

NEW SPECIES OF *AMYNTHAS*, *PHERETIMA* AND *PLEIONOGASTER*
(CLITELLATA: MEGASCOLECIDAE) OF THE MT. KITANGLAD RANGE,
MINDANAO ISLAND, PHILIPPINES

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ABSTRACT. – Earthworm material collected from the Mt. Kitanglad Range, Bukidnon Province, the Philippines, consisted of 18 new species of megascolecoid earthworms. Fifteen new species of *Pheretima* (*Pheretima*) were found, including *Pheretima baletti*, *P. bukidnonensis*, *P. heaneyi*, *P. kitangladensis*, and *P. monothea* in the *P. urceolata* species group with spermathecae in segment vi, and *P. alba*, *P. baungonensis*, *P. diesmosi*, *P. monoporata*, *P. paucisetosa*, *P. rubida*, *P. rugosa*, *P. quincunxia*, *P. vicinipora*, and *P. virgata* in the *P. sangirensis* species group with spermathecae in segment vii or viii. *Amyntas heaneyi*, a new proandric species, was the only member of its genus in the collection. *Pleionogaster kitangladensis* and *Pl. valida* are new species of this Philippine endemic genus, and are distinct from type material of previously described members of the genus. A re-evaluation of *Pleionogaster* revised the genus definition and concluded that some previously synonymized species should be restored. Considering the usual patterns of exotic species invasions and the barriers inherent to earthworm dispersal among Southeast Asian archipelagos, it is very improbable that the species described here are exotic or are actually range extensions of previously known species from Indonesia.

KEY WORDS. – *Pheretima*, *Amyntas*, *Pleionogaster*, Philippines, Megascolecidae, Clitellata.

INTRODUCTION

Lawrence Heaney and collaborators investigated the high elevation mossy forests of the Mt. Kitanglad Range in the northern portion of Mindanao Island, Bukidnon Province, Philippines for their unique mammalian fauna. (Heaney et al., 1999). In the course of studying the small mammals of this region and of Mt. Isarog on Luzon Island, it was discovered that many of the mammals preyed on earthworms, and some, including the Isarog shrew-rat *Rhynchomys isarogensis* (Musser & Freeman, 1981) and *Chrotomys gonzalesi* (Rickart & Heaney, 1991) had diets composed largely of earthworms, and may be called vermivores (Rickart et al., 1991). Other Southeast Asian occurrences of rodents specialized on soft-bodied invertebrates are reviewed in Rickart et al. (1991). The mammalogists' desire to know the identities of the worms on which the Philippine rodents were feeding led to several collections of earthworms from the Kitanglad Range. The first set of collections obtained by Heaney in 1993 contained ten species separable by external features. Dissections revealed that all ten were new species belonging to various perichaetine genera of the *Pheretima* complex (Sims & Easton, 1972) in the subfamily Megascolecinae of the Megascolecidae (sensu Jamieson, 2000). A second set of collections made by D. Balet from

the same general area in 1994 yielded still more new species, and another worm collected in the area in 1992 was also new.

Philippine earthworms have never been collected in an organized manner. All previous accounts of Philippine earthworms were based on specimens obtained in random collecting events, and usually coming to a specialists' attention after residing ignored in museum collections (e.g. Beddard, 1912; Gates, 1937, 1961). The relative abundance of 19th to early 20th century earthworm taxonomists in northern European nations with colonial holdings in Southeast Asia, and the scarcity of such specialists in Spain and the United States of America, may have contributed to a sampling bias favoring the other parts of Southeast Asia. Consequently the Philippine archipelago remained less well known than continental Southeast Asia and the other major archipelagos of the region. The material reported here is the first fairly complete account of the earthworm fauna of a small region within the Philippines. If other islands and other mountain ranges have similarly diverse earthworm faunas, the number of indigenous species in the Philippines could be very large, perhaps as many as 250, compared to the approximately 25 known up to now (an exact count depends on taxonomic opinion).

MATERIALS AND METHODS

The descriptions given below are based on the form and content used in Easton (1979). When giving the ratios AA:AB or ZZ:YZ describing the width of the ventral or dorsal setal gaps (the upper case letters AA, etc. refer to intersetal intervals) in relation to the intersetal distances I follow the convention of designating the dorsal-most setae as z, regardless of the number of setae on that particular segment. Given the within-species variability in setal number on a given segment, it would otherwise be extremely cumbersome to give the data for a number of individuals of the same species. I have also chosen to give the spacing between spermathecal pores of a segment and between male openings as a fraction of the circumference of the adjacent segment (spermathecal pores) or of the circumference of segment xviii (male openings or pores). Though in this rendering it is not so apparent how closely the spermathecal and male opening spacings match, it does give a clear depiction of the location of these pores around the circumference of the body. Taxonomy follows Sims & Easton (1972). Where different individuals within the material examined differ with respect to discrete character states, the descriptive information is given followed by parenthetical numbers indicating the number of individuals having that character state.

In the illustrations I have included only those portions of the ventral views containing important features. Among the *Pheretima* species described here there is little variation in exterior characters other than pigmentation and number, location, and spacing of spermathecal and male pores. A few species have epidermal thickenings near the spermathecal pores, but otherwise there are no external genital markings.

Readers will note that within the genera there are many character states shared among all the species described. The descriptions could be shortened but I have chosen to include shared characters in order to facilitate information retrieval from the separate descriptions. All descriptions are based on external examination and dorsal dissection under a stereomicroscope. Illustrations were prepared with a camera lucida.

All collections were made in the period 1992-1994, and generally in the months of March and April. In several cases, the collection dates are unknown, but probably in March or April of 1994 (D. Balete, pers. comm.).

Holotypes and syntypes are deposited in the National Museum of the Philippines (NMA) in Manila, as required by law of that country. Paratypes and other material are in the Field Museum of Natural History (FMNH), Chicago, Illinois USA or Kansas University Natural History Museum (KUNHM), at the University of Kansas, Lawrence, Kansas USA.

TAXONOMY

MEGASCOLECIDAE

Pheretima Kinberg*Pheretima kitangladensis*, new species

(Figs. 1A, B)

Material examined. – Holotype - adult (NMA 003973) Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 18.5 km S, 4 km. E of Camp Philips, 2250 m. elevation, coll. L. Heaney, 2 Apr. 1993.

Etymology. – The species is named after the mountain range on which it was found.

Description. – Dorsal brown pigment, but pigment lacking in narrow band on segmental equators, unpigmented band sharply constricted at mid-dorsal line. 108 x 3.8 mm (x), 3.5 mm (clitellum), 3.6 mm (xxv), 99 segments; body cylindrical in cross-section, gradually tapered towards head and tail. First dorsal pore 12/13, spermathecal pores paired in 5/6, 0.28 circumference apart; female pore single on papilla in xiv, openings of copulatory bursae paired in xviii, 0.20 circumference apart in 7th or 8th setal line, 8 setae between openings. Setae regularly distributed around segmental equators, 44 setae on vii, 48 setae on xx; no dorsal or ventral gaps in setal spacing. Clitellum annular xiv-xvi; no genital markings (Fig. 1A).

Septa 4/5-6/7, 7/8 muscular, 8/9 thin, 9/10 lacking, 10/11-12/13 muscular. Nephridia in dense tufts on anterior faces of 5/6, 6/7; nephridia of post-clitellar segments in pre-, post-septal rows near septum-body wall junction.

Large gizzard in viii, esophagus with vertical lamellae x-xiii, intestinal origin xvi, simple caeca originating in xxvii, extending forward to xxvi, ventral margins with 3-5 incisions; paired ventral ridges of intestine from mid-ventral in xix to openings of caeca; typhlosole simple fold 1/5 lumen diameter, xxvii-lxviii; 32 longitudinal vessels within intestinal wall xxvii-xl.

Hearts x-xiii esophageal, commissural vessels vi, vii, ix lateral; viii to gizzard; ventral vessel with branches to body wall in viii. Supra-esophageal vessel x-xiii, extra esophageal vessels to ventral esophageal wall in x, efferent parieto-esophageal vessels not seen.

Ovaries and funnels free in xiii, spermathecae paired in vi with nephridia on spermathecal ducts; each spermatheca with large ampulla, single stalked diverticulum terminating in club-shaped receptacle (Fig. 1B). Male sexual system holandric, testes, funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii with dorsal lobes; vasa deferentia free from body wall en route to ental end of prostatic ducts; each prostate racemose occupying xvi-xviii, with stout muscular duct entering central of three bulges of the copulatory bursae in xviii; coelomic surface of copulatory bursae lacking glandular or other

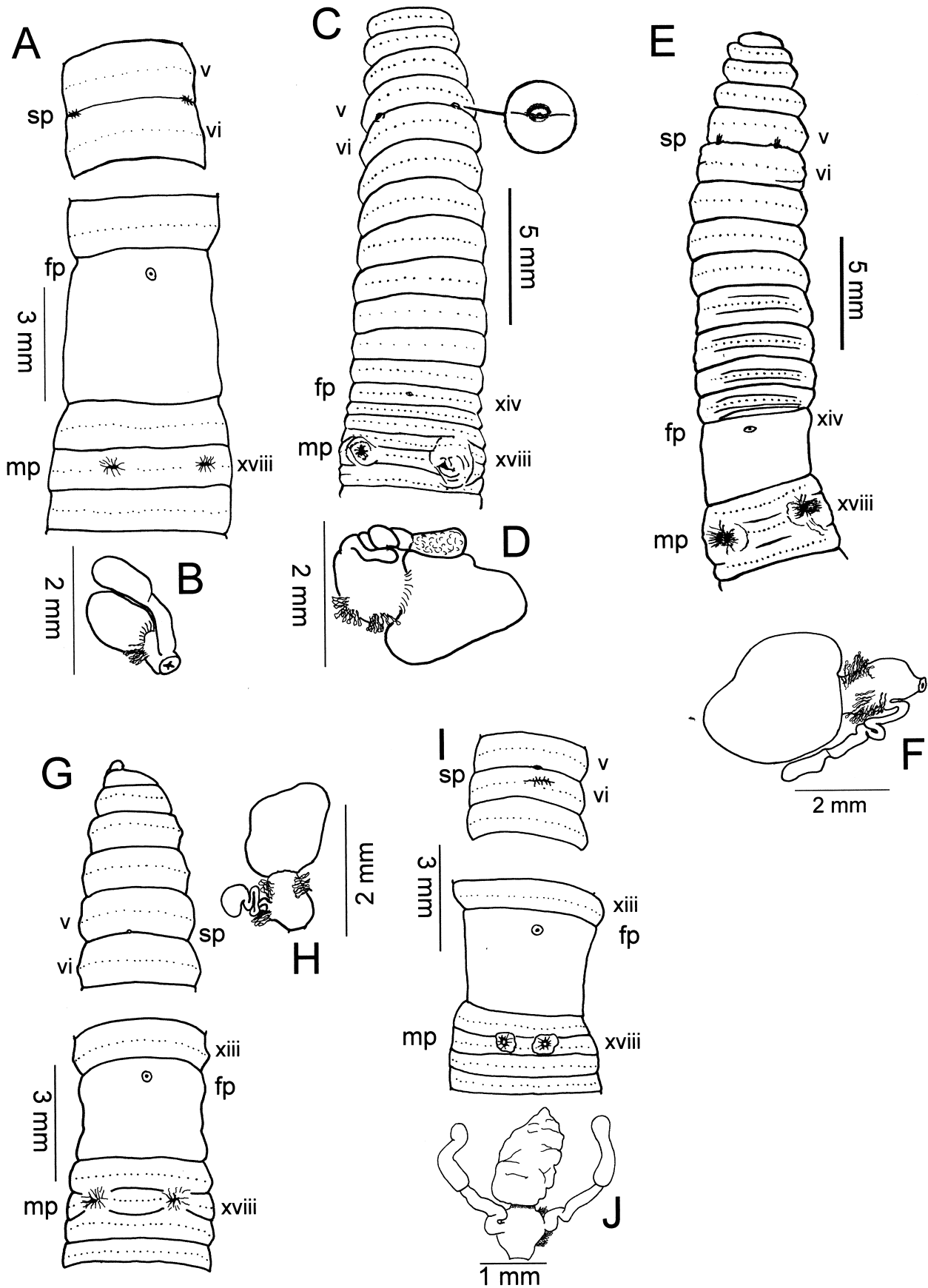


Fig. 1. Spermathecae, and external views (ventral except as noted) showing spermathecal pores, female pores, male pores and if present, genital markings, of *Pheretima kitangladensis* (A, B), *P. baletai* (C, D), *P. heaneyi* (E, F), *P. bukidnonensis* (G. Lateral view of spermathecal pore, ventral view of female and male pores, H), and *P. monothecca* (I, J). Symbols: fp, female pore(s); mp, male pores; sp, spermathecal pores.

projections; anterior and posterior bulges house thick muscular pads flanking transverse ridge occupying place of penis on roof of copulatory bursa.

Remarks. – *Pheretima kitangladensis* keys to the *urceolata* group in Sims & Easton (1972), which is composed of two species, *P. urceolata* (Horst, 1893) and *P. baweanensis* (Michaelsen, 1924). Gates (1961) synonymized these two species and *P. ditheca* (Michaelsen, 1928). These are from Sumatra, Bawean Island, and Borneo, respectively, and have lengths of 70-80mm, 170mm, and 44mm, respectively. Gates (1961) also assigned a Philippine specimen to *P. urceolata*. The collection location was given as “Mt. Apo, east slope at 6200 feet, Davao Province, Mindanao.” Gates suspected human intervention helped to attain this extensive distribution. He admitted that the size range encompassed by adult *P. urceolata* s.l. (44 mm to 170 mm) seemed “unusual.” However, Sims & Easton (1972) placed *P. ditheca* in *Metaphire*, because nephridia were not recorded from the spermathecal ducts, a character reported for other species in Michaelsen (1928). Thus the low end of the size range could be restated as about 70 mm. Human intervention is one hypothesis for the range of *P. urceolata*, but resolution will require more material from Indonesia.

If *P. ditheca* turns out to have nephridia on the spermathecal ducts, some information suggests its inclusion in the synonymy of *P. urceolata* may be premature. Michaelsen (1928) gave the size of *P. ditheca* as that of the largest individual in the lot. He stated the separation of the male pores as about 0.25 of the circumference, and the spermathecal pores at 0.43, which are much less and much greater than the respective pore separations in the type material of *P. urceolata* (see Table 1). He notes the absence of the septa 8/9/10 and the presence of “Chylustaschenstruktur” in the esophageal wall of segments x-xiii, as well as the sharp narrowing of the spermathecal duct as it enters the body wall (Michaelsen, 1928: p. 47, Fig. 12). This last is in contrast to the relatively thick ducts “slightly narrowed at parietes” given in Gates’ definition of *P. urceolata* (1961: p 298).

The presence of a single pair of spermathecae opening on 5/6 defines the species group sensu Sims & Easton (1972) or the species according to Gates. Assuming all for now *P. urceolata* are conspecific, the species described here differ from it and from one another sufficiently to merit species rank. Table 1 contains information on the characters used to distinguish among the members of the *urceolata* group. *Pheretima kitangladensis* differs from *P. urceolata* in having more setae per segment, no dorsal setal gap, more closely spaced spermathecal pores and more widely spaced male pores. Internally, *P. kitangladensis* lacks the thick septum 9/10 reported for *P. urceolata* in Sims and Easton (1972), has two well-developed muscular pads within each copulatory pouch and a thin ridge in place of each penis seen in *P. urceolata*. All information on *P. urceolata* makes no mention of the presence of vertical lamellae in the esophagus, except for the questionable *P. ditheca*, which may be a *Metaphire*.

The locality of *P. kitangladensis* is quite remote from human

disturbance and activity of the sort likely to cause introduction of earthworms from Indonesia, or anywhere else. In all the collections on which this paper is based, only the lowest elevation site (1100 m.) yielded a peregrine species, the glossoscolecoid *Pontoscolex corethrurus* (Müller, 1857). It is highly unlikely that *P. kitangladensis* is an exotic.

The following worm in the Natural History Museum, London, was labeled as *P. urceolata*:

Pheretima urceolata

Material examined. – 1 adult (BMNH 1980.27.494), *Pheretima* (*Pheretima*) *urceolata* (Horst, 1893). [Collector No:] 52W. Beside road 20 miles from Muaraenim on road to Bataradja. Undulating country. Little secondary forest and remains of old paddy area. Considerable cultivation and occasional house within half a mile. Sp. taken from beneath old house and damp areas around. Tabdjungrindu, South-Central Sumatra, Indonesia. 3° 55' S, 103° 53' E, 200 m. coll. G. Lincoln, British Universities Dragon Exped., 8 Jun. 1973. det. E.G. Easton. (Separated from 1980.27.483-494 - houletti complex)

Description. – Adult body size 45 x 2 mm, unpigmented, spermathecal pores paired 5/6, male pores in 6th setal line, 6 setae between male pores. Holandric, testes sacs paired, ventral; copulatory bursae slightly flattened spheres attached ventro-medially by narrow neck, no pads, conical penis flanked by grooved flaps within copulatory bursa; prostates in two main lobes wrapped around anterior, lateral sides of copulatory bursae. Spermathecae with nephridia on thick long duct, as long as narrower sausage-shaped ampulla, diverticulum stalk long, slender, with ovoid chamber.

Remarks. – Though from Sumatra like the material of Horst’s (1893) *P. urceolata*, this worm is at the low end of the size range for the inclusive *urceolata* concept of Gates (1961), has a very different spermathecal shape, 6 setae between the male pores rather than 12 in Horst’s (1893) material, and lacks pigment. I include it here to illustrate that species concepts in *Pheretima* are very broadly defined, relying almost exclusively on the number and location of spermathecae. This problem will intensify as new material comes to light throughout the Southeast Asian archipelagoes.

Pheretima baleteti, new species

(Figs. 1C, D)

Material examined. – Holotype - One preclitellate (NMA 003974) Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 18.5 km S, 4 km. E of Camp Philips, 2250 m. elevation, coll. L. Heaney, 4 Apr. 1993.

Etymology. – Danilo Balete, a Philippine conservation biologist, was instrumental in obtaining many of the earthworms collected at Mt. Kitanglad, and in assisting the author in further research in the Philippines. This species is named in his honor.

Description. – Faint pink dorso-anterior pigment, body > 78 mm x 4.3 mm (vii, x), 4.5 mm (xxv), incomplete posterior

amputee; body cylindrical in cross-section. First dorsal pore 11/12, spermathecal pores on posterior face of small protuberances paired in 5/6, 0.25 circumference apart, female pore single in xiv, openings of copulatory bursae paired in xviii, 0.24 circumference apart in 7th setal line, 6 setae between openings. Setae regularly distributed around segmental equators, 24 setae on vii, 40 setae on xx; no dorsal or ventral gaps in setal spacing. Clitellum not developed; no genital markings (Fig. 1C).

Septa 4/5-6/7 thin, 7/8 muscular, 8/9 lacking, 9/10 very thin, 10/11 very thick, 11/12-13/14 less so but still muscular. Nephridia in dense tufts on anterior faces of 5/6, 6/7; nephridia of post-clitellar segments in pre-, post-septal rows near septum-body wall junction.

Large gizzard in viii, esophagus pebbly x-xi, lamellar xii-xiii, intestinal origin xvii, simple caeca originating in xxvii, extending forward to xxi, ventral margins incised; typhlosole rudimentary, no more than blood vessel on dorsal intestinal wall, xxvii-lix.

Hearts x-xiii esophageal, commissural vessels vi, vii, ix lateral; viii to gizzard; ventral vessel with branches to body wall in viii, ix. Supra-esophageal vessel xi-xiv, extra esophageal vessel to esophageal wall in x, efferent parieto-esophageal vessel not seen.

Ovaries and funnels free in xiii, spermathecae paired in vi with nephridia on lateral faces of spermathecal ducts; each spermatheca with large rounded ampulla, single stalked diverticulum terminating in club-shaped receptacle, stalk tightly looped, first loop closely adherent to spermathecal duct (Fig. 1D). Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii with dorsal lobes; vasa deferentia free from body wall en route to ental end of prostatic ducts; each prostate racemose with two major lobes, stout muscular duct to copulatory bursa in xviii; coelomic surface of copulatory bursae lacking glandular or other projections; well-developed conical penis present, passing through sheath-like sleeve en route to opening.

Remarks. – *Pheretima balettei* also keys to the *P. urceolata* group (or species; see above). It is diagnosed by the following unique set of characteristics: 24 setae on vii (fewer than other members of the species group), very pale pigmentation, male pores about 0.25 circumference apart, septum 8/9 present, lacking 9/10; intestinal origin in xvii, no typhlosole, spermathecal diverticulum stalk looped, copulatory bursa circular, not ellipsoidal or with anterior/posterior bulges; has penes. For more comparisons, see Table 1.

***Pheretima heaneyi*, new species**

(Figs. 1E, F)

Material examined. – Holotype - adult (NMA 003975) Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 8° 10.5' N, 124° 51' E, 16.5 km S, 4 km E of Camp Phillips, 1900 m. elevation, coll. L. Heaney, 22 Mar.1993.

Etymology. – Lawrence Heaney of the Field Museum of Natural History, initiated the expeditions responsible for the discovery of this and many other earthworms from the Philippines, has assisted the author to conduct biodiversity research in the Philippines, and is a great advocate of conservation in the Philippines. Therefore this species is named in his honor.

Paratype – one adult (FMNH 011062) Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 8° 10.5' N, 124° 51' E, 16.5 km S, 4 km E of Camp Phillips, 1900 m. elevation, coll. L. Heaney, 22 Mar.1993.

Other material- five adults (KUNHM 002143), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 8° 10.5' N, 124° 51' E, 16.5 km S, 4 km E of Camp Phillips, 1900 m. elevation, coll. D. Balete, no date; two adults (FMNH 011063) Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 8° 9' N, 124° 44' E, 1800 m. elevation, coll. D. Balete, no date.

Description. – Brown dorsal pigment, pigment absent from segmental equators, body 116-83 x 5.4-3.9 mm (vii), 5.2-4.2 mm (x), 5.2-4.0 mm (xxv), 113-97 segments; body cylindrical in cross-section. First dorsal pore 11/12 (6), 12/13 (3) spermathecal pores paired in 5/6, 0.19-0.22 circumference apart, female pore single in xiv, openings of copulatory bursae paired in xviii, 0.19-0.23 circumference apart in 7th-9th setal line, 6-8 setae between openings. Setae regularly distributed around segmental equators, 32-44 setae on vii, 38-48 setae on xx; in vii ZZ:YZ = 1.6-2.1, in xx ZZ:YZ = 2.0-3.0; no ventral gaps. Clitellum annular xiv-xvi; no genital markings (Fig. 1E).

Septa 4/5-6/7 thin, 7/8 muscular, 8/9 very thin, 9/10 usually lacking, 10/11-13/14 muscular but not thick. Large gizzard in viii, esophagus deeply-pouched, vascularized, with vertical lamellae xi-xv, intestinal origin xviii, simple caeca with slightly incised ventral margins originating in xxvii, extending forward to xxiii or xxiv, sometimes to xxi; typhlosole xxvii-xliii, lxi, lxii, lxiii, lxvi, lxxiii; simple fold one-third lumen diameter; 28 longitudinal blood vessels in intestinal wall xxvii-xl, xli.

Hearts x lateral, xi-xiii esophageal, commissural vessels vi, vii lateral; viii to gizzard, ix lacking; ventral vessel with branches to body wall in viii, ix. Supra-esophageal vessel xi-xiv, xv; extra esophageal vessels join ventral wall of esophagus in x; efferent parieto-esophageal vessels not seen in clitellar region.

Nephridia in dense tufts on anterior faces of 5/6, 6/7; nephridia of post-clitellar segments in pre-, post-septal rows near septum-body wall junction.

Ovaries and funnels free in xiii, spermathecae paired in vi with nephridia on lateral faces of spermathecal ducts; each spermatheca with large rounded ampulla filling vi, single stalked diverticulum terminating in ovate to sausage-shaped receptacle, stalk with one or more tight loops, at least first

Table 1. Comparison of species of the *urceolata* group. Data on *P. urceolata* are from types examined by Gates (1961). Setal counts are given as a pair of numbers separated by a comma, the first of the pair being the count in segment vii, and the second being the number in xx. Setal gap presence is indicated as D for dorsal gap and V for ventral. Septal presence and absence is indicated by + or -, the first of each pair being for septum 8/9. Missing data are shown by a question mark (?).

	<i>Pheretima baletaei</i>	<i>bukidnonensis</i>	<i>heaneyi</i>	<i>kitangladensis</i>	<i>monothecha</i>	<i>urceolata</i>
Setae vi, xx	24, 40	38, 52	38, 43	44, 48	36, 32	20, 42
Setal gaps D, V	none	D	D	none	D	D, ?V
Male pore setae	6	10	6-8	8	3	6
Male pore spacing	0.24	0.17	0.19-0.23	0.20	0.1	0.1
Sp. pore spacing	0.25	0.38	0.19-0.22	0.28	0	0.45
Pigment	pale pink	brown	brown	brown	brown	red
Length mm	78 mm	76 mm	83- 116mm	108 mm	62 mm	70-80 mm
Intestinal origin	xvii	xviii	xviii	xvi	xviii	xvi
typhlosole	-	+	+	+	+	+
Esophageal lamellae	+	+	+	+	+	?
Intestinal vessels	?	20	28	32	36	?
Hearts	x-xiii	xii, xiii	xi-xiii	x-xiii	x-xiii	x-xiii
Septa 8/9/10	-, +	+, +	+, +/-	+, -	-, -	+, -
Bithecate vs mono	Bi	Bi	Bi	Bi	mono	Bi
Penes	+	-	+	-	+	+
Bursal pads	0	0	0	2	0	2
Bursal glands	-	+	+	-	+	-

loop closely adherent to broad spermathecal duct (Fig. 1F). Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii large, with digitiform dorsal lobe; vasa deferentia free from body wall en route to ental end of prostatic ducts; each prostate racemose with two major lobes, stout muscular duct entering just anterior to apex of copulatory bursa in xviii; coelomic surface of copulatory bursae soft, white, glandular in appearance, accompanied by one or two larger glandular masses; these glands with lumen opening into copulatory bursa; penis present, its base surrounded by short sheath.

Remarks. – This species also keys to the *P. urceolata* group, but unlike other members has an intestinal origin in xviii, glandular masses on the copulatory bursae, and lateral hearts in x. It has penes unlike *P. kitangladensis*. The glandular masses on the copulatory bursae are neither secretory diverticula nor stalked glands, as referred to in Sims & Easton (1972) with reference to subgenus *Pheretima* (*Parapheretima*), but another glandular apparatus entirely. Several other species have anterior and posterior bulges in the copulatory bursae, whose surface is entirely muscular in appearance, but the interior of each bulge proves to have a small lumen connected to the main lumen of the pouch. In this case the surface of the copulatory bursae has non-muscular glandular tissue.

Pheretima bukidnonensis, new species

(Figs. 1G, H)

Material examined. – Holotype - adult (NMA 003976) Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 17 km S, 7 km E of Baungon, 8° 10' N, 124° 44' E, 1550 m. elevation, coll. D. Balete, no date.

Etymology. – the species is named after the province where it was collected.

Description. – Dark brown dorsal pigment, pigment diffuse on segmental equators, body 76 x 3.4 mm (vii), 3.5 mm (x), 3.5 mm (xxv), 96 segments; body cylindrical in cross-section, elongate tail tapering. First dorsal pore 12/13, spermathecal pores paired, sublateral in 5/6, 0.38 circumference apart, female pore single in xiv, openings of copulatory bursae paired in xviii, 0.17 circumference apart in 8th setal line, 10 setal follicles but only 8 setae between openings. Setae more crowded ventrally, 38 setae on vii, 52 setae on xx; in vii ZZ:YZ = 2.0, in xx ZZ:YZ = 2.0; no ventral gaps. Clitellum annular xiv-xvi; no genital markings (Fig. 1G).

Septa 4/5-7/8 thin, 8/9, 9/10 very thin, 10/11-12/13 slightly muscular. Nephridia of post-clitellar segments pre- and post-septal on body wall; tufts of nephridia on anterior faces of septa 5/6, 6/7.

Large gizzard in viii, esophagus with vertical lamellae x-1/2xv, pebble-grained until valvular in xvii, intestinal origin

xviii, simple caeca originating in xxvii, extending forward to xix or xviii; typhlosole xxvii-lxiv, simple fold one-third lumen diameter.

Hearts x, xi lateral; xii, xiii esophageal, commissural vessels vi, vii, ix lateral; viii to gizzard; ventral vessel with branches to body wall in viii, ix. Supra-esophageal vessel xii-xv, extra-esophageal vessel not traceable.

Ovaries and funnels free in xiii, spermathecae paired in vi with nephridia on spermathecal ducts; each spermatheca with blocky ampulla, stout duct, single stalked diverticulum terminating in ovate receptacle, stalk tightly coiled, closely adherent to spermathecal duct (Fig. 1H). Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; sacs not connected; seminal vesicles xi, xii, in xii with dorsal lobe; vasa deferentia slender, free from body wall en route to ental end of prostatic ducts; each prostate racemose with two major lobes, stout muscular duct entering copulatory bursa in xviii; coelomic surface of copulatory bursae glandular in appearance, bursae lined with many folds; penes absent.

Remarks. – A further member of the *urceolata* group, *P. bukidnonensis* has the glandular covering of the copulatory bursae seen in *P. heaneyi*, but unlike it lacks penes. Like *P. heaneyi* it has the intestinal origin in xviii and lateral hearts in x, but also has lateral hearts in xi, a very unusual condition for the genus. The spermathecal pores are uncommonly far apart at 0.38 of the circumference, and the typhlosole is also deeper than in *P. kitangladensis* and *P. baletai* but about the same as *P. heaneyi*.

Pheretima monothecca, new species

(Figs. 1I, J)

Material examined. – Holotype - adult (NMA 003977) Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 18 km S, 17 km E of Baungon, 8° 9' N, 124° 45' E, 1800 m. elevation, coll. D. Balete, no date.

Etymology. – The species name refers to the single spermatheca present.

Description. – Medium brown dorsal pigment, body 62 x 2.9 mm (vii), 3.2 mm (x), 3.7 mm (xxv), 96 segments; body cylindrical in cross-section. First dorsal pore 12/13, spermathecal pore single, mid-ventral 5/6, female pore single in xiv, openings of copulatory bursae paired in xviii, 0.11 circumference apart in 4th setal line, 3 setae between openings. Setae more crowded ventrally, 36 setae on vii, 32 setae on xx; in vii ZZ:YZ = 2.2, in xx ZZ:YZ = 2.5; no ventral gaps. Clitellum annular xiv-xvi; infolded slightly thickened epidermal area posterior to spermathecal pore on vi (Fig. 1I).

Septa 4/5-7/8 thin, 8/9, 9/10 absent, 10/11-12/13 slightly toughened but thin. Nephridia of post-clitellar segments pre- and post-septal on body wall; tufts of nephridia on anterior faces of septa 5/6, 6/7.

Large gizzard in viii, esophagus with chevron-patterned lamellae x-xv, pebble-grained xvi, valvular in xvii, intestinal origin xviii, simple caeca originating in xxvii, extending forward to xxiii; typhlosole xxvii-lxiii, simple fold one third lumen diameter; 26 longitudinal vessels in intestinal wall.

Hearts x-xiii esophageal, commissural vessels vi, vii, ix lateral; viii to gizzard. Supra-esophageal vessel x-xiv, extra-esophageal vessel not traceable past x.

Ovaries and funnels free in xiii, spermatheca in vi with nephridia on spermathecal duct; single spermatheca with irregular sac-shaped ampulla, stout duct, two stalked diverticula terminating in sausage-shaped receptacles, stalks kinked, first kink closely adherent to spermathecal duct (Fig. 1J). Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; sacs not connected; seminal vesicles xi, xii, with dorsal lobe; vasa deferentia slender, free from body wall en route to ental end of prostatic ducts; each prostate racemose with two major lobes, stout muscular duct entering center of muscular dome of copulatory bursa in xviii; glandular mass anterior to, communicating with copulatory bursa, elongate conical penis present, surrounded by sheath within bursae.

Remarks. – *Pheretima monothecca* keys to *P. ambonensis* (Cognetti, 1913) in Sims & Easton (1972), but that species has its spermathecal pore in 7/8, is twice the body length, has twice the setae on the post-clitellar segments, the male openings are farther (0.2 circumference) apart, its intestinal origin is three segments more forward in xv, the spermatheca is in vii and its two diverticula have much shorter chambers and stalks (Cognetti, 1913). By spermathecal pore location *P. monothecca* would belong to the *urceolata* species group, within which it would be the only monotheccate member. Furthermore it has fewer setae than most of its group members. The male openings are very close together, corresponding to the single spermathecal pore, and the copulatory bursae have anterior glandular masses and penes. The single spermatheca in vi has two identical diverticula, probably the result of fusion of two spermathecae into one, as is likely the case in *P. ambonensis*. Monotheccy is not known to be common among *Pheretima* (*Pheretima*), where until now *P. ambonensis* was the only one recorded. However monotheccate species are known from other genera of the *Pheretima* complex, including *Pithemera* (Sims & Easton, 1972; James, unpub.data).

Pheretima quincunxia, new species

(Figs. 2A-C)

Material examined. – Holotype - adult (NMA 003978) Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 18.5 km S, 4 km E of Camp Philips, 2250 m. elevation, coll. L. Heaney, 2 Apr. 1993.

Paratypes – four adults (FMNH 011064) Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 18.5 km S, 4 km E of Camp Philips, 2250 m. elevation, coll. L. Heaney, 2 and 4 Apr. 1993.

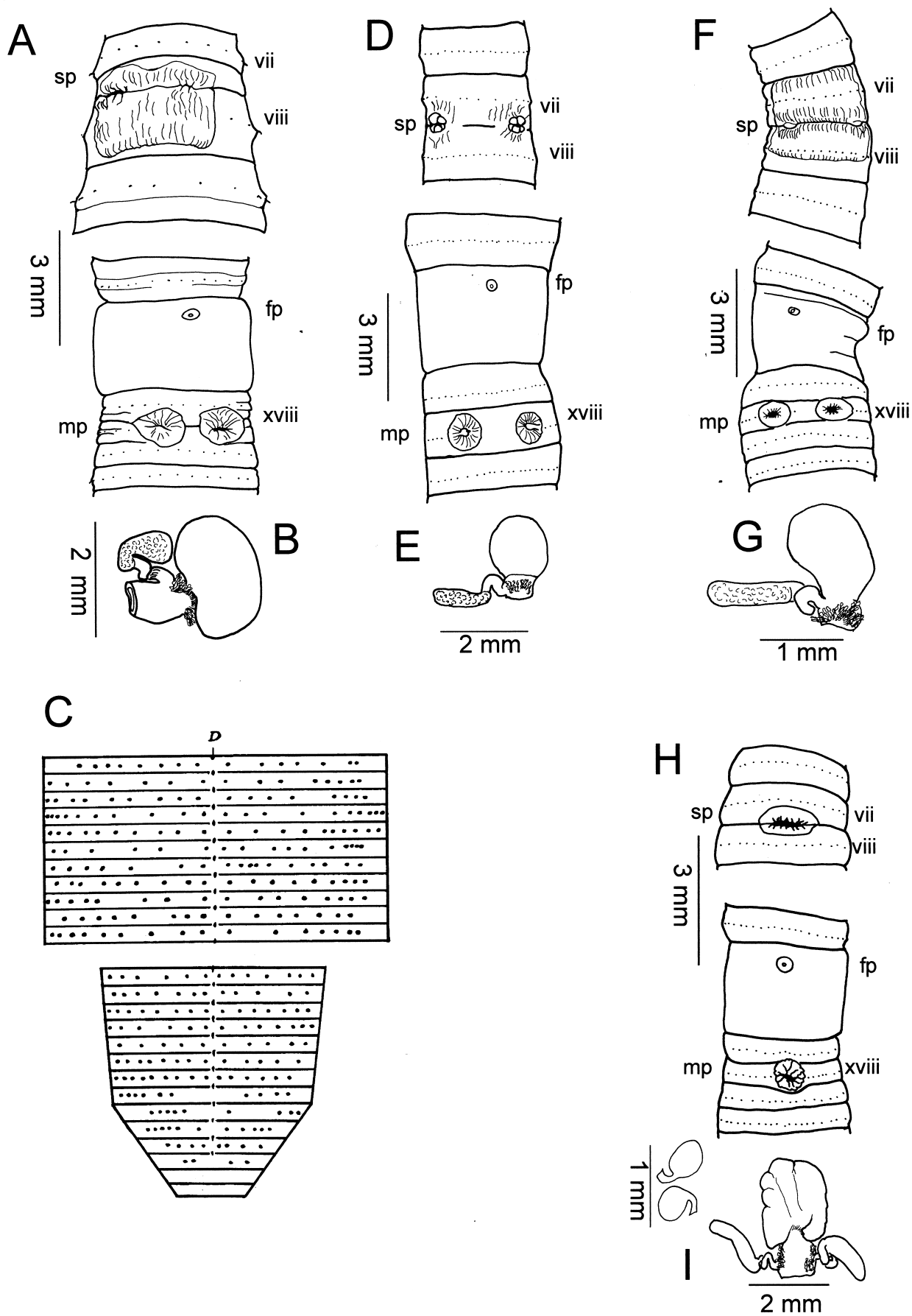


Fig. 2. Spermathecae, and ventral views showing spermathecal pores, female pores, and male pores of *Pheretima quincunxia* (A, B), C: setal distribution pattern of *P. quincunxia* with mid dorsal line of dorsal pores at center, *P. diesmosi* (D, E), *P. rugosa* (F, G), and *P. monoporata* (H, I, with spermatophore). Symbols: fp, female pore(s); mp, male pores; sp, spermathecal pores.

Etymology. – The species is named for its approximately quincunxial setal arrangement.

Description. – Worms unpigmented, body 65-86 x 3.9 mm (vii), 4.8 (x), 4.6mm (xxv), 74-82 segments; body cylindrical in cross-section. First dorsal pore 12/13, spermathecal pores with thick lips paired in 7/8, 0.16 circumference apart, female pore single in xiv, openings of copulatory bursae paired in xviii, 0.13 circumference apart in 2nd or 3rd setal line, 0 (4 individuals) or 2 (1) setae between openings. Behind clitellum setae of adjacent segments offset, irregular, approaching quincunxial arrangement, 16-20 setae on vii, 20-30 setae on xx, 10-15 in tail segments, there widely spaced dorsally, laterally, with 3-5 closely spaced setae on ventral side (Fig. 2C); dorsal gaps irregular, no ventral gaps. Clitellum annular xiv-xvi; rugose epidermally thickened rectangular area covering ventral post-setal third of vii, most of viii (Fig. 2A).

Septa 4/5- 9/10 thin, 10/11-12/13 muscular. Nephridia in dense tufts on anterior faces of 5/6, 6/7; nephridia of post-clitellar segments in pre-, post-septal rows near septum-body wall junction.

Large gizzard in viii, esophagus with vertical lamellae x-xiii, intestinal origin 1/2xvi, simple caeca originating in xxvii, extending forward to xxv; typhlosole rudimentary; 32 longitudinal vessels in intestinal wall.

Hearts x-xiii esophageal, commissural vessels vi, vii, ix lateral; viii to gizzard; ventral vessel with branches to body wall in viii, ix. Supra-esophageal vessel x-xiv; extra-esophageal vessel not seen.

Ovaries and funnels free in xiii, spermathecae paired, preseptal in vii with nephridia on spermathecal ducts; each spermatheca with large rounded ampulla filling its side of vii, single stalked diverticulum terminating in pear-shaped receptacle, stalk tightly looped, first loop closely adherent to spermathecal duct (Fig. 2B). Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii; vasa deferentia free from body wall en route to ental end of prostatic ducts; each prostate racemose occupying xvii-xix, stout muscular duct entering posterior side of copulatory bursa in xviii; coelomic and exterior surfaces of copulatory bursae lacking glandular or other projections; four pads flanking opening to exterior; no well-developed penis, but a small protuberance varying from V-shaped fold to low conical bump with male pore on apex.

Remarks. – *Pheretima quincunxia* keys to the *P. sangirensis* (Michaelsen, 1891), group in Sims & Easton (1972), which once consisted of three species, *P. sangirensis*, *P. ceramensis* (Cognetti, 1922), and *P. crassicystis* (Michaelsen, 1896), which in turn is divided into three subspecies, *P. c. chica* (Michaelsen, 1896), *P. c. crassicystis* (Michaelsen, 1896) and *P. c. toboloensis* (Michaelsen, 1896). However, Michaelsen (1900) synonymized the latter two subspecies of *P. crassicystis* under the name *P. c. crassicystis*, and included all *crassicystis* as subspecies of *P. sangirensis*. A third species in the group, *P. unicystis* (Lee, 1981), was described from

Vanua Tu material (Lee, 1981). The others are from Indonesia, in the Molucca Islands, Halmahera and North Celebes (Sulawesi). I examined material of *P. sangirensis* and *P. ceramensis*, and referred to the original descriptions for further information. The characteristics of *P. sangirensis* are given by Michaelsen (1900) as follows: anterior and ventral setae slightly enlarged, very slight dorsal gap present, male pores from 0.17 to 0.25 circumference apart, spermathecal pores one pair in 7/8, from 0.25 to 0.28 circumference apart, septa 8/9/10 lacking, caeca either simple or with short pockets on the ventral margins, holandric with paired testis sacs, copulatory pouches simple, with short conical penis. The subspecies vary in size (60-240 mm), color, shape of the spermathecal diverticula, and in the structure of the spermathecae.

Pheretima ceramensis is from the Indonesian island of Ceram, just west of New Guinea. It is a large worm, 140- 440 mm X 8-14 mm, 60 setae per segment, dark violet dorsal pigmentation, male pores about 0.2 circumference apart and spermathecal pores slightly closer set; no setae between male pores (Cognetti, 1922). Interior characters are given in Cognetti (1922) as: septa 8/9/10 absent, 10/11-15/16 very muscular, intestinal origin xvi, caeca simple, last hearts xiii; testes sacs paired, unconnected and subesophageal, prostate glands divided in about 12 lobes, prostate ducts muscular, bent, entering large and robust copulatory pouch. Spermathecae one pair in vii, ampulla spherical on a large but short muscular duct, diverticulum chamber elongate. My examination of the type material, whose label data agree entirely with that reported in Cognetti (1922), show some slight differences: septum 8/9 present, intestinal origin 1/2 xv, one seta between male pores, prostate divided in 4 main lobes.

Lee (1981) distinguished *Pheretima unicystis* from the previous species and *P. crassicystis* by the presence of only one asymmetrically placed spermatheca, spermathecal characters, body size, and intestinal origin. My examination of previously undissected material of *P. ceramensis* shows an intestinal origin at 1/2 xv, rather than xvi as reported in Cognetti, and partly relied upon by Lee (1981).

Pheretima quincunxia, *P. paucisetosa* and *P. alba* below, are the only members of the species group lacking pigment, though *P. unicystis* is only weakly pigmented. *Pheretima quincunxia* has spermathecal and male pores more narrowly spaced than in other members of the species group, except for *P. paucisetosa*, *P. alba* and *P. rubida*, whose spacings are comparable (Table 2). It also has fewer setae per segment than all others in the group and the setae have an irregular arrangement approaching quincunxial (alternating position in adjacent segments). It has all anterior septa present, unlike the others except *P. unicystis*. The stalk of the spermathecal diverticulum is not simple as in the *P. sangirensis* group but is tightly looped. While the spermathecal pores are in 7/8, indicating membership in the *sangirensis* group, the spermathecae are in vii, a state shared with the BMNH material of *P. sangirensis*, all *P. ceramensis*, and *P. unicystis*. The presence of other species in the region (*P. diesmosi*, *P. rugosa*, *P. monoporata*, *P. paucisetosa*, *P. alba*, *P.*

Table 2. Comparison of species of the *sangirensis* group. Setal counts are given as a pair of numbers separated by a comma, the first of the pair being the count in segment vii, and the second being the number in xx. Setal gaps presence is indicated as D for dorsal gap and V for ventral. Septal presence and absence is indicated by + or -, the first of each pair being for septum 8/9. For bursal pads, those found on the floor of the bursa are represented by F (e.g. 4F), and those attached to the roof of the bursa are represented by R (e.g. 4R).

	Pheretima quincunxia										
	18, 25	28, 38	24, 32	30, 34	52, 40	38, 50	22, 28	38, 36	34, 36	76, 80	40, 60+
	Irreg.	D	D	D	D	D	D	D	D	none	D, ?V
Male pore setae	0-2	0	0	0	0	8	2	0	4	4	6
Male pore spacing	0.13	0.15	0.15	0.05	0.04	0.19	0.13	0.10	0.12	0.1	.17-.25
Sp. pore spacing	0.16	0.23	0.20	0	0.08	0.38	0.16	0.13	0.20	0.1	.25-.28
pigment	-	brown	brown	brown	brown	brown	-	-	red-brown	brown stripes	variable
Length mm	65-86	128	70	60-70	50	107	115	49	72	290	60-240
Intestinal origin	1/2xvi	xvii	xvii	xvii	xvi	xv	1/2xvi	xvi	xvi	xvi	xv
Typhlosome	-	+	+	+	+	+	-	+	+	+	+
Esoph. lamellae	+	+	+	+	+	+	+	+	+	+	-
Intestinal vessels	32	22	20	18-20	26	32	34	24	26	42	36
Hearts	x-xiii	x-xiii	x-xiii	x-xiii	xi-xiii	x-xiii	x-xiii	x-xiii	x-xiii	x-xiii	x-xiii
Septa 8/9/10	+, +	+, +	+, +	+, +	+, -	+, -	+, +	+, -	+, +	+, -	+, -
Bithecate vs mono	Bi	Bi	Bi	mono	Bi	Bi	Bi	Bi	Bi	Bi	Bi
Thecal segm.	vii	vii	vii	vii	viii	vii	vii	vii	vii	viii	vii
Penes	-	-	+	+	-	-	+	+	+	+	+
Bursal pads	4F	2F	3F	0	2R	2R	3F	0	0	5F, 4R	2F?

baungonensis, *P. rubida*) with the same condition would indicate that the evolution of anteriorly displaced spermathecae took place in a common ancestor of these species and perhaps also *P. ceramensis*. In those *sangirensis* group species described here with spermathecae in vii, the spermathecae are placed in the posterior half of the segment, so I refer to such spermathecae as preseptal, indicating their unusual position within the segment. In all these cases the septal insertions are in line with the external intersegmental boundaries, with no evidence of displacement of septa either posteriorly or anteriorly. Therefore one must conclude that the spermathecae have migrated forwards, and that the simplest interpretation is that this change took place once in a common ancestor of the species in question.

Pheretima sangirensis

Perichaeta sangirensis Michaelsen, 1891:36.
? *Perichaeta sangirensis* - Horst, 1893:317.
Pheretima crassicystis Michaelsen 1896:204.
Amyntas sangirensis Michaelsen, 1899:76.
Pheretima sangirensis - Michaelsen, 1900:300.

Material examined. – Syntype - 1 adult (BMNH 1904.10.5.149), Sangir, Indonesia, no coll., no date.

Description. – Testes sacs ventral, paired; copulatory pouch containing blocky, angular penis, two pads anterior to penis within pouch; spermathecal diverticulum stalk straight, diverticulum chamber elongate bean-shaped; spermathecae within vii.

Pheretima ceramensis

Pheretima ceramensis Cognetti, 1922: p.1.

Material examined. – Type - 1 adult (BMNH 1921.7.30.7/8), Ceram, Indonesia, coll. Pratt, no date.

Description. – Dusky pigmentation, no stripes; 160mm x 13 mm (viii), 7-8 mm elsewhere. Spermathecal pores 7/8, 5 mm apart; male pores xviii 5 mm apart in 6th setal line, one seta between male pores; female pore single; no genital markings.

Septa 4/5-7/8, 10/11-13/14 muscular, 8/9 membranous, 9/10 absent; nephridial masses on anterior faces of septa 5/6/7. Large gizzard viii, esophagus vascular but not lamellar xi-xiii, intestinal origin xv, typhlosole low thin fold from xxvii; 36 longitudinal vessels in intestinal wall; caeca origin xxvii, extends forward to xxiv, simple with smooth margins.

Lateral commissures vii-ix, hearts x-xiii esophageal; supraesophageal vessel visible x-xiii, extraesophageal vessel receives posterior latero-parietal vessels in xiii; these vessels extend from clitellum segments forward to xiii.

Spermathecae in vii, large rounded ampulla filled with coagulated material, soil particles, and small ovate discs < 1mm diam.; duct short, broad; diverticulum stalk short,

straight, chamber sausage-shaped. Holandric, testes sacs paired, ventral; seminal vesicles xi, xii acinous with dorsal appendage; vasa deferentia slightly muscularized, distinctly two tubules but adherent, becoming fused towards junction with ental end of prostatic duct; prostates in four lobes wrapped around large hemispherical copulatory pouch, duct enters apex of pouch; pouch muscular in external appearance, with thick blocky penis from roof, floor with four oval pads, two medial and two lateral to copulatory pouch opening.

Pheretima diesmosi, new species

(Figs. 2D, E)

Material examined. – Holotype - (NMA 003979) Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 16.5 km S, 4 km. E of Camp Philips, 1900 m. elevation, coll. L. Heaney, 22 Mar.1993.

Etymology. – The species is named for Arvin Diesmos, a Filipino herpetologist who has provided the author with assistance of many kinds.

Description. – Brown dorsal pigmentation, body 128 x 3.0 mm (vii), 3.4 mm (x), 3.4 mm (xxv), 102 segments; body cylindrical in cross-section. First dorsal pore 12/13, spermathecal pores paired in 7/8, 0.23 circumference apart, female pore single in xiv, openings of copulatory bursae paired in xviii, 0.15 circumference apart in 6th setal line, 2 empty setal follicles between openings. 8-12 setae closely spaced on ventrum, more widely spaced elsewhere around post-clitellar segments; some setae missing from vii, viii; 28 setae on vii, 38 setae on xx; in vii ZZ: YZ = 2.3, in xx ZZ: YZ = 3.0, no ventral gaps. Clitellum annular xiv-xvi; thickened epidermal areas around spermathecal pores (Fig. 2D).

Septa 4/5- 9/10 thin, 10/11-12/13 slightly muscular. Nephridia in dense tufts on anterior faces of 5/6, 6/7; those of intestinal segments pre- and post-septal at septum-body wall junction.

Large gizzard in viii, esophagus deeply-pouched, vascularized, with vertical lamellae x-xiv, intestinal origin xvii, simple caeca originating in xxvii, extending forward to xxv, ventral margins smooth; typhlosole xxvii-lxxi, low thick ridge 1/4 lumen diameter: 22 longitudinal vessels in intestinal wall.

Hearts x-xiii esophageal, commissural vessels vi, vii, ix lateral; viii to gizzard; supra-esophageal vessel x-xiii, extra esophageal vessel to ventral esophageal wall in x; efferent parieto-esophageal vessel from body wall of xiii-xvii to ventral esophagus in xiii.

Ovaries and funnels free in xiii, spermathecae paired, preseptal in vii with nephridia on lateral faces of spermathecal ducts; each spermatheca with large rounded ampulla filling its side of vii, single stalked diverticulum terminating in sausage-shaped receptacle, stalk short with one bend closely adherent to spermathecal duct (Fig. 2E). Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal

vesicles xi, xii with dorsal lobes; vasa deferentia free from body wall en route to ental end of prostatic ducts, thick and muscular xiii-xviii; each prostate racemose, occupying xvii-xx, bilobed, one lobe with three minor lobes, the other with two, stout muscular duct entering posterior side of copulatory bursa in xviii; coelomic and exterior surfaces of copulatory bursae lacking glandular or other projections; two pads lateral to opening; muscular knob from roof of copulatory bursa in place of penis.

Remarks. – This species also keys to the *P. sangirensis* group in Sims & Easton (1972), but differs from the previously known species in having all anterior septa present, spermathecae with kinked diverticulum stalk, no setae between the male pores, and different location of pads within the copulatory bursae. It is distinguished from other Philippine members of this group in having the intestinal origin in xvii, a muscular vas deferens and a low knob in place of a penis. Additional details of comparison are in Table 2. Its closest affinities are to *P. rugosa*, from which it differs in the details of the copulatory pouch and penis, the greater number of setae per segment, and the lack of genital markings found in *P. rugosa*.

***Pheretima rugosa*, new species**
(Figs. 2F, G)

Material examined. – Holotype - adult (NMA 003980) Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 8° 9' N, 124° 44' E, 1800 m. elevation, coll. D. Balete, no date.

Paratype – adult (FMNH 011065) Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 8° 9' N, 124° 44' E, 1800 m. elevation, coll. D. Balete, no date.

Etymology. – The species is named for broad corrugated pad adjacent to the spermathecal pores.

Description. – Dark brown dorsal pigmentation, body 70 x 2.8 mm (vii), 3.2 (x), 3.4 mm (xxv), 92 segments, six regenerated; body cylindrical in cross-section. First dorsal pore 11/12, spermathecal pores paired in 7/8, 0.20 circumference apart, female pore single in xiv, openings of copulatory bursae paired in xviii, 0.15-0.16 circumference apart between 5th and 6th setal lines, 0 setae between openings. 8-10 setae closely spaced on ventrum, 1.5-2X more widely spaced elsewhere around post-clitellar segments; some setae missing from vii; 18, 24 setae on vii, 36 on viii, 30, 32 setae on xx; no dorsal gap in vii; in xx ZZ: YZ = 2.0, no ventral gaps. Clitellum annular xiv-xvi; ventral surface of vii, anterior 2/3 of viii thickened to form a broad corrugated pad extending laterally just beyond spermathecal pores (Fig. 2F).

Septa all thin, all anterior septa present. Nephridia in dense tufts on anterior faces of 5/6, 6/7; those of intestinal segments pre- and post-septal at septum-body wall junction. Large gizzard in viii, esophagus deeply pouched, vascularized, with vertical lamellae x-xiii, pebble-grained internally xiv, xv, valvular xvi; intestinal origin xvii, simple caeca originating in xxvii, extending forward to xxiv, ventral margins smooth;

typhlosole xxvii-lx, lxv, simple fold approximately 0.4-0.5 lumen diameter: 20 longitudinal vessels in intestinal wall.

Hearts x-xiii esophageal, commissural vessels vi, vii, ix lateral; viii to gizzard; supra-esophageal vessel x-xiii; extra esophageal vessel joins ventral esophageal wall in x, receives efferent parieto-esophageal vessel in xiii.

Ovaries and funnels free in xiii, spermathecae paired, preseptal in vii with nephridia on ducts; each spermatheca with rounded ampulla, single stalked diverticulum terminating in sausage-shaped receptacle, stalk passing through 7/8 to place diverticulum in viii (Fig. 2G). Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; sacs separate; seminal vesicles large in xi, xii, each with dorsal lobe; vasa deferentia free from body wall en route to ental end of prostatic ducts, thick and muscular xiii-xviii; each prostate racemose, occupying xvi-xx, bilobed, each lobe with two or three minor lobes, stout muscular duct entering center of ovate copulatory bursa in xviii; coelomic surfaces of copulatory bursae muscular, lacking glandular or other projections; interior of outer bursa wall with one long pad lateral to opening, two pads medial to opening; penis present.

Remarks. – The spermathecae are preseptal in vii and the diverticulum is in viii, suggesting that the spermatheca migrated forwards one segment while retaining the pore location at 7/8. It has three pads in the copulatory bursae rather than two as in *P. diesmosi* and has true penes. Like *P. quincunxia*, *P. diesmosi* and *P. rubida*, *P. rugosa* has a distinct thickening of the epidermis on vii and viii. The extent of epidermal thickening in vii and viii is greatest in *P. quincunxia* and *P. rugosa*, minimal in *P. diesmosi*, and confined to narrow bands in *P. rubida*. *Pheretima quincunxia* and *P. rugosa* have the greater extent of thickening in viii and vii, respectively.

***Pheretima monoporata*, new species**
(Figs. 2H, I)

Material examined. – Holotype - adult, (NMA 003981), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 16.5 km S, 4 km. E of Camp Phillips, 8° 10.5' N, 124° 51' E, 1900 m. elevation, coll. L. Heaney, 22 Mar.1993.

Paratypes – 2 adults, 2 late juveniles (FMNH 011066), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 16.5 km S, 4 km. E of Camp Phillips, 8° 10.5' N, 124° 51' E, 1900 m. elevation, coll. D. Balete, no date.

Others – 1 adult (KUNHM 002144), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 8° 9' N, 124° 44' E, 1800 m. elevation, coll. D. Balete, no date; 1 adult (KUNHM 002145), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 18.5 km S, 4 km E of Camp Phillips, 8° 9.5' N, 124° 51' E, 2250 m elevation, coll. D. Balete, no date.

Etymology. – The species name comes from the presence of a single spermathecal pore and male pores so closely approximated as to appear to be one pore.

Description. – Faint brown antero-dorsal pigmentation, body 60-70 x 2.2-2.9 mm (vii), 2.5-2.9 (x), 2.3-3.2 mm (xxv), 99, 101 segments (several specimens were amputees); body cylindrical in cross-section. First dorsal pore 12/13 (4), 13/14 (1), spermathecal pore single in 7/8, female pore single in xiv, openings of copulatory bursae paired in xviii, 0.05 circumference apart between 2nd and 3rd setal lines, 0 setae between openings. Setae regularly distributed around segmental equators; 26-34 setae on vii, 32-36 setae on xx; in vii ZZ: YZ = 2.0-4.0, in xx ZZ: YZ = 3-3.5, no ventral gaps. Clitellum annular xiv-xvi; no other genital markings (Fig. 2H).

Septa 4/5-6/7 thin, 7/8 muscular, 8/9-10/11 thin, 11/12, 12/13 slightly muscular. Large gizzard in viii, esophagus with low vertical lamellae x-xiii, xiv, intestinal origin xvii, simple caeca originating in xxvii, extending forward to xxv, xxiii; typhlosole xxvii-lxxiii, lxv, lx, simple fold 0.4 lumen diameter; intestinal wall with 18-20 longitudinal blood vessels xxvii-xxxix.

Hearts x-xiii esophageal, commissural vessels vi, vii, ix lateral, those of ix either greatly different in size or one side lacking; viii to gizzard; supra-esophageal vessel x-xiv; extra esophageal vessel joins ventral esophageal wall in x, receives efferent parieto-esophageal vessel in xiii.

Dense tufts of nephridia on anterior faces of 5/6, 6/7; nephridia of intestinal segments located at septum/body wall junction on anterior and posterior faces of septa, during dissection nephridia come away on septa.

Ovaries and funnels free in xiii, spermatheca single, preseptal in vii with nephridia on duct; spermatheca with large ampulla, broad stout duct, two (4) or three (1) stalked diverticula attached to lateral sides of duct, each terminating in sausage-shaped receptacle, stalks long, kinked with at least one loop closely adherent to spermathecal duct; spermatophores found within ampulla (Fig. 2I). Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii each with digitate dorsal lobe; vasa deferentia slender, free from body wall en route to ental end of prostatic ducts; each prostate racemose, occupying xvi, xvii-xx, bilobed, stout muscular duct entering apex of egg-shaped copulatory bursa in xviii; coelomic and exterior surfaces of paired copulatory bursae muscular, lacking glandular or other projections; bulky angular penis present, no pads flanking opening.

Remarks. – *Pheretima monoporata* keys to *P. ambonensis* in Sims & Easton (1972), but differs from that species in having very closely spaced male openings, appearing as only one externally, whereas *P. ambonensis* has two distinct openings about 0.2 circumference apart. In *P. monoporata* the outer single opening, with its sphincter-like surrounding folds, conceals paired channels leading to the paired copulatory bursae. The ancestral state of two openings has given way to a fusion of the outermost aspects of the two, but there are still independent channels separated by a small distance. The intestinal origin of *P. monoporata* is in xvii, not xv, the body length is half that of *P. ambonensis* (120mm),

and the setae are about half as numerous. The spermatheca of *P. monoporata* has longer diverticulum chambers and stalks. The single spermatheca appears to be derived from fusion of a pair of spermathecae, as in *P. monothecha* and *P. ambonensis*. The copulatory bursae, rather than the usual broadly attached half-ovals or hemispheres of other Mindanao species encountered so far (except *P. alba*; see below), are attached by one apex of the egg-shape. The copulatory bursae lack internal pads, but have penes.

A spermatophore (*Thekozyste*) was reported from the spermathecae in the Sumatran *Metaphire singalangi* (Michaelsen, 1930), but here the spermatophores have a shorter neck and more rounded body. Thecacysts and other free structures related to sperm exchange were discussed in the context of some aquatic Oligochaeta in Michaelsen (1926; p. 27), but a full characterization of these structures is in Stephenson (1930). In the case of *P. monoporata*, the structure found in the spermatheca is most probably a true spermatophore formed in the copulatory pouch, because spermatophores are known to occur in *P. montana*, among other species (Beddard, 1911).

Pheretima vicinipora, new species (Figs. 3A, B)

Material examined. – Holotype - adult (NMA 003982), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 15 km S, 6 km. E of Baungon, 8° 11' N, 124° 44.5' E, 1100 m. elevation, collection date unknown; coll. D. Balete.

Etymology. – The species name comes from the very closely spaced spermathecal and male pores.

Description. – Faint brown antero-dorsal pigmentation, dark stripe at mid-dorsal xvii-xl, amputee 50 x 2.7 mm (vii), 2.9 (x), 3.0 mm (xxv), >76 segments (amputee); body cylindrical in cross-section. First dorsal pore 13/14, spermathecal pores 7/8, 0.08 circumference apart, female pore single in xiv, openings of copulatory bursae paired in xviii, 0.037 circumference apart on floor of small pit, in 2nd setal line, 0 setae between openings. Setae somewhat more crowded ventrally; 52 setae on vii, 40 setae on xx; in vii ZZ: YZ = 1.6, in xx ZZ: YZ = 3.0, no ventral gaps. Clitellum annular xiv-xvi; spermathecal pores surrounded by narrow raised area (Fig. 3A).

Septa all thin, 9/10 absent. Dense tufts of nephridia on anterior faces of 5/6, 6/7; nephridia of intestinal segments located at septum/body wall junction on anterior and posterior faces of septa, during dissection nephridia come away on septa.

Large gizzard in viii, esophagus with low vertical lamellae x-xiii, intestinal origin xvi, simple caeca originating in xxvii, extending forward to xxiii, ventral margins incised; typhlosole xxvii-end, simple fold 0.12 lumen diameter; intestinal wall with 26 longitudinal blood vessels xxvii-xxxix.

Hearts xi-xiii esophageal, commissural vessels vi, vii, ix lateral, ix left side lacking, x both lacking; viii to gizzard;

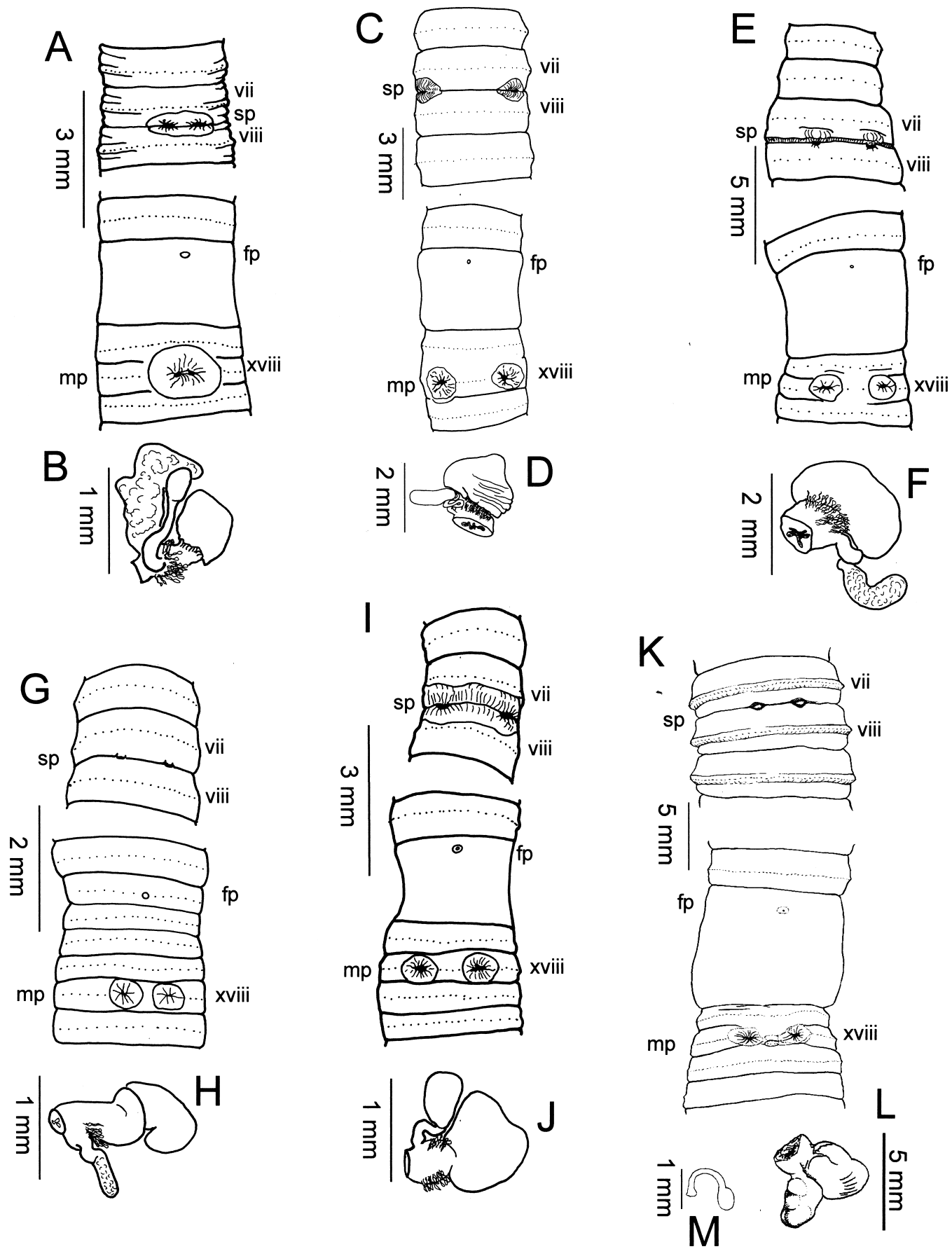


Fig. 3. Spermathecae, and ventral views showing spermathecal pores, female pores, and male pores of *P. vicinipora* (A, B), *P. baugonensis* (C, D), *Pheretima paucisetosa* (E, F), *P. alba* (G, H), *P. rubida* (I, J), and *P. virgata* (K, L, plus M, spermatophore). Symbols: fp, female pore(s); mp, male pores; sp, spermathecal pores.

supra-esophageal vessel xi-xiv; extra esophageal vessel joins ventral esophageal wall in x, receives efferent parieto-esophageal vessel in xiii.

Ovaries and funnels free in xiii, spermathecae paired in viii with nephridia on ducts; each spermatheca with blocky sac-shaped ampulla, broad stout duct, stalked diverticulum attached to ectal portion of duct, terminating in ovate receptacle, stalks long, with one bend closely adherent to spermathecal duct; large glandular mass attached to spermathecal duct adjacent to diverticulum stalk attachment (Fig. 2J). Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii each with digitate dorsal lobe; vasa deferentia slender, free from body wall en route to ental end of prostatic ducts; each prostate a single racemose mass, occupying xvi-xix, stout muscular duct entering posterior surface of copulatory bursa in xviii; coelomic surface of paired copulatory bursae muscular, lacking glandular or other projections; blocky angular appendage in position of penis, two other pads also dependent from roof of copulatory bursae.

Remarks. – *Pheretima vicinipora* is similar to *P. monoporata* in the very close, but slightly wider, spacing of the copulatory bursa openings, but has closely paired spermathecae in viii rather than a single one in vii. In contrast to other Philippine and Indonesian *Pheretima* with spermathecal pore(s) in 7/8, *P. vicinipora* has spermathecae in viii rather than in vii. The present species has fewer esophageal hearts than its Philippine species-group members, more numerous setae in the anterior segments and larger dorsal setal gaps. Further distinctive features are the glandular tissue associated with the spermathecae, and the pads attached to the roof of the copulatory bursae rather than flanking the opening on the floor.

***Pheretima baungonensis*, new species**
(Figs. 3C, D)

Material examined. – Holotype - adult (NMA 003983), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 15 km S, 6 km. E of Baungon, 8° 11' N, 124° 44.5' E, 1100 m. elevation, coll. D. Balete, no date.

Etymology. – The species is named for the nearest village, Baungon.

Description. – Dark brown anterior dorsal pigmentation, medium brown posteriorly, pigment absent from segmental equators, 107 x 4.0 mm (vii), 4.5 (x), 4.2 mm (xxv), 97 segments; body cylindrical in cross-section, tail bulbous, narrowing abruptly in last ten segments. First dorsal pore 13/14, spermathecal pores 7/8, 0.32 circumference apart, female pore single in xiv, openings of copulatory bursae paired in xviii, 0.19 circumference apart in 7th setal line, 8 setae between openings. Setae somewhat more crowded ventrally; 38 setae on vii, 50 setae on xx; in vii ZZ: YZ = 1.8, in xx ZZ: YZ = 1.7, no ventral gaps. Clitellum annular xiv-xvi; spermathecal pores surrounded by thick lips (Fig. 3C).

Septa 6/7, 7/8, 10/11-13/14 muscular, 8/9 thin, 9/10 absent. Dense tufts of nephridia on anterior faces of 5/6, 6/7; nephridia of intestinal segments located at septum/body wall junction mainly on body wall at anterior and posterior faces of septa.

Large gizzard in viii, esophagus with low vertical lamellae x-xiii, intestinal origin xv, simple caeca originating in xxvii, extending forward to xxv, ventral margins slightly incised; typhlosole xxvii-xlvi, simple fold 0.10 lumen diameter; intestinal wall with 32 longitudinal blood vessels xxvii-xxxix.

Hearts x-xiii esophageal, commissural vessels vi, vii, ix lateral, ix left side lacking; viii to gizzard; supra-esophageal vessel x-xiii; extra esophageal vessel joins ventral esophageal wall in x, receives efferent parieto-esophageal vessel in xiii.

Ovaries and funnels free in xiii, spermathecae paired, preseptal in vii with nephridia on ducts; each spermatheca with cordate ampulla, broad stout duct, stalked diverticulum attached to ectal portion of duct, terminating in sausage-shaped receptacle, stalks long, with two coils closely adherent to spermathecal duct (Fig. 3D). Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; seminal vesicles xi, xii each with digitate dorsal lobe; vasa deferentia slender, free from body wall en route to ental end of prostatic ducts; each prostate a single racemose mass, occupying xvii-xix, stout muscular duct entering surface of copulatory bursa in xviii; coelomic surfaces of paired copulatory bursae muscular, lacking glandular or other projections; blocky angular appendage in position of penis, two pads dependent from roof of copulatory bursae.

Remarks. – The spermathecal and male pores of *P. baungonensis* are spaced differently, an unusual condition in this genus. The pore spacings are much greater than in *P. vicinipora*, which is otherwise similar to *P. baungonensis*, and the former has spermathecae in viii rather than vii as in *P. baungonensis*. These two species also differ in setal counts, the number of longitudinal blood vessels in the intestinal wall, the intestinal origin, and the shape of the spermathecal diverticulum.

***Pheretima paucisetosa*, new species**
(Figs. 3E, F)

Material examined. – Syntypes - 2 adults (NMA 003984), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 16.5 km S, 4 km. E of Camp Philips, 8° 10.5' N, 124° 51' E, 1900 m. elevation, coll. L. Heaney, 22 Mar. 1993.

Etymology. – The species name refers to the low numbers of setae compared to its congeners.

Description. – Unpigmented, body 115 x 5.0 mm (vii), 5.5 (x), 6.0 mm (xxv), 89 segments; body cylindrical in cross-section. First dorsal pore 11/12, spermathecal pores paired in 7/8, 0.16 circumference apart, female pore single in xiv, openings of copulatory bursae paired in xviii, 0.13 circumference apart in 5th setal line, 2 setae between openings. Setae more crowded ventrally; 22 setae on vii, 28 setae on

xx; in vii ZZ: YZ = 1.8, in xx ZZ: YZ = 1.9, no ventral gaps; setae of ii-ix larger than those following. Clitellum annular xiv-xvi; no genital markings (Fig. 3E).

Septa 4/5-6/7 thin, 7/8 muscular, 9/10 thin, adherent to 10/11 at ectal edges, 10/11-13/14 muscular. Dense tufts of nephridia on anterior faces of 5/6, 6/7; nephridia of intestinal segments located at septum-body wall junction on anterior and posterior faces of septa, primarily on posterior faces.

Large gizzard in viii, esophagus with vertical lamellae xi-xiii, intestinal origin 1/2xxvi, full size xvii, simple caeca originating in xxvii, extending forward to xxv, ventral margins smooth; typhlosole xxvii-xlii, mere wrinkle; intestinal wall with 34 longitudinal blood vessels xxxi-xxxix.

Hearts x-xiii esophageal, commissural vessels vi, vii, ix lateral; viii to gizzard; supra-esophageal vessel x-xiv; extra-esophageal vessel to esophageal wall in x; efferent parieto-esophageal vessel from body wall to ventral esophagus in xiii.

Ovaries and funnels free in xiii, spermathecae paired, preseptal in vii with nephridia on ducts; each spermatheca with large rounded ampulla, stalked diverticulum terminating in sausage-shaped receptacle, stalks long, kinked with one or two loops closely adherent to spermathecal duct (Fig. 3F). Male sexual system holandric, testes and funnels enclosed in separate paired sacs in x, xi; seminal vesicles xi, xii with digitate dorsal lobe; vasa deferentia free from body wall en route to ental end of prostatic ducts; each prostate racemose, occupying xvii-xix, bilobed, stout muscular duct entering posterior side of copulatory bursa in xviii; coelomic and exterior surfaces of paired copulatory bursae lacking glandular or other projections; floor of copulatory bursae with three pads, one medial as long as bursal chamber, two lateral half as long, together forming a T-shaped intersection over the opening of bursa; penis present.

Remarks. – *Pheretima paucisetosa* has relatively few setae per segment, though not much different in this respect from *P. quincunxia*, and setae of the head segments are larger than the rest. However the setae of *P. paucisetosa* are regularly arranged rather than irregular to offset. Among species described here and other members of the *sangirensis* group, it is unique in having the combination of an intestinal origin in xvi, no typhlosole, spermathecae in vii, lack of pigment, regular setal arrangement and three large pads on the copulatory bursae floors. It most closely resembles *P. alba* but differs in body size, number of intestinal blood vessels, the number and sizes of anterior setae, and the lack of a typhlosole.

***Pheretima alba*, new species**

(Figs. 3G, H)

Material examined. – Holotype - preclitellate (NMA 003985), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 18 km S, 17 km. E of Baungon, 8° 9' N, 124° 45' E, 1800 m. elevation, coll. D. Balete, no date.

Etymology. – The species name refers to its lack of pigmentation.

Description. – Unpigmented, body 49 x 2.0 mm (vii), 2.5 (x), 2.3 mm (xxv), 104 segments; body cylindrical in cross-section with long taper towards tail. First dorsal pore 13/14, spermathecal pores paired in 7/8, 0.13 circumference apart, female pore single in xiv, openings of copulatory bursae paired in xviii, 0.10 circumference apart in 3rd setal line, 0 setae between openings. Setae regularly distributed around segmental equators; 38 setae on vii, 36 setae on xx; in vii ZZ: YZ = 2.0, in xx ZZ: YZ = 2.1, no ventral gaps. Clitellum not developed; no genital markings (Fig. 3G).

Septa all thin, 8/9, 9/10 not seen. Large gizzard in viii, esophagus with vertical lamellae xi-xiii, intestinal origin xvi, simple caeca originating in xxvii, extending forward to xxv, ventral margin smooth; typhlosole xxvii-lxvi, simple fold 0.25 lumen diameter; 24 longitudinal blood vessels in intestinal wall xxvii- xl.

Hearts x-xiii esophageal, though no supra-esophageal vessel visible in x, commissural vessels vi, vii, ix lateral; viii to gizzard; supra-esophageal vessel xi-xiv, extra-esophageal vessel not seen; efferent parieto-esophageal vessels join esophageal wall in xiii.

Nephridia of intestinal segments pre-and post-septal at septum-body wall junctions, dense tufts of nephridia on anterior faces of 5/6, 6/7.

Ovaries and funnels free in xiii, spermathecae paired, preseptal in vii with nephridia on ducts; each spermatheca with sac-shaped ampulla, broad muscular duct longer than ampulla, stalked diverticulum terminating in sausage-shaped receptacle, stalks with one or two kinks (Fig. 3H). Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; all sacs separate; seminal vesicles xi, xii with dorsal lobe; vasa deferentia free from body wall en route to ental end of prostatic ducts; each prostate racemose, occupying xvii-xix, bilobed, lobes wrapped around copulatory bursa, stout muscular duct entering apex of vertically-oriented egg-shaped copulatory bursa in xviii; coelomic surface of copulatory bursae muscular, lacking glandular or other projections; no pads, very slender penis from roof of copulatory bursa.

Remarks. – This species also keys to the *P. sangirensis* group in Sims & Easton (1972), but differs from the previously known species in having the combination of paired spermathecae in vii, intestinal origin in xvi, unpigmented body wall, and an egg-shaped copulatory bursa mounted on its apex, which condition it shares with the monothecal *P. monoporata*. Additional differences from *P. paucisetosa* are noted above, plus the lack of pads in the copulatory bursae.

***Pheretima rubida*, new species**

(Figs. 3I, J)

Material examined. – Holotype - adult (NMA 003986), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 17 km S, 7 km E of Baungon, 8° 10' N, 124° 44' E, 1550 m. elevation, coll. D. Balete, no date.

Etymology. – The species is named for its reddish pigmentation.

Description. – Red-brown pigment covering entire length, dorsal 2/3 of circumference, body 72 x 2.2 mm (vii), 2.7 (x), 3.1 mm (xxv), 110 segments; body cylindrical in cross-section with long taper towards tail. First dorsal pore 11/12, spermathecal pores paired in 7/8, 0.2 circumference apart, female pore single in xiv, openings of copulatory bursae paired in xviii, 0.12 circumference apart in 4th setal line, 4 setae between openings. Setae regularly distributed around segmental equators; 34 setae on vii, 36 setae on xx; in vii ZZ: YZ = 3.0, in xx ZZ: YZ = 2.0, no ventral gaps. Clitellum annular xiv-xvi; posterior of vii, anterior of viii ventral side thickened to form a pad spanning spermathecal pores, pad thinner at midventral line (Fig. 3I).

Septa all thin, all present. Nephridia of intestinal segments pre- and post-septal at septum-body wall junctions, dense tufts of nephridia on anterior faces of 5/6, 6/7.

Large gizzard in viii, esophagus with vertical lamellae xi-xiv, intestinal origin xvi, simple caeca originating in xxvii, extending forward to xxv, ventral margin smooth; typhlosole xxvii-lxxii, simple fold 0.33 lumen diameter; 26 longitudinal blood vessels in intestinal wall xxvii-xl.

Hearts x-xiii esophageal, commissural vessels vi, vii, ix lateral; viii to gizzard; supra-esophageal vessel x-xiv, extra-esophageal vessel enters esophageal wall x; efferent parieto-esophageal vessels not seen.

Ovaries and funnels free in xiii, spermathecae paired, preseptal in vii with nephridia on ducts; each spermatheca with blocky sac-shaped ampulla, broad muscular duct shorter than ampulla, stalked diverticulum terminating in ovate receptacle, stalks with one or two kinks (Fig. 3J). Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; all sacs separate; seminal vesicles xi, xii with dorsal lobe; vasa deferentia free from body wall en route to ental end of prostatic ducts; each prostate racemose, occupying xvi-xx, bilobed, lobes subdivided in three or four sections, stout muscular duct entering apex of copulatory bursa in xviii; coelomic surface of copulatory bursae muscular, lacking glandular or other projections; stout penis from roof of copulatory bursae, no pads flanking opening.

Remarks. – This species also keys to the *P. sangirensis* group in Sims & Easton (1972), but differs from the previously known species in having the combination of 4 setae between male openings, paired spermathecae in vii, intestinal origin in xvi, extensively pigmented body wall, esophageal lamellae in xiv, and a relatively large typhlosole and penes. Compared to *P. paucisetosa*, it differs in having pigmentation and a typhlosole, and lacking pads within the copulatory bursae.

***Pheretima virgata*, new species**

(Figs. 3K-M)

Material examined. – Holotype - adult (NMA 003987), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 18 km S, 17 km E of Baungon, 8° 9' N, 124° 45' E, 1800 m. elevation, coll. L. Heaney, 15 May.1992.

Etymology. – The species name is derived from the Latin for striped; referring to the alternating pigmented and unpigmented bands.

Description. – Dark brown dorsal pigment in stripes encircling dorsal 2/3 of circumference, ventral ends of stripes tapered, segmental equators unpigmented, body 290 x 13 mm (x), 11 mm (xxv), 125 segments; body cylindrical in cross-section. First dorsal pore 12/13, spermathecal pores paired 7/8, openings semi-circular with half-round flaps extending from posterior edge of vi, 0.1 circumference apart; female pore single in xiv, openings of copulatory bursae paired in xviii, 0.1 circumference apart in 8th setal line, 4 setae between openings. Setae approximately uniformly distributed around segmental equators, 76 setae on vii, 80 setae on xx; no dorsal or ventral gaps. Clitellum annular xiv-xvi; no genital markings (Fig. 3K).

Septa 4/5-7/8 tough but not thick, 8/9 membranous to posterior of gizzard, 9/10 absent, 10/11-13/14 very muscular. Nephridia of post-clitellar segments pre- and post-septal on body wall; tufts of nephridia on anterior faces of septa 5/6, 6/7.

Large gizzard in viii, esophagus with densely crowded deep vertical lamellae xi-xiii, valvular in xv, intestinal origin xvi, simple caeca originating in xxvii, extending forward to xxi; typhlosole xxvii-lxxviii, simple fold one-fifth lumen diameter; 42 longitudinal vessels in anterior intestinal wall.

Hearts x-xiii esophageal, hearts of x lacking connection to dorsal vessel but no supra-esophageal vessel visible in x; commissural vessels vi, vii, ix lateral; viii to gizzard, vi also to nephridial mass preseptal in vi, vii also to anterior gizzard. Supra-esophageal vessel xi-xiv, extra-esophageal vessel not traceable past ix, with branches to body wall in vii-ix; efferent parieto-esophageal vessels from xiii-xvi to ventral esophageal wall in xiii.

Ovaries and funnels free in xiii, paired spermathecae in viii with nephridia only on posterior face of spermathecal ducts; spermathecae with ovate ampulla, short stout duct composed of ectal bulb from which narrower ducts lead to ampulla, diverticulum; diverticulum with several large chambers arranged in U-shape around central canal (Fig. 3L). Thecocyts present in spermatheca ampullae, each round with long stalk (Fig. 3M). Male sexual system holandric, testes and funnels enclosed in paired sacs in x, xi; sacs not connected, sacs of xi enclose seminal vesicles; seminal vesicles xi, xii, with dorsal lobe; vasa deferentia slightly muscular, free from body wall en route to ental end of prostatic ducts; each prostate racemose with 2-3 major lobes, stout muscular duct entering posterior face of muscular dome of copulatory bursa in xviii; no glandular masses or other appendages to copulatory bursae; bursae roofs lined with several blocky pads, no penis, bursae floors composed of four or five triangular pads with apices towards bursal openings.

Remarks. – In Sims & Easton (1972) *P. virgata* keys to the *P. sangirensis* group, within which the spermathecal structure

is distinctive, particularly the multiple chambers of the diverticulum arranged along a curved diverticular axis, and the broad base or ectal bulb of the spermathecal duct. The previously published species of the *sangirensis* group have the spermathecae in vii, as do most of the species of this group described above. In contrast, the spermathecae of *P. virgata* are in viii, its broad duct just posterior to the insertion of septum 7/8. The large number of pads on the inside of the copulatory bursae is also unique among Philippine species in the *P. sangirensis* group, and not yet known in the Indonesian species. The large size and distinctive coloration are unique among species from the Mt. Kitanglad region.

Amyntas Kinberg

Amyntas heaneyi, new species

(Figs. 4A, B)

Material examined. – Holotype - adult (NMA 003988), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 8° 9.5' N, 124° 51' E, 2250 m. elevation, Camp II, coll. D. Balete, no date.

Paratypes – 1 adult, 2 juveniles (FMNH 011067), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 8° 9.5' N, 124° 51' E, 2250 m. elevation, Camp II, coll. D. Balete, no date; 1 adult, 1 juvenile (NMA 003989), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 8° 9.5' N, 124° 51' E, 2250 m. elevation, Camp II, coll. D. Balete, no date.

Others – 1 adult, 1 juvenile (KUNHM 002146), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range 8°10.5' N, 124° 51' E, 1900 m. elevation, Camp I, coll. D. Balete, no date.

Etymology. – The species is named after Lawrence Heaney.

Description. – Dark gray to black pigment on inner surface of body wall, giving dusky appearance externally, body 84-111 x 4.6-5.7 mm (vii), 4.6-5.8 (x), 4.5-5.2 mm (xxv) measurements from complete adults; 98, 113, 123, 132 segments; body cylindrical in cross-section. First dorsal pore 12/13, once 13/14; spermathecal pores paired in 7/8, 0.11 circumference apart, female pore single in xiv, male pores paired in xviii, 0.14-0.16 circumference apart in 4th to 6th setal lines, 2-6 setae between male pores, male pores within distinct but shallow indentations. Setae regularly distributed around segmental equators; 42-52 setae on vii, 48-56 setae on xx; in vii ZZ: YZ = 2.0, in xx ZZ: YZ = 2.0-4.0, no ventral gaps. Clitellum annular xiv-xvi; genital markings paired, medial to spermathecal pore level in vii, paired presetal (5), some with one midventral in each of viii, ix (2); paired presetal medial to male pore level 16/17, paired postsetal, in line with male pores xvii, paired on 17/18, medial to male pores, three small genital markings around each male pore in xviii, paired medial to male pores 19/20, 20/21 (Fig. 4A).

Septa 5/6-7/8, 10/11-14/15 muscular, 8/9, 9/10 absent. Tufted nephridia on anterior faces of 5/6, 6/7; nephridia of intestinal segments pre- and post-septal at body wall-septum junctions.

Large gizzard in viii-x, esophagus with vertical lamellae x-xiii, intestinal origin xvi, simple caeca originating in xxvii,

extending forward to xxv, xxiv, ventral margin of each caecum incised; typhlosole xxvii-lxx, lxxv simple fold one third lumen diameter. Intestinal wall with 26 longitudinal blood vessels beginning in xxvii.

Hearts xi-xiii esophageal, commissural vessels v-vii, x lateral, only one of two commissural vessels in x fully developed, sometimes left, sometimes right, the other much smaller; one pair of vessels in space of viii, ix, this to gizzard. Supra-esophageal vessel x-xiv, extra-esophageal vessel joins esophagus wall at 10/11.

Ovaries and funnels free in xiii, spermathecae paired in viii without nephridia on ducts; each spermatheca with rounded ampulla, short muscular duct, diverticulum elongate at end of muscular stalk of same length as spermathecal duct, stalks sometimes penetrating 7/8 to place diverticulum in vii (Fig. 4B). Male sexual system proandric, testes and funnels enclosed in broad midventral sac in x; seminal vesicles xi acinous; vasa deferentia free from body wall en route to ental end of prostatic ducts; each prostate a single racemose mass, occupying xvii-xix or xvi-xviii; stout muscular duct widens three-fold towards body wall, then narrows slightly just before body wall. Stalked genital marking glands present for each genital marking; in largest specimen glands large, dense, acinous, stalks very short.

Remarks. – *Amyntas heaneyi* keys to the *zebrus* species-group in Sims & Easton (1972). This group is composed of *A. culminus* (Michaelsen, 1899), *A. hilgendorfi* (part) (Michaelsen, 1892), *A. principalis* (Michaelsen, 1932), *A. palmosus* (Chen, 1946), *A. zebrus* (Benham, 1896), *A. zuongmontis* (Thai & Samphon, 1990), *A. magnipapillatus* (Qiu & Wang, 1992), *A. elegans* (Qiu & Wang, 1992), and *A. fasciculus* (Qiu, Wang & Wang, 1993). Mainland Asian species are *A. palmosus*, *A. fasciculus*, *A. magnipapillata*, *A. elegans* (China), and *A. zuongmontis* (Vietnam). The peregrine *A. hilgendorfi* is probably from Japan, and the other species are from Indonesia, primarily Sulawesi. Even on a cursory inspection this species group is polyphyletic, as suggested by Sims & Easton (1972). Lee (1981) also commented that the species groups in Sims & Easton (1972) and Easton (1979) were unsatisfactory. The group contains members with simple and manicate caeca, with and without genital marking glands, and with and without secondary male openings leading to a small pocket containing the actual male pores. Blakemore (in litt.) has interpreted these pockets as intramural copulatory pouches in the sense of *Metaphire* and has transferred *A. hilgendorfi* to *Metaphire*. That decision should be evaluated with an independent data set, because it is possible that the small pockets of certain *Amyntas* could have evolved independently of the intramural pouches of *Metaphire*. Other than being members of *Amyntas* as currently defined, the *zebrus* group and the newly described species presented here are united only by the position of the spermathecae. In the case of *A. hilgendorfi*, with manicate caeca, the majority of specimens are parthenogenetically degraded morphs with variable numbers of spermathecae or lacking them entirely (Gates, 1972). *Amyntas palmosus* also has manicate caeca, different pigmentation, greatly fewer

setae per segment, sessile genital marking glands and differently shaped spermathecae placed at about mid-lateral (Chen, 1946). The Chinese species *A. elegans* and *A. magnipapillatus* have manicate caecae, male pores on very large papillae, are holandric, and the spermathecal pores are about 0.4 circumference apart. *Amyntas fasciculus* is much larger than *A. heaneyi*, holandric, and has very few genital markings, each with small, densely packed glands. The remaining species include two from Sulawesi (*zebrus*, *culminus*) and one from Bali (*principalus*), which are large (200-400 mm) and have striped pigmentation much like many *Pheretima*: dark between segmental equators, and an unpigmented equatorial stripe broadening ventrally until there is no pigment below mid-lateral, more or less. They also have secondary male openings as discussed above (Michaelsen, 1932). Thus *A. heaneyi* is easily distinguished from the other members of the genus with spermathecae in viii only, and it is proandric, rather than holandric like the rest of the species group.

There are other proandric *Amyntas* from the Philippines

(Hong and James 2004) and Taiwan (Gates, 1959; James et al. 2004) but these have very different characteristics. The Philippine species have small hoods over the male pores and very few genital markings, while the prostatic ducts of Taiwan species form by the union of numerous ductlets in a fan-like array.

***Pleionogaster* Michaelsen**

Perichaeta (part) Beddard, 1886:298.
Pleionogaster Michaelsen, 1892: 247; 1896: 198; Beddard, 1895: 433; Easton, 1979:114.
Plionogaster Michaelsen, 1900: 210; Stephenson, 1930:840; 1933: 923; Gates, 1943:105; Jamieson, 1971: 82.

Type species. – *Pleionogaster jagori* Michaelsen, 1892 (Easton, 1979).

Diagnosis. – Perichaetine Megascolecidae with larger

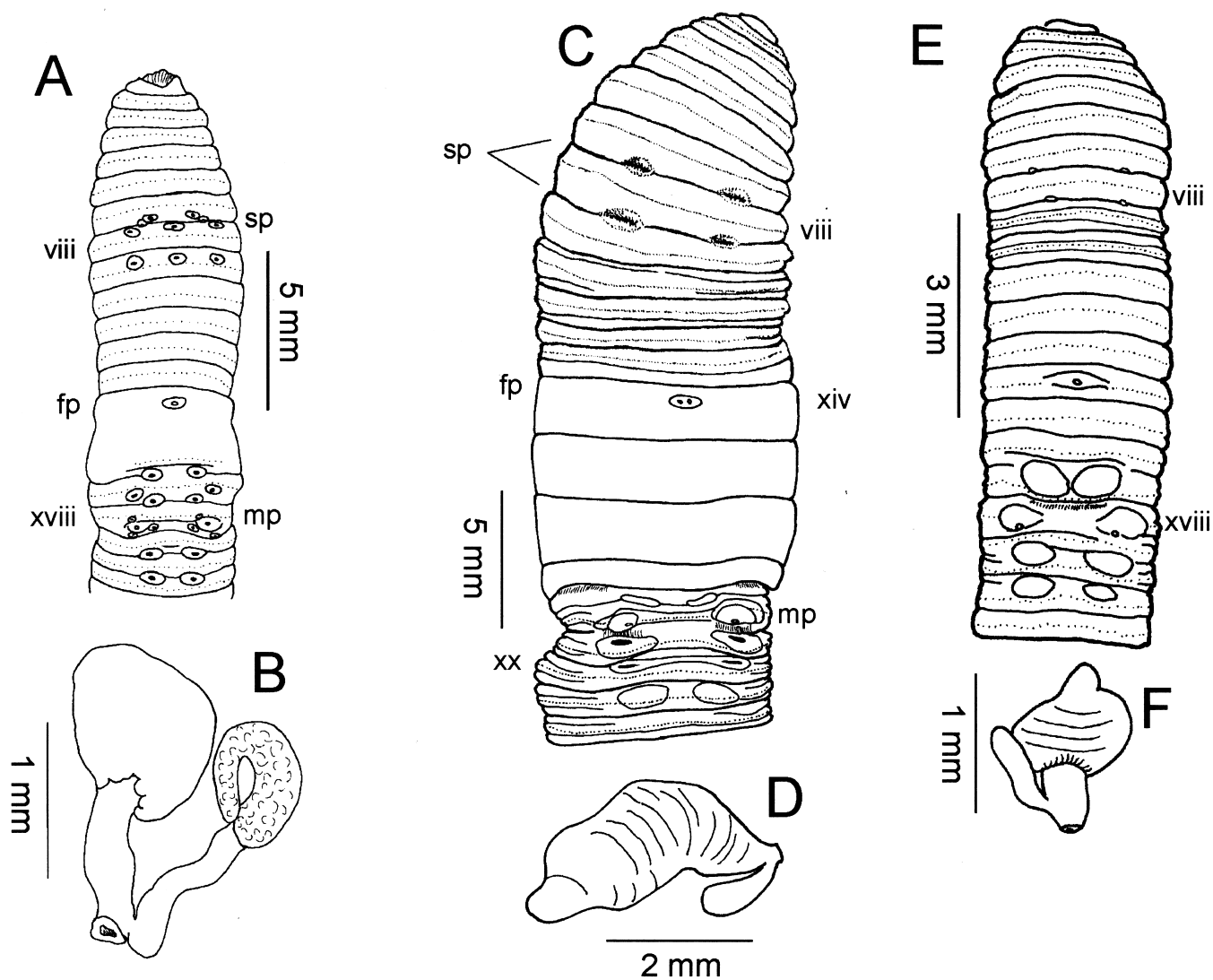


Fig. 4. Spermathecae, and ventral views showing spermathecal pores, female pores, and male pores of *Amyntas heaneyi* (A,B), *Pleionogaster valida* (C, D), and *Pleionogaster kitangladensis* (E, F). Symbols: fp, female pore(s); mp, male pores; sp, spermathecal pores.

numbers of setae in the head segments than in post-clitellate segments, reduced esophageal gizzard in viii, intestinal gizzards in the region xxiv-xxxii, post-giceriate atyphlosolate section of intestine terminated by an intestinal constriction in region of xxxviii-lv; paired enteric stomate meganephridia and regular ranks of exoic micronephridia in post-clitellate segments, and single pair of racemose prostates whose ducts are united with vasa deferentia near the middle of the duct.

Remarks. – So far as is known, the genus is restricted to the Philippines, since in all likelihood the record attributed to Ternate, Moluccas, Indonesia should be Ternate, Luzon, Philippines (Easton, 1979). All known species have two pairs of spermathecae located in segments viii and ix, and superficial male pores of crescent shape with the concave side facing anteriorly. In light of the recent evaluation of infra-familial systematics of the Megascolecidae (Jamieson et al 2002), I have expanded the diagnosis from that given in Easton (1979). For discussion of the proper spelling of the genus name and the designation of the type species, see Easton (1979).

Relationships with other megascolecine genera are not clear. *Gastrodrilus* (Blakemore, 2000b) has numerous (7-10) intestinal gizzards in the same general region of the intestine, but has an esophageal gizzard in v, is lumbricine, has tubuloracemose prostates, no dorsal pores, has penial setae, and lacks meganephridia. *Anisogaster* (Blakemore, 2000a) is perichaetine at least in the posterior regions, lacks penial setae, has racemose prostates, has dorsal pores, has intestinal gizzards in the same general region of the intestine as *Pleionogaster*, but lacks meganephridia and the esophageal gizzard is also in v. Blakemore (2000a, 2000b) describes the intestinal gizzards as moniliform, meaning like a string of beads. This condition is seen clearly in the Moniligastridae for example, but this is not the case in *Pleionogaster*, in which each intestinal gizzard is a thickened ring around the posterior half of the intestine in each giceriate segment. This leaves a non-giceriate interval between each gizzard. By simple similarity, *Anisogaster* among known taxa is morphologically closest to *Pleionogaster*.

Easton (1979) synonymized the five known *Pleionogaster* species as *Pl. horsti* Beddard, 1886, an action with which I disagree. Examination of material seen by Easton supports my doubts, as will be seen below.

***Pleionogaster sivickisi* Stephenson, 1933**

Pleionogaster sivickisi Stephenson, 1933: 923.

Pleionogaster horsti (part) Easton, 1979: 115.

Material examined. – Syntype - one preclitellate (BMNH 1930:12:26:5-7), Manila, Philippines, P.B. Sivickis coll., no date.

Description. – Genital markings paired in line with male pores post-setal xvii, presetal xix-xxi, midventral presetal xviii-xx; male pores in 10th setal line, 2.3 mm apart; female pores paired, separate; spermathecal pores 7/8/9, 2.2 mm apart. Setae estimated 132 in vii, 94 in x, xxv.

Intestinal origin xix, gizzards xxviii-xxx, intestinal constriction xlii-xliii; typhlosolar origin xliii; gizzard of viii very reduced, only a thin layer of shiny white connective tissue around the esophagus. Spermathecal ducts differentiated from ampulla, ampulla rounded, diverticulum digitiform. Male reproductive system holandric, seminal vesicles slender arcs in xi, xii; not enclosed in testes sacs.

Remarks. – With reference to the following specimen from another part of Luzon well to the north of Manila in the Central Cordillera mountains, one can see that the definition of *Pl. horsti* must be so expansive as to be nearly meaningless. Further comments follow data on the next specimen.

“*Pleionogaster horsti*”

Material examined. – 1 adult (BMNH 1978:41.49-55), Philippines, Ifugao Province, Lagawe municipality, R.D. Guerrero, coll. 4 Jul.1978, E.G. Easton det.

Description. – Unpigmented, body 150 mm x 4 mm. (vii), 4.5 mm (xv), 4.5 mm (xxv); first dorsal pore 12/13; spermathecal pores paired in 7/8, 8/9, surrounded by slight tumidity, female pores not seen, male pores crescentic openings paired in xviii on raised porophores, in 12th setal line, 4-6 setae between male pores. Setae regularly distributed around segmental equators; estimated at 220 setae on vii, 210 on x, 126 setae on xxv. Clitellum annular 1/2xiii, xiv-1/2xvii; genital markings midventral broad pad presetal xvii, ends in line with male porophores, midventral short pad presetal xix. Nephridiopores not visible. Septa 5/6-8/9 thick, muscular, 9/10 thinner, remainder membranous. Weak gizzard in viii with very thin iridescent layer, intestinal origin xix, no caeca; thick intestinal gizzards xxvii-xxx.

Hearts x-xiii esophageal, commissural vessels v-ix lateral. Supra-esophageal vessel x-xvii, one pair efferent parieto-esophageal vessels from body wall of xiv-xviii to ventral esophagus in xiv. Nephridia not discernible.

Ovaries and funnels free in xiii, spermathecae paired in viii, ix without nephridia on ducts; each spermatheca almost cylindrical, tapered towards ental end, ampulla not sharply demarked from duct; simple club-shaped diverticulum joins duct near body wall. Male sexual system holandric, testes and funnels enclosed in annular sacs in x, xi, these sacs encompass only testes and funnels, exclude hearts, seminal vesicles; seminal vesicles xi, xii small, acinous.

Remarks. – The syntype of *Pl. sivickisi* bears a strong resemblance to the figure representing *Pl. horsti* in Easton (1979: p. 115). The pattern of genital markings and shape of the spermathecae are virtually identical to that figured. Genital marking patterns of *Pl. ternatae* (Michaelsen, 1896) and *Pl. horsti* s.s. are very similar to that of *Pl. sivickisi*, but the three species differ in the locations of the intestinal gizzards: xxv-xxvii, xxvi-xxviii, and xxviii-xxx respectively. Michaelsen (1896) gives the location of gizzards in *Pl. ternatae* as xxv, xxvii and xxix, which may be mistaken. The

typical intestinal gizzard in this genus occupies the posterior half of the segment, the anterior half's gut having the typical appearance of the intestine. This could lead one to believe that gizzards are in alternate segments, but Michaelsen's difficulty in determining segmental location may have been due to poorly preserved material. The Lagawe worm has long, slender spermathecae whose duct and ampulla are not clearly differentiated, and a completely different pattern of genital markings (only midventral broad pads) more like that of *Pl. samariensis* (Michaelsen, 1892) but differing from this species in the genital marking segmental locations. *Pleionogaster sivickisi* has only three intestinal gizzards, unlike the Lagawe material, which has four placed more posteriorly. The two worms are also unlike in general aspect, the length/width ratio of the Lagawe material being greater and more like other members of the genus (James unpub. data). The Lagawe worm's testes sacs do not encompass the other contents of segment xi, whereas *Pl. horsti* is said to have testes sacs enclosing the seminal vesicles (Easton, 1979). This worm from Lagawe probably represents a new species, not a range extension of *Pl. horsti*.

The other two species placed as synonyms of *Pl. horsti*, *Pl. jagori* (Michaelsen, 1892) and *Pl. samariensis*, have far fewer genital markings, and differ from each other in number of micronephridia per segment (14 and 6-10 respectively, the uncertainty in the latter being Michaelsen's) and number of intestinal gizzards (4 and 3).

The facts that so much variation was ignored in the synonymization of all previous *Pleionogaster* into *Pl. horsti*, and that the Lagawe worm was determined by Easton to be conspecific with a concept of *Pl. horsti* that includes Stephenson's *Pl. sivickisi* cast doubt on the taxonomic decision in Easton (1979). This leads me to the conclusions that *Pl. jagori* and *Pl. samariensis* should be removed from the synonymy of *Pl. horsti* and that *Pl. sivickisi* and *Pl. ternatae* should be re-evaluated with reference to type material. Because I have not seen all the necessary types, and because I have further Philippine material collected close to the locations of the taxa in question, I will try to resolve these questions in a later paper. For the time being, I support retention of *Pl. sivickisi* and *Pl. ternatae* as junior synonyms of *Pl. horsti*.

***Pleionogaster valida*, new species**
(Figs. 4C, D)

Material examined. – Holotypes – adult (NMA 003990), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 8° 9' N, 124° 45' E, 1800 m. elevation, coll. D. Balete, no date.

Others – (KUNHM 002147) Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 8° 10.5' N, 124° 51' E, 1900 m. elevation, coll. L. Heaney, 22 Mar.1993; 1 adult, 1 late juvenile (FMNH 011068), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 8° 10.5' N, 124° 51' E, 1900 m. elevation, coll. L. Heaney, 22 Mar.1993; 1 adult (NMA 003991) Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad

Range, 8° 10.5' N, 124° 51' E, 1900 m. elevation, coll. D. Balete, no date.

Etymology. – The species name *valida* means strong, robust or durable, and was chosen for the sturdy construction of this relatively large species.

Description. – Unpigmented, body 160-260 mm x 6.2-9.0 mm (vii), 6.0-9.5 (xv), 5.3-8.0 mm (xxv); 223-286 segments; body cylindrical in cross-section. segment x biannulate, xi-xiii triannulate, in postclitellar segments posterior annulus divided again to make segments quadrannulate. First dorsal pore 12/13 (4), 13/14 (1); spermathecal pores paired in 7/8, 8/9, 0.16 circumference apart, female pores closely paired in xiv, male pores paired in xviii, 0.15 circumference apart in 9th setal line (3), 10th line (1), 7th line (1); 8-14 setae between male pores. Setae regularly distributed around segmental equators; estimated at 192-235 setae on vii, 106-135 setae on xxv; in vii no dorsal gap, in xx ZZ: YZ = 1.3-2.1, no ventral gaps. Clitellum annular xiv-2/3xvii; genital markings paired on 17/18 (4, including syntypes), anterior portion of xviii (1), paired anterior to and surrounding male pores, paired 18/19, broad single genital marking 19/20-2/3 xx (3), shorter unpaired genital markings anterior 2/3 of xxi, sometimes xxii (Fig. 4C). Body wall deeply folded inward over segments xviii, xix; fold slightly wider than separation of male pores. Nephridiopores visible on trailing edge of clitellum in xvii, as gaps in setal rings of postclitellar segments, apparently 10 pores per segment.

Septa 5/6-10/11 thick, muscular, 11/12 thinner, remainder thin. Weak gizzard in viii with typical iridescent outer wall but flaccid, esophagus heavily vascularized, with low vertical folds xi-xvi, intestinal origin xix, no caeca; thick annular intestinal gizzards xxvii-xxx (4, including syntypes), xxvi, xxviii-xxix (1); intestinal constriction 46/47-xlvii; typhlosole xlix-lxxv, lxxx, xcv, simple fold with lateral processes, 0.1-0.15 lumen diameter.

Hearts x-xiii esophageal, commissural vessels v-ix lateral. Supra-esophageal vessel x-xvii, efferent parieto-esophageal vessels from body wall of xiv-xviii to ventral esophagus in xiv, extra-esophageal vessel seen from vi to xvii, where it enters gut wall. Longitudinal blood vessel slightly below mid lateral on body wall of anterior intestinal segments.

Nephridia present as peptonephridia on anterior face of 5/6, micronephridia preseptal vi-ix, on body wall thereafter; from xix posteriorly ten micronephridia per segment in regular ranks plus 2 meganephridia per segment, meganephridia connected to ureters flanking dorsal vessel.

Ovaries and funnels free in xiii, spermathecae paired in viii, ix without nephridia on ducts; each spermatheca with elongate ampulla bearing apical knob, ampulla not sharply demarcated from duct; simple sac-shaped diverticulum joins duct near body wall (Fig. 4D). Male sexual system holandric, testes and funnels enclosed in annular sacs in x, xi, these sacs encompass hearts, seminal vesicles of xi; seminal vesicles xi, xii small, acinous; vasa deferentia extremely small, travel

up prostatic ducts to join ental end of prostatic ducts; each prostate a single racemose mass, occupying xviii; with stout muscular duct; copulatory bursae lacking.

Remarks. – *Pleionogaster valida* is distinguished from *Pl. horsti* by its greater size, completely different arrangement of genital markings (no longitudinal row of midventral markings), closer spacing of male and spermathecal pores, different location of the intestinal gizzards, smaller number of micronephridia (10 vs. 14 per segment in *Pl. horsti*) and probably many other characters not recorded in previous publications on the genus. Differences from *Pl. samariensis* are greater number of micronephridia, greater number of intestinal gizzards, much larger body size, greater number of setae, and very different pattern of genital markings. Compared to *Pl. jagori*, *Pl. valida* has fewer micronephridia, more setae per segment, a similar body size, but different distribution, number and shape of genital markings.

In Easton (1979) and Michaelsen (1900) no mention is made of important nephridial characters, the different regions of the intestine, the unusually posterior appearance of the typhlosole, the longitudinal blood vessels on the body wall of intestinal segments, or the unusually long supra-esophageal blood vessel. These may be of intrageneric importance in distinguishing species, and important to higher-level systematics.

***Pleionogaster kitangladensis*, new species**
(Figs. 4E, F)

Material examined. – Holotype - preclitellate (NMA 003992), Philippines, Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, 8° 10.5' N, 124° 51' E, 1900 m. elevation, coll. L. Heaney, 22 Mar. 1993.

Etymology. – The species is named for the mountain range in which it was discovered.

Description. – Unpigmented, body 75 mm x 2.7 mm (vi), 2.5 (xv), 2.4 mm (xxv); 246 segments; body cylindrical in cross-section. First dorsal pore 12/13; spermathecal pores paired in 7/8, 8/9, 0.16, 0.13 circumference apart respectively, female pore single in xiv, male pores paired in xviii on small papillae, 0.16 circumference apart in 7th setal line, 6 setae between male pores. Setae regularly distributed around segmental equators; estimated at 170 setae on vii, 78 setae on xx; no dorsal or ventral gaps. Clitellum not developed; genital markings paired on posterior third of xvi, anterior two thirds of xvii, paired presetal in xx, xxi. Nephridiopores not seen (Fig. 4E).

Septa 5/6-9/10 thick, muscular, 10/11-13/14 thinner, muscular; remainder thin. Nephridia present as peptonophridia on anterior face of 5/6, micronephridia preseptal vi-ix, on body wall thereafter; from xix 8 micronephridia plus two meganephridia per segment.

Slight muscularity of esophagus in vii, viii; esophagus heavily vascularized, without lamellae xiv-xvi, intestinal origin xix,

full size xx, no caeca; thick annular intestinal gizzards xxviii-xxix; typhlosole 39/40-lvi, simple fold one fourth lumen diameter.

Hearts x, xi arising from esophageal wall, though supra-esophageal vessel not visible in those segments, xii esophageal, xiii latero-esophageal, commissural vessels vi-ix lateral. Supra-esophageal vessel xii-xvii, efferent parieto-esophageal vessels, extra-esophageal vessels not seen. Small blood vessel runs posteriorly on body wall slightly below mid-lateral from below esophagus at 16/17 -cxvi, one on each side.

Ovaries and funnels free in xiii, spermathecae paired in viii, ix without nephridia on ducts; each spermatheca with sagittate ampulla with apical knob; short duct differentiated from ampulla, diverticulum stalk arising from duct near duct junction with body wall, diverticulum digitate (Fig. 4F). Male sexual system holandric, testes and funnels enclosed in U-shaped sac open dorsally in x, segments x, xi filled with coagulum; testes and funnels free in xi; seminal vesicles xi, xii small, acinous; vasa deferentia extremely small, travel up prostatic ducts to join ental end of prostatic ducts; each prostate a single racemose mass, occupying xviii; with stout muscular duct.

Remarks. – *Pleionogaster kitangladensis* has testes sacs closed laterally but open dorsally in x, but entirely lacking testes sacs in xi, rather than the single annular or inverted U-shaped closed sacs in each of x and xi as found in all other known *Pleionogaster* species. It also has a different arrangement of genital markings in the male field from *Pl. horsti* and *Pl. valida*, in that it lacks midventral small markings found in *Pl. horsti*, does not have the sunken male field or the wide midventral marking behind the male pores, of *Pl. valida*. Other differences from *Pl. valida* are: fewer gizzards, differentiation of the spermathecal axis into duct and ampulla, single female pore, fewer micronephridia, and fewer setae per segment. On the other hand its spermathecae are differentiated into duct and ampulla as in *Pl. horsti*.

DISCUSSION

The collectors and Rickart et al. (1991) reported that total earthworm density appeared high, which is to say that earthworms were easy to find in good numbers, which they did not only for collecting earthworm specimens but also to use as bait in small mammal traps. This is in accord with other estimates of earthworm populations from tropical montane ecosystems (Moore & Burns, 1970) and the author's experience in the Caribbean. It appears that in mid- and high-elevation tropical forests earthworms have greater ecological importance than in lower elevation humid tropical forests (Lee, 1985). This may be due to the lower rates of microbial decomposition of leaf litter and soil organic matter. In the case of the Philippine forests, within-site earthworm species diversity is also quite high, exceeding the three to six species per site that seems to be fairly routine across a wide variety of habitats both temperate and tropical (e.g. Lee, 1959, 1985).

Blakemore (1999, 2002) also found high within-site diversity, ranging from 16-26 species, but in each case about one third of the species present were exotics.

The species described here increase the size of two *Pheretima* species groups of Sims & Easton (1972), and may raise the question that fine distinctions are being made. Given the heavy dependence of *Pheretima*-complex taxonomy on numbers and locations of spermathecae, this is inevitable and will only get worse as contemporary researchers continue to collect and study East Asian material. For this reason I have tried to use as many somatic characters as possible (as per Gates, 1972), and to pay close attention to details of the sexual characters. For the time being I can offer a biogeographical defense of the distinctions being made.

It seems unlikely that the Indonesian species previously known in the species groups affected have had any geologically recent (last 2 million years) opportunity to colonize the Philippines or to exchange genetic material with Philippine earthworms. A small archipelago extends north from the Sulawesi-Moluccas region towards Mindanao, Philippines but water depths between islands are in excess of 200 meters and up to 1000 meters, disallowing Pleistocene exposure of a land connection. Other possible above-water connections to Indonesian/Asian land include a continental fragment now in southwest Mindanao (Hall, 1996) and the relatively shallow (but still deeper than Pleistocene low sea levels) waters of the Sulu Archipelago between Borneo and Mindanao (Heaney, 1985). In any of these scenarios land connections must have been either ancient, brief or both. Thus it seems unlikely that the material reported here represents extensions of the ranges of known species.

Lee (1981) proposed that certain earthworms of the Vanua Tu fauna were transported there by the indigenous peoples of the South Pacific over the many centuries of their travel and trade, and that others were recent arrivals due to European peoples' activities. These were referred to as "coral island taxa" and "tropical tramps" respectively. The problem re-emphasized by the species described here is to determine whether or not the material identified as *P. urceolata*, *P. sangirensis*, *P. ceramensis* and perhaps the species placed in synonymy of *Pl. horsti* are (1) narrow endemics poorly differentiated, (2) widely but naturally distributed species with very conservative evolution, or (3) peregrines, although so far limited to SE Asian archipelagoes. For the present they are so imperfectly known that we cannot be certain of the truth.

The large number of peregrine perichaetine Megascolecidae (cf. Gates, 1972) and the resultant proliferation of synonyms (Sims & Easton, 1972) have generated considerable caution among contemporary taxonomists, when it comes to material sharing traditionally important character states but obtained from widely separated locations. Yet in the present case the material was collected in remote uninhabited mountain forests, where human influences are minimal and agriculture is not practiced. These being the only kind of primary forests

available in most of the Philippines, biological collections should be made in them to find the indigenous species.

In order to clarify the distinctions made among the species described above, and to facilitate further study of earthworms in Bukidnon Province and nearby areas, I am providing a key. Users should be aware that it is very easy to find species not present in this key, which will yet seem to fit the couplets to some degree. Until more is known about the earthworms of Mindanao this key should only be used to identify earthworms from within a 100 km radius of the collection location. This limit is very arbitrary, but serves to make clear the limited usefulness of the key.

Key to the known earthworms of the Mt. Kitanglad Range

1. Gizzards present in any of xxvi-xxx, gizzard of viii small and weakly developed, if present 2
 - Gizzard in viii well-developed, hard, muscular; no intestinal gizzards 3
2. Length greater than 15 cm, male field sunken, intestinal constriction near xlv *Pleionogaster valida*
 - Length less than 9 cm, male field not sunken, intestinal constriction near xl *Pleionogaster kitangladensis*
3. Copulatory bursae lacking, no nephridia on spermathecal ducts *Amyntas heaneyi*
 - Copulatory bursae present, nephridia on spermathecal ducts 4
4. Spermathecae in vi, paired or single, pores in 5/6 5
 - Spermathecae in vii or viii, pores in 7/8 9
5. Intestinal origin in xvi or xvii, no glandular masses adjacent to copulatory bursae 6
 - Intestinal origin in xviii, glandular masses adjacent to copulatory bursae 7
6. Intestinal origin in xvi, dorsal brown pigmentation, no penis *Pheretima kitangladensis*
 - Intestinal origin in xvii, pale anterior pink pigmentation, penis present *Pheretima baletei*
7. A single spermatheca in vi *Pheretima monothea*
 - Paired spermathecae 8
8. Penis present *Pheretima heaneyi*
 - Penis absent *Pheretima bukidnonensis*
9. Intestinal origin xvii 10
 - Intestinal origin xv or xvi 12
10. One unpaired spermatheca in vii *Pheretima monoporata*
 - Paired spermathecae in vii or viii 11
11. Copulatory bursae with two internal muscular pads lateral to bursa opening, a mere knob in place of penis, vas deferens muscular *Pheretima diesmosi*
 - Copulatory bursae with two internal muscular pads medial, one long pad lateral to bursa opening, penis present, vas deferens not muscular *Pheretima rugosa*
12. Intestinal origin in xv *Pheretima baungonensis*
 - Intestinal origin in xvi 13
13. Setae of adjacent segments offset at least in posterior portion of body *Pheretima quincunxia*
 - Setae of adjacent segments in regular rows 14
13. Worms unpigmented 15
 - Worms pigmented 16
14. Approximately 22 setae in segment vii *Pheretima paucisetosa*
 - Approximately 38 setae in segment vii *Pheretima alba*
16. Spermathecae in vii, well developed penis, approximately 34 setae in segment vii *Pheretima rubida*
 - Spermathecae in viii 17

17. Spermathecae in viii, with glands associated; penis lacking *Pheretima vicina*
 – Spermathecal pores in 7/8, spermathecal diverticulum broad, multilocular *Pheretima virgata*

ACKNOWLEDGEMENTS

This paper was made possible by the collecting efforts of Lawrence Heaney, of the Field Museum of Natural History, his colleagues including Danilo Balete and Eric Rickart, and numerous Filipino assistants and guides from the Kitanglad region. The author completed the paper while supported by National Science Foundation grant DEB-0072764. R. Blakemore and an anonymous reviewer made constructive suggestions for the manuscript. John Stimson assisted with the illustrations.

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