

## Six New Earthworms of the Genus *Pheretima* (Oligochaeta: Megascolecidae) from Balbalan-Balbalasang, Kalinga Province, the Philippines

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**Yong Hong and Samuel W. James (2010)** Six new earthworms of the genus *Pheretima* (Oligochaeta: Megascolecidae) from Balbalan-Balbalasang, Kalinga Province, the Philippines. *Zoological Studies* 49(4): 523-533. Six new species of the genus *Pheretima* are described from forested lands near the village of Balbalasang in Barangay Balbalan, Kalinga Province, Luzon I., the Philippines: *Pheretima kalingaensis* sp. nov., *Pheretima aguinaldoi* sp. nov., *Pheretima balbalanensis* sp. nov., *Pheretima banaoi* sp. nov., *Pheretima pugnatoris* sp. nov., and *Pheretima tabukensis* sp. nov. *Pheretima kalingaensis* sp. nov. and *P. aguinaldoi* sp. nov. have spermathecal pores in 6/7, which are 0.09-0.16 and 0.21 circumferences apart, respectively. *Pheretima balbalanensis* sp. nov. and *P. banaoi* sp. nov. belong to the *dubia*-group of Sims and Easton (1972) with 3 pairs of spermathecal pores in 6/7-8/9. In *P. balbalanensis* sp. nov., the penis is a transverse ridge with an apical pore, but in *P. banaoi* sp. nov. the penis is a small elliptical bump. *Pheretima pugnatoris* sp. nov. and *P. tabukensis* sp. nov. belong to the *darnleiensis*-group of Sims and Easton (1972) with 4 pairs of spermathecal pores in 5/6-8/9. *Pheretima pugnatoris* sp. nov. has pale pigmentation, lacks septa 8/9/10, and has a typhlosole. *Pheretima tabukensis* sp. nov. has dark pigmentation including part of the ventral surface, has septa 8/9/10, and lacks a typhlosole. Descriptions of the new species are provided, including illustrations of the ventral view, and representative spermathecae. The reproductive anatomy suggests that the penes of the Philippine *darnleiensis*-group members are not intromittent organs, and that some of the non-*darnleiensis* group members were derived from the *darnleiensis*-group. <http://zoolstud.sinica.edu.tw/Journals/49.4/523.pdf>

**Key words:** Earthworms, Megascolecidae, *Pheretima*, New species, the Philippines.

The Balbalasang-Balbalan area is included in the Philippine National Integrated Protected Areas System under the category of Natural Biotic Areas. Balbalasang-Balbalan is one of the most interesting and important sites for biodiversity conservation in the country. Its hardwood, pine, and mossy forests have survived the rash of mining and logging operations that have scarred much of the Luzon Cordillera. Balbalasang is a village within Barangay (the smallest political unit in the Philippines) Balbalan. The topography of Kalinga Province is rugged and steep with mountain peaks

ranging 1,500-2,500 m high. The province's western portion is characterized by sharp-crested interlinking peaks, isolated flatlands, plateaus, and valleys. The eastern portion is generally rolling with gradually sloping foothills.

This paper is one of a series of reports on the earthworm fauna of the Philippines (Hong and James 2004a, James 2004ab 2006, James et al. 2004). Beginning in early 2001, we surveyed numerous sites in the northern Philippines, one of which is covered here. The 6 new earthworm species reported here belong to the genus

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*Pheretima* as redefined by Sims and Easton (1972). Two new species, *P. kalingaensis* sp. nov. and *P. aguinaldoi* sp. nov., have a single pair of spermathecal pores in 6/7. *Pheretima balbalanensis* sp. nov. and *P. banaoi* sp. nov. with 3 pairs of spermathecal pores in 6/7-8/9 belong to the *dubia*-group. *Pheretima pugnatoris* sp. nov. and *P. tabukensis* sp. nov. with 4 pairs of spermathecal pores in 5/6-8/9 belong to the *darnleiensis*-group of Sims and Easton (1972).

## MATERIALS

Holotypes and paratypes are deposited in the National Museum of the Philippines Annelid collection (NMA), Manila, the Philippines. Paratypes are deposited in the Kansas University Natural History Museum (KUNHM), Lawrence, KS, USA, and National Institute of Biological Resources (NIBR), Incheon, Korea.

## RESULTS

### *Pheretima kalingaensis* sp. nov.

(Fig. 1)

**Holotype:** Clitellate (NMA 4336): Philippines, Kalinga Province (Prov.), Barangay (Bgy.) Balbalan, sitio Magdalao (17°27.31'N, 121°04.32'E), 15 Mar. 2001, S.W. James coll. Two paratypes: 1 clitellate (KUNHM), 1 semiclitellate (NIBR): same data as for holotype. Other material: (KUNHM) 4 semi-clitellates, 6 acitellates, same data as for holotype.

**Diagnosis:** One pair of spermathecal pores in 6/7 at 6th setal lines, dark pigmentation, intestinal origin in xvii, non-muscular spermathecal ducts, copulatory bursae opening flanked anteriorly and posteriorly by internal circular pads; penis folded towards mid-ventral, longitudinal slit along inner curve of fold.

**Description:** Pigmentation dark violet brown dorsally, ventrally in i-iv, pigment slightly lighter around setae. Dimensions 50-75 × 4.5 mm at segment x, 4.5 mm at xxx, 5 mm at clitellum, segments 70-85; body circular in cross-section. Dorsal setae more widely spaced than ventral, setae numbering 29 or 30 at vii, 36-39 at xx; 4-7 setae between male pores, setal formula AA: AB: YZ: ZZ = 2: 2: 4: 7 at xiii. Clitellum annular xiv-xvi; setae not visible externally.

First dorsal pores 12/13. One pair of

spermathecal pores in 6/7 at 6th setal lines, at lateral margins of ventrum; spermathecal pores 0.11-0.16 circumferences apart ventrally; 0.4 mm openings of copulatory bursae, paired in xviii at 6th setal lines, 0.09-0.16 circumferences apart ventrally. Female pore single (only seen in 1 individual of 5) in xiv. Genital markings lacking.

Septa 5/6 thin, 6/7 thick muscular fiber, 7/8 thin, 8/9/10 absent, 10/11-12/13 a few muscular fibers and thin. Gizzard in viii-x, intestine beginning in xvii, medium paired lymph glands from xxvii along dorsal vessel; intestinal ceca simple originating in xxvii, and extending anteriorly about to xxiii, large finger-shaped sac; typhlosole < 1/5 lumen diameter from xxvii. Hearts x-xiii esophageal, x very small, xii and xiii very large.

Ovaries and funnels in xiii, spermathecae in vii with nephridia on ducts; spermathecae with large broad egg-shaped ampulla, flattened by gizzard, narrow non-muscular duct just shorter than ampulla; diverticulum with large elongate oval iridescent chamber, length variable. Male sexual system holandric, testes and funnels in ventral paired sacs in x and xi. Seminal vesicles 2 pairs in xi and xii, elongate knobby dorsal lobes

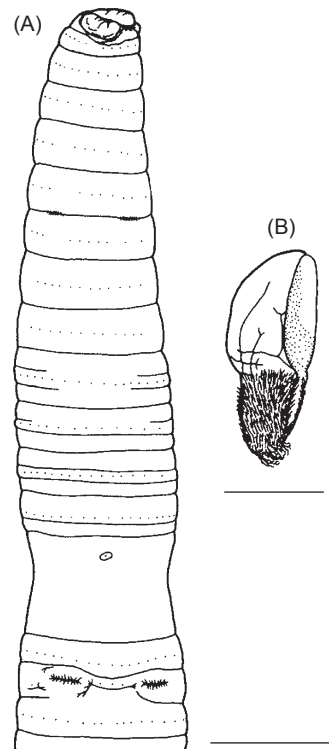


Fig. 1. *Pheretima kalingaensis* sp. nov. (A) Ventral view; (B) spermathecae and diverticulum. Scale bars: A = 5 mm; B = 2 mm.

attached medially in deep clefts, prostates in xvi-xviii bilobate, anterolateral to copulatory bursae, with muscular ducts curving from anterior-lateral to center of copulatory bursae without coelomic glands; copulatory bursae opening flanked anteriorly and posteriorly by internal circular pads; penis folded towards mid-ventral, longitudinal slit along inner curve of fold.

**Etymology:** The species is named for the province of the type locality.

**Remarks:** The new species shares the spermathecal pores in 6/7 with *P. aguinaldoi* sp. nov. There are no published *Pheretima* with a single pair of spermathecal pores in 6/7 and spermathecae in vii. *Pheretima kalingaensis* sp. nov. is similar to *P. aguinaldoi* sp. nov., but differs from it in having more segments, dark pigmentation, a more-posterior intestinal origin, and non-muscular spermathecal ducts. An unpublished species from Mountain Prov. (Hong and James unpubl. data) with the same location of spermathecal pores has lenticular-shaped ampullae, non-muscular spermathecal ducts, and semicircular bursal pads. The Mountain Prov. worm is darkly pigmented like *P. kalingaensis* sp. nov. but is unlike the unpigmented *P. aguinaldoi* sp. nov.

***Pheretima aguinaldoi* sp. nov.**

(Fig. 2)

**Holotype:** One clitellate (NMA 4337): Philippines, Kalinga Prov., Bgy. Balbalan, 2 h hike from Mapga towards Magdalao camp, upper montane forest, soil, 1,500 m, 13 Mar. 2001, S.W. James coll. Two paratypes: 1 clitellate (KUNHM), 1 semiclitellate (NIBR): same data as for holotype. Other material: 2 acitellates (KUNHM), same data as for holotype.

**Diagnosis:** One pair of spermathecal pores at 6/7, unpigmented, intestinal origin in xvi, muscular spermathecal ducts, copulatory bursa openings flanked posteriorly and anteriorly by internal circular pads, penial base transverse oval, long, roughly conical laterally elevated with deep groove on medial face, groove ends at base of short curved penis tip.

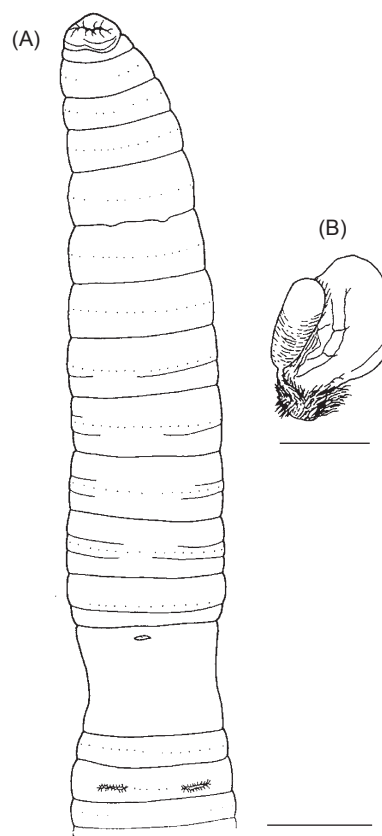
**Description:** Unpigmented. Dimensions 45-79 × 4.6 mm at segment x, 5.5 mm at xxx, 4.6 mm at clitellum, segments 68; body circular in cross-section. Setae numbering 32 at vii, 41 at xx; 6 between male pores, size uniform, ventral setae spaced closer, setal formula AA: AB: YZ: ZZ = 3: 2: 4 :6 at xiii. Clitellum annular xiv-xvi, setae not

visible externally.

First dorsal pores 11/12. One pair of spermathecal pores in 6/7 at 7th setal lines, 0.21 circumferences apart; 0.5 mm openings of copulatory bursa paired in xviii at 7th setal lines, 0.17 circumferences apart. Genital markings lacking.

Septa 5/6-7/8 slightly muscular, 8/9 membranous, 9/10 absent unless it is the membrane covering hearts of x, 10/11 thin, 11/12/13/14 slightly muscular. Gizzard in viii-x, intestine beginning in xvi, small paired lymph glands from xxvii along dorsal vessel; intestinal ceca simple originating in xxvii, extending anteriorly about to xxiv, narrow triangular sac; typhlosole medium about 1/4 lumen diameter from xxv; 28 intestinal wall blood vessels. Hearts in x-xiii esophageal; ix lateral, connected to body wall, viii to gizzard, vii to ventral vessel.

Ovaries and funnels in xiii, spermathecae 1 pair in vii, with nephridia on ducts and diverticulum stalks, spermatheca medium-sized thumb-



**Fig. 2.** *Pheretima aguinaldoi* sp. nov. (A) Ventral view; (B) spermathecae and diverticulum. Scale bars: A = 5 mm; B = 2 mm.

shaped ampulla, slightly flattened by gizzard; thick muscular duct shorter than ampulla, diverticulum chamber long-ovate to club-shaped; iridescent, with small black pigment spots on surface, stalks shorter than chamber. Male sexual system holandric, testes and funnels in ventrally paired sacs in x and xi. Seminal vesicles 2 pairs in xi and xii well-developed with stalked dorsal lobes set in medial clefts, prostates in xvii and xviii, with short and very stout muscular ducts, entering top center of copulatory bursae without stalked glands; copulatory bursa openings flanked posteriorly and anteriorly by internal circular pads, penial base transverse oval, long roughly conical, laterally elevated with deep groove on medial face, groove ending at base of short curved penis tip.

**Etymology:** The species is named after the 1st president of the Philippines, Emilio Aguinaldo.

**Remarks:** *Pheretima aguinaldoi* sp. nov. is distinguished from *P. kalingaensis* sp. nov. and a Mountain Province worm according to the remarks under the latter species.

***Pheretima balbalanensis* sp. nov.**

(Fig. 3)

**Holotype:** Clitellate (NMA 4338): Philippines, Kalinga Prov., Bgy. Balbalan, Mapga Ridge (17° 28.46'N, 121°04.50'E), 1,100 m, 14 Mar. 2001, S.W. James coll. Two paratypes: 1 clitellate (KUNHM), 1 clitellate (NIBR): same data as for holotype. Other materials: (KUNHM) 1 semi-clitellate, 2 a clitellates, same data as for holotype.

**Diagnosis:** Three pairs of spermathecal pores in 6/7, 7/8, and 8/9 at 7th setal lines, 0.28-0.32 circumferences apart; openings of copulatory bursae paired 0.22 circumferences apart, copulatory bursa openings flanked anteriorly and posteriorly by large internal circular pads with associated glandular masses; penis a transverse ridge with apical pore, intestinal origin in xvi.

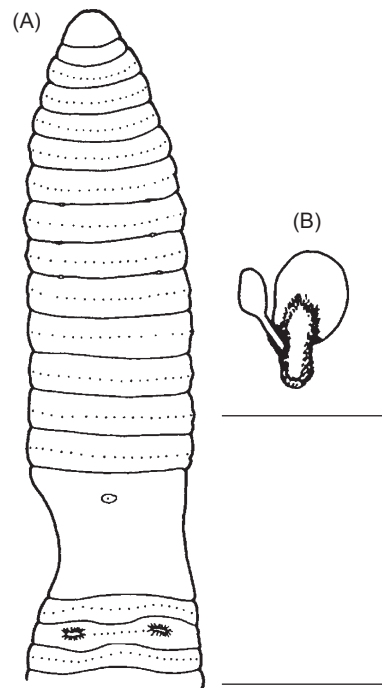
**Description:** Pigmentation medium reddish-brown, setal zones unpigmented, sharp boundary to ventral unpigmented 1/2. Dimensions 42-50 × 2.5-2.6 mm at segment x, 2.5-3 mm at xxx, 2.2-2.7 mm at clitellum, segments 72-85; body circular in cross-section. Setae numbering 29-31 at vii, 41 or 42 at xx; 6-8 between male pores, size and distance regular around equators, setal formula AA: AB: YZ: ZZ = 2.5: 2: 3: 4 at xiii. Clitellum annular xiv-xvi; setae not visible externally.

First dorsal pores 11/12. Three pairs of spermathecal pores in 6/7, 7/8, and 8/9 at 7th

setal lines (counted in IX), ventrally placed; spermathecal pores 0.28-0.32 circumferences apart; 0.3-0.5 mm openings of copulatory bursae paired in xviii between 6th and 7th setal lines, 0.22 circumferences apart, ventrally placed within thickened areas. Genital markings lacking.

Septa 5/6-7/8 thinly muscular, 8/9, 9/10 absent, 10/11-13/14 thin. Gizzard in viii-x, intestine beginning in xvi, small paired lymph glands from xxviii along dorsal vessel; intestinal ceca simple originating in xxviii, and extending anteriorly to about xxiv, finger-shaped sac; typhlosole vestigial. Hearts in x-xiii esophageal.

Ovaries and funnels in xiii, spermathecae 3 pairs in vii-ix, with nephridia on ducts; spermatheca with small short pyriform to oval-shaped ampulla, flattened by gizzard, very short duct non-muscular, mostly in body wall, diverticulum with small egg-shaped, iridescent chamber, short slender stalk shorter than chamber. Male sexual system holandric, testes and funnels in ventrally paired sacs in x and xi. Seminal vesicles 2 pairs in xi and xii, dorsal lobes digitate, apical, prostates in xvii and xviii, glands small, bilobate with straight ducts entering center top of copulatory bursae without coelomic glands; copulatory bursa openings flanked anteriorly and posteriorly by large internal



**Fig. 3.** *Pheretima balbalanensis* sp. nov. (A) Ventral view; (B) spermathecae and diverticulum. Scale bars: A = 5 mm; B = 2 mm.

circular pads with associated glandular masses; penis a transverse ridge with apical pore.

**Etymology:** The species is named for its type locality in Barangay Balbalan.

**Remarks:** *Pheretima balbalanensis* sp. nov. keys to the *dubia*-group in Sims and Easton (1972), which is composed of 5 species, *P. philippina* Rosa, 1891, *P. callosa* Gates, 1937, *P. dubia* Horst, 1893, *P. korinchiana* Cognetti, 1922, and *P. poiana* Michaelsen, 1913. Blakemore et al.'s (2007) surprising suggestion that *P. poiana* may be a junior synonym of *P. darnleiensis* Fletcher, 1887 should not affect the present set of comparisons. The present species is small, with a body length of 42-50 mm, and 72-85 segments, but *P. poiana* and *P. philippina* are large worms, > 180 mm in length and with more than 110 segments. The latter species also has distinctive long tubular dorsal lobes of the seminal vesicles and very dark pigmentation, both differs from *P. balbalanensis* sp. nov. (*P. balbalanensis* sp. nov. (Rosa 1891). *Pheretima callosa* is large-bodied (330 × 16 mm), has at least twice as many setae per segment as *P. balbalanensis* sp. nov., has large pseudovesicles in xiii and xiv, and large conical penes cleft at the tips (Gates 1937). *Pheretima callosa* is from Benguet Prov., Luzon I., the Philippines at 2,130 m in oak forests, and so is geographically the nearest neighbor among the *dubia*-group. *Pheretima philippina* is from Cebu, a more southerly island in the Philippines. *Pheretima dubia* is only twice the length of *P. balbalanensis* sp. nov. and has spirally twisted spermathecal diverticula. *Pheretima korinchiana* is also much larger (90-180 mm), has a violet brown dorsal pigment, 12 setae between the male pores, laterally placed spermathecal pores, and a club-shaped diverticulum on an undulating or spiral stalk.

The present species appears to be closely related to a *Pheretima* sp. from Kalbaryo, Ilocos Norte, Luzon I. (Hong and James, in press). The Kalbaryo worm has more setae on segment xx, an intestinal origin in xv, very short ceca extending only 1 segment forward, and the penis is a small bump. In contrast, *P. balbalanensis* sp. nov. has the intestinal origin in xvi, a ceca extending 3 segments forward, and a penis that is a substantial transverse ridge with an apical pore.

***Pheretima banaoi* sp. nov.**

(Fig. 4)

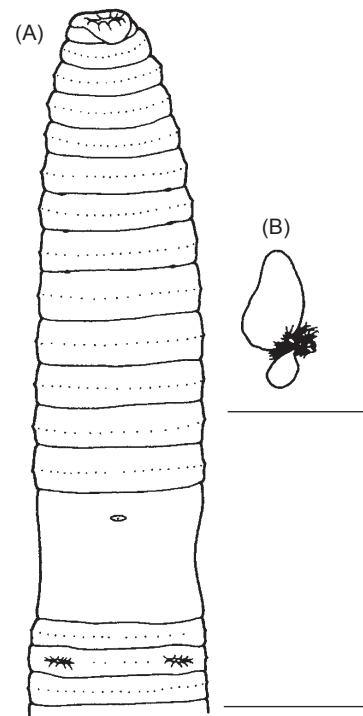
**Holotype:** Clitellate (NMA 4339): Philippines, Kalinga Prov., 2 h hike from Mapga towards

Magdala camp, upper montane forest, 1,500 m, 13 Mar. 2001, S.W. James coll. One paratype: 1 clitellate (KUNHM): same data as for holotype. Other material: 1 aclitellate, same data as for holotype.

**Diagnosis:** Three pairs of spermathecal pores deep in 6/7, 7/8, and 8/9 at 9th setal lines, 2 pairs spermathecae in vii and 1 in viii, openings of copulatory bursae 0.19-0.22 circumferences apart, copulatory bursa opening flanked anteriorly and posteriorly by circular pads; penis a low elliptical bump on roof.

**Description:** Yellowish to brown dorsal pigment, fainter around setae. Dimensions 53-60 × 3-3.5 mm at segment x, 3.4-3.6 mm at xxx, 3.2-3.3 mm at clitellum, segments 89-97; body circular in cross-section. Setae numbering 25-35 at vii, 46 or 47 at xx; 6-12 between male pores, ventral setae slightly more crowded, setal formula AA: AB: YZ: ZZ = 3.5: 2: 2.5: 4.5 at xiii. Clitellum annular xiv-xvi; setae not visible externally.

First dorsal pores 12/13. Three pairs of spermathecal pores deep in 6/7, 7/8, and 8/9 at 9th setal lines (counted in ix) near lateral margins of ventrum; spermathecal pores 0.16-0.19 circumferences apart; 0.3-0.4 mm openings of



**Fig. 4.** *Pheretima banaoi* sp. nov. (A) Ventral view; (B) spermathecae and diverticulum. Scale bars: A = 5 mm; B = 2 mm.

copulatory bursae, paired in xviii at 9th setal lines, at lateral margins, 0.19-0.22 circumferences apart. Female pore single in xiv on 0.1 mm white porophore. Genital markings lacking.

Septa 5/6-7/8 very thin, 8/9 and 9/10 a few muscular fibers, very thin, only ventral, 10/11-13/14 thin. Gizzard in viii-x, intestine beginning in xvi, medium paired lymph glands from xxviii along dorsal vessel; intestinal ceca simple originating in xxvii, and extending anteriorly about to xxiv, finger-shaped sac; typhlosole very low simple fold from xxvii. Hearts x-xiii esophageal, x very small.

Ovaries and funnels in xiii, spermathecae postseptal in vii, preseptal in vii, postseptal in viii with nephridia on ducts; spermathecae increasing in size posteriorly with medium broad egg-shaped ampulla, flattened by gizzard, duct shorter than ampulla; diverticula with small ovate or spherical iridescent chamber, stalk shorter than duct and ampulla. Male sexual system holandric, testes and funnels in ventral paired sacs in x and xi. Seminal vesicles 2 pairs in xi and xii, elongate dorsal lobes medial in deep clefts, prostates in xvi-xviii bilobate, anterolateral to copulatory bursae, straight muscular short ducts, entering center of copulatory bursae without coelomic glands; copulatory bursa opening flanked anteriorly and posteriorly by circular pads; penis a low elliptical bump on roof.

**Etymology:** The species is named for the Banao tribe, which forms the population of the village of Balbalasang. The guides from the tribe, particularly Mr. Benedict, were among the most helpful and expert woodsmen we encountered in the Philippines.

**Remarks:** *Pheretima banaoi* sp. nov. is also in the *dubia*-group of Sims and Easton (1972). The new species appears to be related to *P. balbalanensis* sp. nov., by several somatic and sexual characters but it can be easily distinguished from several others. The pigmentation color and pattern differ, the location of the dorsal lobes of the seminal vesicles differ (apical vs. medial in *P. banaoi* sp. nov.), and the penes differ. The new species has penes that are low elliptical bumps on the copulatory bursa roof, but in *P. balbalanensis* sp. nov., the penes are transverse ridges with an apical pore. Also *P. banaoi* sp. nov. has partial septa 8/9 and 9/10, and its spermathecae are not in the conventional locations of vii-ix, but 2 pairs are in vii and 1 pair is in viii.

*Pheretima banaoi* sp. nov. shares the locations of the spermathecae (2 pairs in vii and 1 pair in viii) with 2 *P. dubia*-group species, sp. J and sp. L from Barlig, Mountain Province, Luzon (Hong

and James unpubl. data). Both the Barlig worms are atyphlosolate and have at least one of septa 8/9/10.

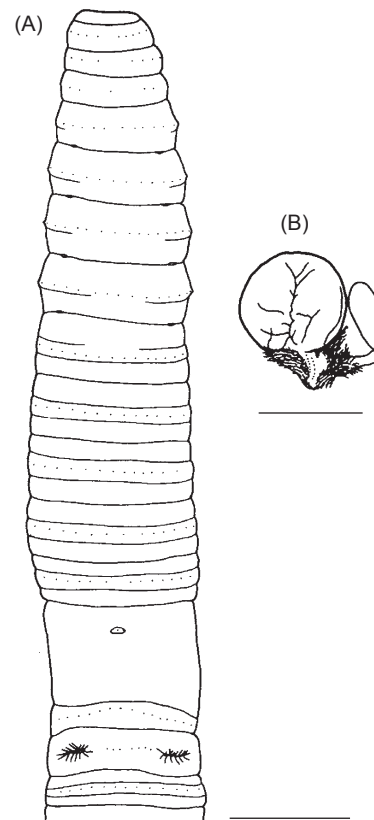
***Pheretima pugnatoris* sp. nov.**

(Fig. 5)

**Holotype:** Clitellate (NMA 4340): Philippines, Kalinga Prov., Balbalasang Amlikao Ridge (17° 26.28'N, 121°04.41'E), 1,860 m, soil, 18 Mar. 2001, S.W. James coll. Two paratypes: 1 clitellate (KUNHM), 1 clitellate (NIBR): same data as for holotype.

**Diagnosis:** Four pairs of spermathecal pores in 5/6-8/9 at 6th setal lines, 0.4-0.5 mm openings of copulatory bursae 0.17-0.18 circumferences apart, dorsal setae more widely spaced and much larger than ventral setae in ii-ix, typhlosole prominent, copulatory bursa openings flanked anteriorly and posteriorly by internal circular pads; penis conical, a lateral extension of rounded transverse conical protrusion from copulatory bursa roof.

**Description:** Light brown dorsal pigment, faint



**Fig. 5.** *Pheretima pugnatoris* sp. nov. (A) Ventral view; (B) spermathecae and diverticulum. Scale bars: A = 5 mm; B = 2 mm.

in setal zones. Dimensions 72-125 × 4.9-5 mm at segment x, 4.5-5.0 mm at xxx, 4.5-4.8 mm at clitellum, segments 61-102; body circular in cross-section. Setae numbering 16-19 at vii, 34 or 35 at xx; 5-7 between male pores, dorsal setae more widely spaced and much larger than ventral setae in ii-ix, setal formula AA: AB: YZ: ZZ = 5: 4.5: 6: 8 at xiii. Clitellum annular xiv-xvi; setae not visible externally.

First dorsal pore 11/12. Four pairs of spermathecal pores in 5/6-8/9 at 6th setal lines (counted in ix), sub-lateral; spermathecal pores 0.26-0.29 circumferences apart; 0.4-0.5 mm openings of copulatory bursae paired in xviii at 6th setal lines, 0.17-0.18 circumferences apart. Genital markings lacking.

Septa 5/6 thin, 6/7-7/8 muscular but transparent, 8/9, 9/10 absent, 10/11-13/14 thick. Gizzard in viii-x, intestine beginning in xv, medium-sized paired lymph glands from xxvii along dorsal vessel; intestinal ceca simple originating in xxvii, and extending anteriorly to about xxiv, broad triangular sac; typhlosole low folded from xxvi, 20 longitudinal intestinal wall blood vessels. Hearts in x-xiii esophageal, vii, ix lateral, viii to gizzard.

Ovaries and funnels in xiii, spermathecae 4 pairs in vi-ix with nephridia on ducts; spermathecae of vi and vii smaller, ampulla small thumb-shaped or lenticular, flattened by gizzard, slightly muscular duct shorter than ampulla; diverticulum large egg-shaped, iridescent chamber with many small black pigment spots, straight slender stalk equal to ampulla length. Male sexual system holandric, testes and funnels in ventrally paired sacs in x and xi. Seminal vesicles 2 pairs in xi and xii, small elongate dorsal lobes median, low, facing esophagus, prostates in xvii-xix, 2 main lobes lateral to copulatory bursae, ducts expanded enlarging, becoming more muscular distally, curving across anterior of copulatory bursae, then bending to posterior to enter top center of copulatory bursae; copulatory bursa openings flanked anteriorly and posteriorly by internal circular pads; penis conical, a lateral extension of rounded transverse conical protrusion from copulatory bursa roof.

*Etymology:* The epithet *pugnatoris*, Latin for fighter, refers to the Kalinga tribes' history as fighters and headhunters.

*Remarks:* *Pheretima pugnatoris* sp. nov. belongs to the *darnleiensis*-group of Sims and Easton (1972), at that time consisting of 15 species, all of which were synonymized by Sims and Easton (1972). This species group is defined

by having either 4 or 5 pairs of spermathecae, the last pair in segment ix, and an optional 5th in segment v. Blakemore et al. (2007) recently expanded the synonymy to include some very large (700 mm) worms from Mt. Kinabalu, Borneo and possibly some of the *P. dubia*-group (3 pairs of spermathecae vii-ix). We discussed the *darnleiensis* problem elsewhere, although not to our complete satisfaction (Hong and James, in press). We hold that the synonymy is excessive and buries significant morphological and geographical diversity in an increasingly meaningless concept of *P. darnleiensis*. In Blakemore et al. (2007) it is stated that the 45-700 mm size range “suggests either high plasticity or too wide synonymy.” We especially agree with the latter possibility. We examined material of *P. belli* Rosa, 1898; *P. floweri* Benham, 1897; *P. madelinae* Benham, 1897; and *P. martensi* Michaelsen, 1892, all synonymized by Sims and Easton (1972), but to our estimation, these are distinct species with different sizes, colorations, and morphological characters. The names placed in the synonymy of *P. darnleiensis* include those applied to unpigmented, distinctly striped, and solidly pigmented worms, with pigment colors ranging from dark brown to bluish-gray. Developmental plasticity in the intestinal ceca as indicated by Sims and Easton (1972; p. 264) for 2 lineages within the synonymy is not necessarily applicable to other lineages. Furthermore, Sims and Easton (1972) indicated that the species-groups they created were done merely for convenience, and they did not expect these groups all to have taxonomic standing or even validity as homogenous groups. The examination of several of the species included in the synonymy of *P. darnleiensis* suggests that what are ordinarily considered species level differences among pheretimid worms have been dismissed in favor of heavily weighting the number of spermathecae. We recognize that a separate paper reviewing the synonymy decisions in this species-group is needed and hope to address the issue with morphological and molecular data in the near future.

Morphologically indistinguishable or similar species have respectively been discovered or differentiated by molecular data (Chang and Chen 2005, Domínguez et al. 2005, Pérez-Losada et al. 2005, King et al. 2008). Of particular interest here is the work of Chang et al. (2009), who showed that size, coloration, and genital marking patterns correctly identified genetically distinct

lineages within what was previously considered to be a variable species of *Amyntas*. In the face of those discoveries, placing morphologically distinguishable taxa into synonymy is probably not useful. Therefore, we will proceed by distinguishing the new species from a relatively restricted sense of *P. darnleiensis*, that of Sims and Easton (1972), but with the understanding that we find their synonymy far too broad.

*Pheretima pugnatoris* sp. nov. differs from *P. darnleiensis* sensu stricto in having fewer setae per segment, fewer segments (*P. darnleiensis* 155 segments), smooth, simple ceca, and light-brown dorsal pigment. The spermathecal diverticula have a straight slender stalk equal to the ampulla length in *P. pugnatoris* sp. nov., and the dorsal setae are more widely spaced and much larger than the ventral setae in ii-ix. None of these character states is found in *P. darnleiensis*. Looking at geographically close neighbors within the synonymy of *P. darnleiensis*, there are 4 published species to consider. Two species from northern Luzon, *P. decipiens* Beddard, 1912 and *P. benguetensis* Beddard, 1912, both have enlarged setae in segments ii-viii, but not only on the dorsal surface. Both have more widely set male pores, and more posterior intestinal origins in xvi and xvii, respectively (Beddard 1912). The former species is about the same size as *P. pugnatoris* sp. nov. but in addition to the above-mentioned differences, its prostates are restricted to the 18th segment. *Pheretima benguetensis* is a large species (150-190 mm) with very dark bluish-purple dorsal pigmentation, ceca extending through 5 segments, vasa deferentia of a side remaining separated until the prostatic duct, a diverticulum axis of greater length than the main spermathecal axis, and apically placed dorsal lobes of the seminal vesicles (Beddard 1912). All of these character states differ from those of *P. pugnatoris* sp. nov. Another species from Luzon is *P. vaillantii* Beddard, 1890. It has distinctive dorsal tube-like outgrowths of the seminal vesicles, which may have been dorsally connected in the intact specimen (Beddard 1890). No septa are thickened. Both character states separate it from *P. pugnatoris* sp. nov. Finally *P. belli* Rosa 1898 from Mindoro I. south of northern Luzon I. has darker pigmentation with distinct white stripes on the segmental equators, roughly twice as many setae per segment, no thickened septa, and spermathecal diverticula as long as the main spermathecal axis (Rosa 1898). All of these are distinct from *P. pugnatoris* sp. nov.

Distinctions between *P. pugnatoris* sp. nov.

and other *darnleiensis*-group species of northern Luzon are now to be explored. Some as yet-unpublished species from Kalbaryo, Ilocos Norte (Hong and James, in press) are referred to herein as species 1, 2, and 3 in their order of appearance in the Kalbaryo paper. Species 1 lacks a typhlosole, has darker brown pigment, has more setae in vii, and fewer in xx and between the male pores. Species 2 has darker pigment alternating with white stripes, far more setae in all segments, and a much larger body size. Species 3 has mid-lateral spermathecal pores and striped pigmentation. *Pheretima* sp. B from Barlig, Mountain Province (Hong and James unpubl. data) is much larger (225-255 mm) and has an intestinal origin in xvi and anterior septa 8/9/10. *Pheretima cabigati* Hong and James, 2008 from Banaue, Ifugao Prov., Luzon also has an intestinal origin in xvi, has ventral as well as dorsal setal gaps, and has more intestinal wall blood vessels. *Pheretima tabukensis* sp. nov. (below) has dark pigmentation with light stripes on the setal rings, ventral setal gaps, septa 8/9/10, and lacks a typhlosole.

***Pheretima tabukensis* sp. nov.**

(Fig. 6)

*Holotype*: Clitellate (NMA 4341): Philippines, Kalinga Prov., 2 h hike from Mapga towards Magdalaao camp, upper montane forest, 1,500 m, 13 Mar. 2001, S.W. James coll. One paratype: 1 clitellate (KUNHM): same data as for holotype. Other material: same data as for holotype, 1 semi-clitellate.

*Diagnosis*: Four pairs of spermathecal pores deep in 5/6-8/9 at 7th setal lines, openings of copulatory bursae 0.18-0.22 circumferences apart, septa 8/9/10 present, spermathecal diverticulum chambers as large as ampullae, typhlosole absent, copulatory bursa openings flanked anteriorly and posteriorly by internal circular pads; penis begins as a ridge from medial to lateral, with large free end hooked down lateral to pads; penis with groove on inside of hooked curve.

*Description*: Darkly pigmented dorsally, ventrally only in i-v, lighter ventrally vi-xiii, ventrum unpigmented elsewhere, unpigmented setal zones throughout but widening ventrally. Dimensions 65-74 × 3.5-4 mm at segment x, 3-3.5 mm at xxx, 3.2-3.9 mm at clitellum, segments 65-103; body circular in cross-section. Setae numbering 19 or 20 at vii, 23-36 at xx; 6 between male pores, ventral setal spacing less than dorsal, setae larger dorsally in anterior segments; many scattered gaps

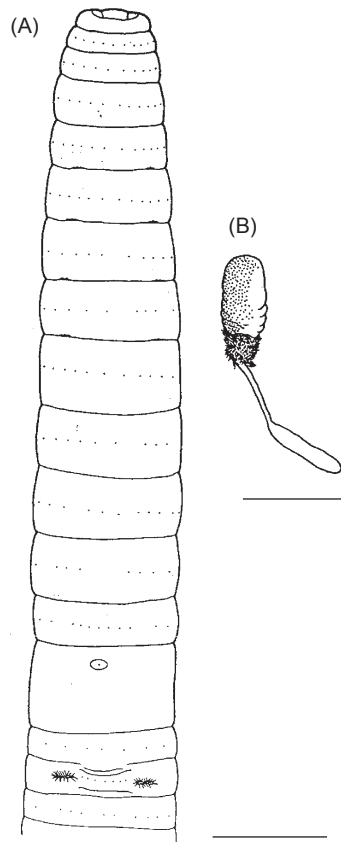


in setal rings; setal formula AA: AB: YZ: ZZ = 7: 3: 4: 6 at xiii. Clitellum annular xiv-xvi; setae not visible externally.

First dorsal pores 11/12. Four pairs of spermathecal pores deep in 5/6/7/8/9 at 7th setal lines (counted in ix), sub-lateral; spermathecal pores 0.23-0.24 circumferences apart; 0.3-0.4 mm openings of copulatory bursae paired in xviii at 6th setal lines, 0.18-0.22 circumferences apart, area between openings indented. Genital markings lacking.

Septa 5/6 muscular medium thickness, 6/7, 7/8 thick, 8/9, 9/10 very delicate membranous, 10/11-13/14 thick. Gizzard in xviii, intestine beginning in xv, large paired lymph glands from xxvii along dorsal vessel; intestinal ceca simple originating in xxvii, and extending anteriorly to about xxv, short triangular sac; typhlosole vestigial from xxvii. Hearts in x-xiii esophageal.

Ovaries and funnels in xiii, spermathecae 4 pairs in vi-ix, with nephridia on ducts; spermathecal ampulla of variable size and shape; generally small elongate ovals, larger in viii and ix than in vi and vii,



**Fig. 6.** *Pheretima tabukensis* sp. nov. (A) Ventral view; (B) spermathecae and diverticulum. Scale bars: A = 5 mm; B = 2 mm.

duct shorter than ampulla, but narrow rather than stout, diverticulum with pear- to eggplant-shaped iridescent chamber, stalk as long as or longer than chamber, chambers may be as large as spermathecal ampulla, several diverticula passing through septa to next segment posterior. Male sexual system holandric, testes and funnels in ventrally paired sacs in x and xi. Seminal vesicles 2 pairs in xi and xii, dorsal lobes long, set deep in dorsal clefts; prostates in xvii and xviii glands with 1 or 2 lobes, slender muscular ducts curving around anterior and medial sides of copulatory bursae, entering center top of copulatory bursae without coelomic glands; copulatory bursa openings flanked anteriorly and posteriorly by internal circular pads; penis beginning as a ridge from medial to lateral, with large free end hooked down lateral to pads; penis with a groove on inside of hooked curve.

**Etymology:** The species is named for Tabuk, the nearest large city in Kalinga Prov.

**Remarks:** *Pheretima tabukensis* sp. nov. also belongs to the *darnleiensis*-group of Sims and Easton (1972). Most of the character states used to distinguish *P. pugnatoris* from *P. decipiens* and *P. benguetensis* also serve to differentiate *P. tabukensis* sp. nov. The remarks under *P. pugnatoris* contain enough information to make distinctions from the published species of Luzon. Two of the most distinctive character states of *P. tabukensis* sp. nov. are the presence of septa 8/9/10 and the spermathecal chambers being nearly as large as the ampullae. The differences from *P. pugnatoris* sp. nov. include its darker dorsal pigment alternating with light stripes and ventral pigment in segments i-v. *Pheretima tabukensis* sp. nov. has a shorter length and ventral setal gaps, and lacks a typhlosole. *Pheretima pugnatoris* sp. nov. has penes as lateral extensions of rounded transverse conical protrusions, but *P. tabukensis* sp. nov. has penes with a groove on the inside of a hooked curve. The diverticulum of *P. tabukensis* sp. nov. has a stalk as long as or longer than the chamber, but *P. pugnatoris* sp. nov. has a straight slender stalk equal to the ampulla length.

Compared to the Kalbaryo species of the *darnleiensis*-group, *P. tabukensis* sp. nov. is most similar to species 1 and 3. The latter has mid-lateral spermathecal pores, and the former has slightly wider-spaced copulatory bursal openings. Species 1 has egg-shaped diverticula that often pass through the septa to the anterior, while *P. tabukensis* sp. nov. has very large

pyriform chambers that often pass to the next segment posterior. *Pheretima cabigati* and the Barlig species mentioned in the remarks on *P. pugnatoris* sp. nov. both have typhlosoles and intestinal origins in xvi, and are both larger than *P. tabukensis* sp. nov.

## DISCUSSION

Some of the characteristic features of the Philippine *darnleiensis*-group species are the shape of the primary male pore, the configuration of pads in the copulatory bursae, and the dimensions of the spermathecal pores and ducts. In most if not all species examined to date, the primary male pore is a medial slit with the length of the penial body. One possible exception is *Pheretima* sp. 2 of Kalbaryo (Hong and James, in press), in which the pore is shorter but still on the medial face. The pads are always a pair, located on the floor of the copulatory bursae, 1 to the anterior and 1 to the posterior. When the bursae are everted, these pads function as suckers adhering to the mate's segmental surfaces anterior and posterior to an intersegmental furrow bearing a pair of spermathecal pores. In this species group, the spermathecal pores and ducts are typically small, especially compared to the *sangirensis*-group species (James 2004) with a single pair in 7/8. We suggest that the *darnleiensis*-group mating mechanism does not use penes as intromittent organs, but instead the male pore slits are aligned with intersegmental furrows and function as seminal grooves, although the furrows themselves could also function in this manner. These long slits and the flexibility/extensibility of the penes allow compensation for variations in the segmental diameter. Another feature in common is that the spacing of the bursal opening is always less than or rarely equal to the spermathecal pore spacing. The difference can be made up by the slit length. We have never observed mating in these worms, so the scenario described above is entirely hypothetical. A distinct alternative is that the flexibility of earthworm bodies alone can compensate for diameter variations among segments, although in other earthworm groups, there are clear structures to accomplish this, such as, for example, internal transverse muscle bands in the male field segments and/or large tubercula pubertates.

*Pheretima kalingaensis* sp. nov. and *P. aguinaldoi* sp. nov., although not in the

*darnleiensis*-group, have the same primary male pore structure, bursal pad configuration, and spermathecal duct dimensions. However, *P. aguinaldoi* sp. nov. has a muscular spermathecal duct. *Pheretima balbalanensis* sp. nov. and *P. banaoi* sp. nov. also have most of the suite of characters, but the primary male pores are apical, not slits along the medial side. If reproductive anatomy is evolutionarily stable, as postulated in the classical view of earthworm systematics (see Gates 1972), then we suggest that these 4 species, and probably many others such as *P. banauensensis* Hong and James 2008 from Banaue, Luzon, are derived from the *darnleiensis* spermathecal configuration by reduction of the spermathecal battery. Molecular data analysis indicated that a reduction of an octothecal condition gave rise to at least 3 different spermathecal batteries (vi-viii, vii-ix, and vi) within *Pheretima* (James 2005). Therefore, as Sims and Easton (1972) suspected, at least some of their species groups are not monophyletic.

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