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New species of *Pheretima*, *Amynthas*, *Polypheretima*, and *Pithemera* (Clitellata: Megascolecidae) from Mindanao and Associated Islands, Philippines

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Nonillon M. Aspe and Samuel W. James (2016) Studies over the past decade have shown the Philippine native earthworm fauna to be highly diverse, with apparent high endemism among islands and localities. Here we describe 17 new species of pheretimoid earthworms collected from priority conservation sites on Mindanao and associated islands. Nine species of the subgenus *Pheretima* (*Pheretima*), distinguished by the absence of secretory diverticula on the coelomic surface of the copulatory bursae, were detected. *Pheretima acia* n. sp., *P. dinagatensis* n. sp., *P. enormis* n. sp., *P. hamiguitanensis* n. sp., *P. lantapanensis* n. sp. belong to the *P. urceolata* species group, with a pair of spermathecal pores in 5/6; *P. timpoongensis* n. sp., *P. camiguinensis* n. sp., *P. sibucalensis* n. sp., and *P. apoensis* n. sp. belong to the *P. sangirensis* group, with a pair of spermathecal pores in 7/8. *Pheretima* (*Parapheretima*) *pandanensis* n. sp. and *P.* (*Parapheretima*) *boaensis* n. sp., members of the subgenus *Pheretima* (*Parapheretima*), with secretory diverticula on the coelomic surface of the copulatory bursae, are the first Philippine records of *Parapheretima*. In the genus *Amynthas*, *A. dinagatensis* n. sp. is athecate; *A. cagdianaoensis* n. sp. belongs to the belongs to the *A. supuensis* species group, with a pair of spermathecal pores at 8/9; and *A. talaandigensis* n. sp. belongs to *A. rimosus* group, with intrasegmental spermathecae in 6, 7, 8, and 9. In the genus *Polypheretima*, *P. bukidnonensis* n. sp. belongs to the *Po. elongata* species group, with paired genital markings on xix and successive segments, and paired spermathecal batteries in vi and/or vii; *Po. zamboangensis* n. sp., either has spermathecal pores in 5/6/7 or lacks them, and has a metandric male sexual system. *Pithemera nolani* n. sp. is unique among congeners in having only one pair of spermathecal pores in 5/6 and in having copulatory bursae. The geological history of Mindanao, which is a collision complex between three arc systems, may have contributed to the high diversity of the earthworm fauna on Mindanao. Future molecular studies can help elucidate the evolutionary relationships and geographical distribution of species and populations, and shed light on mechanisms of earthworm diversification in the Philippines.

Key words: *Pheretima*, *Amynthas*, *Polypheretima*, *Pithemera*, New species, Oligochaeta, Mindanao, Philippines.

BACKGROUND

Mindanao is the southernmost major island group in the Philippines, consisting of Mindanao Island and small surrounding islands. It is surrounded by four seas: the Sulu Sea to the west, the Philippine Sea to the east, the Celebes Sea to the south, and the Mindanao Sea to the north. With a land area of 104,630 km^2, Mindanao is the second largest island in the Philippines next to Luzon. The island is mountainous, and is home to Mount Apo, the highest mountain in the country. Mindanao initially consisted of separate islands, but these merged in the Miocene due to closing of the Eurasian and Australian plates, which affected minor plates in between (Hall 1996). Partly due its

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complex geological history, Mindanao has very high species diversity (Heaney and Rabor 1982; Heaney et al. 2006; Heaney and Tabaranza 2006; Welton et al. 2010; James 2004; Aspe and James 2014). However, as in other parts of the Philippines, the biodiversity on Mindanao is under severe threat due to habitat alteration, overexploitation of natural resource, urban development, and increasing human population. Specific threats include mining and logging operations, and land conversion for industry, agriculture, and urban development. Overall, less than six percent of the original forest of the Philippines now remains, and 491 species of animals are listed as globally threatened on the 2004 IUCN Red List of Threatened Species (CI et al. 2006). Adequate knowledge of the natural resources is crucial to enacting effective laws and designing conservation management strategies.

Prior to 2004, knowledge on Philippine earthworms was very limited. Taxonomic studies over the past decade, however, have resulted in the identification of around 200 species of native earthworms representing eight genera in the Philippines (James 2004, 2005a, 2006, 2009; James et al. 2004; Hong and James 2004, 2008a-c, 2009a, 2010, 2011a, b; Aspe and James 2014, 2015). These indicate high diversity and high local endemicity of earthworms in the Philippines. Most of the Philippine earthworm species detected in the last decade described were from Luzon and associated islands, with only around 20% from Mindanao, where James (2004) described 18 species from Mt. Kitanglad, and Aspe and James (2014, 2015) described 22 species from Mt. Malindang. In this study, we describe 17 new earthworm species in the genera *Pheretima* (*Pheretima*), *Pheretima* (*Parapheretima*), *Amynthas*, *Polypheretima*, and *Pithemera*, from various localities on Mindanao, Camiguin, and Dinagat Islands.

MATERIALS AND METHODS

Collecting localities

Collection sites were chosen based primarily on the Key Conservation Sites identified by the Haribon Foundation (Mallari et al. 2001). These sites roughly correspond to those identified as Priority Sites for Conservation in the Philippines, which are actually or potentially managed for conservation (CI et al. 2006). Collection was conducted intermittently from December 2003 to December 2012. The collection sites (Fig. 1) include Mt. Timpoong on Camiguin Island, approximately 10 km north of the Misamis Peninsula (11-15 October 2004); Cagdianao Municipality on Dinagat Island northeast of Mindanao (23-26 April 2004); the Mt. Kitanglad Range and Mt. Musuan in Bukidnon Province in central Mindanao (26-31 October 2012); the Mt. Apo National Park; the Mt. Hamiguitan Range Wildlife Sanctuary in Davao Occidental Province in southeastern Mindanao (7-10 May 2006); the Mt. Malindang Range in Misamis Occidental Province at the base of the Zamboanga Peninsula (18-23 February 2004); and the Mt. Timolan Protected Landscape in Zamboanga del Sur Province (18-20 December 2012). Since most of the collection sites are in areas protected by the Protected Areas and Wildlife Bureau (PAWB) of the Department of Environment and Natural Resources (DENR), Prior Informed Consent certificates were secured from the Protected Area Management Board for these sites before collecting was conducted.

Sampling

Collecting was done from soil in primary and secondary forests at the high elevations away from human settlements or trails to increase the likelihood that the earthworms collected are native species. Other habitats including tree bark, ferns, mosses, and the insides of rotten logs were also checked for earthworms. Upon collection, earthworms were rinsed in tap water, killed in 10% ethanol, and placed in Saranex sealable plastic bags filled with a volume of 10% formalin that was at least three times the total volume of the earthworms. After two days, the formalin was replaced with 80% ethanol. Elevations were read by GPS (Magellan Map 410; Luzon map datum) if a satellite signal was detectable, or with an altimeter if not. Elevation is expressed in this paper as meters above sea level (m asl).

Examination and descriptions

Worms were sorted in the field to putative species, using body size, coloration, and number and location of spermathecal pores as identifying characters. External and internal characters were examined later in the laboratory for a representative subset of specimens of each species. All descriptions are based on external examination and on dorsal dissection under a stereomicroscope, following the terminology and

conventions of Easton (1979). Descriptions of body color are based on living specimens. Body dimensions refer to fixed material. The degree of separation between pores is expressed as a proportion of the circumference of the worm; for example, 'spermathecal pores 0.21 circumference apart ventrally' means the distance between the pores is 0.21 the circumference of the worm at that point, with the circumference calculated as π times segment diameter. The generic diagnoses and assignment to species groups follow Sims and Easton (1972). While the species described share many character states diagnostic for the genus, we include shared characters to facilitate information retrieval from the separate descriptions. For convenience in species comparison, we initially compared the new species with the other members of the same species group by their sizes and by the spermathecal pores spacing and the male pores spacing. However, we made sure that the combinations of all the morphological characters were used to examine and compare all the members of the species group. Line drawings were prepared with Adobe Illustrator ver. CS5. Holotypes and paratypes are deposited in the National Museum of the Philippines Annelid Collection (NMA), P. Burgos St., Manila, Philippines. Other paratypes are deposited in the Annelid Collection of the Zoological Reference Collection (ZRC. ANN) of the Lee Kong Chian Natural History Museum (formerly Raffles Museum of Biodiversity Research), Faculty of Science, National University of Singapore, Singapore.

RESULTS

We detected 17 new earthworm species on Mindanao and associated islands. Table 1 lists the species found, and the total number of species currently known, at each site. Nine of the 17 new species belong to the subgenus *Pheretima* (*Pheretima*) Kinberg 1867, which differs from the other subgenus, *Pheretima* (*Parapheretima*) Cognetti 1912, in lacking secretory diverticula on the coelomic surface of the copulatory bursae. Among the new *Pheretima* species, five (*P. acia*, *P. dinagatensis*, *P. enormis*, *P. hamiguitanensis*,

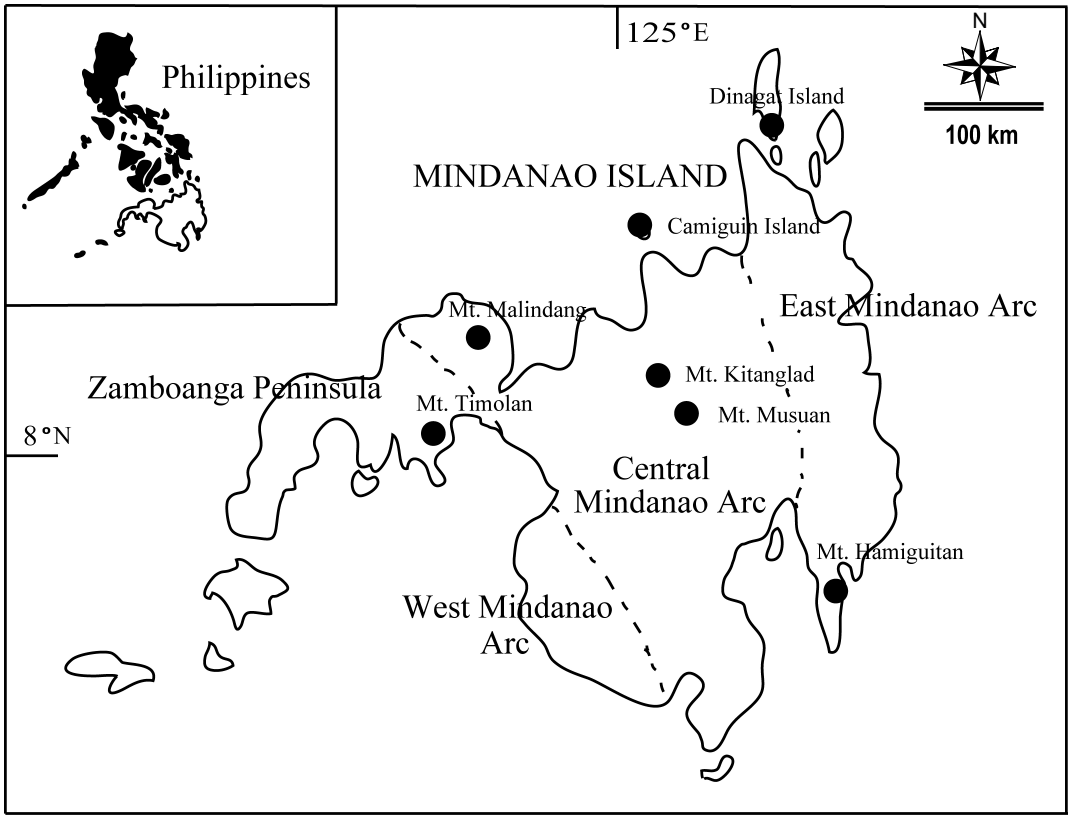

Fig. 1. Map of Mindanao and associated islands. Black circles indicate collecting sites; dashed lines indicate the boundaries among three arc systems and the Zamboanga Peninsula, which coalesced between the Early Miocene and late Pliocene (20-1 Ma).

and *P. lantapanensis*) belong to the *P. urceolata* group of Sims and Easton (1972), characterized by having a pair of spermathecal pores on intersegments 5/6; three (*P. timpoongensis*, *P. camiguinensis*, *P. sibucalensis* and *P. apoensis*) belong to the *P. sangirensis* group of Sims and Easton (1972), characterized by having a pair of spermathecal pores on intersegments 7/8. Two new species, *P.* (*Parapheretima*) *pandanensis* and *P.* (*Paraph.*) *boaensis*, are members of the subgenus *Pheretima* (*Parapheretima*), characterized by having secretory diverticula on the coelomic surface of the copulatory bursae. Three new species are in *Amynthas*, characterized by lacking nephridia on the spermathecal ducts and lacking copulatory bursae. These include *A. dinagatensis*, which is athecate; *A. cagdianaoensis*, which belongs to the *A. supuensis* group of Sims and Easton (1972), characterized by having a pair of spermathecal pores at 8/9; and *A. talaandigensis*, which belongs to the *A. rimosus* group of Sims and Easton (1972), characterized by having intrasegmental spermathecae in 6, 7, 8, and 9. Two species are in *Polypheretima*: *Po. bukidnonensis* n. sp., which belongs to the *Po. elongata* group, has a pair of genital markings in xix, successive segments in line with the male pores, and paired batteries of up to 28 spermathecae in vi and/or vii; *Po. zamboangensis* either has spermathecal pores at intersegments 5/6/7 or lacks spermathecal pores, has 220+ segments, and has a proandric male sexual system. Finally, one new species is in *Pithemera*. *Pithemera nolani* is unique among congeners in having only a pair of spermathecal pores in 5/6 and in possessing copulatory bursae, and it is by far the largest species of *Pithemera* in the Philippines.

TAXONOMY

Family Megascolecidae Rosa 1891
Genus *Pheretima* Kinberg 1867
Subgenus *Pheretima* Kinberg 1867
Type species. *Pheretima montana* Kinberg 1867

Generic diagnosis

Body circular in cross section, with numerous setae regularly arranged equatorially around each segment; setae absent on first and last segments. Male pores paired within copulatory bursae opening on segment xviii; one or more pairs of spermathecal pores in intersegmental furrows between 4/5 and 8/9. Clitellum annular, covering three segments (xiv to xvi). Single midventral female pore on xiv. Genital markings usually

Table 1. The list of new species collected in each site

Locality	Current total no. of earthworm species	New species
Mt. Timpoong, Camiguin Island	3	*Pheretima* (*Pheretima*) *timpoongensis* n. sp.
		Pheretima (*Pheretima*) *camiguinensis* n. sp.
		Pheretima (*Parapheretima*) *pandanensis* n. sp.
Cagdianao, Dinagat Island	5	*Pheretima* (*Pheretima*) *acia* n. sp.
		Pheretima (*Pheretima*) *dinagatensis* n. sp.
		Pheretima (*Parapheretima*) *boaensis* n. sp.
		Amynthas dinagatensis n. sp.
		Amynthas cagdianaoensis n. sp.
Mt. Kitanglad Range, Bukidnon	21	*Pheretima* (*Pheretima*) *lantapanensis* n. sp.
		Amynthas talaandigensis n. sp.
		Pheretima (*Pheretima*) *apoensis* n. sp.*
Mt. Apo	2	*Pheretima* (*Pheretima*) *apoensis* n. sp.*
		Pheretima (*Pheretima*) *hamigitanensis* n. sp.*
Mt. Musuan, Bukidnon	2	*Pheretima* (*Pheretima*) *apoensis* n. sp.*
		Polypheretima bukidnonensis n. sp.
Mt. Hamiguitan Range, Davao Occidental	3	*Pheretima* (*Pheretima*) *enormis* n. sp.
		Pheretima (*Pheretima*) *hamigitanensis* n. sp.*
		Pithemera nolani n. sp.
Mt. Malindang Range, Misamis Occidental	23	*Pheretima* (*Pheretima*) *sibucalensis* n. sp.
Mt. Timolan, Zamboanga del Sur	1	*Polypheretima zamboangensis* n. sp.

*indicates that the species is found in more than one locality.

absent. Internally, esophageal gizzard usually originating in viii; a pair of caeca originating in xxvii, extending forward. Ovaries and funnels free in xiii. Male sexual system holandric, with paired testes and funnels enclosed in sacs in x and xi, and seminal vesicles in xi and xii. Spermathecae one pair, multiple pairs, sometimes single and located midventrally, or sometimes lacking. Nephridia present on spermathecal duct(s). One pair of prostate glands, racemose. Copulatory bursae present; secretory diverticula lacking on coelomic surface of copulatory bursae.

***Pheretima acia* n. sp.**

(Fig. 2A, Table 2)
urn:lsid:zoobank.org:act:9C182FE8-4413-4598-AFAF-C8A746D1AA28

Material examined: Holotype: preclitellate (NMA 4585), Brgy (Barangay) Boa, municipality of Cagdianao, Dinagat Province, (10°05'53"N, 125°39'42"E), 250 m asl, Dinagat Island, Philippines, coll. N. Aspe, J. Adeva, 23-26 Apr. 2004. Paratypes: two adults (NMA 4601), same collection data as for holotype.

Etymology: The species name is from the Latin *acia* (thread, yarn), referring to the small, thread-like body.

Diagnosis: Very small, brown worm with thread-like body; adult length 38-47 mm, diameter 1-1.2 mm; pigmented segmental equator; pair of spermathecal pores at intersegment 5/6; prostates small in xvii to xviii; penes present.

Description: Brown, equators pigmented. Length 33-47 mm (*n* = 3 adults); diameter 1.2 mm at x, 1 mm at xx; body circular in cross-section, tail tapering; 87-94 segments. First dorsal pore at 12/13, paired spermathecal pores at 5/6, spermathecal pores 0.8 mm (0.21 circumference apart ventrally). Female pore single in xiv, openings of copulatory bursae paired in xviii, distance between openings 0.8 mm (0.24 circumference apart ventrally), 3 setae between openings. Clitellum annular, from xiv to xvi. Setae unevenly distributed around equators in some segments; 26-35 setae on vii, 29-38 setae on xx, dorsal and ventral setal gaps lacking. Genital markings lacking.

Septa 4/5-7/8 and 10/11-13/14 thin, 8/9/10 lacking. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia in intestinal segments located mainly on body near septum/body wall junction. Large gizzard in viii-x, esophagus with low vertical lamellae x-xiii, intestinal origin in xv; caeca simple, originating in xxvii, extending forward to xxvi; typhlosole originating in xxvi, simple fold, 1/3 lumen diameter; intestinal wall with 38 longitudinal blood vessels. Hearts in x to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; those in viii extend to gizzard.

Ovaries and funnels free in xiii. Spermathecae paired, postseptal in vi, with nephridia on ducts. Each spermatheca with ovate ampulla; slender, bulbous, muscular duct; single stalked diverticulum attached to the ental portion of the right face of duct of right spermatheca, and on left face of duct of left spermatheca; stalk short, terminating in ovate to sausage-shaped receptacle. Male sexual system holandric; testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii, each with digitate dorsal lobe**;** vesicles of xi enclosed in testes sac; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; prostates small, in xvii to xviii; each prostate a single, dense, racemose mass; short muscular duct entering anterior margin of copulatory bursa. Copulatory bursae round, in xvii-xix; coelomic surfaces muscular, secretory diverticula lacking; roof with thick pad, floor with thin pad; short conical penis present.

Remarks: *Pheretima acia* n. sp. belongs to the *P. urceolata* species group of Sims and Easton (1972), characterized by having spermathecal pores opening only on intersegment 5/6. Sims and Easton (1972) assigned *P. urceolata* Horst 1893 and *P. baweanensis* Michaelsen 1928 to this species group, but Gates (1961) synonymized these two species. Currently, there are 20 species members of the *urceolata* group, including the new species described here. *Pheretima acia* differs markedly from any member of the *P. urceolata* group and from the rest of the congeners in having a very small, thread-like body. Other relatively short members of *P. urceolata* group have body diameters two to three times that of *P. acia*: *P. dinagatensis* n. sp. (65 mm × 2.5-3 mm), *P. lantapanensis* n. sp. (> 58 mm × 2.5-3 mm), *P. abiadai* Hong and James 2008c (33-60 mm × 2.2-3 mm), *P. nagaensis* Hong and James 2008c (36-53 mm × 2.5-3 mm), *P. viracensis* Hong and James 2009a (38-61 mm × 2-2.6 mm), and *P. doriae* Hong and James 2009a (34-45 mm × 2-2.4 mm). Like *Pheretima acia*, all these species except *P. lantapanensis* have penes, but the spermathecal pores in *P. acia* are more closely spaced (0.21 circumference) than those of *P. dinagatensis* (0.31), *P. abiadai* (0.25), *P. nagaensis* (0.29), *P. viracensis* 0.32-0.36) and *P. doriae*

(0.32). The male pores in *P. acia* are closer (0.24) than those in *P. doriae* (0.32) and more widely spaced compared to that of *P. abiadai* (0.18-0.2). *Pheretima acia* has small prostates, which only extends in two segments (xvii-xviii) while the other species have relatively bigger prostates, covering three to five segments (xv-xix). Although *P. lantapanensis* also has prostates that extends in two segments, they are in xvi-xvii. In addition, the caeca in *P. acia* are very short, covering only two segments extending only from xxvii-xxvi, whereas the other species have caeca that are longer, extend from xxvii-xxv or -xxiv or -xxiii (Table 2). No other species in the *P. urceolata* group closely resemble *P. acia*.

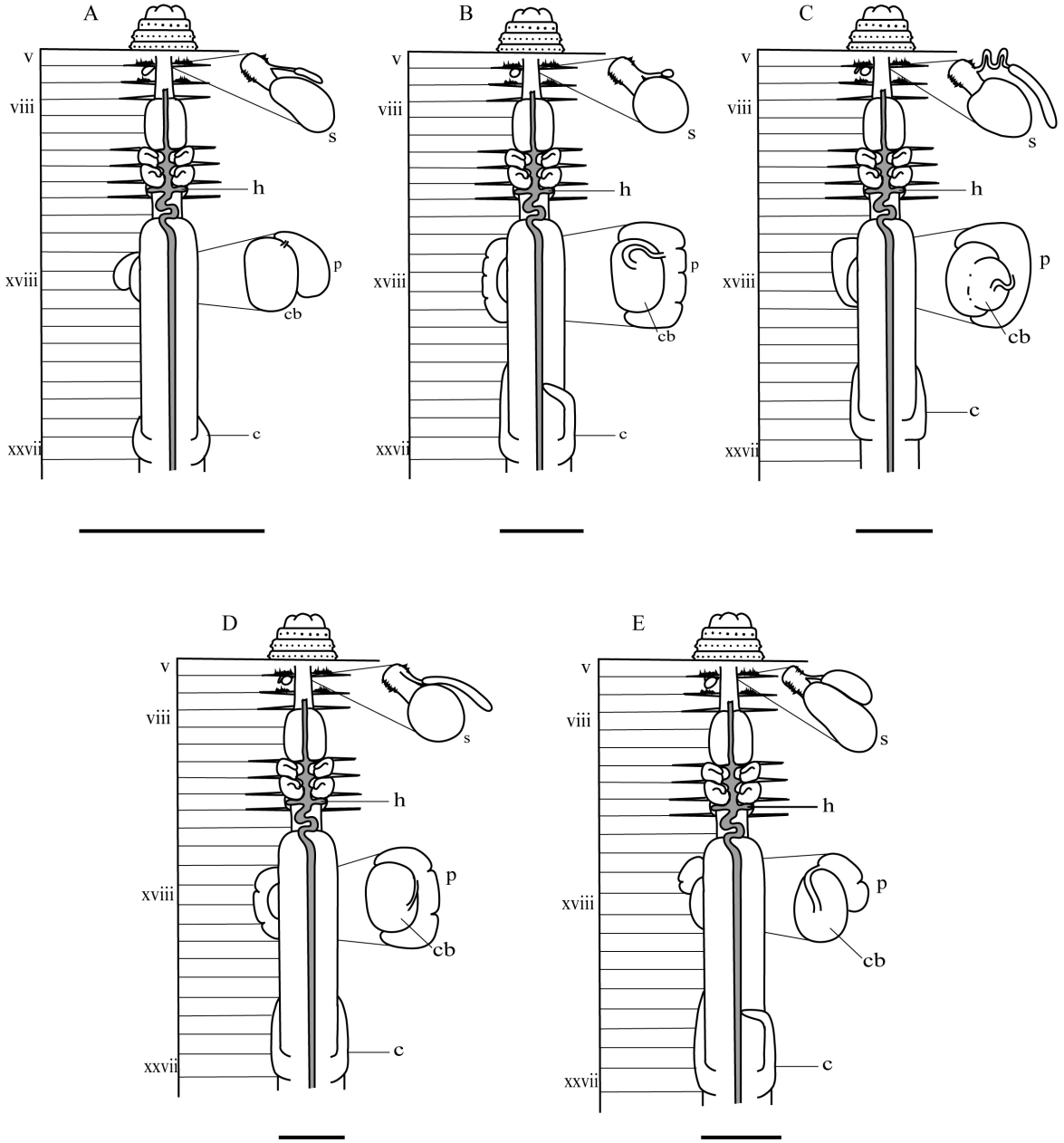

Fig. 2. Schematic dorsal views of the internal morphology of the *Pheretima urceolata* group species described here. (A) *P. acia* n. sp.; (B) *P. dinagatensis* n. sp.; (C) *P. enormis* n. sp.; (D) *P. hamiguitanensis* n. sp., with the intestinal origin in xv and prostates in xvii-xx; (E) *P. lantapanensis* n. sp. Abbreviations: s, spermatheca; h, heart; p, prostate gland; cb, copulatory bursa; c, caecum. Scale bars: A, B, D, E, 5 mm; C, 15 mm.

***Pheretima dinagatensis* n. sp.**
(Fig. 2B, Table 2)
urn:lsid:zoobank.org:act:1ABBFFA9-4720-444B-919F-C0260B43F486

Material examined: Holotype: adult (NMA 4586), Brgy Boa, municipality of Cagdianao, Dinagat Province, (10°05'53"N, 125°39'42"E), 250 m asl, Dinagat Island, Philippines, coll. N. Aspe, J. Adeva, 23-26 Apr. 2004. Paratypes: two adults, amputee (NMA 4602); three adults, amputee (ZRC.ANN 0055), same collection data as for holotype.

Etymology: The species is named after Dinagat Island.

Diagnosis: Worm with adult length of 65 mm; reddish brown dorsal stripes at intersegmental furrows, ventrum pale; pair of spermathecal pores at intersegment 5/6; first dorsal pore 11/12; spermathecal pore distance 0.31 circumference apart ventrally; setae between male pores numerous, 12-14; penes present.

Description: Reddish brown dorsal stripes at intersegmental furrows, pale ventrum, equators

Table 2. Comparison of species in the *Pheretima urceolata* group

Characters	*P. urceolata* Horst, 1893*	*P. acia* n. sp.	*P. dinagatensis* n. sp.
Length	70-80	33-47	65
Width x, xx	4, 4	1.2, 1	2.5, 3
Dorsal pigmentation	?	brown	Reddish brown stripes
Segment equator	?	pigmented	unpigmented
Segments	92-104	87-94	127
1st dorsal pore	12/13	12/13	11/12
Setal gaps D, V	+, -	-, -	-, -
Sperm. pore distance	0.45	0.21	0.31
Male pore distance	0.1	0.24	0.24
Setae between openings	?	3	12-14
Setae vii, xx	20, 42	26-35, 29-38	39, 43-48
Gizzard	viii-?	viii-x	viii-x
Intestinal origin	xvi	xv	xiv/xv
Caeca	xxvii-xxiii/xxi	xxvii-xxvi	xxvii-xxiii
Prostate	xvii-xviii or xviii	xvii-xviii	xv/xvi-xix
Copulatory bursae	?	xvii-xix	xvii-xix
Penes	+	+	+

Characters	*P. enormis* n. sp.	*P. hamiguitanensis* n. sp.	*P. lantapanensis* n. sp.
Length	305-347	81-90	> 58
Width x, xx	13.5-15.5, 13-16.5	3-3.5, 3.5-4	2.5, 3
Dorsal pigmentation	Purplish brown	brown	brown
Segment equator	unpigmented	unpigmented	pigmented
Segments	110-147	108-111	?
1st dorsal pore	13/14	12/13	11/12
Setal gaps D, V	+, -	+, -	+, -
Sperm. pore distance	0.17	0.07	0.38
Male pore distance	0.14	0.12	0.23
Setae between openings	7	2	8
Setae vii, xx	45-46, 75-80	38-42, 44-47	30-39, 31-36
Gizzard	viii-x	viii-x	viii-x
Intestinal origin	xv	xv/ xvii	xv
Caeca	xxvi-xxiii	xxvii-xxiv	xxvii-xxiii
Prostate	xvi-xix	xvii-xx/ xv-xix	xvi-xvii
Copulatory bursae	xvii-xix	xvii-xix	xvii-xix
Penes	+	-	-

*based from type examined by Gates (1961).

non-pigmented. Length 65 mm (*n* = 1 adult); diameter 2.5 mm at x, 3 mm at xx; body circular in cross-section, tail tapering; 127 segments. First dorsal pore 11/12, paired spermathecal pores at 5/6, positioned on the lateral margins, distance between spermathecal pores 2.4 mm (0.31 circumference apart ventrally). Female pore single in xiv, openings of copulatory bursae paired in xviii, distance between openings 2.3 mm (0.24 circumference apart ventrally), 12-14 setae between openings. Clitellum annular, from xiv to xvi. Setae irregularly distributed around equator of some segments; 39 setae on vii, 43-48 setae on xx, dorsal and ventral setal gaps lacking. Genital markings lacking.

Septa 4/5-7/8 and 10/11-13/14 membranous, 8/9/10 lacking. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia in intestinal segments located mainly on body near septum/body wall junction. Large gizzard in viii-x, esophagus with low vertical lamellae x-xiii, intestinal origin in xiv or xv; caeca simple, originating in xxvii, extending forward to xxiii, may be folded up or tucked under intestine in xxv or xxiv; typhlosole originating in xxvi, simple fold, 1/3 lumen diameter, intestinal wall with 31-33 longitudinal blood vessels. Hearts in x to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; those in viii extend to gizzard.

Ovaries and funnels free in xiii. Spermathecae paired, postseptal in vi, with nephridia on ducts; each spermatheca with round ampulla and slender, bulbous, muscular duct; single stalked diverticulum attached to the ental portion of right face of duct of right spermatheca, and on left face of duct of left spermatheca; stalks short, terminating in small, round to oval receptacle. Male sexual system holandric; testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii, each with digitate dorsal lobe; vesicles of xi enclosed in testes sac; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; prostates in xv or xvi to xx; each prostate a single, dense, racemose mass with four lobes; muscular duct entering center of copulatory bursa, forming a coil. Copulatory bursae round in xvii-xix; coelomic surfaces muscular, secretory diverticula lacking; roof with two thick pads, floor pads lacking; short conical penis present.

Remarks: *Pheretima dinagatensis* belongs to *P. urceolata* group of Sims and Easton (1972). Members of *P. urceolata* group with body dimensions similar to *P. dinagatensis* n. sp. include *P. lantapanensis* n. sp., *P. abiadai*, *P. nagaensis*, *P. viracensis,* and *P. doriae* but the former differs from the latter four in having dorsal stripes. *Pheretima dinagatensis* is also similar to *P. lantapanensis* n. sp. in the location of the first dorsal pore but differs from the latter in having more setae between the male pores and more setae in the post-clitellar area (8 and 31-36, respectively in *P. lantapanensis*), and in having penes. *Pheretima dinagatensis* has more body segments (127) and has more setae between the male pores (12-14) than *P. abiadai* (74-78 segments and 6-9 setae, respectively), *P. nagaensis* (57-76 and 7-10, respectively) *P. viracensis* (83-96 and 7-10, respectively), and *P. doriae* (77-86 and 5-8, respectively). The first dorsal pore in *P. dinagatensis* is on 11/12 in *P. dinagatensis* but on 12/13 in *P. abiadai* and *P. nagaensis*. Like *P. abiadai*, *P. nagaensis*, *P. viracensis* and *P. doriae*, the spermathecal ampulla is round, however, the spermathecal duct is slender whereas in others it is short. In addition, *P. dinagatensis* has longer caeca (xxvii-xxiii) compared to that of *P. abiadai*, *P. nagaensis*, *P. viracensis* and *P. doriae*, which extend from xxvii-xxiv or -xxv. No other species in the *P. urceolata* group closely resemble *P. dinagatensis*.

***Pheretima enormis* n. sp.**

(Fig. 2C, Table 2)

urn:lsid:zoobank.org:act:F80F164F-2EFA-47E8-BA33-DC811AD8CBC8

Material examined: Holotype: adult (NMA 4587), municipality of San Isidro, Davao Occidental Province, Mt. Hamiguitan (06°44'03"N, 126°12'15"E), 1430 m asl, Mindanao Island, Philippines, coll. Nolan Aspe, J. Cantil, 7-10 May 2006. Paratypes: one adult (NMA 4603); two adults, amputee (ZRC.ANN 0056), same collection data as for holotype.

Etymology: The species name is from the Latin ‘enormis’ (huge, enormous), referring to the large body size.

Diagnosis: Very large worm with adult dimension 305-347 mm × 13.5-16.5 mm; purplish brown dorsum, ventrum pale; equators non-pigmented, making the body appear striped; pair of spermathecal pores at intersegment 5/6; first dorsal pore in 13/14; setae in vii 45-46, setae in xx 75-80; 7 setae between male pores; penis lacking.

Description: Purplish brown dorsum, lighter ventrum; equators non-pigmented, making the body appear striped. Length 305-347 mm (*n* = 2 adults); diameter 13.5-15.5 mm at x, 13-16.5 mm at xx; body cylindrical in cross-section, tail

tapering; 110-147 segments. First dorsal pore at 13/14; paired spermathecal pores at 5/6, distance between spermathecal pores 8.5 mm (0.17 circumference ventrally apart). Female pore single in xiv; openings of copulatory bursae paired in xviii, distance between openings 7.5 mm (0.14 circumference apart ventrally), 7 setae between openings. Clitellum annular, from xiv to xvi. Setae irregularly distributed around equators in some segments; 45-46 setae on vii, 75-80 setae on xx, dorsal setal gaps present, no ventral gaps. Genital markings lacking.

Septa 4/5-7/8 and 10/11-13/14 muscular, 8/9/10 lacking. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia of intestinal segments located mainly on body near septum/body wall junction. Large gizzard in viii-x, esophagus with low vertical lamellae x-xiii, intestinal origin in xv; caeca simple, originating in xxvi, extending forward to xxiii; typhlosole originating in xxvii, simple fold, 1/3 lumen diameter; intestinal wall with 38 longitudinal blood vessels. Hearts in x to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; those in viii extend to gizzard.

Ovaries and funnels free in xiii. Spermathecae paired, postseptal in vi, with nephridia on ducts; each spermatheca with round to ovate ampulla and bulbous, muscular duct; stalked diverticulum attached to the right face of duct of right spermatheca, and on left face of duct of left spermatheca; stalks long, convoluted, with two kinks, terminating in long, sausage-shaped receptacle, receptacle longer than the ampulla. Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii, each with digitate dorsal lobe; vesicles of xi enclosed in testes sac; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; prostates in xvi to xix; each prostate a single, dense, racemose mass; short muscular duct from lateral margin of prostate entering center of copulatory bursa. Copulatory bursae ovate in xvii-xix, with bulge in center forming a dome; coelomic surfaces muscular, secretory diverticula lacking; roof with two pads, floor pad lacking; blocky penis present.

Remarks: *Pheretima enormis* n. sp. belongs to *P. urceolata* group of Sims and Easton (1972). While most members of *P. urceolata* group have body dimensions within 33-116 mm × 1.2-5.4 mm, *P. enormis* has an adult body size of 305-347 mm × 13-16.5 mm. Other *Pheretima* species with large body size include *P. maculodorsalis* Aspe and James 2014 (226-235 mm); *P. tigris* Aspe and James 2014 (230-283); *P. immanis* Aspe and James 2014 (365 mm); *P. lago* Aspe and James 2014 (223-315 mm); *P. virgata* James 2004 (290 mm); *P. ceramensis* Cognettti 1922 (140-440 mm); *P. barligensis* Hong and James 2011b (225-255 mm); *P. callosa* Gates 1937 (330); and a large earthworm that Blakemore et. al. (2007) identified as *P. darnleiensis* Fletcher 1887 (700 mm). *Pheretima enormis* differs from these species in having one pair of spermathecal pores on 5/6, whereas the others have one pair on 7/8 (*P. maculodorsalis*, *P. tigris*, *P. immanis*, *P. lago*, *P. virgata*, and *P. ceramensis*), four pairs on 5/6-8/9 (*P. barligensis* and *P. darnleiensis*), or three pairs on 6/7-8/9 (*P. callosa*). In addition, *P. enormis* has the first dorsal pore at 13/14 (12/13 in the other species), has more setae (7) between male pores (2-4 in *P. maculodorsalis*, 0-4 in *P. tigris*, 4 in *P. virgata*, 5 in *P. immanis*, and 0-2 in *P. lago*), and has a different pigmentation pattern than the other species (the dorsal intersegmental furrows have red oval dots in *P. maculodorsalis*, stripes in *P. tigris* and *P. virgata*, and very thick stripes in *P. immanis*).

***Pheretima hamiguitanensis* n. sp.**

(Fig. 2D, Table 2)

urn:lsid:zoobank.org:act:37C39A3E-70FC-4075-892E-80398EC781DF

Material examined: Holotype: adult (NMA 4588), municipality of San Isidro, Davao Occidental Province, Mt. Hamiguitan (06°44'03"N, 126°12'15"E), 1430 m asl, Mindanao Island, Philippines, coll. Nolan Aspe, J. Cantil, 7-10 May 2006. Paratypes: three adults (NMA 4604), two adults, same collection data as for holotype, one adult, Brgy Baracatan, Davao City, Mt. Apo National Park (7°00'04"N, 125°21'55"E), 1524 m asl, Mindanao Island, Philippines, coll. N. Aspe, A. Solis, Dec. 11-14, 2003.

Etymology: The species is named for Mt. Hamiguitan, the type locality.

Diagnosis: Worm with adult length 81-90 mm; dorsum brown, ventrum pale, equators non-pigmented; pair of spermathecal pores at intersegments 5/6; setae in vii 38-42; spermathecae with ovate ampulla, spermathecal diverticulum terminating in elongate receptacle that is longer than the ampulla; penis lacking.

Description: Brown dorsum, lighter ventrum, equators non-pigmented, making the body appear striped. Length 81-90 mm (n = 2 adults); diameter

3-3.5 mm at x, 3.5-4 mm at xx; body round in cross-section, tail tapering; 108-111 segments. First dorsal pore at 12/13, paired spermathecal pores at 5/6, distance between spermathecal pores 0.7 mm (0.07 circumference apart ventrally). Female pore single in xiv; openings of copulatory bursae paired in xviii, distance between openings 1.3 mm (0.12 circumference apart ventrally), 2 setae between openings. Clitellum annular, from xiv to xvi. Setae irregularly distributed around equators in some segments, 38-42 setae on vii, 44-47 setae on xx; dorsal setal gaps present, no ventral gaps. Genital markings lacking.

Septa 4/5-7/8 membranous, 10/11-13/14 muscular, 8/9/10 lacking. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia in intestinal segments located mainly on body near septum/body wall junction. Large gizzard in viii-x, esophagus with low vertical lamellae x-xiii, intestinal origin in xv or xvii; caeca simple originating in xxvii, extending forward to xxiv; typhlosole and longitudinal blood vessels not observed due to damage. Hearts in x to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; those in viii extend to gizzard.

Ovaries and funnels free in xiii. Spermathecae paired, postseptal in vi, with nephridia on ducts; each spermatheca with ovate ampulla, bulbous, muscular duct, and stalked diverticulum; diverticulum attached to ectal portion of right face of duct near ampulla of right spermatheca, and on left face of duct of left spermatheca; stalks short, terminating in elongate receptacle, receptacle longer than ampulla. Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii, each with digitate dorsal lobe**;** vesicles of xi enclosed in testes sac; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; prostates variably in xvii to xx, or xv to xix; each prostate a dense, racemose mass, with three lobes; muscular duct from anterior margin of prostate entering to lateral margin of copulatory bursa. Copulatory bursae ovate in xviii-xix; coelomic surface muscular, secretory diverticula lacking; roof with thick pad, floor pad lacking; penis lacking.

Remarks: *Pheretima hamiguitanensis* n. sp. belongs to the *P. urceolata* group of Sims and Easton (1972). Members of *P. urceolata* group with body dimensions relatively similar to *P. hamiguitanensis* n. sp. include *P. bicolensis* Hong and James 2009a (71-98 mm × 3.8-4.6 mm); *P. kitangladensis* James 2004 (108 mm × 3.6-3.8 mm); *P. baletei* James 2004 (> 78 mm × 4.3-4.5 mm); *P. bukidnonensis* James 2004 (76 mm × 3.5 mm); and *P. makilingensis* Hong and James 2008b (110 mm × 4-4.2 mm). However, *P. hamiguitanensis* has more closely spaced spermathecal pores (0.07 circumference) than *P. kitangladensis* (0.28), *P. baletei* (0.25), *P. bukidnonensis* (0.38), and *P. makilingensis* (0.15). Its male pores are more closely spaced (0.12 circumference) than those of *P. bicolensis* (0.14), *P. kitangladensis* (0.2), *P. baletei* (0.25), *P. bukidnonensis* (0.17) but are more distantly spaced than those of *P. makilingensis* (0.08). It has fewer setae (2) between male pores than *P. kitangladensis*, *P. bukidnonensis*, *P. makilingensis* (all with 8 setae), and *P. baletei* (6 setae). There are more setae in the pre-clitellar area (38-47 per segment) than in the other species (29-34 in *P. bicolensis*, 24 in *P. baletei* and *P. bukidnonensis*, and 35 in *P. makilingensis*). *Pheretima hamiguitanensis* also differs from *P. bicolensis*, *P. baletei* and *P. makilingensis* in lacking penes. In addition, the shape of the spermathecae differs from the other species (diverticulum with small oval receptacle in *P. bicolensis*, club-shaped receptacle in *P. kitangladensis*, short club-shaped receptacle in *P. baletei*, ovate receptacle in *P. bukidnonensis*, and globular to ovate receptacle in *P. makilingensis*). No other species in the *P. urceolata* group closely resemble *P. hamiguitanensis*.

***Pheretima lantapanensis* n. sp.**

(Fig. 2E, Table 2)

urn:lsid:zoobank.org:act:8EC52E4D-0405-403B-8E80-BED7D15C1EDF

Material examined: Holotype: adult, amputee (NMA 4589), Brgy Songco, municipality of Lantapan, Bukidnon Province, Mt. Kitanglad Range (8°05'47"N, 124°55'21"E), 2200 m asl, Mindanao Island, Philippines, coll. N. Aspe, 27-31 Oct. 2012. Paratype: one adult, amputee (NMA 4605), same collection data as for holotype.

Etymology: The species is named for the municipality of Lantapan, Bukidnon Province, where this species was collected.

Diagnosis: Worm with adult diameter 2.5-3 mm; dorsum brown, ventrum pale, equators pigmented; pair of spermathecal pores at intersegment 5/6; setae in vii 30-39; gizzard origin in ix; prostates small, xvi-xvii; penis lacking.

Description: Brown dorsum, pale ventrum, equators pigmented. Length > 58 mm; diameter 2.5 mm at x, 3 mm at xx (*n* = 2 adults); body circular in cross-section. First dorsal pore at

11/12, paired spermathecal pores at 5/6, distance between spermathecal pores 3 mm (0.38 circumference apart ventrally). Female pore single in xiv; openings of copulatory bursae paired in xviii, distance between openings 2.2 mm (0.23 circumference apart ventrally), 8 setae between openings. Clitellum annular, from xiv to xvi. Setae irregularly distributed around equator in some segments; 30-39 setae on vii, 31-36 setae on xx, dorsal setal gaps present, ventral setal gaps lacking. Genital markings lacking.

Septa 4/5-7/8 and 10/11-13/14 thin, 8/9/10 lacking. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia in intestinal segments located mainly on body near septum/body wall junction. Large gizzard in viii-x, esophagus with low vertical lamellae x-xiii, intestinal origin in xv; caeca simple, originating in xxvii, extending forward to xxiii, may be folded up or tucked under the intestine in xxiv; typhlosole originating in xxvi, simple fold slightly less than lumen diameter; intestinal wall with 33 longitudinal blood vessels. Hearts in x to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; those in viii extend to gizzard.

Ovaries and funnels free in xiii. Spermathecae paired, postseptal in vi, with nephridia on ducts. Each spermatheca with pear-shaped ampulla; slender, bulbous, muscular duct; single stalked diverticulum attached to ectal portion of right face of duct of right spermatheca, and on left face of duct of left spermatheca; stalks short, terminating in large, ovate receptacle. Male sexual system holandric; testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii, each with digitate dorsal lobe**;** vesicles of xi enclosed in testes sac; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; prostates small in xvi to xvii; each prostate a dense, racemose mass with two lobes; thin duct entering from anterior margin of prostate to center of copulatory bursa. Copulatory bursae round in xvii-xix; coelomic surfaces muscular, secretory diverticula lacking; roof with two thick pads, floor pads lacking; penis lacking.

Remarks: *Pheretima lantapanensis* n. sp. belongs to the *P. urceolata* group of Sims and Easton (1972). Members of the *P. urceolata* group with body width similar to *P. lantapanensis* include *P. dinagatensis*, *P. abiadai*, *P. nagaensis*, and *P. viracensis*. *Pheretima lantapanensis* differs from these species in having pigmented segmental equators and in lacking penes. The distance between spermathecal pores in *P. lantapanensis* is very wide (0.38) compared to that of *P. dinagatensis* (0.31), *P. abiadai* (0.25), *P. nagaensis* (0.29) and *P. viracensis* (0.32-0.36). The new species has relatively fewer setae (30-39) on the post-clitellar segments and the extent of the prostates is only xvi-xvii compared with that of *P. dinagatensis* n. sp. (43-48 and xv/xvi-xix, respectively), *P. abiadai* (42-47 and xvii-xix, respectively), *P. nagaensis* (41-48 and xvii-xx, respectively), and *P. viracensis* (40-45 and xvii-xix, respectively). *Pheretima lantapanensis* also also has large pear-shaped spermathecal ampulla with slender duct and prominent ovate diverticula, whereas the others have relatively small, round ampulla with short ducts. Although the spermathecal duct in *P. dinagatensis* is also slender, its diverticular receptacle is round and small. No other member of the *P. urceolata* group closely resembles *P. lantapanensis*.

***Pheretima timpoongensis* n. sp.**

(Fig. 3A, Table 3)

urn:lsid:zoobank.org:act:99A6DF1A-3761-4E27-A49B-22B3EA7F44A5

Material examined: Holotype: adult (NMA 4590), Brgy Pandan, Mambajao City, Camiguin Province, Mt. Timpoong (9°10'45"N, 124°43'15"E), 1350 m asl, Camiguin Island, Philippines, coll. N. Aspe, J. Adeva, 11-15 Oct. 2004. Paratypes: seven adults (NMA 4606); six adults (ZRC.ANN 0059), same collection data as for holotype.

Etymology: The species is named for Mt. Timpoong, where this species was collected.

Diagnosis: Large, purplish brown worm with adult dimensions 147-225 mm x 7-9.5 mm; ventrum pale; equators non-pigmented; pair of spermathecal pores at intersegment 7/8; large gizzard in ix-x or x-xi; intestinal origin in xv or xvi; prostates extend from xvii-xx; penes present.

Description: In living animals, purplish brown dorsum, lighter ventrum, equators non-pigmented. Length 147-225 mm (*n* = 14 adults); diameter 7.3-9.5 mm at x, 7-8.5 mm at xx; body circular in cross-section, tail tapering; 98-119 segments. First dorsal pore at 12/13; paired spermathecal pores at 7/8, spermathecal pores 6 mm (0.20 circumference apart ventrally). Female pore single in xiv; openings of copulatory bursae paired in xviii, distance between openings 5.4 mm (0.23 circumference apart ventrally), 2-5 setae between openings. Clitellum annular, from xiv to xvi. Setae unevenly distributed around equator in some segments; more closely spaced on ventrum; 29-43

setae on vii, 49-73 setae on xx; dorsal setal gaps present, no ventral gaps. Genital markings lacking.

Septa 4/5-6/7 membranous, 7/8 and 10/11-13/14 muscular, 8/9/10 lacking. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia in intestinal segments located mainly on body near septum/body wall junction. Large gizzard in viii-x, esophagus with low, vertical lamellae x-xiii, intestinal origin in xv or xvi, caeca simple originating in xxvii, extending forward to xxiv or xxiii; typhlosole originating in xxvii, simple fold, 1/3 lumen diameter; intestinal wall with 31-44 longitudinal blood vessels. Hearts in x to xiii; hearts esophageal.

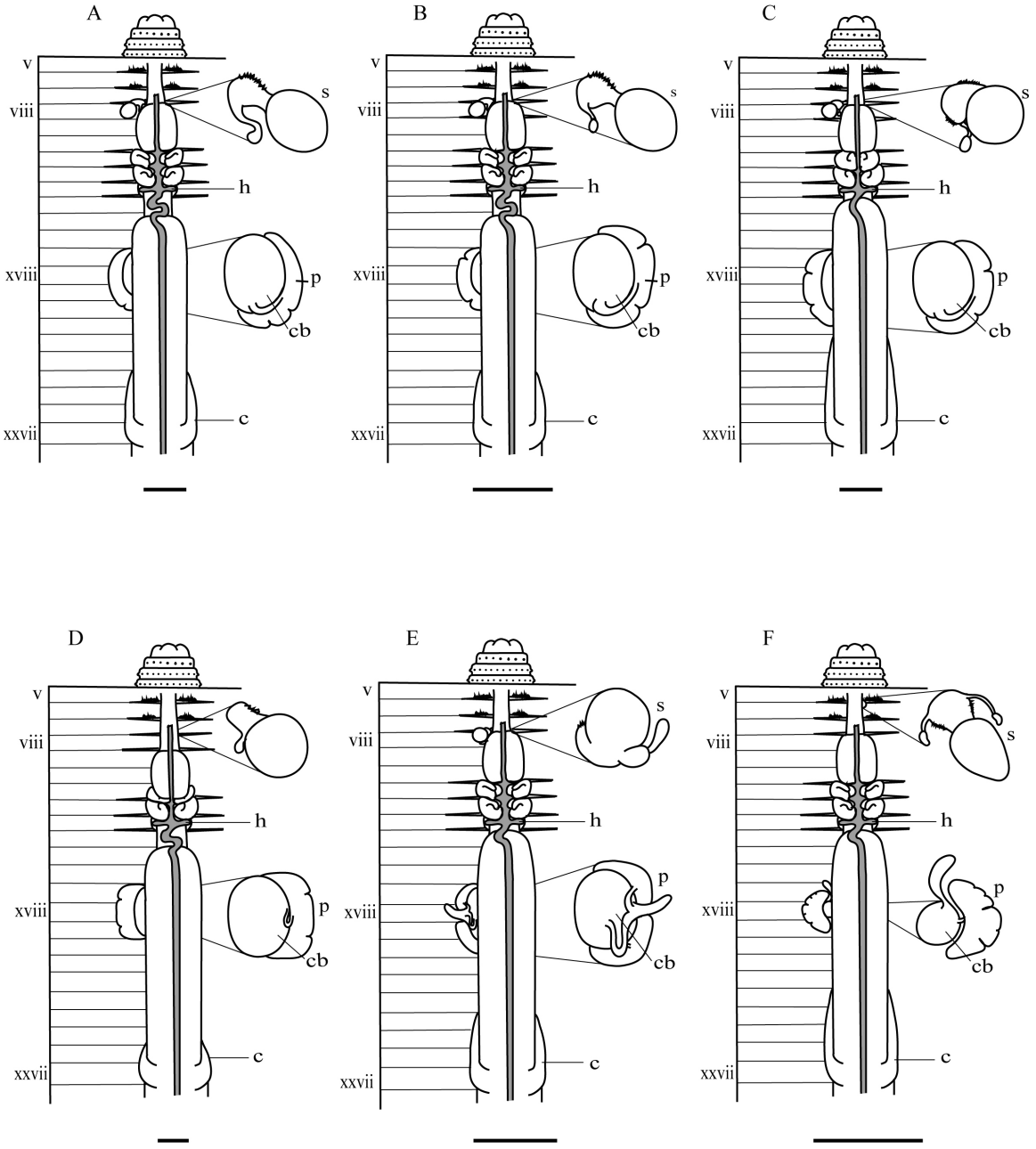

Fig. 3. Schematic dorsal views of the internal morphology of other *Pheretima* species described here. (A) *P. timpoongensis* n. sp., with intestinal origin in xv, and caeca extending from xxvii-xxiv; (B) *P. camiguinensis* n. sp., with prostates in xvii-xxi, and caeca extending from xxvii-xxi; (C) *P. sibucalensis* n. sp.; (D) *P. apoensis* n. sp. with spermathecae; (E) *P.* (*Paraph.*) *pandanensis* n. sp.; (F) *P.* (*Paraph.*) *boaensis* n. sp., with intestinal origin in xiv, prostates in xvii-xix, and caeca extending from xxvii-xxiii. Abbreviations: s, spermatheca; h, heart; p, prostate gland; cb, copulatory bursa; c, caecum. Scale bars: A-F, 5 mm.

Ovaries and funnels free in xiii. Spermathecae paired, postseptal in viii, with nephridia on ducts; each spermatheca with ovate ampulla, stout muscular duct, and stalked diverticulum. Diverticulum attached to the ectal portion of left face of duct of right spermatheca, and on right face of duct of left spermatheca; stalks short, with one coil, terminating in ovate receptacle. Spermathecae contain two small, ovate spermatophores. Male sexual system holandric; testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii, each with digitate dorsal lobe**;** vesicles in xi enclosed in testes sac; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; prostates in xvii to xx, each a dense, racemose mass with two or three lobes; thick muscular duct from lateral margin of prostate entering posterior margin of copulatory bursa. Copulatory bursae ovate-hemispherical in xvii-xix; coelomic surfaces muscular, secretory diverticula lacking; roof with two pads, floor with folding encircling the opening; penes present;

Table 3. Comparison of species in the *Pheretima sangirensis* group and *Pheretima* (*Parapheretima*) species

Characters	*P. sangirensis* * (Michaelsen, 1891)	*P. timpoongensis* n. sp.	*P. camiguinensis* n. sp.
Length	54-240	147-225	63-122
Width x, xx	4-8	7.3-9.5, 7-8.5	3.5-4.8, 3.5-5.2
Dorsal pigmentation	Variation of purple	Purplish brown	Reddish brown
Segment equators	?	unpigmented	unpigmented
Segments	?	98-119	87-103
1st dorsal pore	?	12/13	12/13
Spermathecal pores	Paired at 7/8	Paired at 7/8	Paired at 7/8
Sperm. pore distance	0.25-0.28	0.2	0.17
Male pore distance	0.17-0.25	0.23	0.15-0.18
Setae between openings	6-10	2-5	1-4
Setae vii, xx	40; 60+	29-43, 49-73	32-34, 39-44
Gizzard	viii-?	ix-x/ ix-xi	viii-x/ ix-xi/ ix-x
Intestinal origin	xv	xv/ xvi	xv
Caeca	xxvii-?	xxvii-xxiv/ xxiii	xxvii-xxiv/ xxiii/ xxii
Prostate	xvii-xix	xvii-xx	xvii-xx/ xxi
Copulatory bursae	present	xvii-xix	xvii-xix
Secretory diverticula	-	-	-
Penes	+	+	-

Characters	*P. sibucalensis* n. sp.	*P. apoensis* n. sp.	*P.* (*Parapheretima*) *pandanensis* n. sp.	*P.* (*Parapheretima*) *boaensis* n. sp.
Length	> 165	163-350	86-150	94-133
Width x, xx	6.5, 7	7.2-11, 8-12	4-5, 4-5	3.5, 4-4.5
Dorsal pigmentation	Dark gray-brown	Purplish brown	Dark reddish brown	Reddish brown
Segment equators	unpigmented	unpigmented	unpigmented	pigmented
Segments	?	102-120	85-104	94-146
1st dorsal pore	12/13	12/13	12/13	12/13
Spermathecal pores	Paired at 7/8	-, paired at 7/8	Paired at 7/8	Single midventral at 5/6
Sperm. pore distance	0.21	-, 0.16	0.23	-
Male pore distance	0.17	0.15-0.16	0.23-25	0.16
Setae between openings	9	4-5	4-9	6-9
Setae vii, xx	70, 89	37-48, 50-58	36-44, 50-55	41-46, 57-59
Gizzard	ix-xi	ix-xi	ix-x	ix-x
Intestinal origin	xiv	xv	xiv	xiv/xv
Caeca	xxvii-xxii	xxvii-xxvi/xxiv	xxvii-xxv/ xxiv	xxvii-xxiv/ xxiii
Prostate	xvii-xxi	xv/xvii-xix	two parts, in xvii-xviii, and xix-xx	xvii-xix/ xvi-xviii
Copulatory bursae	xvii-xx	xvii-xix	xvii-xix	xviii
Secretory diverticula	-	-	+	+
Penes	-	-	+	-

penis sheath lacking.

Remarks: *Pheretima timpoongensis* n. sp. belongs to *P. sangirensis* species group of Sims and Easton (1972), which differs from the *P. montana* Kinberg 1867 group in having spermathecal pore(s) opening only at 7/8, and no penial sheaths in the copulatory bursae. Members of the *sangirensis* group have a holandric male system, with paired testis sacs; the copulatory bursae are simple, and some species have short, conical penes. Blakemore (2007) acknowledged three valid subspecies in *P. sangirensis*: *P. s. sangirensis*; *P. s. crassicystis* Michaelsen 1896; and *P. s. chica* Michaelsen 1896. Currently there are 26 species members of *P. sangirensis* group, including the new species described here. *Pheretima timpoongensis* is larger (147-225 mm × 7-9.5 mm) than *P. s. sangirensis* (140 mm × 3.5-4.5 mm) and *P. s. chica* (54-120 mm) but shorter than *P. s. crassicystis* (240 mm × 8 mm). The spermathecal pores in *Pheretima timpoongensis* (0.2 circumference) are closer than in *P. sangirensis* (0.25-0.28) and there are fewer setae between male pores in the new species (2-5 vs 6-10 in *P. sangirensis*; particularly 10 in *P. s. crassicystis*). Also, there is no dorsal setal gap in *P. s. crassicystis*, the caeca are not simple and they have stubby pockets that are deeply divided from one another, the stalk of the spermathecal diverticulum originates entally, and the copulatory bursae are fairly flat, in contrast to that of the new species. Among other species in the *P. sangirensis* group, *P. timpoongensis* is similar to *P. lago* Aspe and James 2014 and *P. nunezae* Aspe and James 2014 from Mt. Malindang (the smaller *P. lago* specimens (223-315 mm × 10-11 mm) overlap in size with the larger *P. timpoongensis* specimens; the *P. nunezae* specimens were amputees but width (8.5-9 mm) are similar) in the number of setae around segments, and in having penes. However, *P. lago* is dark brown, has fewer setae between male pores (0-2), has closer male pores (0.15 circumference apart ventrally), has stalked diverticulum originating entally and terminating in a receptacle with 2-4 chambers, the prostates are located anterior of the copulatory bursae, and the duct form the prostate enters the anterior margin of the copulatory bursa. On the other hand, *P. nunezae* is dark gray-brown, has more setae (9) between the male pores, has greater distance (0.28 circumference) between the spermathecal pores, has fewer blood vessels on the intestinal wall (20-23), has smaller copulatory bursae (xviii), has stalked diverticulum originating entally and terminating in sausage-shaped receptacle, has relatively smaller prostates (xvii-xix), and the duct from the prostate enters the lateral margin of the copulatory bursa. *Pheretima timpoongensis* is also similar to *P. apoensis* n. sp. (see below) from Mt. Apo in relative size and in the number of setae around equators. However, *P. timpoongensis* have greater distance between male pores, the stalked diverticulum originating ectally is less stout, the duct from the prostate enters the posterior margin of the copulatory bursa, and penes are present. *Pherertima timpoongensis* also have some relatively overlapping features with some individuals of *P. camiguinensis* n. sp. (described below): the color, the number of setae on the segments, the number of setae between male pores, the position of the gizzard and the intestinal origin, the length of caeca and relative size of the prostates. However, *P. timpoongensis* is larger, have wider space between spermathecall pores and between male pores, and penes is present.

***Pheretima camiguinensis* n. sp.**

(Fig. 3B, Table 3)

urn:lsid:zoobank.org:act:1602441D-DB34-4392-9173-ED5D9A2818C4

Material examined: Holotype: adult (NMA 4591), Brgy Pandan, Mambajao City, Camiguin Province, Mt. Timpoong (9°10'45"N, 124°43'15"E), 1350 m asl, Camiguin Island, Philippines, coll. N. Aspe, J. Adeva, 11-15 Oct. 2004. Paratypes: nine adults (NMA 4607); nine adults (ZRC.ANN 0060), same collection data as for holotype.

Etymology: The species is named for Camiguin Island.

Diagnosis: Reddish brown worm with adult length 63-122 mm; pair of spermathecal pores at intersegment 7/8; spermathecal pores 0.17 circumference apart, male pores 0.15-0.18 circumference apart; 32-34 setae on vii, 39-44 setae on xx; penis lacking.

Description: In living animals, reddish brown dorsum, pale ventrum, equators non-pigmented. Length 63-122 mm (*n* = 19 adults); diameter 3.5-4.8 mm at x, 3.5-5.2 mm at xx; body circular in cross-section, tail tapering; 87-103 segments. First dorsal pore at 12/13, paired spermathecal pores at 7/8, distance between spermathecal pores 1.9-2.8 mm (0.17 circumference apart ventrally). Female pore single in xiv, openings of copulatory bursae paired in xviii, distance between openings 2-2.5 mm (0.15-0.18 circumference ventrally apart), 1-4 setae between openings. Clitellum

annular, from xiv to xvi. Setae unevenly distributed around equator in some segments; 32-34 setae on vii, 39-44 setae on xx, dorsal setal gaps present, no ventral gaps. Genital markings lacking.

Septa 5/6-7/8 and 10/11/12 thick; 4/5, 8/9, and 13/14 thin; 9/10 lacking. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia in intestinal segments located mainly on body near septum/body wall junction**.** Large gizzard in viii-x; esophagus with low, vertical lamellae x-xiii; intestinal origin in xv; caeca originating in xxvii, extending forward to xxiv, xxiii, or xxii; caeca may be folded over, or tucked under the intestine in xxiii; typhlosole originating in xxvii, simple fold slightly less than lumen diameter; intestinal wall with 26-30 longitudinal blood vessels. Hearts in x to xiii; heart esophageal.

Ovaries and funnels free in xiii. Spermathecae paired, postseptal in viii, with nephridia on ducts; each spermatheca with ovate ampulla, stout muscular duct, and stalked diverticulum attached to ectal portion of left face of duct of right spermatheca, and on right face of duct of left spermatheca; stalks short, with one coil, terminating in ovate receptacle. Spermathecae contain two small, ovate spermatophores. Male sexual system holandric; testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii, each with digitate dorsal lobe**;** vesicles of xi enclosed in testes sac; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; prostates in xvi to xx (or xxi in some individuals); some individuals have asymmetrical prostates (e.g. xvi to xx on left and xvi to xxi on right); each prostate a dense, racemose mass, with three to five lobes; thick muscular duct from lateral margin of prostate entering posterior margin of copulatory bursa. Copulatory bursae ovate-hemispherical in xvii-xix; coelomic surfaces muscular, secretory diverticula lacking; roof with thick pad, floor pads lacking; short, blocky penis present.

Remarks: *Pheretima camiguinensis* n. sp. belongs to the *P. sangirensis* group of Sims and Easton (1972). The new species is similar in size to *P. s. chica* Michaelsen 1896; *P. baungonensis* James 2004; *P. quincunxia* James 2004; *P. malindangensis* Aspe and James 2014; and *P. wati* Aspe and James 2014. However, the spermathecal pores (0.17 circumference in *P. camiguinensis*) are farther apart in *P. s. chica* (0.25-0.28) and *P. baungonensis* (0.32) and closer in *P. quincunxia* (0.13). The male pores are closer in *P. camiguinensis* (0.15-0.18 circumference) than in *P. baungonensis* (0.19) but farther than in *P. wati* (0.08). *Pheretima camiguinensis* has more setae per segment (32-34 in vii, 39-44 in xx) than *P. quincunxia* (16-20; 20-30) but fewer than *P. malindangensis* (43-47; 50-57) and *P. wati* (59-71; 52-60). The prostates in *P. camiguinensis* (xvii-xx/ xxi) are larger than in *P. baungonensis* and *P. quincunxia* (xvii-xix for both), but both the prostates and copulatory bursae are smaller than in *P. malindangensis* (xvi-xxi and xvii-xx, respectively) and *P. wati* (xv-xxii and xv-xxi, respectively). *Pheretima camiguinensis* differs from *P. baungonensis* in that the latter has the first dorsal pore at 13/14, more setae (8) between male pores, and shorter caeca (xxvii-xxv). *Pheretima camiguinensis* (reddish brown) differs in color from *Pheretima s. chica* (purple) and *P. quincunxia* (non-pigmented). No other member of the *P. sangirensis* group closely resembles *P. camiguinensis*.

Although there are variations in the size of the gizzard and prostates, and in the length of the caeca, among individuals of *P. camiguinensis*, molecular data for the mitochondrial 16S and CO1 genes reveal that these are intraspecific variations (0-0.013 [*n* = 4] and 0.002 [*n* = 2], respectively, in terms of K2P; Aspe and James, unpublished data). Numerous parasitic nematodes were commonly observed near the caeca in individuals of *P. camiguinensis*.

Pheretima sibucalensis **n. sp.**

(Fig. 3C, Table 3)

urn:lsid:zoobank.org:act:8FB93CE1-0FC1-47CB-B018-2767C788F24B

Material examined: Adult, amputee (NMA 4510), Brgy Sibucal, Oroquieta City, Misamis Occidental Province, Mt. Malindang Range (8°19'31"N, 123°38'02"E), 991 m asl, Mindanao Island, Philippines, coll. N. Aspe, M. Lluch, and J. Adeva, 18-23 Feb. 2004.

Etymology: The species is named after Brgy Sibucal of Oroquieta City, where this species was collected.

Diagnosis: Dark gray-brown worm, diameter 6.5-7 mm, ventrum and equators non-pigmented; pair of spermathecal pores at 7/8; spermathecal pores and male pores, 0.21 and 0.17 circumference apart, respectively; 70 setae on vii, 89 setae on xx; 9 setae between male pores; prostate extends from xvii to xxi; penes lacking.

Description: Living animals with dorsum dark gray-brown anteriorly, fading posteriorly; ventrum non-pigmented; equators non-pigmented; clitellum

gray, darker than adjacent segments. Length > 165 mm (*n* = 1 adult, amputee); diameter 6.5 mm at x; 7 mm at xx; body circular in cross-section. First dorsal pore at 12/13, paired spermathecal pores at 7/8, 0.21 circumference apart; female pore single in xiv; openings of copulatory bursae paired in xviii, 0.17 circumference apart, depressed area with 9 setae between openings. Clitellum annular, extending from xiv to xvi. Setae evenly distributed, 70 setae on vii, 89 setae on xx, dorsal gap present, ventral gap absent.

Septa 4/5/6/7/8 slightly muscular, 8/9 membranous, 9/10 absent, 10/11-13/14 slightly muscular. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia of intestinal segments located mainly on body wall on anterior and posterior faces of septa, at septum/body wall junction**.** Large gizzard in viii-x; esophagus with lamellae from x to xiii; intestinal origin in xiv; caeca originate in xxvii, extend forward to xxii, with pocketed ventral margin; typhlosole in xxvii/xxvi, simple fold of about 1/8 lumen diameter, intestinal wall with 38 longitudinal blood vessels. Hearts in x to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; viii extends to gizzard.

Ovaries and funnels free in xiii; paired spermathecae preseptal in vii, with nephridia on ducts; each spermatheca with round ampulla; short, bulbous, muscular duct; stalked diverticulum attached to the ental portion of left face of duct near ampulla of the right spermatheca, and on left face of duct of left spermatheca; stalks short, terminating in bean-shaped receptacle. Each spermatheca contains two spermatophores. Male sexual system holandric; testes and funnels enclosed in paired sacs in x and xi; seminal vesicles in xi and xii, each with short, spherical dorsal lobe; vasa deferentia slender, free from body wall, passing around lateral face of copulatory bursae en route to ental end of prostatic ducts; each prostate racemose from xvii to xxi; muscular duct from lateral margin of prostate entering posterior margin of copulatory bursa. Ductlets of lobes meet vasa deferentia at common junction with muscular prostatic duct. Copulatory bursae ovate in xvii-xx; coelomic surfaces muscular, secretory diverticula lacking; roof with thick pad, floor pad lacking; penes lacking.

Remarks: *Pheretima sibucalensis* n. sp. belongs to the *P. sangirensis* group of Sims and Easton (1972). It differs from *P. sangirensis* in having more setae on segmental equators (70-89 vs. 40-60+), closer spermathecal pores, the intestinal origin in xiv rather than xv, larger prostates, and no penes. *Pheretima sibucalensis* is similar to *P. nunezae* (Aspe and James 2014) from Mt. Malindang, in size, coloration, presence of dorsal gaps and absence of ventral gaps, arrangement of the septa, origin of the gizzard, and the length of the caeca. However, *P. sibucalensis* has shorter distance between male pores and between spermathecal pores (0.21 and 0.17, respectively) compared to that of *P. nunezae* (0.28 and 0.22, respectively). The setae on the segmental equators in *P. sibucalensis* is more numerous (70 in vii and 89 in xx, respectively) than that of *P. nunezae* (46 in vii, 51 in xx, respectively). The new species also differs from *P. nunezae* in the intestinal origin (xiv vs. xv), in the number of blood vessels on the intestinal wall (38 vs. 28-33), in the extent of caeca (xxvii-xxii vs. xxvii-xxiv), in the extent of the prostate and copulatory bursae (xvii-xxi vs. xvii-xix and xvii-xx vs. xviii), and in lacking penes. *Pheretima timpoongensis* n. sp., which also closely resembles *P. nunezae*, differs from *P. sibucalensis* in having larger body diameter, fewer setae on each segment, in having a wider space between male pores, in having fewer setae between the male pores, and in lacking penes. *Pheretima sibucalensis* does not closely resemble any other members of the *P. sangirensis* group.

***Pheretima apoensis* n. sp.**

(Fig. 3D, Table 3)

urn:lsid:zoobank.org:act:A7D459BD-D3BC-4F29-B330-39AC7E257887

Material examined: Holotype: adult (NMA 4592), Brgy Baracatan, Davao City, Mt. Apo National Park (7°00'04"N, 125°21'55"E), 1524 m asl, Mindanao Island, Philippines, coll. N. Aspe, A. Solis, Dec. 11-14, 2003. Paratypes: seven adult (NMA 4608), five adults same collection data as for holotype, two adults, municipality of Maramag, Bukidnon Province, Mt. Musuan Range (7°52'53.8"N, 125°03'57.6"E), 400 m asl, Mindanao Island, Philippines, coll. N. Aspe, 26 Oct. 2012; three adults (ZRC.ANN 0061), same collection data as for holotype; two adults, same collection data as for the ones collected in Mt. Musuan.

Etymology: The species is named after Mt. Apo, where this species was first collected.

Diagnosis: Large worm, adult body dimension 163-350 mm × 7.2-12 mm; 102-120 segments; dorsum purplish brown, ventrum pale; equators non-pigmented; spermathecal pores lacking in athecate individuals, at 7/8 in thecate individuals; 37-48 setae on vii, 50-58 setae on xx; 4-5 setae

between male pores; male pores 0.15-0.16 circumference apart; penis lacking.

Description: In living animals, purplish brown dorsum, lighter ventrum, equators non-pigmented making the worm appear striped. Length 163-350 mm (*n* = 13 adults); diameter 7.2-11 mm at x, 8-12 mm at xx; body cylindrical in cross-section, tail tapering; 102-120 segments. First dorsal pore 12/13, spermathecal pores lacking in some individuals, thecate individuals with paired spermathecal pores at 7/8, distance between spermathecal pores 0.16 circumference apart ventrally. Female pore single in xiv, openings of copulatory bursae paired in xviii, distance between openings 0.15-0.16 circumference apart ventrally, 4-5 setae between openings. Clitellum annular, from xiv to xvi. Setae unevenly distributed around equators in some segments; 37-48 setae on vii, 50-58 setae on xx, dorsal setal gaps present, ventral setal gaps lacking. Genital markings lacking.

Septa 4/5-8/9 membranous, 11/12-13/14 thick, 9/10/11 lacking. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia of intestinal segments located mainly on body near septum/body wall junction. Large gizzard in ix-xi, esophagus with low vertical lamellae x-xiii, intestinal origin in xv, caeca simple originating in xxvii, extending forward to xxvi or xxiv; typhlosole originating in xxvii, simple fold, 1/3 lumen diameter, intestinal wall with 32-38 longitudinal blood vessels. Hearts in xi to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; those in viii extend to gizzard.

Ovaries and funnels free in xiii. Spermathecae lacking in some individuals, thecate individuals with a pair of spermathecae postseptal in viii, with nephridia on ducts; each spermatheca with round ampulla, short, stout muscular duct, stalked diverticulum attached to the ental portion of the left face of duct of the right spermatheca, and on right face of duct of left spermatheca, stalks short, terminating in small, round receptacle. Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii, each with digitate dorsal lobe**;** vesicles of xi enclosed in testes sac; vasa deferentia slender, free from body wall en route to ental end of prostatic ducts; prostates in xv or xvii to xix, each a single, dense, racemose mass with 3 lobes; short muscular duct entering middle area of the surface of copulatory bursa. Copulatory bursae ovate-hemispheric in xvii-xix; coelomic surfaces muscular, secretory diverticula lacking; roof with thick pad, floor pads lacking; penis lacking.

Remarks: *Pheretima apoensis* n. sp., belonging to the *P. sangirensis* group of Sims and Easton (1972), is a large worm similar to *P. ceramensis* Cognetti 1922 from Indonesia, *P. lago* Aspe and James 2014 from Mt. Malindang, and *P. timpoongensis* n. sp. from Camiguin Island, in relative size and in having pigmentation over the entire dorsal area that gradually fade toward the ventrum. However, *P. apoensis* differs from these species in lacking penes. It has closer male pores than in *P. ceramensis* (0.2 circumference apart) and in *P. timpoongensis* (0.23 circumference apart), has closer spermathecal pores (for thecate individuals) than in *P. lago* and in *P. timpoongensis* (0.18-0.24 and 0.2 circumference apart, respectively), and has fewer setae than in *P. ceramensis* (60 per segment). Its prostates also are in different position compared to that of *P. lago* (positioned in xiv–xviii, anterior of the copulatory bursae) and its stalked diverticulum has different structure (stalked diverticulum in *P. lago* terminating in a receptacle with 2-4 chambers). Although *P. virgata* James 2004 from Mt. Kitanglad, and *P. tigris* Aspe and James, 2014, *P. maculodorsalis* Aspe and James 2014, and *P. immanis* Aspe and James 2014 from Mt. Malindang are also similar to *P. apoensis* in size, these species significantly differ from the new species in pigmentation pattern from *P. virgata* and *P. tigris* (with dorsal intersegmental stripes in *P. virgata* and *P. tigris*; with mid-dorsal intersegmental oval dots in *P. maculodorsalis*; and with very thick dorsal intersegmental stripes in *P. immanis*).

The *P. apoensis* that were collected from Mt. Apo (nine adults; 163-188 × 7.2-9 mm) are smaller compared to the ones in Bukidnon Province (four adults; 324-350 × 10-12 mm) and all individuals collected from Mt. Musuan are athecate. Also, the caeca from *P. apoensis* collected from Mt. Apo are longer by two segments and the prostates are more extensive (xv-xix vs. xvii-xix). The *P. apoensis* from Mt. Musuan and the *P. apoensis* from Mt. Apo have a genetic divergence of 0.011 (or 1.1%) based on mitochondrial 16S gene using K2P model, which indicates that the two are conspecific. On another note, a study on cryptic species of hormogastrid earthworms showed an upper limit of 4.27% intraspecific divergence in *Hormogaster elisae* using K2P based on 16S (Novo et al. 2010). It is most likely that geographic isolation (e.g. the distance between Mt. Apo and Mt. Musuan is approximately 110 km) may have caused divergence in some morphological features such as the body size and the loss of spermathecae,

in this case, the *P. apoensis* from Mt. Musuan. A study on the reproductive traits of *Aporrectodea trapezoides* showed that isolation of an earthworm in a controlled environment can trigger the earthworm to reproduce parthenogenetically (Férnandez et al. 2010). *Pheretima apoensis* was also observed in Mt. Kitanglad Range, which is close to Mt. Musuan.

Subgenus *Parapheretima* Cognetti, 1912

Type species: *Pheretima aberrans* Cognetti 1911.

Diagnosis: *Pheretima* species with a secretory diverticulum discharging into each copulatory bursa.

Pheretima (*Parapheretima*) *pandanensis* n. sp.

(Fig. 3E, Table 3)

urn:lsid:zoobank.org:act:6B9AB7F7-FEF2-43F3-89C3-12503816176D

Material examined: Holotype: adult (NMA 4593), Brgy Pandan, Mambajao City, Camiguin Province, Mt. Timpoong (9°10'45"N, 124°43'15"E), 1350 m asl, Camiguin Island, Philippines, coll. N. Aspe, J. Adeva, 11-15 Oct. 2004. Paratypes: five adults (NMA 4609); four adults (ZRC.ANN 0062), same collection data as for holotype.

Etymology: The species is named for Brgy Pandan of Mambajao City, Camiguin Province, where this species was collected.

Diagnosis: Dark reddish brown worm, adult length 85-150 mm; ventrum pale; pair of spermathecal pores at intersegment 7/8; male pores and spermathecal pores 0.23 and 0.23-0.25 circumference apart; 50-55 setae on xx; 4-9 setae between male pores; single secretory diverticulum projecting from lateral surface of each copulatory bursa; long, tapering penis.

Description: In living animals, dark reddish brown dorsum, lighter ventrum, equators non-pigmented. Length 86-150 mm (*n* = 10 adults); diameter 4-5 mm at x, 4-5 mm at xx; body circular in cross-section, tail tapering; 85-104 segments. First dorsal pore at 12/13, paired spermathecal pores at 7/8, distance between spermathecal pores 3 mm (0.23 circumference apart ventrally), spermathecal pores inconspicuous in some individuals. Female pore single in xiv, openings of copulatory bursae paired in xviii, distance between openings 3-4 mm (0.23-0.25 circumference apart ventrally), 4-9 setae between openings. Clitellum annular, from xiv to xvi. Setae unevenly distributed around equators; 36-44 setae on vii, 50-55 setae on xx, dorsal setal gaps present, no ventral gaps. Genital markings lacking.

Septa 6/7/8 and 10/11-12/13 muscular, 4/5/6 and 8/9/10 lacking. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia of intestinal segments located mainly on body near septum/body wall junction. Large gizzard in viii-x, esophagus with low vertical lamellae x-xiii, intestinal origin in xiv; caeca simple, originating in xxvii, extending forward to xxv or to xxiv, margins serrated; typhlosole originating in xxvii, simple fold slightly less than lumen diameter, intestinal wall with 31-53 longitudinal blood vessels. Hearts in x to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; those in viii extend to gizzard.

Ovaries and funnels free in xiii. Spermathecae paired, postseptal in viii, with nephridia on ducts. Each spermatheca with round ampulla, very large, short, bulbous, muscular duct; single stalked diverticulum attached to ectal portion of left face of duct close to the ampulla of the right spermatheca, and on right face of duct of left spermatheca; stalks terminating in elongate receptacle, becoming bulbous abruptly midway toward duct. Spermathecae contained two small, ovate spermatophores, lacking in some individuals. Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii, each with digitate dorsal lobe; vesicles of xi enclosed in testes sac; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; prostate glands in two parts, in xvii-xviii, and in xix-xx, each part dense, racemose mass with two or three lobes; long duct from each prostate joins others to form thick, coiling, muscular duct connecting to copulatory bursa. Each copulatory bursa hemispheric in xvii-xix; coelomic surface muscular, with single secretory diverticulum projecting from lateral surface; roof with two pads, floor with thin pads; long, tapering penis arises from padded roof.

Remarks: *Pheretima* (*Parapheretima*) *pandanensis* n. sp. and *P.* (*Paraph.*) *boaensis* n. sp. (see next description) are the first *P.* (*Paraph.*) species reported from the Philippines. *Pheretima* (*Paraph.*) *pandanensis* n. sp. differs from other *P*. (*Paraph*.) species in the location of the spermathecae, which are paired in intersegment 7/8. Other *P*. (*Paraph*.) species are either monothecate (members of the *P*. (*Paraph*.) *barbara* Cognetti 1913 species group), or if bithecate, have the spermathecae located at intersegment 6/7 [*P*. (*Paraph*.) *bernhardi* Gates 1948 or members of

the *P*. (*Paraph*.) *beauforti* Cognetti 1913 species group] or at intersegments 5/6/7 [*P*. (*Paraph*.) *saba* Sims and Easton 1972]. *Pheretima* (*Paraph*.) *pandanensis* is similar to *P. camiguinensis* n. sp. in size and coloration, but differs from the latter in having a wider distance between spermathecal pores and between male pores, in having more setae between the male pores, and in having more post-clitellar setae on the segmental equators (Table 3).

Pheretima (*Parapheretima*) *boaensis* n. sp.

(Fig. 3F, Table 3)

urn:lsid:zoobank.org:act:7FC61F12-455E-4A4B-B6BF-A67E884E7C35

Material examined: Holotype: adult (NMA 4594), Brgy Boa, municipality of Cagdianao, Dinagat Province, (10°05'53"N, 125°39'42"E), 250 m asl, Dinagat Island, Philippines, coll. N. Aspe, J. Adeva, 23-26 Apr. 2004. Paratypes: two adults (NMA 4610); three adults (ZRC.ANN 0063), same collection data as for holotype.

Etymology: The species is named after Brgy Boa ion the municipality of Cagdianao, Dinagat Province, where this species was collected.

Diagnosis: Reddish brown worm, adult length 94-133 mm; ventrum pale; single spermathecal pore midventrally at intersegment 5/6; single muscular secretory diverticulum projecting from anterior margin of each copulatory bursa; 6-9 setae between male pores; penis lacking.

Description: Reddish brown dorsum, lighter ventrum, equators pigmented. Length 94-133 mm (*n* = 6 adults); diameter 3.5 mm at x, 4-4.5 mm at xx; body circular in cross-section, tail tapering; 94-146 segments. First dorsal pore at 12/13, single midventral spermathecal pore at 5/6. Female pore single in xiv, openings of copulatory bursae paired in xviii, distance between openings 2.3 mm (0.16 circumference apart ventrally), 6-9 setae between openings. Clitellum annular, from xiv to xvi. Setae unevenly distributed around equators in some segments; 41-46 setae on vii, 57-59 setae on xx, dorsal setal gaps present, no ventral gaps. Genital markings lacking.

Septa 4/5/6 thin, 7/8 and 10/11-13/14 muscular, 8/9/10 lacking. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia of intestinal segments located mainly on body near septum/body wall junction. Large gizzard in viii-x, esophagus with low vertical lamellae x-xiii, intestinal origin in xiv or xv, caeca simple originating in xxvii, extending forward to xxiii. One individual with caeca folded upward in xxiii, extending about length of one segment. Typhlosole originating in xxvi, simple fold, 1/3 lumen diameter; intestinal wall with 35-39 longitudinal blood vessels. Hearts in x to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; those in viii extend to gizzard.

Ovaries and funnels free in xiii. Single midventral spermatheca positioned on right side of the body, postseptal in vi, with nephridia on duct. Spermatheca with irregularly round ampulla; bulbous, muscular duct; two stalked diverticula attached ectally to duct, terminating in bean-shaped receptacle, stalk short. Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii, each with digitate dorsal lobe; vesicles of xi enclosed in testis sac; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; prostates in xvii to xix (one individual has the prostates in xvi to xviii); each prostate a dense, racemose mass with three lobes; muscular duct entering anterior margin of copulatory bursa. Each copulatory bursa round in xviii; coelomic surface muscular, with single, muscular, banana-shaped secretory diverticulum projecting from the anterior margin; roof with thick pad, floor pads lacking; short, blocky penis present.

Remarks: Having a single midventral spermatheca indicates that *Pheretima* (*Parapheretima*) *boaensis* n. sp. belongs to the *P. barbara* group of Sims and Easton (1972). However, this species group is characterized by having a midventral spermatheca in 6/7 and 7/8. Sims and Easton (1972) assigned to this species group *P.* (*Paraph.*) *barbara barbigua* [replacement name for *P.* (*Paraph.*) *barbara ambigua* Cognetti 1913 by Blakemore (2004)]; *P.* (*Paraph.*) *barbara barbara* Cognetti 1913; and *P.* (*Paraph.*) *hellwigiana* Cognetti 1913. The new species differs from these species in having a single midvental spermatheca in 5/6. The shape of the secretory diverticula also differs; in the other species, the diverticula are more elongate, form kinks, and project from the posterior end of the copulatory bursae. *Pheretima* (*Parapheretima*) *boaensis* differs from *P.* (*Paraph.*) *pandanensis* n. sp. in the number and location of the spermathecae, distance between male pores, and projection of the secretory diverticula from the anterior end of the copulatory bursae.

Genus *Amynthas* Kinberg 1867

Type species: *Amynthas aeruginosus* Kinberg 1867.

Generic diagnosis

Body circular in cross section, with numerous setae regularly arranged equatorially around each segment; setae absent on first and last segments. Male pores paired and superficial, opening on xviii. Spermathecal pores small or large, usually paired (bithecate) but occasionally numerous (polythecate) or single (monothecate). Spermathecal pores positioned either intersegmental or intrasegmental between 4/5 and 8/9. Clitellum annular, covering three segments (xiv to xvi). Single female pore midventrally on xiv. Genital markings present or absent. If genital markings present, variable in number and forming complex pattern on segments near male pores. Esophageal gizzard usually originating in viii; esophageal bursae lacking; pair of caeca originating in xxvii, extending forward. Ovaries and funnels free in xiii. Male sexual system holandric, metandric, or proandric. Spermathecae a single pair, multiple pairs, sometimes single and located midventrally, or sometimes lacking. Nephridia on spermathecal duct lacking. One pair of prostate glands, racemose. Copulatory bursae lacking.

Amynthas dinagatensis n. sp.

(Fig. 4A, Table 4)

urn:lsid:zoobank.org:act:3151BD49-87AF-40F3-B22B-5112CBCD992D

Material examined: Holotype: preclitellate (NMA 4595), Brgy Boa, municipality of Cagdianao, Dinagat Province, (10°05'53"N, 125°39'42"E), 250 m asl, Dinagat Island, Philippines, coll. N. Aspe, J. Adeva, 23-26 Apr. 2004. Paratypes: two preclitellate individuals (NMA 4611); three preclitellate individuals (ZRC.ANN 0064), same collection data as for holotype.

Etymology: The species is named for Dinagat Island.

Diagnosis: Purplish brown worm, body dimension 240 mm x 7-9 mm (longest preclitellate specimen among samples); ventrum pale; equators non-pigmented, making the body appear striped; spermathecal pores and spermathecae lacking; 20 setae between male pores; intestinal origin in xiii; caeca long, from xxvii to xxi; prostate glands small, rudimentary, confined to xviii.

Description: Purplish brown dorsum, lighter ventrum, equators non-pigmented, making the body appear striped. Large preclitellates with length 223-240 mm (*n* = 6 individuals); diameter 6.5-9 mm at x, 6-7 mm at xx; body circular in cross-section, tail tapering; 163-167 segments. First dorsal pore at 12/13, spermathecal pore

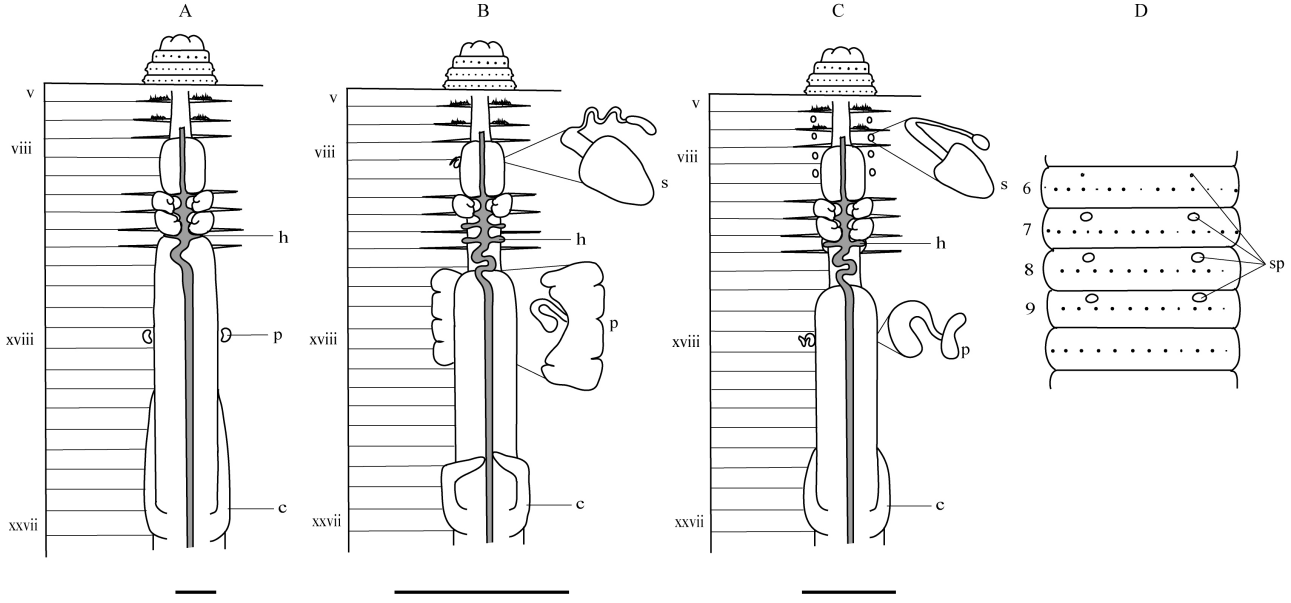

Fig. 4. Schematic dorsal views of the internal morphology of the three *Amynthas* species described here. (A) *A. dinagatensis* n. sp.; (B) *A. cagdianaoensis* n. sp.; (C) *A. talaandigensis* n. sp. Scale bars: A-C: 5 mm. (D) Schematic ventral view of polythecal *A. talaandigensis* n. sp., showing the intersegmental spermathecal pores (sp). Abbreviations: s, spermatheca; h, heart; p, prostate gland; c, caecum; sp, spermathecal pores.

absent. Female pore single in xiv, openings of male pores paired in xviii, distance between pores 6 mm (0.27 circumference apart ventrally), 20 setae between pores. Setae irregularly distributed around equators in some segments; 35-48 setae on vii, 70-73 setae on xx, dorsal setal gaps present, no ventral gaps. Genital markings lacking.

Septa 5/6/7 membranous, 7/8 and 10/11-12/13 muscular, 8/9/10 lacking. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia of intestinal segments located mainly on body near septum/body wall junction. Large gizzard in viii-x, esophagus with low vertical lamellae x-xii, intestinal origin in xiii, caeca simple originating in xxvii, extending forward to xxi; typhlosole originating in xxvi, simple fold, about 1/5 lumen diameter, intestinal wall with 43 longitudinal blood vessels. Hearts in x to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; those in viii extend to gizzard.

Ovaries and funnels free in xiii. Spermathecae lacking. Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii, each with short spherical dorsal lobe; vesicles of xi enclosed in testes sac; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; racemose prostates small, rudimentary, confined to xviii.

Remarks: The main distinguishing characters that separate *Amynthas* from *Pheretima* are the absence of nephridia on the spermathecal ducts and the absence of copulatory bursae in *Amynthas* (Sims and Easton 1972). Despite having no spermathecae to determine if nephridia is present on the spermathecal ducts or not, we assign *A. dinagatensis* n. sp. in *Amynthas* on the basis of the absence of copulatory bursae. Even at preclitellate stage, the spermathecae and the copulatory bursae in thecate *Pheretima* species should already be evident.

Prior to the last decade, seven *Amynthas* species had been reported from the Philippines, all from Luzon Island: *A. albobrunneus* Beddard 1912; *A. americanorum* Beddard 1912; *A. orientalis* Beddard 1912; *A. pauaiensis* Beddard 1912; *A. sodalis* Beddard 1912; *A. robustus* Vaillant 1889; and *A. corticis* Kinberg 1867. However, due to the lack of information on the location of the caeca on Beddard's (1912) five *Amynthas* species, and because the types of these species could not be located (Reynolds and Cook 1976), Hong and James (2004) proposed that placement of these species in *Amynthas* be considered provisional. Furthermore, Beddard's (1912) *Amynthas* species have share some features with Philippine *Pithemera* (James et al. 2004), leading Hong and James (2004) to suspect that the four species might actually be *Pithemera*.

Since all the *A. dinagatensis* specimens collected were preclitellate, we provisionally assign the new species to the *A. illotus* group of Sims and Easton (1972), which includes *Amynthas*

Table 4. Comparison of *Amynthas*, *Polypheretima*, and *Pithemera* species

Characters	*A. dinagatensis* n. sp.	*A. cagdianaoensis* n. sp.	*A. talaandigensis* n. sp.	*P. bukidnonensis* n. sp.	*P. zamboangensis* n. sp.	*P. nolani* n. sp.
Length	240	>52	85-110	131	223-306	143-159
Width x, xx	9, 7	2.6, 3	3.2-4.5, 3.7-4.5	5-6.5, 5.5-6.5	3.5-4, 4-5	3.5, 3.5
Dorsal pigmentation	Dark brown	brown	brown	brown	unpigmented	Reddish brown
Segment equator	unpigmented	pigmented	unpigmented	pigmented	unpigmented	unpigmented
Segments	163-167	?	85-105	147	227-248	100-114
1st dorsal pore	12/13	11/12	13/14	12/13	12/13	11/12
Setal gaps D, V	+, -	+, -	-, -	+, -	+, +	+, +
Spermathecal pores	-	Paired at 8/9	Paired at 6,7,8,9	Batteries at 5/6/7	-, paired at 5/6/7	Paired at 5/6
Sperm. pore distance	-	0.12	0.13	-	inconspicuous	0.19
Male pore distance	0.27	0.11	0.2	0.22	0.31	0.20
Setae between openings	20	3	12-13	6-7	8-9	9-11
Setae vii, xx	35-48, 70-73	40, 39	32-37, 40-45	39-45, 46-58	60-84, 69-70	34-36, 56-59
Genital markings	-	-	-	Paired in xix-xxi	Paired in xix-xxii	-
Gizzard	viii-x	viii-x	viii-x	viii-x	x-xi	viii-x
Intestinal origin	xiii	xv	xvi	xv	xvii	xiv
Caeca	xxvii-xxi	xxvii-xxiii	xxvii-xxiv	-	-	xxiii-xxi
Prostate	xviii	xv-xix	xviii	xvi/xvii-xix	xvi-xix	xvi-xx/ xv-xix
Copulatory bursae	-	-	-	-	-	xvii-xix

species without spermathecae. Tsai et al. (2002) acknowledged five species in this group: *A. hohuanmontis* Tsai et al. 2002; *A. illotus* Gates 1932; *A. assacceus* Chen 1935; *A. sheni* Chen 1935; and *A. oyuensis* Ohfuchi 1937. Blakemore (2007) eliminated this species group, with species assigned to it either considered have doubtful identity (given the status *species inquirenda*) and in need of further investigation, or synonymized with other species. *Amynthas dinagatensis*, despite having no clitellate specimen, differs markedly from other Philippine *Amynthas* in its relatively large size (240 mm × 7- 9 mm; adult body dimensions of other species range from 32-48 mm × 2.7-3.5 mm (*A. mindoroensis* Hong and James, 2004) to 84-111 mm × 4.6-5.8 mm (*A. heaneyi* James 2004); in having numerous setae (20) between male pores (6-9 in *A. isarogensis* Hong and James 2004; 4-7 in *A. malinaoensis* Hong and James 2004; 2-6 in *A. heaneyi* James 2004; and 0 in *A. philippinensis* Hong and James 2004, *A. mindoroensis* and *A. halconensis* Hong and James 2004); in having the intestinal origin in xiii (in xv, xvi, or xvii in the others); and in having longer caeca (xxvii-xxi) than the others (xxvii-xxv, xxiv, or xxiii). Although *A. dinagatensis* is similar in size to *A. americanorum* (200 mm × 8 mm) and *A. robustus* (113-244 mm × 5.6-7.5 mm), in contrast, the new species appears to have stripes because the segmental equators don't have pigmentation, whereas the equators are pigmented in *A. robustus* while *A. americanorum* has pale brown coloration. The new species also lacks genital markings around the spermathecal pores, while the latter two have, and the genital markings are especially numerous in *A. americanorum*. The intestinal origin of *A. dinagatensis* is in xiii while it is in xiv or xv in *A. robustus* and *A. americanorum*. Also, the caeca is long, covering seven segments, extending from xvii-xxi, while it only covers three segments in the latter two. In addition, the prostate glands are small, rudimentary, and confined to xviii in *A. dinagatensis*, but these are larger in *A. americanorum* (xvi-xxii) and *A. robustus* (xvi-xx or xxi).

***Amynthas cagdianaoensis* n. sp.**

(Fig. 4B, Table 4)

urn:lsid:zoobank.org:act:BBE85AA1-A978-4733-BBCE-8E5DF196C183

Material examined: Holotype: adult, amputee (NMA 4596), Brgy Boa, municipality of Cagdianao, Dinagat Province, (10°05'53"N, 125°39'42"E), 250 m asl, Dinagat Island, Philippines, coll. N. Aspe, J. Adeva, 23-26 Apr. 2004.

Etymology: The species is named for the municipality of Cagdianao, Dinagat Province, where this species was collected.

Diagnosis: Brown worm, body width 2.6-3 mm; closely paired spermathecal pores at intersegment 8/9; first dorsal pore 11/12; spermathecal pores and male pores 0.12 and 0.11, respectively; 3 setae between male pores; genital markings lacking; proandric male sexual system.

Description: Brown dorsum, pale ventrum, equators pigmented. Length > 52 mm (*n* = 1, adult amputee); diameter 2.6 mm at x, 3 mm at xx; body circular in cross-section. First dorsal pore at 11/12, paired spermathecal pores closely paired at 8/9, distance between spermathecal pores 1 mm (0.12 circumference apart ventrally). Female pore single in xiv, openings of male pores paired in xviii, distance between pores 1 mm (0.11 circumference apart ventrally), 3 setae between pores. Clitellum annular, from xiv to xvi. Setae irregularly distributed around equators in some segments; 40 setae on vii, 39 setae on xx, dorsal setal gaps present, ventral gaps lacking. Genital markings lacking.

Septa 4/5-7/8 and 10/11-13/14 thin, 8/9/10 lacking. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia of intestinal segments located mainly on body near septum/body wall junction. Large gizzard in ix-x, esophagus with low vertical lamellae x-xiii, intestinal origin in xv; caeca simple, originating in xxvii, folding upward in xxv, extending for two segments; typhlosole originating in xxvi, simple fold, about 1/4 lumen diameter, intestinal wall with 24 longitudinal blood vessels. Hearts in x to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; those in viii extend to gizzard.

Ovaries and funnels free in xiii. Spermathecae paired, postseptal in ix, no nephridia on ducts. Each spermatheca with pyriform ampulla; short, slender, muscular duct; single stalked diverticulum attached to ectal portion of right face of duct of right spermatheca, and on left face of duct of left spermatheca; stalks long and convoluted, terminating in sausage-shaped receptacle. Male sexual system proandric, testes and funnels enclosed in paired sacs in x; seminal vesicles xi, each with short spherical dorsal lobe; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; prostates in xv to xix; each prostate a dense, racemose mass with four lobes; stout U-shaped muscular duct from lateral margin of prostate widens toward body wall, then

narrows slightly just before body wall.

Remarks: *Amynthas cagdianaoensis* n. sp. belongs to the *A. supuensis* group of Sims and Easton (1972), characterized by having a pair of spermathecal pores at 8/9. Four species are assigned to this group: *A. antefixus* Gates 1935 and *A. supuensis* Michaelsen 1896 (both described from Halmahera, Indonesia), and *A. dinghumontis* Zhang et. al, 2006 and *A. liaoi* Zhang et. al, 2006 (both described from Guandong, China). The new species is smaller than *A. antefixus* (85-120 mm × 3.5-5 mm) and *A. supuensis* (115 mm × 6 mm) and lacks genital markings, whereas *A. antefixus* has the genital markings at the midventral line on iii, iv and v, and *A. supuensis* has them around the spermathecal and male pores. The first dorsal pore is at 11/12 in *A. cagdianaoensis*, but at 12/13 in *A. antefixus* and *A. supuensis*. Also, the male pores in *A. antefixus* are distantly spaced and located towards the lateral margins, while in *A. cagdianaoensis*, the male pores are much closer, (1 mm, 0.11 circumference apart ventrally). Moreover, the spermathecal diverticulum in *A. antefixus* has short stalk while in the new species it is long and convoluted. *Amynthas cagdianaoensis* is larger than *A. dinghumontis* (13-60 mm x 0.6-2 mm) and *A. liaoi* (55 mm x 1.1-2 mm), and although *A. dinghumontis* lacks genital markings like *A. cagdianaoensis*, the spermathecal and male pores of the former are more widely spaced (0.25 and 0.17-0.25, respectively). *Amynthas liaoi* differs from *A. cagdianaoensis* in having genital markings around the spermathecal and male pores, and more setae (8) between male pores. No Philippine congener closely resembles *A. cagdianaoensis* n. sp.

***Amynthas talaandigensis* n. sp.**

(Fig. 4C, 4D, Table 4)

urn:lsid:zoobank.org:act:D9356AF7-E305-43E9-9D7F-FEDCA398816F

Material examined: Holotype: adult (NMA 4597), Brgy Songco, municipality of Lantapan, Bukidnon Province, Mt. Kitanglad Range (8°05'47"N, 124°55'21"E), 2200 m asl, Mindanao Island, Philippines, coll. N. Aspe, 27-31 Oct. 2012. Paratypes: one adult (NMA 4613); two adults (ZRC. ANN 0066), same collection data as for holotype.

Etymology: The species is named for the Talaandig indigenous tribe of Mt. Kitanglad.

Diagnosis: Brown worm, adult length 85-110 mm; pair of spermathecal pores on small protrusions at intrasegments anterior of setal equators of 6, 7, 8, 9; first dorsal pore at 13/14; genital markings lacking; intestinal origin in xvi, prostate glands small, confined to xviii.

Description: Brown dorsum, pale ventrum, equators non-pigmented. Length 85-110 mm (*n* = 4 adults); diameter 3.2-4.5 mm at x, 3.7-4.5 mm at xx; body circular in cross-section, tail tapering; 85-105 segments. First dorsal pore at 13/14, paired spermathecal pores on small protrusions at intrasegments anterior of setal equators of 6, 7, 8, 9; spermathecal pores inconspicuous on 6; distance between spermathecal pores 1.8 mm (0.13 circumference apart ventrally). Female pore single in xiv, openings of male pores paired in xviii, distance between pores 2.8 mm (0.20 circumference apart ventrally), 12-13 setae between pores. Clitellum annular, from xiv to xvi. Setae irregularly distributed around equators in some segments; 32-37 setae on vii, 40-45 setae on xx, dorsal and ventral setal gaps present. Genital markings lacking.

Septa 4/5-6/7 and 12/13/14 thin, 7/8 and 10/11/12 muscular, 8/9/10 lacking. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia in intestinal segments located mainly on body near septum/body wall junction. Large gizzard in viii-x, esophagus with low vertical lamellae x-xiii, intestinal origin in xvi; caeca simple, originating in xxvii, extending forward to xxiv; typhlosole originating in xxvi, simple fold slightly less than lumen diameter, intestinal wall with 27-40 longitudinal blood vessels. Hearts in x to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; those in viii extend to gizzard.

Ovaries and funnels free in xiii. Spermathecae paired, postseptal in vi, vii, viii and ix, nephridia on ducts lacking. Each spermatheca with pyriform ampulla; long, slender, muscular duct; single stalked diverticulum attached to the ectal portion of right face of duct of right spermatheca, and on left face of duct of left spermatheca; stalk long, terminating in ovate receptacle. Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii, each with short, spherical dorsal lobe; vesicles of xi enclosed in testes sac; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; prostates very small, attached to wall in xviii; stout U-shaped muscular duct widens towards body wall, then narrows slightly just before body wall.

Remarks: *Amynthas talaandigensis* n. sp. belongs to the *A. rimosus* group of Sims and Easton (1972), which is characterized by having

intrasegmental spermathecae in 6, 7, 8, and 9. Sims and Easton assigned to this group *A. rimosus rimosus* (Gates 1931) and *A. rimosus effeminatus* (Gates 1932), both described from Myanmar. However, Blakemore (2007) suggested that the latter subspecies is probably a synonym of the nominal subspecies. The new species differs from *A. r. rimosus* in the location of the first dorsal pore (at 13/14, compared to 12/13 in *A. r. rimosus*), the absence of genital markings or distinctly demarcated porophores around the male pores (Gates in 1931 described *A. r. rimosus* to have a pair of thickly crescent-shaped genital markings in xviii, but in 1972, he described the species to have distinctly demarcated porophores around the male pores instead of genital markings), the origin of the intestine (in xvi, compared to xv in *A. r. rimosus*), and the size of the prostate glands (in xviii, compared to covering five segments from xv-xix in *A. r. rimosus*). Another species with ventral intrasegmental spermathecal pores is *A. monstriferus* (Kobayashi 1936) from Korea. This species is much larger (235 mm) than *A. talaandigensis*, has genital markings on viii, and has manicate intestinal caeca. Hong and James (2009b) included *A. ani*, also from Korea, in this species group; *Amynthas ani* is larger (164-171 mm × 7.8 mm) than *A. talaandigensis*, has more segments and more setae around segments vii and xx (125-130, 65 and 68, respectively), and has longer prostate glands (xvii-xx). *Amynthas talaandigensis* is the second *Amynthas* species described from Mt. Kitanglad Range, following *Amynthas heaneyi* (James 2004).

Genus *Polypheretima* Michaelsen 1934

Type species: *Perichaeta stelleri* Michaelsen 1892.

Generic Diagnosis

Body cylindrical; setal arrangement perichaetine; annular clitellum covering segments xiv-xvi; pair of male pores in xviii on circular porophores that may be within copulatory bursae; ventral genital markings present or absent; esophageal gizzard in viii; intestine begins in xv or xvi; nephridia on spermathecal ducts lacking; caeca lacking; male sexual system usually holandric, with testes and funnels enclosed in paired sacs in x and xi; seminal vesicles in xi and xii; spermathecal pores small, spermathecal diverticula simple and usually ectal in origin; prostates racemose; copulatory bursae may or may not be present; ovaries free in xiii; oviducts lead to single or closely paired opening (Easton 1979).

Polypheretima bukidnonensis n. sp.

(Fig. 5A, 5B, Table 4)

urn:lsid:zoobank.org:act:A39D1ED9-69B3-4E63-9A90-F7A6D258AA6C

Material examined: Holotype: adult (NMA 4598), municipality of Maramag, Bukidnon Province, Mt. Musuan Range (7°52'53.8"N, 125°03'57.6"E), 400 m asl, Mindanao Island, Philippines, coll. N. Aspe, 26 Oct. 2012. Paratype: one adult, amputee (NMA 4614), same collection data as for holotype.

Etymology: The species is named for the province of Bukidnon.

Diagnosis: Brown worm, adult length 131 mm; paired spermathecal battery pores at intersegments 5/6/7; 7-11 pyriform-shaped spermathecae in each battery; male pores 0.22 circumference apart; 39-45 setae on vii, 46-58 setae on xx; genital markings widely paired on xix to xxi, in line with the male pores; gizzard origin in viii; copulatory bursae lacking.

Description: Brown dorsum, pale ventrum, equators pigmented. Length 131 mm (*n* = 1 adult); diameter 5-6.5 mm at x, 5.5-6.5 mm at xx; body circular in cross-section, tail tapering; 147 segments. First dorsal pore at 12/13, paired spermathecal battery pores at intersegments 5/6/7. Female pore single in xiv, openings of male pores paired in xviii, distance between pores 3.8-4.5 mm (0.22 circumference apart ventrally), 6-7 setae between pores. Clitellum annular, from xiv to xvi. Setae unevenly distributed around equators in some segments; 39-45 setae on vii, 46-58 setae on xx, dorsal setal gaps present, ventral setal gaps lacking. Paired genital markings widely spaced on xix to xxi, in line with male pores.

Septa 4/5 membranous, 5/6-7/8 and 10/11-13/14 thin, 8/9/10 lacking. Dense tufts of nephridia on anterior faces of 4/5, 5/6, and 6/7; nephridia of intestinal segments located mainly on body near septum/body wall junction. Large gizzard in viii-x, esophagus with low vertical lamellae x-xiii, intestinal origin in xv, caeca lacking; typhlosole originating in xxvi, simple fold, 1/3 lumen diameter. Hearts in x to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; those in viii extend to gizzard.

Ovaries and funnels free in xiii. Spermathecal

batteries paired, postseptal in vi and vii. One adult individual with eight spermathecae closely aligned on left side and nine spermathecae closely aligned on right side in vi, and eight spermathecae closely aligned on left side and 10 spermathecae closely aligned on right side in vii. Another adult individual with eight spermathecae closely aligned on left side and 11 spermathecae closely aligned on right in vi, and seven spermathecae on left and 11 on right in vii. Spermathecae small, ampulla pyriform, spermathecal duct short, slender; diverticulum stalk long and slender, attached ectally to duct, terminating in short, sausage-shaped receptacle; no nephridia on spermathecal ducts. Male sexual system holandric, testes and funnels enclosed in paired ventral sacs in x and xi; seminal vesicles in xi and xii; pseudovesicles in xiii; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; prostates in xvii to xix, each prostate racemose, compact; muscular duct from lateral margin of prostate widens towards body wall, then narrows slightly just before body wall; copulatory bursae lacking.

Remarks: *Polypheretima bukidnonensis* n. sp. belongs to the *Po. elongata* Perrier 1872 group of Easton (1979), characterized by having paired genital markings in xix and successive segments in line with the male pores, paired batteries of

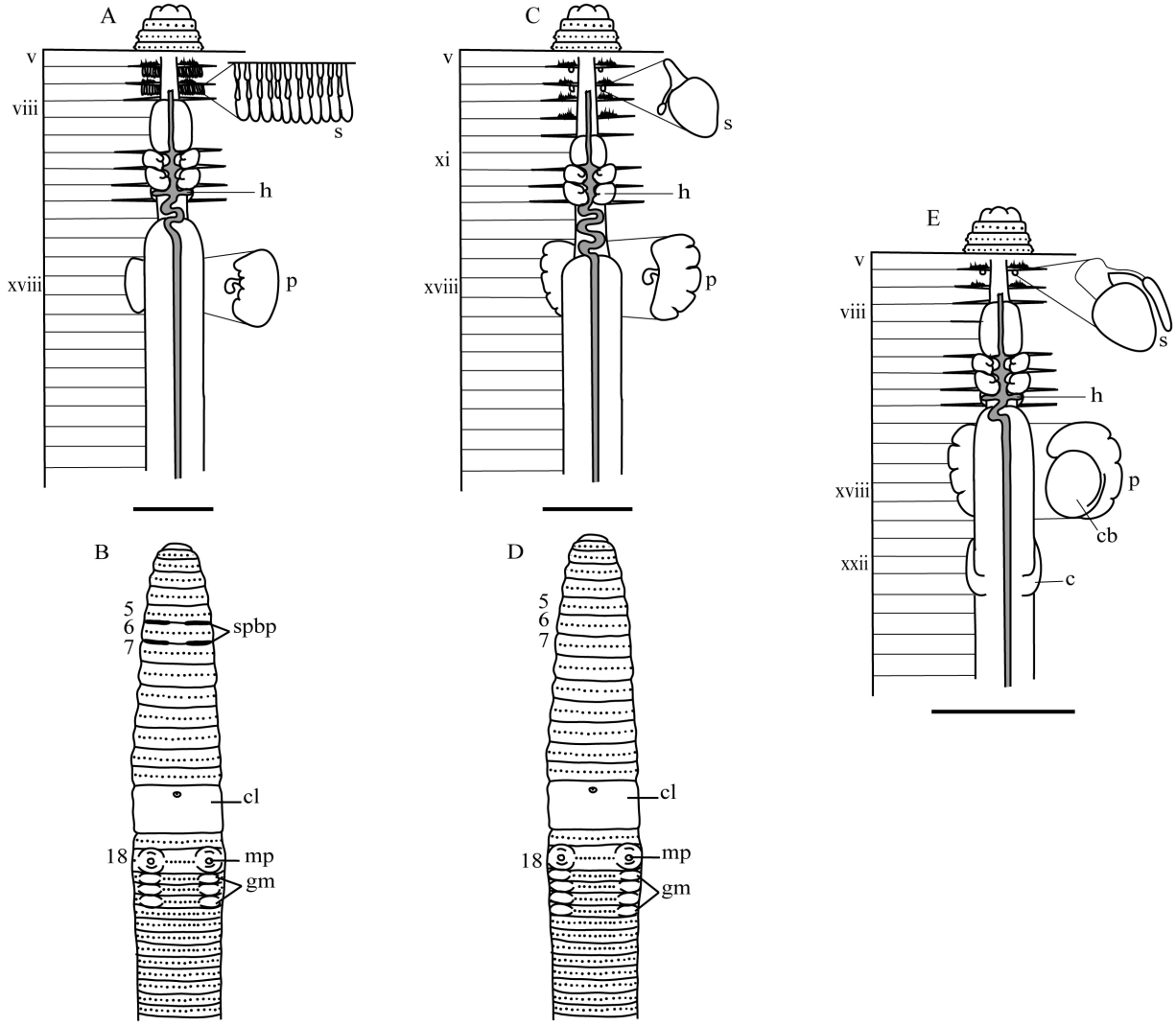

Fig. 5. Schematic views of the internal and external morphology of the *Polypheretima* and *Pithemera* species described here. (A, B) *Polypheretima bukidnonensis*; (A) dorsal view of internal morphology; (B) external ventral view; (C, D) *Polypheretima zamboangensis* n. sp.; (C) dorsal view of internal morphology; (D) external ventral view; (E) *Pithemera nolani* n. sp., dorsal view of internal morphology, with prostates in xv-xix. Abbreviations: s, spermatheca; h, heart; p, prostate gland; cb, copulatory bursa; c, caecum; spbp, spermathecal batteries pores; cl, clitellum, mp, male pores, gm, genital markings. Scale bars: A-E, 5 mm.

up to 28 spermathecae in vi and/or vii, and a shallow copulatory bursae with no stalked glands. Easton (1979) included five species in the group: *Po. elongata*; *Po. everetti* Beddard and Fedarb 1895; *Po. kinabaluensis* Beddard and Fedarb 1985; *Po. phacellotheca* Michaelsen 1899; and *Po. stelleri* Michaelsen 1892. *Polypheretima mindanaoensis* Aspe and James 2015 from Mt. Malindang was recently added to this species group. Among members of *Po. elongata* group, *Po. bukidnonensis* is similar to *Po. elongata* and *Po. everetti* in having paired genital markings widely spaced on xix to xxi or xxi, in line with the male pores. However, *Po. elongata* and *Po. everetti* are large worms (355 mm and 300 mm, respectively); the male pores are more widely spaced (0.25 circumference apart ventrally); there are many more setae per segment (up to 130), whereas *Po. bukidnonensis* has only 39-58 setae; and these species have copulatory bursae, whereas *Po. bukidnonensis* lacks them. *Polypheretima elongata* is also non-pigmented and rarely has more than three spermathecae per battery in 5/6/7, while *Po. everetti* has 6-17 spermathecae per battery in 5/6/7, and there are 16 setae between male pores. *Polypheretima bukidnonensis* is similar to *Po. mindanaoensis* in size (90-118 mm × 5.1-7 mm) and in lacking copulatory bursae, but the latter is non-pigmented and the genital markings extend from xix to xxvi. In addition, *Po. mindanaoensis* has fewer spermathecae (0-5) per battery in 5/6/7, and its gizzard originates in viii.

***Polypheretima zamboangensis* n. sp.**

(Fig. 5C, 5D, Table 4)

urn:lsid:zoobank.org:act:CC5B1AC9-260E-4E39-BE08-01A417ED5776

Material examined: Holotype: adult (NMA 4599), Brgy Timolan, municipality of Tigbao, Zamboanga del Sur Province, Mt. Timolan (7°48'00.0"N 123°15'00.0"E), 1000 m asl, Mindanao Island, Philippines, coll. N. Aspe, 18-20 Dec. 2012. Paratypes: five adults (NMA 4615); four adults (ZRC.ANN 0068), same collection data as for holotype.

Etymology: The species is named for the province of Zamboanga del Sur.

Diagnosis: Slender worm, adult body dimension 223-306 mm × 3.5-5; body non-pigmented; 227-248 segments; spermathecal pores paired and inconspicuous at intersegments 5/6/7, or lacking; 60-84 setae on vii, 69-70 setae on xx; male pores 0.31 circumference apart; gizzard in x; metandric male sexual system.

Description: Body non-pigmented, equators non-pigmented. Length 2230-306 mm (*n* = 10 adults); diameter 3.5-4 mm at x, 4-5 mm at xx; body circular in cross-section, tail tapering; 227-248 segments. First dorsal pore at 12/13; paired spermathecal pores at intersegments 5/6/7, inconspicuous, lacking in some specimens. Female pore single in xiv, openings of male pores paired in xviii, distance between openings 3.9 mm (0.31 circumference apart ventrally), 8-9 setae between openings. Clitellum annular, from xiv to xvi. Setae irregularly distributed around equators in some segments; 60-84 setae on vii, 69-70 setae on xx; two first ventral setal lines prominent; dorsal and ventral setal gaps present. Paired genital markings widely spaced on xix to xxii, in line with male pores.

Septa 4/5-9/10 muscular, 11/12-13/14 thin, 10/11 lacking. Dense tufts of nephridia on anterior faces of 5/6-8/9; nephridia of intestinal segments located mainly on body near septum/body wall junction. Gizzard in x-xi, esophagus with low vertical lamellae x-xiii, intestinal origin in xvii, caeca lacking; typhlosole originating in xx, simple fold, about 1/5 lumen diameter. Hearts in xi to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; those in viii extend to gizzard.

Ovaries and funnels free in xiii. In one specimen, spermathecae two pairs, postseptal in vi and vii, spermathecal ampulla pyriform, spermathecal duct short, slender; stalked diverticulum attached to ental portion of left face of duct near ampulla of right spermatheca, and on left face of duct of left spermatheca; stalks short, terminating in small ovate receptacle; no nephridia on spermathecal ducts. Spermathecae lacking in other specimens. Male sexual system metandric, testes and funnels enclosed in paired ventral sacs in xi; seminal vesicles in xii and xiii; pseudovesicles in xiii; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; prostates in xvi to xix, each prostate racemose, compact, with five minor lobes; stout U-shaped muscular duct from lateral margin of prostate widens towards body wall, then narrows slightly just before body wall; copulatory bursae lacking.

Remarks: A metandric male sexual system and paired spermathecal pores in 5/6/7 indicate that *Po. zamboangensis* n. sp. belongs to the *Po. huoensis* Easton 1979 species group. However, members of this species group are confined to Papua New Guinea (Easton 1979) and have a different genital marking pattern (genital markings

present on vii-ix, xvii, and xix). Ten species in *Polypheretima* have been reported from the Philippines: *Polypheretima monticola* Beddard 1912 from Benguet Province, Luzon Island; *Po. elongata* Perrier 1872 and *Po. everetti* Beddard and Fedarb 1895, both from Balabac Island, Palawan Province; *Po. fruticosa* Hong and James 2008a, *Po. perlucidula* Hong and James 2008a, and *Po. bannaworensis* Hong and James 2008a, from Banaue, Luzon Island; *Po. pagudpudensis* Hong and James 2011a from Kalbaryo, Luzon Island; and *Po. mindanaoensis* Aspe and James 2015, *Po. bukidnonensis* n. sp. (this study), and *Po. zamboangensis* n. sp. (this study), from Mindanao Island. Among these species, *Po. zamboangensis* is similar to *Po. perlucidula* and *Po. pagupdudensis* in having a pair of spermathecae in vi and vii and in lacking body pigmentation. However, the latter two species are smaller (*Po. perlucidula*, 38-56 mm x 1.3-1.5 mm; *Po. pagudpudensis*, 56-63 mm x 2.1-2.2 mm); *Po. perlucidula* lacks genital markings, and there are only epidermal thickenings on segment xviii in *Po. pagudpudensis*. In addition, in the latter two species the pre-clitellar setae are more numerous than the post-clitellar setae (50 and 23, respectively, in *Po. perlucidula*; 63 and 27 in *Po. pagupudensis*), the origin of gizzard is in viii, and the male sexual system is holandric. *Polypheretima zamboangensis* has more segments (227-248) than all other Philippine *Polypheretima* species (*Po. fruticosa*, 105-107; *Po. perlucidula*, 117-131; *Po. bannaworensis*, 67-95; *Po. pagudpudensis*, 126-136; *Po. mindanaoensis* M, 140-141; *Po. bukidnonensis* n. sp., 147; *Po. everetti*, 126) except for *Po. elongata* (136-297). But the male pores in *Po. zamboangensis* are more distant (0.31 circumference apart ventrally) compared to that of *Po. elongata* (0.25 circumference apart ventrally), the gizzard is bigger (x-xi vs. ix in *Po. elongata*), the intestinal origin is in xvii (vs. xv in *Po. elongata*), and the prostates are smaller (xvi-xix vs. xvi-xxi in *Po. elongata*). The other species have holandric male sexual system and either have spermathecal batteries in 5/6/7 (*Po. bukidnonensis* n. sp., *Po. mindanaoensis*, *Po. elongata*, and *Po. everetti*), have four pairs of spermathecae in 5/6-8/9 (*Po. monticola* and *Po. bannaworensis*), or have only one pair in 5/6 (*Po. fruticosa*).

Genus *Pithemera* Sims and Easton 1972

Type species: Perichaeta bicincta Perrier 1875.

Generic Diagnosis

Body cylindrical; setae numerous, regularly arranged around each segment; clitellum annular, covering two, two and a half, or three segments from xiv to xv, and/or half of xvi; spermathecal pores small, three to five pairs from 4/5 to 8/9; female pore single or paired in xiv; genital markings present or absent; intestinal caeca originate in or near xxii (in *Pheretima*, caeca originate in xxvii); spermathecal ducts lack nephridia (as in *Amynthas* and *Polypheretima*); male system holandric or metandric; prostate gland racemose; copulatory bursae may be present or absent.

Pithemera nolani n. sp.

(Fig. 5E, Table 4)

urn:lsid:zoobank.org:act:0A779DE1-6BC2-449F-B6A6-C684CEEB8989

Material examined: Holotype: adult (NMA 4600), municipality of San Isidro, Davao Occidental Province, Mt. Hamiguitan (06°44'03"N, 126°12'15"E), 1430 m asl., Mindanao Island, Philippines, coll. Nolan Aspe, J. Cantil, 7-10 May 2006. Paratypes: five adults (NMA 4616); four adults (ZRC.ANN 0069), same collection data as for holotype.

Etymology: The species is named after Nolan Aspe, who assisted in the fieldwork.

Diagnosis: Reddish brown worm, adult length 143-159 mm; equators non-pigmented making the body appear striped; pair of spermathecal pores at intersegment 5/6; first dorsal pore at 11/12; 9-11 setae between male pores; spermathecae large, ovate; intestinal origin in xiv; copulatory bursae present.

Description: Reddish brown dorsum, pale ventrum, equators non-pigmented, making the body appear striped. Length 143-159 mm (n = 5 adults); diameter 7.5 mm at x, 7 mm at xx; body circular in cross-section, tail tapering; 100-114 segments. First dorsal pore at 11/12, paired spermathecal pores at 5/6, distance between spermathecal pores 4.5 mm (0.19 circumference apart ventrally). Female pore single in xiv, openings of male pores paired in xviii, distance between pores 4.5 mm (0.20 circumference apart ventrally), 9-11 setae between pores. Clitellum annular, from xiv to xvi. Setae irregularly distributed around equators in some segments; 34-36 setae on vii, 56-59 setae on xx, dorsal setal gaps present, ventral setal gaps lacking. Genital markings lacking.

Septa 4/5-7/8 and 13/14 thin, 10/11-12/13 muscular, 8/9/10 lacking. Dense tufts of nephridia on anterior faces of 5/6 and 6/7; nephridia of intestinal segments located mainly on body near septum/body wall junction. Large gizzard in viii-x, esophagus with low vertical lamellae x-xiii, intestinal origin in xiv; caeca simple, originating in xxiii, extending forward to xxi; typhlosole originating in xxiii, simple fold slightly less than lumen diameter. Hearts in x to xiii, esophageal; commissural vessels in vi, vii, and ix lateral; those in viii extend to gizzard.

Ovaries and funnels free in xiii. Spermathecae paired, postseptal in vi, nephridia on ducts lacking. Each spermatheca large, with ovate ampulla; bulbous, muscular duct; single stalked diverticulum attached to right face of duct of right spermatheca, and to left face of duct of left spermatheca; stalks long, terminating in sausage-shaped receptacle. Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal vesicles in xi, xii, each with digitate dorsal lobe; vasa deferentia slender, free from body wall on way to ental end of prostatic ducts; prostates in xvi to xx or xv to xix; each prostate a dense, racemose mass with four lobes; muscular duct entering from the lateral margin of prostate to posterior margin of copulatory bursa. Copulatory bursae round in xvii-xix; coelomic surfaces muscular, secretory diverticula lacking; roof with two thick pads, floor pads lacking; penis lacking.

Remarks: Sims and Easton (1972) include the absence of copulatory bursae as one of the distinguishing characters of *Pithemera*. But despite the presence of copulatory bursae in *Pi. nolani* n. sp., we assign this new species in *Pithemera* rather than in *Pheretima* on the basis of having no nephridia on the spermathecal ducts and in having the caecal origin near xxii. Therefore, we amend the generic diagnosis of *Pithemera* Sims and Easton 1972, to include species with copulatory bursae.

Pithemera species reported from the Philippines include: *Pi. bicincta* Perrier 1875; *Pi. rotunda* James et al. 2004; *Pi. philippinensis* James et al. 2004; *Pi. duhuani* Hong and James 2008a; *Pi. fragumae* Hong and James 2008a; *Pi. ifugaoensis* Hong and James 2008a; *Pi. triangulata* Hong and James 2008a; *Pi. glandis* Hong and James 2011a; *Pi. fusiformis* Hong and James 2011a; *Pi. levii* Hong and James 2011a; *Pi. malindangensis* Aspe and James 2015; *Pi. duminagati* Aspe and James 2015; *Pi. donvictorianoi* Aspe and James 2015; and *Pi. nolani* n. sp. (this study). *Pithemera nolani* n. sp. differs from the other *Pithemera* species in having only a pair of spermathecal pores in 5/6, whereas the others have either five pairs in 4/5-8/9 (*Pi. bicincta*, *Pi. rotunda*, *Pi. philippinensis*, *Pi. duhuani*, *Pi. fragumae*, *Pi. ifugaoensis*, *Pi. triangulata*, *Pi. glandis*, *Pi. fusiformis*, *Pi. levii*, *Pi. malindangensis* and *Pi. duminagati*), four pairs in 5/6-8/9 (*Pi. donvictorianoi*), four pairs in 4/5-7/8 (*Pi. levii*), or three pairs in 4/5-6/7 (*Pi. triangulata*). *Pithemera nolani* also markedly differs among congeners in possessing copulatory bursae. In addition, *Pi. nolani* is also the largest (143-159 mm × 3.5 mm) species of *Pithemera* in the Philippines; other species range from 20-22 mm × 1.7-1.8 mm (*Pi. fusiformis*) to 91-144 mm × 3.5-4 mm (*Pi. malindangensis*), with most having maximum lengths less than 100 mm.

DISCUSSION

Blakemore (2007) listed a total of 40 valid *Pheretima* species in SE Asia and the Pacific region, described from 1886 to 2004. The list includes 18 Philippine species that were described in James (2004) and James et al. (2004). From 2004 to the present, including the new species described here, there are now 80 known *Pheretima* species in the Philippines, comprising 58% of the world's *Pheretima*. Aspe and James (2015) likewise stated that the Philippines has the highest diversity for *Pithemera*, with now 14 species, comprising 43% of the world's *Pithemera*. These figures suggest that the archipelago may be the center of species radiation for these groups. For *Polypheretima*, of the 68 valid species recorded, Indonesia has the highest diversity with 26% of the total number, followed by Vietnam with 19%, and the Philippines with 15%. For *Amynthas*, with a record of around 470 valid species, China showed to have the highest diversity (17%) followed by Korea (12%), Myanmar and Indonesia (each with 11%), and Taiwan (10%) (Blakemore 2007, Hong 2007, Tsai et al. 2010, Bantaowong et al. 2011, Shen 2012, Blakemore et al. 2013, Hong and James 2013, Shen et al. 2013, 2014, Sun et al. 2013, Zhao et al. 2013). These figures also suggest that Indochina may be the center of species radiation for these groups.

de Bruyn et al. (2014) conducted meta-analyses of geological, climatic, and biological data sets from SE Asia to determine which areas have been the sources of long-term biological

diversity, particularly in the pre-Miocene, Miocene, and Plio-Pleistocene intervals. Their study included published molecular phylogenies of taxa representing plants, insects and spiders, freshwater crustaceans, freshwater molluscs, freshwater fishes, herpetofauna, birds, and mammals. Despite having no data for earthworms, their results, which suggest that Borneo and Indochina were the major "evolutionary hotspots" and were the source of species dispersal of a diverse range of fauna and flora in the region, including the Philippines, in the early Miocene, seem to agree with the suggestion regarding the species radiation in earthworms. Some species may have likely dispersed from Borneo to the Philippines (except Palawan) through the Sulu Archipelago "land bridges" during sea level minima, with subsequent interspecific competition between invaders and members of the original populations (Sims and Easton 1972; Oliveros and Moyle 2010). For other species, dispersal across water may have been achieved by rafting (de Queiroz 2005; Vidal et al. 2008). The geographical origins and affinities of the Borneo and Philippine earthworms may extend to Australasia, where some native earthworm species are regarded as being congeneric with the Asian species (Sims and Easton 1972).

Mindanao itself is a collision complex of three arc systems: the East Mindanao arc, which includes Dinagat Island and the Mt. Hamiguitan Range; the Central Mindanao volcanic arc, which includes Camiguin Island, Mt. Kitanglad, Mt. Musuan, and Mt. Apo; and the West Mindanao arc (Corpus 1992) (Fig. 1). The East Mindanao arc, which originated near the Australian plate, collided and coalesced with the Central Mindanao volcanic arc around the Early Miocene (~20 Ma) as the Philippine Sea Plate was moving northward towards a subduction zone in the Philippine trench (Hall 1996). The East/Central Mindanao complex collided and coalesced with the West Mindanao arc by strike-slip fault motion by the end of Miocene (~5 Ma) by progressive merging of the West Sangihe arc with Talaud-Halmahera arc system (Corpus 1992; Hall 1996). By the late Pliocene (~1 Ma), the Zamboanga Peninsula, which is a part of Sunda Shelf from the north, coalesced with the rest of Mindanao (Hall 1996). This geological history may provide hint on why the Mindanao earthworm fauna is so diverse.

It is unknown whether the distributions of the species reported here were broader prior to human invasion. What we see as their present distributions could be artifacts of human disturbance and/or limited sampling, which was conducted in undisturbed forests to the exclusion of other sites. Future molecular studies can elucidate the phylogeny and geographical distribution of species and populations at several levels: among the West Mindanao, Central Mindanao, and East Mindanao arcs; among the Philippine Island groups; and among the Philippine archipelago and other archipelagos and continental areas in SE Asia. In a preliminary molecular phylogenetic analysis of genera in the *Pheretima* group (James 2005b) based on combined data from the 16S and 28S rRNA genes, the *sangirensis* group formed a clade with 100% nodal support. However, the analysis included only Luzon specimens, and a broader analysis including specimens from Mindanao and Visayas Islands is needed to confirm monophyly of this group. In the same analysis, *Pithemera* and *Polypheretima* from Luzon formed a strongly supported clade, whereas the Philippine *urceolata* species group emerged as polyphyletic. A phylogenetic study with broader taxonomic and geographical coverage will be necessary for a clear understanding of the evolutionary relationships among pheretimoid earthworms in the Philippines.

The number of species collected from the sites here (except Mt. Malindang and Mt. Kitanglad) is fewer, with only one to five species per site (Table 1) compared to the number of species collected at Mt. Malindang (22 species in Aspe and James 2014, 2015) and at Mt. Kitanglad (18 species in James 2004). This is due to that the sampling duration in the sites reported here was shorter (three to six days) compared to the sampling duration and effort reported in Aspe and James (2014, 2015) and James (2004), which took several weeks. However, we highly anticipate that there are still more species waiting to be discovered in these, sites and in the rest of the Philippines, especially when we would already include to examine the earthworm composition in the Visayas group of islands, with each island being ecologically unique. The morphological distinctions among the known species are relatively clear at present, but as the described diversity continues to increase, we can expect the distinctions to become more subtle, and will need verification from molecular data. For now, we provide a key to the species described herein from Mindanao, Camiguin, and Dinagat islands, which is useful for regional studies. This key can be used together with the keys provided in James (2004) and Aspe and James (2014, 2015) to identify species, but this key should be used with caution

in identifying earthworms from outside Mindanao and associated islands.

Key to earthworms reported from Mindanao, Camiguin, and Dinagat islands

1. Nephridia on spermathecal ducts lacking 2
- Nephridia on ducts present; copulatory bursae present .... (*Pheretima*) 6
2. Copulatory bursae lacking 3
- Copulatory bursae present, intestinal caeca originating in xxiii; reddish brown dorsum; equators non-pigmented, making the body appear striped; pair of spermathecal pores at 5/6; adult length 143-159 mm .... *Pithemera nolani* n. sp.
3. Intestinal caeca originating in xxvii ..... (*Amynthas*) 4
- Intestinal caeca lacking ..... (*Polypheretima*) 5
4. Spermathecae lacking, purplish brown dorsal, equators non-pigmented making the body appear striped, first dorsal pore 12/13, 20 setae between male pores, 240 mm × 7-9 mm ..... *Amynthas dinagatensis* n. sp.
- Spermathecae paired at intersegments 8/9; brown dorsum; first dorsal pore at 11/12; 3 setae between male pores; body width 2.6-3 mm ..... *Amynthas cagdianaoensis* n. sp.
- Spermathecae paired at intrasegments 6, 7, 8, 9; brown dorsum; first dorsal pore at 13/14; 12-13 setae between male pores; adult length 85-110 mm .... *Amynthas talaandigensis* n. sp.
5. Spermathecae in pairs at 5/6/7; body non-pigmented; proandric male system; adult length 223-306 mm .... *Polypheretima zamboangensis* n. sp.
- Spermathecae in batteries at 5/6/7; dorsum brown; holandric male system; adult length 131 mm .... *Polypheretima bukidnonensis* n. sp.
6. Secretory diverticula projecting from copulatory bursae present ..... *P.* (*Parapheretima*) 7
- Secretory diverticula projecting from copulatory bursae lacking ..... *P.* (*Pheretima*) 8
7. Spermathecae paired at 7/8; secretory diverticula projecting from lateral surface of copulatory bursae; long, tapering penes ..... *P.* (*Paraph.*) *pandanensis* n. sp.
- Single midventral spermatheca at 5/6; secretory diverticula projecting from anterior margin of copulatory bursae; penes lacking ..... *P.* (*Paraph.*) *boaensis* n. sp.
8. Spermathecae at ..... (*P. urceolata* species group) 9
- Spermathecae at 7/8 ..... (*P. sangirensis* species group) 12
9. Body length ≤ 90 mm 10
- Body 305-347 mm in length; purplish black dorsum; equators non-pigmented, making the body appear striped; first dorsal pore at 13/14; penes lacking .... *Pheretima enormis* n. sp.
10. Brown pigmentation over entire dorsum 11
- Segmental equators non-pigmented making the body appear striped; body 81-90 mm × 3-4 mm; first dorsal pore at 12/13; 2 setae between male pores; penis lacking .... *Pheretima hamiguitanensis* n. sp.
- Reddish-brown dorsal stripes; first dorsal pore at 11/12; 12-14 setae between male pores; penes present .... *Pheretima dinagatensis* n. sp.
11. Body 33-47 mm × 1-1.2 mm, thread-like; first dorsal pore at 12/13; 3 setae between male pores; penes present .... *Pheretima acia* n. sp.
- Body > 58 mm × 2.5-3 mm; first dorsal pore at 11/12; 8 setae between male pores; penis lacking .... *Pheretima lantapanensis* n. sp.
12. Large worm, body 163-350 mm × 7.2-12 mm; purplish brown dorsum; may have no spermathecae; spermathecal pores 0.16 circumference apart for individuals with spermathecae; male pores 0.15-0.16 circumference apart; penis lacking ..... *Pheretima apoensis* n. sp.
- Large worm, body 147-225 mm × 7-9.5 mm; purplish brown dorsum; spermathecal pores 0.2 circumference apart; male pores 0.23 circumference apart; penes present .... *Pheretima timpoongensis* n. sp.
- Body 63-122 mm × 3.5-5.2 mm; reddish brown dorsum; spermathecal pores 0.17 circumference apart; male pores 0.15-0.18 circumference apart; penis lacking .... *Pheretima camiguinensis* n. sp.
- Body > 165 mm × 6.5-7 mm; spermathecal pores 0.21 circumference apart; male pores 0.17 circumference apart; penis lacking ..... *Pheretima sibucalensis* n. sp.

CONCLUSIONS

With the addition of new species in this paper, there are now currently 80 known species of *Pheretima* (of which two belong to subgenus *Parapheretima*), 16 species of *Amynthas*, 10 species of *Polypheretima*, and 14 species of *Pithemera* recorded in the Philippines. Among the *Pheretima* (*Pheretima*), which is the most speciose among the earthworm genera in the Philippines, there are now currently 27 species of the *sangirensis* group of Sims and Easton (1972), 20 species of the *urceolata* groups of Sims and Easton (1972), and one athecate species in the country.

List of abbreviations

n. sp.- new species, Ma- million years ago, Brgy- Barangay= precinct, NMA- National Museum of the Philippines Annelid Collection, ZRC.ANN- Annelid Collection of the Zoological Reference Collection, Lee Kong Chian Natural History Museum, NUS, Singapore, s- spermathecae, h- heart, cb- copulatory bursa, c- caecum, spbp- spermathecal battry pores, cl- clitellum, mp- male pores, gm- genital markings

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the manuscript. Both authors approved the final manuscript.

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