8	11	11	22
8	Specimen 8	4	4	8	9	9	18
9	Specimen 9	4	4	8	10	10	20
10	Specimen 10	4	4	8	10	10	20

Polypheretima phacellotheca (Michaelsen, 1899)
(Fig. 6)

Amyntas phakellotheca (sic) Michaelsen, 1899: 47.
Amyntas phacellotheca: Beddard, 1900: 640.
Pheretima phacellotheca: Michaelsen, 1900: 293; Gates, 1961: 304.
Pheretima (*Polypheretima*) *phacellotheca*: Michaelsen, 1934: 15.
Metapheretima phacellotheca: Sims & Easton, 1972: 233; Easton, 1976: 44.
Polypheretima phacellotheca: Easton, 1979: 55

Material examined. 4 clitellates (MZB Oli. 0060), secondary forest (0°30′39.5″N, 120°34′1.7″E), elevation of 7 m asl., Ogotumubu Barat village, Tomini sub-district, Parigi Mautong district, Central Sulawesi province, Indonesia, 25 April 2016, leg. Fahri and Fitrallisan. 6 clitellates (UNTAD Oli. 0006), same data as for MZB Oli. 0060.

Re-description. *External characters*. Body cylindrical. Large size, length 210–220 mm, diameter 4–7 mm, segments 210–256. Colour similar on dursum and ventrum, yellow brownish in pre-clitellum and post-clitellum and pink around clitellum.

Prostomium prolobous. First dorsal pore in 12/13. Setae 44–67 in v, 59–76 in vii, 62–85 in viii, 46–98 in xxv, and 4–8 between male porophores in xviii; setae distance aa=1–3ab, zz=1–3zy. Clitellum annular, xiv–xvi, smooth without setae and dorsal pores. Female pore single, mid-ventral in xiv.

Spermathecal pores paired lateroventrally in 5/6. Ventral distance between spermathecal pores about 0.25× body circumference. No genital markings in the spermathecal region.

Male pores located inside copulatory pouches in xviii, each copulatory pouch with a large opening. Distance between the openings of copulatory pouches about 0.25× body circumference ventrally. Genital markings large, paired (rarely single) on setal rings in xix–xxii (Table 5).

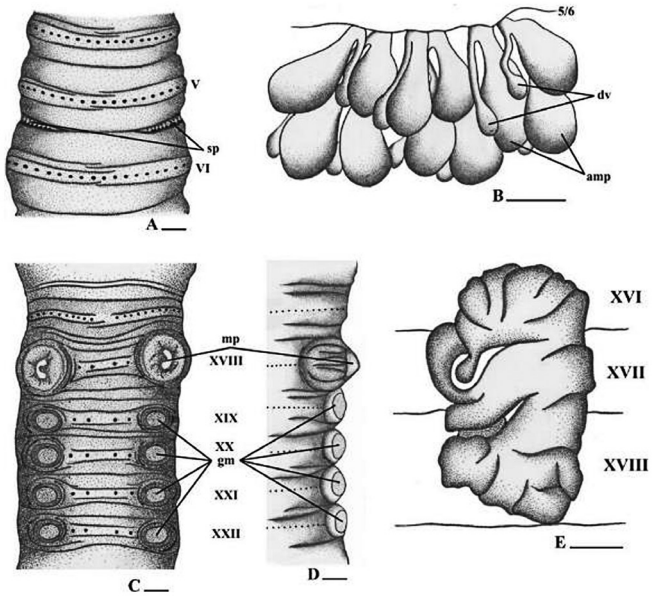

Fig. 6. *Polypheretima phacellotheca* (Michaelsen, 1899). A, Spermathecal pores; B, Spermathecae (amp=ampulla, dv=diverticula); C, Male pore region (mp=opening of copulatory pouchs, gm=genital marking); D, Male pore region, lateral view; E, Prostate gland. Scale bar = 1 mm.

Internal characters. Septa 3/4/5/6/7/8 thick, 8/9/10 absent, 10/11/12/13 thin. Gizzard round after viii. Last hearts in xiii. Typhlosole simple. Intestine beginning from xv; caeca absent. Pharyngeal micronephridia well-developed on 6/7.

Spermathecae small to large, 9–11 in left and right in vi, respectively. Number of spermathecae variable in specimens (Table 5). Ampulla waterdrop-shaped; duct about 1/3–1/5 as long as ampulla. Diverticulum thin, slightly shorter than ampulla, attached to duct at base; distal part expanded to seminal chamber. No accessory glands.

Holandric. Testes sacs paired in x–xi, small, separated, ventral, yellowish. Seminal vesicles in xi–xii. Ovaries paired in xiii and ovisacs developing in xiii. Prostate glands racemose, paired in xvi–xviii. Prostatic ducts C-shaped. No accessory glands.

Habitat and ecology. Specimens were found around banana trees in house yards. They were collected from the ground muddy at a depth of 0–20 cm.

Remarks. The species was previously reported from Mt. Masarang, above Tomohon (Northeast Sulawesi) (Michaelsen, 1899; Easton, 1976). We found this species near a beach at elevation of only 7 m asl in the Ogotumubu village, central part of Sulawesi. With new fresh specimens, the distributional area of the species has been expanded to central Sulawesi.

In addition, Michaelsen (1899) described this species from northeast Sulawesi without illustrations. New illustrations, thus, are provided to support his description.

Polypheretima elongata (Perrier, 1872)
(Fig. 7)

Perichaeta elongata Perrier, 1872: 124
Megascolex elongata Vaillant, 1889: 81
Perichaeta biserialis Perrier, 1875: 1044
Perichaeta acystis Beddard, 1895: 423
Amyntas elongatus Beddard, 1900: 650
Pheretima elongata Michaelsen, 1900: 265
Metapheretima elongata Sims & Easton, 1972: 233; Easton, 1976: 40
(For more synonyms, see Easton, 1976)

Material examined. 4 clitellates (MZB Oli. 0061), the yard, Margapura village (0°31′2.35″N, 120°57′45.15″E), elevation of 5 m asl., Bolano Lambunu sub-district, Parigi Mautong district, Central Sulawesi province, Indonesia, 20–21 January 2017, leg. Fahri and Fitrallisan. 6 clitellates (UNTAD Oli. 0007), same data as for the sample MZB Oli. 0061.

Description. *External characters*. Body generally cylindrical. Prostomium prolobous. First dorsal pore in 12/13. Setae 68–74 in v, 70–86 in vii, 72–88 in viii, 80–92 in xxv, and 8–12 between male porophores in xviii. Clitellum annular, xiv–xvi, smooth without setae and dorsal pores. Female pore single, mid-ventral in xiv.

Spermathecal pores small, lateroventrally two paired in 5/6/7. Male porophores highly elevated, large; male pores located inside copulatory pouches in xviii. Genital markings simple, large, presetal, paired in xix–xxi, rarely xxii.

Internal characters. Septa 3/4/5/6/7/8 thickened, 8/9/10 absent, 10/11/12/13 thin. Gizzard large, round after viii. Last heart in xiii. Intestinal origin at xv; caeca absent. Pharyngeal micronephridia well-developed on septum 7/8. Typhlosole simple.

Spermathecae large, about 1–5 altogether, 1–2 per segment in 5/6 and 1–2 per segment in 6/7 (Table 6). The number of spermathecae variable in specimens (Table 6). Ampulla large and round; duct relatively short, about 1/6 as long as ampulla. Diverticulum simple, much shorter than ampulla, slightly expanded distad, and attached to the base of duct. No accessory glands.

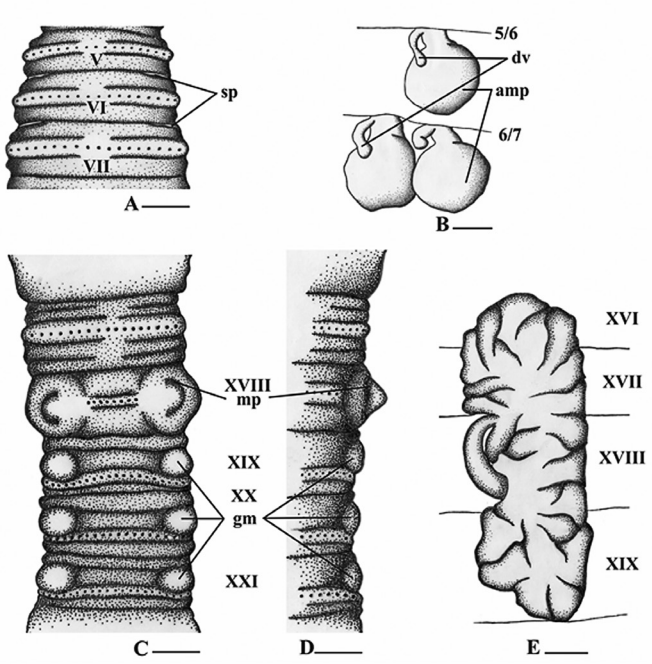

Fig. 7. *Polypheretima elongata* (Michaelsen, 1872). A, Spermathecal pores; B, Spermathecae (amp=ampulla, dv=diverticulum); C, Male pore region, ventral view (mp=opening of copulatory pouchs, gm=genital marking); D, Male pore region, lateral view; E, Prostate gland. Scale bar = 1 mm.

Holandric. Testes sacs paired in x and xi, small, separated, ventral, yellowish. Seminal vesicles in xi–xii. Ovaries paired in xiii, ovisacs in xiii. Prostate glands paired from xvi–xix, racemose. Prostatic ducts C-shaped, bigger distally, ending at xviii. No accessory glands.

Habitat and ecology. Specimens were found in the yard in Margapura village, Bolano Lambunu district at 5 m asl. It was collected from sandy soils near water drainages at depth of 5–20 cm.

Remarks. *Polypheretima elongata* is an exotic species widely distributed in Sulawesi and other regions in Indonesia (Easton, 1976). It is also commonly found in the Indochinese region (Thai, 1983; Nguyen et al., 2016).

Key to species of the genus *Polypheretima* in Sulawesi

1. Spermathecal pores in 5/6/7 2
– Spermathecal pores absent or in 5/6 only 3

2. Spermathecae more than 3 in each battery 4
– Spermathecae less than 3 in each battery; ampulla oval or globose, duct stout and short. Genital markings paired in xix–xxi ..... *P. elongata*
– Spermathecae about 2–5 in each battery; ampulla claviform, duct about 2/3 times as long as ampulla. Genital markings paired in xix–xxii ..... *P. cokelat*, new species

3. Holandric. Spermathecae about 9–12 in each battery. Ampulla water-drop shaped. Genital markings in xix–xxi ..... *P. phacellotheca*
– Metandric. If present, spermathecae about 1–3 altogether. Ampulla large globose. Genital markings in xix–xxiii ..... *P. sahlani*, new species

Table 6. Character comparison among *Polypheretima elongata* species group.

Characters		*P. elongata*	*P. everetti*	*P. kinabaluensis*	*P. phacellotheca*	*P. stelleri*
External	Length	198–278 mm	–	–	210–220 mm	–
	Diameter	4–5mm	–	–	4–7 mm	–
	Segment	134–227	–	–	210–256	–
	Colouration	–	–	–	yellow brownish, clitellum pink.	–
	Prostomium	Prolobous	–	–	Prolobous	–
	Setae in VII	80–130	up tp 130	less than 40	59–76	up tp 130
	Setae between male pores	8–12	–	–	4–8	–
	Clitellum	–	–	–	xiv–xvi	
	Spermathecal pores	5/6/7	5/6/7	5/6/7	5/6	5/6/7
	Shape of spermathecal pores	–	–	–	–	–
	Genital marking	–	–	–	Paired (rarely single) in xix–xxii	–
	The openings of copulatory pouch	–	–	–	Crescentic	–
Internal	Septa 8/9/10	–	–	–	Present	–
	Spermathecae in each battery	Rarely more than 3	6–12	6–12	9–12	Up to 28
	Shape of ampulla				Waterdrop-shaped	–
	Shape of diverticulum				Stalk thin, shorter than ampulla, distal part expanded to seminal chamber, attached to duct at base	–
	Pharyngeal micronephridia	–	–	–	6/7	–

Note: Data obtained from Easton (1979, 1982, 1984), Aspe & James (2015), Aspe & James (2016).

P. mindanaoensis	***P. bukidnonensis***	***P. cokelat***	***P. sahlani***	***P. elongatoides***	***P. kalimpaaensis***
90–118 mm	131 mm	54–185mm	152–195 mm	118–240 mm	124–156 mm
5.1 mm	5–6.5 mm	4.5–6.0 mm	4.5–6.0 mm	4–8 mm	3–5 mm
140–141		169–214	113–281	97–153	150–223
White, clitellum pinkish-grey	Brown dorsum, pale ventrum, equators pigmented	Pinkish brown	Pre-clitellarregion purplish pink, post-clitellarregion purplish brown	Brownish	Purplish pink, andclitellum brownish pink
–	–	Prolobous	Prolobous	Prolobous	Prolobous
41–53	39–45	52–63	78–89	38–56	42–74
10	6–7	8–10	8–10	6–10	8–10
xiv–xvi	xiv–xvi	xiv–xvi	xiv–xvi	xiv–xvi	xiv–xvi
5/6/7	5/6/7	5/6/7	Absent or 5/6	5/6/7	5/6/7
Lacking or inconspicuous	–	Large	Small and inconspicuous	Large	Large
Paired xix–xxv or xxvi	Paired xix–xxi	xix–xxii or xxiii	Paired xix–xxiii or xxiv	Paired xix–xxi or xxii	Paired (rarely single) xix–xx
–	–	Crescentic	Crescentic	Crescentic	Crescentic
Absent	Lacking	Present	Present	Present	Present
0–5	7–11	2–5	1–3	3–9	4–5
Pyriform, duct short and slender	Pyriform, duct short and slender	Claviform, duct relatively long	Large and globose, ducts very short	Irregular, oval, jagged and folded	More or less subcylindrial; duct very short
Stalk long and slender, attached ectally to duct, with one kink, terminating in short, sausage-shaped receptacle	Stalk long and slender, attached ectally to duct, terminating in short, sausage-shaped receptacle	Simple, shorter than ampulla, with a seminal chamber at distal end, attached to the base of ducts	Cylindrical, shorter than ampulla, slightly twisted, with a seminal chamber at distal end, attached to the base of duct	Cylindrical, stalk straight or slightly curved, distal end slightly expanded, much shorter than ampulla, attached to duct at base	Cylindrical, slightly expanded at distal end, much shorter than ampulla, attached to duct at base
–	–	6/7	6/7	6/7	4/5

4. Setae up to 130 in vii.....5
– Setae less than 80 in vii.....6

5. Spermathecae about 6–12 in each battery; ampulla claviform, duct short, not distinct from ampulla. Genital markings paired in xix–xxiii .....*P. everetti*
– Spermathecae up to 28 in each battery. Genital markings paired in xix–xxi.....*P. stelleri*

6. Spermathecae about 3–9 in each battery; ampulla oval-shaped, duct about ½ times as long as ampulla. Setae 38–56 in vii. Genital markings paired in xix–xxi ....*P. elongatoides*, new species
– Spermathecae about 4–5 in each battery; ampulla irregular shaped, more or less cylindrical, duct not distinct from ampulla. Setae 51–74 in vii. Genital markings paired in xix–xx..... ..... *P. kalimpaaensis*, new species

CONCLUSION

A total of eight *Polypheretima* species have been recorded in Sulawesi, Indonesia, namely, *Polypheretima elongata* (Perrier, 1872), *P. everetti* (Beddard & Fedarb, 1895), *P. phacellotheca* (Michaelsen, 1899), *P. stelleri* (Michaelsen, 1891), and four new species, *P. cokelat*, *P. elongatoides*, *P. kalimpaaensis*, and *P. sahlani*. However, the number of species is far from reflecting the rich biodiversity of Sulawesi. More intensive surveys may reveal more new species awaiting discoveries.

ACKNOWLEDGEMENTS

We would like to thank Tri Atmowidi, Bambang Suryobroto (Bogor Agricultural University) and Andi Darmawan (Institut Teknologi Sumatera), Hari Nugruho (Research Center for Biology, Indonesia Institute of Science), for his comments to improve the paper. We would like to thank the head of the Lore Lindu National Park for the collecting permission. We thank M. Syarif Indra Gunawan, Evans Madiono, Nurliana H Laewa, Ardiansyah, Adhi Pranata, Wanda Damayanti, Fitriana, Auni Ade Putri, Fitrallisan and Sahlan for their assistance during fieldworks. Our thanks are also sent to Wahyuni for the excellent illustrations of *P. elongata*. The paper is supported by the Project "Penelitian Kerja Sama Antar Perguruan Tinggi" funded by Ministry of Research, Technology and Higher Education Indonesia.

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