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Seven new species of *Amynthas* (Clitellata: Megascolecidae) and new earthworm records from Taiwan

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Abstract

Earthworm specimens collected in southern Taiwan consisted of seven new species of *Amynthas* and several previously known species, mostly widely distributed peregrines. The new species are *A. nanrenensis* of the octothecal *A. corticis* species group, *A. monsoonus* and *A. huangi* of the sixthcal *A. aeliamus* species group, and four proandric octothecal species: *A. chaishanensis*, *A. hengchunensis*, *A. kaopingensis* and *A. ailiaoensis*. *Amynthas chaishanensis* has dorsal intrasegmental spermathecal pores, but the other three proandric species have dorsal, lateral or ventral intersegmental spermathecal pores, respectively. The proandric species are united by several features, including the enclosure of segment xi in a sac, as in *A. formosae* (also proandric), octothecal with spermathecae in vi–ix, spermathecal diverticula stalks generally kinked and often enclosed in membrane, and prostatic ducts divided polytomously into numerous small ductlets, which may be grouped into bundles of two to five. In *A. ailiaoensis* the prostatic duct trunk contains up to seven separate lumens in the ental half, surrounded by the circular muscle of the duct, while in *A. chaishanensis* the prostatic duct trunk contains about 40 small lumens. Of the previously known species in the collection, *Pontodrilus litoralis* and *Metaphire houlleti* are first reported from Taiwan. Additional locations for *A. incongruus* and *A. robustus* are given, and in the latter case the material appears to be the usual male-sterile morph. Other species found are *Pontoscolex corethrurus*, *Amynthas corticis*, *A. gracilis*, *Metaphire californica*, and *Polypheretima elongata*.

Keywords: *Amynthas*, *Annelida*, *Clitellata*, *Earthworms*, *Megascolecidae*, *Metaphire*, *Polypheretima*, *Pontodrilus*, *Pontoscolex*, *Taiwan*

Introduction

The earthworm fauna of Taiwan has received considerable attention in recent years, beginning with Shih et al.'s (1999) review of the species known from the island and continuing with several publications by a group at the Taiwan Endemic Species Research Institute (Tsai et al. 1999, 2000, 2001, 2002; Shen et al. 2002, 2003a, 2003b), in which 13

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new species of *Amynthas* and *Metaphire* were described. While working on the literature review, H.-T. Shih made several collections over a period of 5 years with the members of the laboratory of H.-W. Chang of the National Sun Yat-sen University in Kaohsiung, Taiwan. In contrast to most of the previous collections, which were from the northern part of Taiwan, these were made in the south. Seven species in these collection lots were determined to be new by reference to published descriptions of Taiwan and other East Asian *Amynthas*.

Materials and methods

From 1996 to 2000, the earthworm fauna of Kaohsiung City, Kaohsiung County and Pingtung County (Figure 1) was surveyed. Collections were made by digging and hand sorting soils and litter, by collecting earthworms on the soil surface where available, and by permanent traps containing formalin. GPS readings were taken at many of the collection localities. Specimens were preserved by killing in alcohol and fixing in 10% formaldehyde, after which they were transferred to 70% ethanol. Internal anatomy was examined by dorsal dissection, and drawings prepared with a drawing tube mounted on a stereomicroscope. All materials are deposited at the National Museum of Natural Science, Taichung, Taiwan (NMNS). By convention, we use lower case Roman numerals to refer to segment numbers and Arabic numerals separated by diagonal lines to indicate segmental boundaries both external and internal. Setae are labeled with upper-case letters with the ventral-most of a side as A and the dorsal-most as Z, regardless of the actual number of setae in a segment.

We use the definition of the Megascolecidae offered by Jamieson et al. (2002), which is supported by a molecular analysis. It is identical to that of Blakemore (2000), the two systems differing greatly regarding definitions of the Acanthodrilidae, and the non-recognition by Jamieson et al. (2002) of the Octochaetidae and Exxidae.

Taxonomic description

Amynthas nanrenensis sp. nov.

(Figure 2A, B)

Holotype: one adult specimen collected 13 July 1998 at Nanrenshan, Kending, Pingtung County, Taiwan, 22°05'03"N, 120°50'07"E; 150 m by Chung-Chi Huang, NMNS 4054-001. Paratype: one adult, same collection data as holotype, NMNS 4054-002.

Etymology

This species is named after Nanrenshan, which means Mt. Nanren.

Description

Dimensions 97 mm by 4.3 mm at segment x, 4.2 mm at xxx, 4.2 mm at clitellum; body cylindrical throughout, segments 98. Setae regularly distributed around segmental equators, numbering 60–64 at vii, 62–72 at xx; 10–12 setae between male pores, male pores 0.21 circumference apart in seventh setal line; setal formula AA:AB:YZ:ZZ=2.5:1:1:3 at xxv. Female pore single in xiv. Prostomium epilobic, with tongue open. Unpigmented. First dorsal pore 11/12 or 12/13. Clitellum annular xiv–xvi; setae invisible externally.

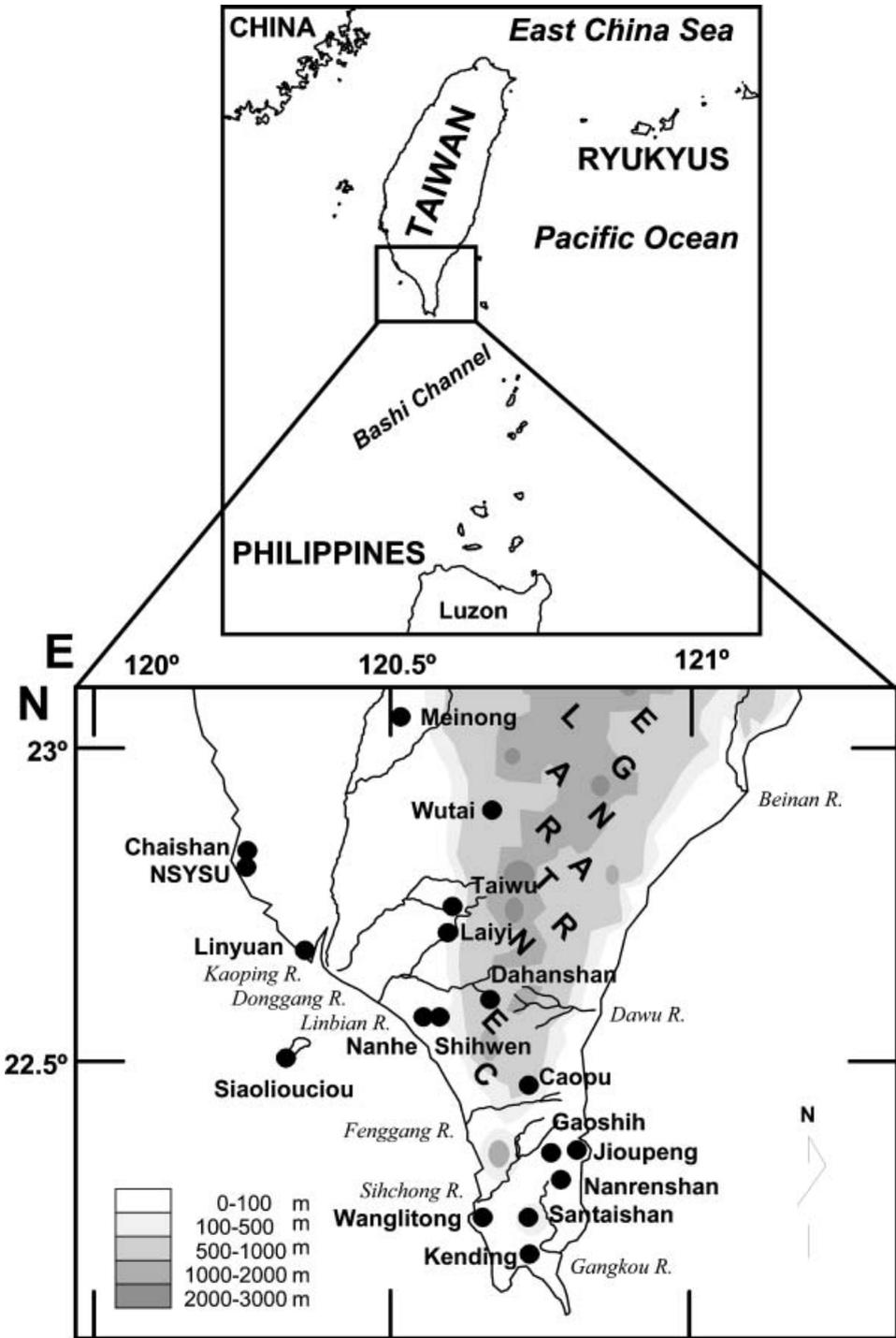


Figure 1. Collection locations in southern Taiwan, represented by dark circles.

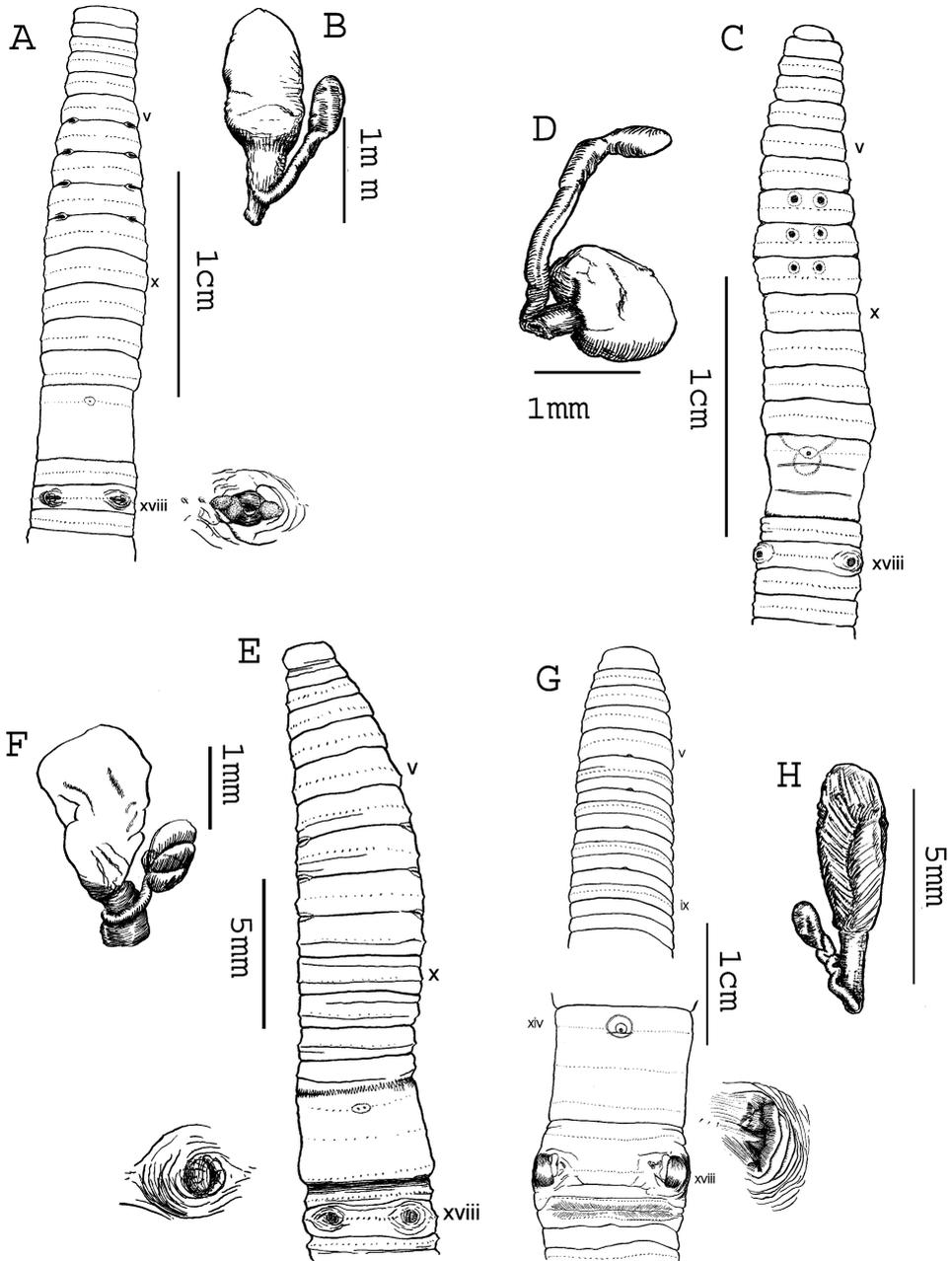


Figure 2. (A) Ventral view of *Amynthus nanrenensis* holotype, with detail of the male pore; (B) spermatheca of *Amynthus nanrenensis*; (C) ventral view of *Amynthus monsoonus* holotype; (D) spermatheca of *Amynthus monsoonus*; (E) ventral view of *Amynthus huangi* holotype; (F) spermatheca of *Amynthus huangi*; (G) left lateral view of segments i–ix and ventral view of xiv–xix of *Amynthus hengchunensis*, with detail of male pore; (H) spermatheca of *Amynthus hengchunensis*.

Male pores each flanked by two circular 0.2 mm genital markings closely median, lateral to male pores. Spermathecal pores ventral in 5/6/7/8/9, 0.22 circumference apart. Genital markings not present in spermathecal segments (Figure 2A).

Septa 5/6/7/8 thickly muscular, 8/9, 9/10 absent, 10/11–13/14 muscular; gizzard viii–x. Intestinal origin xvi; lymph glands present from xxvii; typhlosole simple fold one-third lumen diameter from xxvii, but extends forwards as small ridge to xvi. Intestinal caeca simple, originating in xxvii, extending anteriorly to xxiii, no incisions. Oesophageal hearts two pairs in xii–xiii, no hearts in x, xi; commissural vessels vii, ix lateral, viii to gizzard.

Male sexual system holandric, testes, funnels in ventrally joined sacs in x, xi. Seminal vesicles large in xi, xii, with dorsal lobe. Prostates xviii, two or three main lobes, ducts thick, muscular, join vasa deferentia distal to glandular portion; vasa deferentia non-muscular; genital marking glands lacking.

Ovaries in xiii. Paired spermathecae in vi–ix; ampulla ovoid, diverticulum chamber elongate ovoid to almond shaped, stalk slender, straight; diverticulum axis longer than ampulla axis (Figure 2B); no nephridia on spermathecal ducts.

Remarks

Amyntas nanrenensis keys to the “*diffringens*” species group (which should be known as the *corticis* species group, as *diffringens* is a junior synonym) in Sims and Easton (1972). Blakemore (2003) provides a detailed synonymy for *A. corticis* (Kinberg, 1867), including many names indicated as questionable or uncertain in the synonymy, and a diagnosis of the species. The diagnosis is brief, based on the location, number and spacing of spermathecal pores (0.3 body circumference apart), the variable presence of paired or variable small genital markings near the spermathecal and male pores, and the simple or incised condition of the intestinal caeca. The only character on which the present material differs from Blakemore’s (2003) diagnosis is the narrower spacing of the spermathecal pores. However, in view of the other differences between *A. nanrenensis* and *Pheretima diffringens* (Baird, 1869) (= *A. corticis*) as described in detail in Gates (1972) it is not the widespread peregrine “species” composed entirely of a set of parthenogenetic morphs, for which a hermaphroditic sexual population is as yet unknown (Gates 1972).

Gates (1959) reported two specimens from Taiwan (American Museum of Natural History 3575) in which male function was present, and he remarked that these resemble a hypothetical hermaphroditic ancestor of *A. corticis*. These specimens share with *A. nanrenensis* the larger number of setae per segment than *A. corticis*, but differ in having spermathecal pores near mid-lateral, different arrangement of genital markings in the male field, presence of genital markings in the spermathecal segments, and hearts in xi. Male function is clearly present in *A. nanrenensis*, with iridescent male funnels and iridescent spermathecal diverticulum chambers, the latter indicating that mating has taken place and sperm has been received. Spermathecal segment genital markings are lacking in *A. nanrenensis*, unlike *A. corticis* which generally has them. Genital marking glands are absent, another separation from *A. corticis*, and cannot, as has been done in other cases, be ascribed to parthenogenetic degradation of sexual characters.

The complete absence of hearts in x and xi is unusual, and not found in Gates’ (1972) material, where hearts of x are “usually aborted” but hearts are uniformly present in xi. The missing hearts might be taken as a developmental abnormality, but the next species also shows deletion of some hearts. *Amyntas nanrenensis* differs from all other known *Amyntas* with spermathecae in vi–ix and ventrally placed spermathecal pores with respect to the lack

of hearts in x and xi, plus the arrangement of genital markings in the male field. Absence of hearts in x and xi distinguishes it from most other *Amynthas*, the nearest in this respect being the similarly octothecal Vietnamese *A. primadamae* (Michaelsen, 1934), in which the contractile hearts are also in xii and xiii only, with a pair of small lateral hearts enclosed in the testes sacs in xi. *Amynthas nanrenensis* has oesophageal hearts in xi, has more narrowly placed spermathecal and male pores, and has a very differently shaped spermathecal diverticulum. It may be necessary to place *A. primadamae* in the synonymy of *A. corticis* based on its spermathecal battery and pore spacing, if Blakemore's diagnosis of the latter is sufficient, and modification of hearts is not considered important.

***Amynthas monsoonus* sp. nov.**

(Figure 2C, D)

Holotype: one adult specimen collected 13 July 1998 at Nanrenshan, Kending, Pingtung County, Taiwan, 22°05'03"N, 120°50'07"E; 150 m by Chung-Chi Huang, NMNS 4054-005.

Etymology

The species is named for the tropical monsoon forest in Nanrenshan which is unusual for such a northern latitude.

Description

Dimensions 102 mm by 3.6 mm at segment x, 4.0 mm at xxx, 3.8 mm at clitellum; body cylindrical throughout, segments 83. Setae regularly distributed around segmental equators, numbering 38 at vii, 42 at xxv; size, interval regular; setal formula AA:AB:YZ:ZZ=1:1:1:2 at xxv. Female pore single in xiv. Prostomium epilobic, with tongue open. Brown anterior dorsal pigmentation with unpigmented setal zones, pigment diminishing posteriorly but present to end. First dorsal pore 12/13. Clitellum annular xiv–xvi; setae invisible externally.

Male pores lacking associated genital markings, 16 setae between male pores. Spermathecal pores lateral in 6/7/8/9. Genital markings paired, presetal vii–ix between third, fourth setal lines (Figure 2C).

Septa 6/7/8 thickly muscular, 8/9, 9/10 absent, 10/11–13/14 thinly muscular; gizzard viii–x. Intestinal origin xvi; lymph glands present from xxvi; typhlosole simple fold 0.5 lumen diameter from xxvii. Intestinal caeca simple, originating in xxvii, extending anteriorly to xxiv, small incisions on ventral margin. Oesophageal hearts two pairs in xii–xiii; hearts x, xi lacking; commissural vessels vii, ix lateral, viii to gizzard; extra-oesophageal vessels to ventral oesophageal wall in x.

Male sexual system holandric, testes, funnels in paired ventral sacs in x, xi. Seminal vesicles large in xi, xii, with dorsal lobe. Prostates small xviii, two main lobes, ducts thick, muscular, vasa deferentia join duct at duct–glandular portion junction; vasa deferentia non-muscular.

Ovaries in xiii. Paired spermathecae in vii–ix; ampulla warty spherical, duct very short, diverticulum small ovate, stalk muscular, straight (Figure 2D); no nephridia on spermathecal ducts; paired sessile genital marking glands vii–ix.

Remarks

In Sims and Easton (1972) this worm keys to the *sieboldi* group. Easton (1981) transferred *A. sieboldi* (Horst, 1883) to *Metaphire*, so the species group name may no longer be appropriate. On the other hand, the male pores of the type of *M. sieboldi* (National Natuurhistorisch Museum, Leiden, Netherlands, cat. no. 1825) are subapical on blunt cones surrounded by elevated circular lips leaving wide openings. Through this opening the cone is clearly visible. The circular trough surrounding the cone is wholly confined to the body wall, which shows no trace of bulging into the coelom. This leaves one in grave doubt about the validity of assigning *A. sieboldi* to *Metaphire*. Gates (1975, p. 7) wrote, "Presence or absence of copulatory chambers is too vague. The really important character is whether the male pores are superficial or invaginate. In the latter case, whether in slight transverse slits or much deeper spaces still confined to the parietes or whether thick-walled copulatory chambers deeply penetrating into coelomic cavity (cf Gates 1972, p. 150)". In Easton (1981) no details are given in support of the transfer, and he further commented on *M. riukiensis* that it was uncertain if the male pores were in seminal grooves or copulatory pouches, so it was unclear if it should be placed in *Amyntas* or *Metaphire*. If the definition of "copulatory pouch" is so vague, then a critical review of the character and assignments of species to genera based on the character are clearly needed. We support following the suggestion of Gates (1975) to better characterize the status of various types of non-superficial male pores. For now we support restricting *Metaphire* to those species distinguishable from *Pheretima* only by the absence of nephridia from the spermathecal ducts (Sims and Easton 1972). This would require the presence of well-developed copulatory pouches protruding into the coelom (as in *Pheretima*), but leaves unclear what to do with species whose copulatory pouches are entirely intramural and could thus be distinguished from *Pheretima*.

Pending the outcome of these issues, the species group could be renamed the *aelianus* group after *A. aelianus* (Rosa, 1892), that being the first in the species group list in Sims and Easton (1972). This group should also include six recently described species from Taiwan with spermathecal pores in 6/7/8/9: *A. binoculatus* Tsai, Shen and Tsai, 1999, *A. fenestrus* Shen, Tsai and Tsai, 2003, *A. sexpectatus* Tsai, Shen and Tsai, 1999, *A. tayalis* Tsai, Shen and Tsai, 1999, *A. tenuis* Shen, Tsai and Tsai, 2003, and *A. tungpuensis* Tsai, Shen and Tsai, 1999. *Amyntas monsoonus* differs from them all in lacking the anterior two pairs of hearts, like *A. nanrenensis*. It also has a different genital marking pattern from its Taiwanese sixthelal congeners. The missing hearts suggest that it is more closely related to *A. nanrenensis* than to the *aelianus* group members. No one has tested the hypothesis that the spermathecal battery is evolutionarily more conservative than details of the circulatory system, and there is evidence to the contrary. The locations of hearts are widely conserved among *Amyntas*, across great variation in other characters, particularly the numbers and locations of spermathecae. *Amyntas monsoonus* and the previous two species are quite unusual in having lost the hearts of x, or x and xi. These three are very similar with respect to other somatic characters and spermathecal morphology. Therefore it seems possible that their similarity is due to common ancestry, and that some species groups defined by spermathecal batteries could be polyphyletic or paraphyletic (addition or deletion of a pair would remove a taxon from its clade, rendering the latter paraphyletic). Advocates of sexual characters as indicators of phylogenetic relationships include most of the classical authors (prominent among them Michaelsen and Stephenson). Promotion of somatic characters for this purpose is one of the central themes of Gates' work (Gates 1972), but the question will not be decided without recourse to a third and independent set of characters. Nucleic acid sequence data are an obvious choice.

A suggestion that *A. monsoonus* is very similar to *A. carnosus* (Goto and Hatai, 1899) discounts the more anterior location of the three or four pairs of spermathecae in the latter, as well as its possession of genital markings in segments xviii and xix, greater numbers of setae per segment, lack of genital marking glands, and the very different spermathecal morphology. Blakemore's (2003) diagnosis of *A. carnosus* and subsequent remarks all place its first pair of spermathecal pores in 5/6.

***Amyntas huangi* sp. nov.**
(Figure 2E, F)

Holotype: adult collected at Shihwen, Pingtung County, Taiwan, 22°21'53"N, 120°39'45"E; 391 m, 18 August 1999 by Chung-Chi Huang and Jin-Kuan Yang, NMNS 4054-011.

Etymology

This species is named after Mr. Chung-Chi Huang who helped the collection work extensively.

Description

Dimensions 70 mm by 3.5 mm at segment x, 3.1 mm at xxx, 3.2 mm at clitellum; body cylindrical throughout, segments 101. Setae regularly distributed around segmental equators, numbering 38 at vii, 48 at xxv; size and distance regular; no dorsal gaps, ventral gap AA:AB=4:3 at xxv. Female pores paired in xiv. Prostomium epilobic, with tongue open. Pale brown dorsal pigmentation, formalin preservation. First dorsal pore 12/13. Clitellum annular xiv–xvi; setae invisible externally.

Male pores on small knobs visible under hoods covering male pore openings; 10 setae between male pores. Spermathecal pores lateral, deep slits in 6/7/8/9. Genital markings not visible externally (Figure 2E).

Septa 6/7/8 thinly muscular, 8/9, 9/10 absent, 10/11–13/14 thinly muscular; gizzard viii–x. Intestinal origin xv, typhlosole simple fold one-quarter lumen diameter from xxvii. Intestinal caeca simple, originating in xxvii, extending anteriorly to xxiv. Oesophageal hearts four pairs in x–xiii; commissural vessels vii, right ix lateral, viii to gizzard; extra-oesophageal vessels to ventral oesophageal wall in x.

Male sexual system holandric, testes, funnels in ventral paired sacs in x, xi. Seminal vesicles small in xi, xii, without dorsal lobe. Prostates large xviii, deeply lobed; ducts thick, muscular, short; vasa deferentia join duct at duct–glandular portion junction; vasa deferentia non-muscular; prostatic duct flanked by large sessile glandular masses on body wall.

Ovaries in xiii. Paired spermathecae in vii–ix; ampulla ovoid, large; diverticulum large flat ovate mass composed of tightly folded tubular chamber, short slender straight stalk (Figure 2F); no nephridia on spermathecal ducts; genital marking glands with long stalks meeting body wall in vi–viii next to spermathecal ducts.

Remarks

The male pores are clearly not within intra-coelomic copulatory pouches, such as characterize *Pheretima* s.s. and perhaps *Metaphire*. In the present case, and in some species

described below, the male pores are within slight folds of the body wall. In the absence of additional evidence supporting transfer to *Metaphire*, we assign this species to *Amyntas*. Sims and Easton (1972) stated that in the absence of spermathecae, it is not possible to distinguish a *Pheretima* from a *Metaphire*. In light of the fact that *Pheretima* all have intracoelomic copulatory pouches appearing as domes of tissue (usually muscular in appearance) partially separable from the body wall, this must also be a characteristic of *Metaphire*, or Sims and Easton (1972) were wrong. We are open to both possibilities, but to date no one has adequately addressed this question. In our experience, there exist species with large intramural copulatory pouches within a thickened body wall of xviii, and these consistently fall in *Metaphire*. Such structures appear to us not homologous to the intracoelomic pouches of *Pheretima*, but we could be mistaken. Based on this we prefer to restrict *Metaphire* to those species with well-characterized copulatory pouches and no nephridia on the spermathecal ducts (Sims and Easton 1972), excluding those whose pores lie within wrinkles or seminal grooves, under small flaps, or within shallow indentations.

Amyntas huangi belongs to the *aelianus* species group, in which it is most similar to *A. taipeiensis* (Tsai, 1964). However, the differences are many: smaller size than *A. taipeiensis*, fewer setae, no setal enlargement ventro-anteriorly, male pore area different, hood or flap over male pores present, colour different, intestinal origin in xvi not xv, seminal vesicles lack dorsal lobes, prostatic ducts short and straight, not coiled or bent, diverticulum chamber coiled with straight stalk versus stalk kinked in *A. taipeiensis*, and no genital marking glands in *A. taipeiensis*. Note that genital marking glands are present in xviii even though no externally visible genital markings are present. This suggests that the genital markings are hidden under the hoods partially obscuring the male pores. Furthermore, the spermathecal segment genital markings must be deep in the pore slits or even within the pores themselves, out of view.

***Amyntas hengchunensis* sp. nov.**
(Figure 2G, H)

Holotype: adult collected at Nanrenshan, Kending, Pingtung County, Taiwan, 22°05'03"N, 120°50'07"E; 150 m, 28 April 1999 by H.-T. Shih, NMNS 4054-006.

Other material examined. One adult, Nanrenshan, Kending, Pingtung County, Taiwan, October 1998, Chung-Chi Huang coll., NMNS 4054-007; one adult, Kending, Hengchun, Pingtung County, Taiwan, 4 February 1998, Chi-Yuan Huang coll., NMNS 4054-008; one adult, Santaishan, Hengchun, Pingtung County, Taiwan, 22°02'12"N, 120°45'56"E; 93 m, 31 March 1999, H.-T. Shih coll., NMNS 4054-009; two adults, Kending, Hengchun, Pingtung County, Taiwan, 21°54'17"N, 120°51'33"E; 45 m, 6 January 2000, H.-T. Shih coll., NMNS 4054-010.

Etymology

This species is named after Hengchun Peninsula, Pingtung County, Taiwan, where it was discovered.

Description

Dimensions 200–252 mm by 9–11 mm at segment x, 9.5–11 mm at xxx, 8–9.5 mm at clitellum; body cylindrical throughout, segments 138–148. Setae regularly distributed

around segmental equators, numbering 120–170 at vii, 140–164 at x, 170–208 at xxv; size uniform; setal formula AA:AB:YZ:ZZ=1.7:1:1:3 at xxv. Female pore single in xiv. Prostomium epilobic, with tongue open. Unpigmented, first dorsal pore 12/13. Clitellum annular xiv–xvi; setae invisible externally.

Male pores minute on low conical porophores at posterior extension of spatulate longitudinally orientated genital marking surrounded by epidermal folds, lateral fold close to male pores enlarged to form flap or hood partially covering male porophore; 26–28 setae between male pores, pores 0.33 circumference apart on setal line 20. Spermathecal pores dorso-lateral in 5/6/7/8/9, 0.37–0.40 circumference apart dorsally, segmental edges posterior to pores thickened (Figure 2G).

Septa 5/6/7/8 thinly muscular, 8/9 membranous, 9/10 absent, 10/11–13/14 thickly muscular; gizzard viii. Intestinal origin 1/2xv; typhlosole simple fold from xxiv gradually to full size xxviii, one-fifth lumen diameter. Intestinal caeca conical, margins smooth, xxvii–xxiii; lymph gland from xv; blood glands in v. Oesophageal hearts x–xiii, very small links to dorsal vessel xi–xiii; commissural vessels vii, ix lateral, viii to gizzard; supraoesophageal vessel xi–xiv; extraoesophageal vessels join ventral oesophageal wall in x, prior to this receive vessels from ventral posterior face of gizzard; posterior latero-parietal vessels from body wall of xiv–xvi, septum 13/14 to ventral oesophageal location of extraoesophageal vessels in xiii.

Male sexual system proandric, testes, funnels in ventrally joined sac in x. Seminal vesicles large in xi, with small dorsal lobe; seminal vesicles, other contents of xi enclosed in thin sac. Prostates large in xviii, four main lobes, each lobe served by two to five small ductlets radiating fan-like from ental end of prostatic duct; ducts stout, straight, muscular, narrowing towards body wall; vasa deferentia join duct at duct–glandular portion junction; vasa deferentia non-muscular.

Ovaries in xiii. Paired spermathecae vi–ix; ampulla ovate, duct shorter than ampulla, diverticulum small ovate chamber, stalk slender composed of entally widening hairpin loops not enclosed in membrane (Figure 2H); no nephridia on spermathecal ducts.

Remarks

Amyntas hengchunensis is similar to *A. formosae* (Michaelsen, 1922) with respect to proandry, the enclosure of the contents of xi in a sac, being octothecal in vi–ix, the general form of the spermathecae, the body size, the intestinal origin, and the very large number of setae in the anterior segments. In contrast, *A. hengchunensis* has many more setae, especially in the post-clitellate segments, and has spermathecal pores more ventrally placed. Other differences (*A. hengchunensis* features given) include the male field possessing a flap partially covering the male porophore, much shorter caeca, and lack of membranous covering of the diverticulum stalk. This species is the second proandric *Amyntas* known from Taiwan, with three more described below. *Amyntas hengchunensis* also has a different prostatic duct structure from that encountered in most *Amyntas*, the only one similar to it being *A. formosae*. The ordinary *Amyntas* prostatic duct has a multiple approximately dichotomous branching pattern, with occasional trichotomies. In the present species, and the next three described below, numerous ductlets of equal size join the large prostatic ducts at the same point, creating a single polytomy. This polytomy may form from two or more groups of ductlets, or as in *A. chaishanensis*, which is described later in this paper, one undivided fan of ductlets.

Amynthas formosae (Michaelsen, 1922)

Amynthas yuhsi Tsai 1964, p. 5.

Material examined

Type, adult, Koseypo (=Jiasian, Kaohsiung County), Taiwan. National Natuurhistorisch Museum, Leiden, Netherlands, cat. no. 1817.

Description

Slight dorsal-anterior dark pigmentation, male field with conical porophores composed of concentric rings, innermost ring surrounding semi-circular protrusion from within slight indentation; this protrusion placed laterally to a smaller round protrusion of lower elevation; male pores not seen but probably on the smaller protrusion or between the two protrusions. Thirty setal follicles between porophores, 27 present in these; porophore apices 8 mm apart, or 0.25 body circumference. Spermathecal pores intrasegmental at equators of presetal annulus in each of segments vi–ix, subdorsal, 0.06–0.08 circumference apart from dorsal side.

Prostates composed of four or five main lobes, each connected by numerous very small ductlets to large muscular prostatic duct; prostatic ducts consisting of thick circular muscle layer surrounding spongy tissue composed of numerous very small tubules.

Remarks

The single type specimen examined is missing the gut, hearts and male organs from ix–xvii. Additional type material formerly in the Zoologisches Institut Hamburg (cat. no. 9309) was discovered to be missing when requested for examination, the bottle and label being present but no material within. Thus little more than the above could be learned regarding internal anatomy. It is now clear that the spermathecal pores are intrasegmental and very close to the mid-dorsal line, in contrast to representations made in Gates (1959) for other material. The prostatic duct structure of the type is clearly generally similar to *A. hengchunensis* and the other proandric species described below. Gates' (1959) material may belong to a separate species, because the spermathecal pores are given as "well towards mL", rather than nearly mid-dorsal dorsal and intrasegmental as in *A. formosae*. *Amynthas yuhsi* as described by Tsai (1964) is indistinguishable from the remains of the type of *A. formosae*, so it is a junior synonym.

Amynthas kaopingensis sp. nov.

(Figure 3A, B)

Holotype: adult collected at Caopu, Shihzih, Pingtung County, Taiwan, 17 November 1996, by Gao-Shih Hsiang, NMNS 4054-014.

Other material. One adult, Caopu, Shihzih, Pingtung County, Taiwan, 8 August 1998, Chang-Yi Tsai coll., NMNS 4054-015. Three adults, Dahanshan (=Mt. Dahan), Pingtung County, Taiwan, 22°24'48"N, 120°24'48"E; 61 m, 21 February 2000, H.-T.

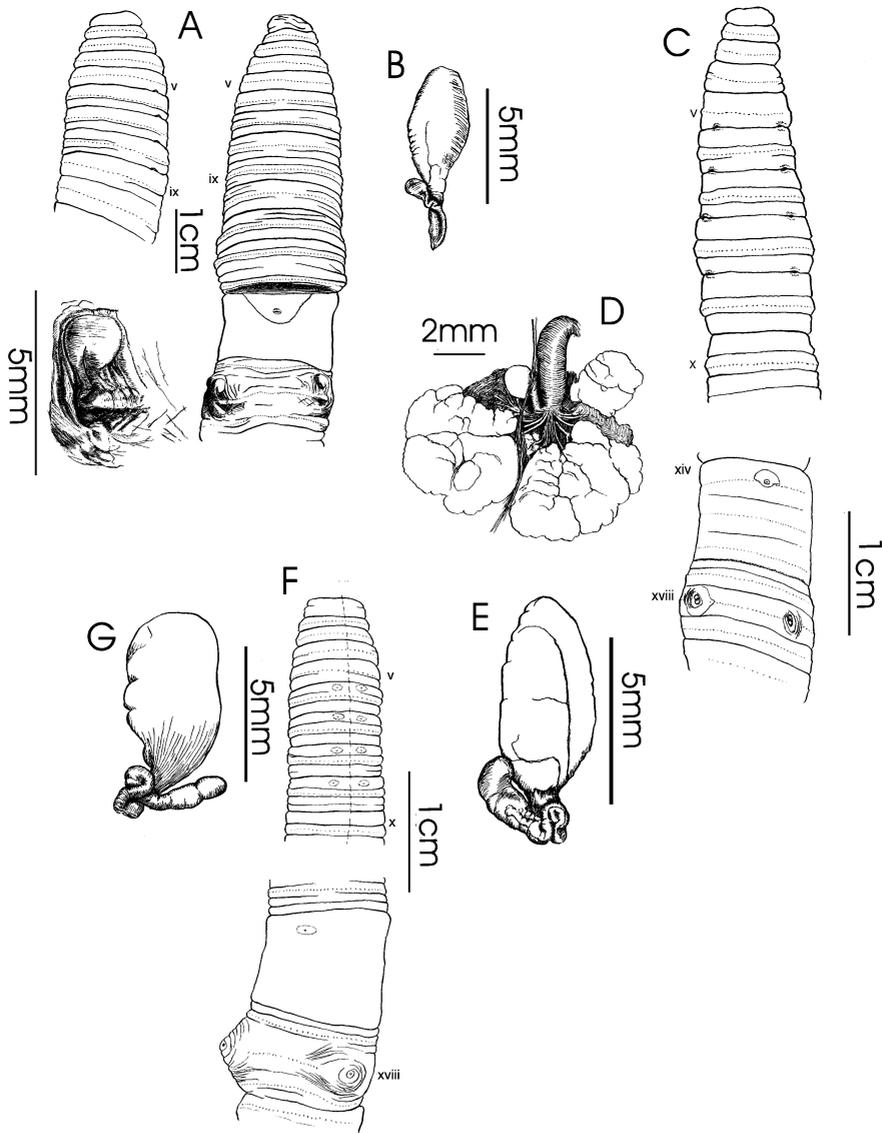


Figure 3. (A) Left lateral view of segments i–ix and ventral view of *Amynthas kaopingensis*, with detail of male pore; (B) spermatheca of *Amynthas kaopingensis*; (C) dorsal view of segments i–x and ventral view of xiv–xix of *Amynthas ailiaoensis*; (D) left prostate gland of *Amynthas ailiaoensis*, showing numerous small ductlets (curved line traversing the gland is septum 17/18); (E) spermatheca of *Amynthas ailiaoensis*; (F) dorsal view of segments i–x and ventral view of xiii–xix, *Amynthas chaishanensis* (the dashed line on the dorsal view represents the mid-dorsal line); (G) spermatheca of *Amynthas chaishanensis*.

Shih coll., NMNS 4054-016. Five adults, Taiwu, Pingtung County, Taiwan, 29 January 2000, Chi-Pin Wu coll., NMNS 4054-017. One adult, Dahanshan, Pingtung County, Taiwan, 22°24'52"E, 120°39'46"E; 665 m, 22 February 2000, H.-T. Shih coll., NMNS 4054-018. One adult, Meinong, Kaohsiung County, Taiwan, 8 March 1999, Chao-Shen Chen coll., NMNS 4054-019.

Etymology

This species is named after the combination of prefixes, “kaoping”, of its localities, Kaohsiung and Pingtung Counties.

Description

Dimensions 170–300 mm by 10–14 mm at segment x, 8–11 mm at xxx, 9–11 mm at clitellum; body cylindrical throughout, segments 160–177. Setae regularly distributed around segmental equators, numbering 130–170 at vii, 126–170 at x, 104–126 at xxv; size uniform; setal formula AA:AB:YZ:ZZ=1:1:1:2 at xxv. Female pore single in xiv. Prostomium epilobic, with tongue open. Unpigmented to dorsal brown pigment of variable darkness, first dorsal pore 12/13, 13/14. Clitellum annular xiv–xvi; setae invisible externally.

Male pores minute at posterior end of seminal grooves extending from centre of ovate to rounded angular genital pad longitudinally orientated from 17/18 to equator of xviii, surrounded by epidermal folds, lateral folds closest to male pores enlarged to form flap adjacent to or partially covering genital pad (Figure 3A); one specimen with paired oval genital markings presetal xvii slightly median to male pore line; 32–40 setae between male pores, pores 0.32 circumference apart on setal line 22. Spermathecal pores dorsal in 5/6/7/8/9, 0.29–0.32 circumference apart dorsally.

Septa 5/6/7/8 thickly muscular, 8/9 membranous, 9/10 absent, 10/11–13/14 thickly muscular; gizzard viii. Intestinal origin 1/2xv; typhlosole simple fold from 27/28, one-quarter lumen diameter or smaller. Intestinal caeca simple, margins smooth, xxvii–xxiii; lymph glands from xv, those of xvi very large, acinous. Oesophageal hearts x–xiii, very small links to dorsal vessel xi–xiii; commissural vessels vii, ix lateral, viii to gizzard; supraoesophageal vessel xi–xiv; extraoesophageal vessels join ventral oesophageal wall at 10/11; posterior latero-parietal vessels from body wall of xiv–xvi, septum 13/14 to ventral oesophageal location of extraoesophageal vessels in xiii.

Male sexual system proandric, testes, funnels in ventrally joined sac in x. Seminal vesicles large in xi, with small fine-textured dorsal lobe; seminal vesicles, other contents of xi enclosed in thin sac. Prostates large in xviii, three to five main lobes, each lobe served by two to five small ductlets radiating fan-like from ental end of prostatic duct; ducts stout, straight, muscular, narrowing towards body wall; vasa deferentia join duct at duct-glandular portion junction; vasa deferentia non-muscular.

Ovaries in xiii. Paired spermathecae vi–ix; ampulla pear-shaped, duct shorter than ampulla, diverticulum small ovate chamber, stalk slender, either straight or kinked, about same length as duct (Figure 3B); no nephridia on spermathecal ducts.

Remarks

Another octothecal proandric species with dorsal intersegmental spermathecal pores, *A. kaopingensis* is closest to *A. hengchunensis* in all respects, including details of internal anatomy such as the structure of the ductlets of the prostates, the membrane enclosing segment xi, and the presence of septum 8/9. It differs from *A. hengchunensis* in the features of the male field, a more dorsal placement of spermathecal pores, and the structure of the spermathecal diverticulum. There seems to be considerable morphological unity among *A. kaopingensis*, *A. hengchunensis* and *A. formosae*.

The male field of *A. kaopingensis* has seminal grooves, a feature not previously reported in the literature of Taiwan earthworms, but well known among Korean *Amyntas* (Kobayashi 1936; Hong and James 2001; Hong et al. 2001) and species from other parts of Asia: *A. glabrus* (Gates, 1932), *A. japonicus* (Horst, 1883), *A. papilio* (Gates, 1930), *A. plantoporophoratus* (Thai, 1984), and *A. riukiensis* (Ohfuchi, 1957). The locations of these species include Myanmar, Japan, Vietnam, and the Ryukyu Islands. The grooves are commonly formed within an otherwise flat genital pad of varying shape, but in *A. riukiensis* they are formed by folds on the male field. It is not clear if all are descended from a common ancestral type, or if there could be two or more independent evolutions of seminal grooves in *Amyntas*. In any case, none of the species with seminal grooves also has copulatory pouches, and therefore these do not belong to *Metaphire*.

***Amyntas ailiaoensis* sp. nov.**

(Figure 3C–E)

Holotype: adult collected at Wutai, Pingtung County, Taiwan, 24 August 1998 by Chung-Chi Huang, NMNS 4054-020. Paratypes: four adults, collected at Wutai, Pingtung County, Taiwan, 24 August 1998 by Chung-Chi Huang, NMNS 4054-021.

Etymology

This species is named after the Ailiao River, of the locality Wutai.

Description

Dimensions 215–310 mm by 9–12.5 mm at segment x, 9–10 mm at xxx, 8–12 mm at clitellum; body cylindrical throughout, segments 110–140. Setae regularly distributed around segmental equators, numbering 86–96 at vii, 90–94 at x, 126–140 at xxv; size uniform; setal formula AA:AB:YZ:ZZ=1:1:1:2.5 at xxv. Female pore single in xiv. Prostomium epilobic, with tongue open. Brown pigment on dorsal third, intensity variable; first dorsal pore 12/13. Clitellum annular xiv–xvi; setae invisible externally.

Male pores within shallow circular invagination of body wall, in each of which one oblong longitudinally orientated genital marking is folded in half transversely; 20 setae between male pores, pores 0.26 circumference apart on setal line 15. Spermathecal pores mid-lateral to slightly ventral of mid-lateral 5/6/7/8/9 (Figure 3C).

Septa 5/6/7/8 muscular, 8/9/10 absent, 10/11–13/14 muscular; gizzard viii; oesophageal wall with low lamellae xii–xiii. Intestinal origin 1/2xv; 42–50 longitudinal intestinal blood vessels; typhlosole simple fold from 27/28, 1/8 lumen diameter. Intestinal caeca simple, margins smooth, xxvii–xxiii; lymph glands from xv; blood glands in v. Oesophageal hearts x–xiii, commissural vessels vii, ix lateral, viii to gizzard; supraoesophageal vessel xi–xiii; extraoesophageal vessels join ventral oesophageal wall in x; posterior latero-parietal vessels from body wall of xiv–xvi, septum 13/14 to ventral oesophageal location of extraoesophageal vessels in xiii.

Male sexual system proandric, testes, funnels in ventrally joined sac in x. Seminal vesicles large in xi, with large dorsal lobes; seminal vesicles, other contents of xi sometimes enclosed in thin sac. Prostates large in xviii, seven main lobes, each lobe served by two to three small ductlets radiating fan-like from ental end of prostatic duct (Figure 3D); ducts stout,

muscular, narrowing towards body wall; vasa deferentia join duct at duct–glandular portion junction; vasa deferentia non-muscular.

Ovaries in xiii. Paired spermathecae vi–ix; ampulla pear-shaped, duct much shorter than ampulla, diverticulum with small ovate chamber, stalk slender, tightly convoluted in hairpin loops enclosed in membrane (Figure 3E); no nephridia on spermathecal ducts.

Remarks

The fourth octothecal proandric *Amyntas* of Taiwan is much more similar to Gates' (1959) material from Chao-Chow (=Chaozhou), Pingtung and Green Mountain (=Yangmingshan), Taipei than the others. Differences from Gates' material are few. It is possible that these are the same species. *A. ailiaoensis* has paired genital markings within a shallow invagination of the male field, lacks septum 8/9, has much shorter caeca, and the spermathecal pores are at or above mid-lateral rather than "well towards mL" which might mean below mid-lateral but close. Many small nematodes were found in the body cavity, mainly around the caeca, prostates and seminal vesicles.

Amyntas chaishanensis sp. nov.

(Figure 3F, G)

Holotype: adult collected at Chaishan, near National Sun Yat-sen University, Kaohsiung City, Taiwan 22°39'19"N, 120°16'06"E; 80 m, 30 September 1999, by H.-T. Shih, NMNS 4054-022. Paratypes: three adults, same collection data as holotype, NMNS 4054-023.

Etymology

This species is named after the locality Chaishan (=Mt. Chai), Kaohsiung City, Taiwan.

Description

Dimensions 203–228 mm by 8–11 mm at segment x, 6–9 mm at xxx, 8–11 mm at clitellum; body cylindrical throughout, segments 112–137. Setae regularly distributed around segmental equators, numbering 130–150 at vii, 126–138 at x, 104–120 at xxv, size and distance regular; setal formula AA:AB:YZ:ZZ=2:1:1:3 at xxv. Prostomium epilobic, with tongue open. Dark purple-brown pigment on dorsalmost third, formalin preservation. First dorsal pore 12/13. Clitellum annular xiv–xvi; setae invisible externally.

Male pores on large alate porophores in shallow apical invagination, 0.33 circumference apart; 20 setae between male pores. Female pore single in xiv. Spermathecal pores dorsal, intrasegmental on small indistinct porophores in presetal annulus of triannulate segments vi–ix, 0.10 circumference apart (Figure 3F).

Septa 5/6/7/8 very thick, muscular, 8/9 present ventrally, 9/10 absent, 10/11–13/14 very thick, diminishing in muscularity posteriorly; gizzard viii, blood glands iv, v. Intestinal origin half xv; typhlosole simple fold one-third lumen diameter from xxvii. Intestinal caeca simple, long slender, originating in xxvii, extending anteriorly to xxv, xxiii, no incisions. Oesophageal hearts two pairs in xii–xiii; x, xi lacking, commissural vessels vii, ix lateral, viii to gizzard. Extraoesophageal vessels fuse to single vessel on ventral side of oesophagus in x.

Male sexual system proandric, testes, funnels in ventrally joined sacs in x. Seminal vesicles large in xi, with dorsal lobe, enclosed within sac containing all segmental contents. Prostates xviii, numerous deeply incised main lobes covering xvii–xx, ducts short, thick, muscular, straight; numerous ductlets from glandular portion form undivided fan-shaped array, ental portion of prostatic duct with approximately 40 very small lumens, one larger lumen probably sperm duct; vasa deferentia join at duct–glandular portion junction; vasa deferentia non-muscular.

Ovaries in xiii. Paired spermathecae in vi–ix; ampulla large ovate sac, duct stout but flaccid, half length of ampulla, diverticulum stalk long convoluted kinks enclosed within membrane, chamber terminal ovate knob; diverticulum axis shorter than ampulla axis (Figure 3G); no nephridia on spermathecal ducts.

Remarks

This proandric octothecal species with intrasegmental spermathecal pores keys to the *rimosus*-group in Sims and Easton (1972), all members of which are from Myanmar. *Amyntas rimosus* (Gates, 1931) is holandric and its spermathecal pores are ventral. The true affinities of *A. chaishanensis* lie with the other Taiwanese proandric species, and particularly with *A. formosae*. *Amyntas chaishanensis* has numerous prostatic ductlets of equal size joining the large prostatic ducts at the same point, creating a single undivided fan of ductlets. This is in contrast to the other species described here and *A. formosae*, all of whose ductlets gather into small bundles prior to joining the main prostatic duct.

Amyntas chaishanensis is one of two known proandric *Amyntas* species with dorsal intrasegmental pores on vi–ix, the other being *A. formosae*. It is further distinguished by having hearts only in xii and xiii but *A. formosae*'s hearts are unknown, beyond having the last hearts in xiii. However, Gates (1959) noted the presence of hearts in x–xiii in his material and did not note this as a distinction between his material and *A. formosae*. Other differences from *A. formosae* are many more setae in the anterior segments, fewer setae between the male pores, slightly more widely spaced (from mid-dorsal line) spermathecal pores, caeca originating in xxvii, lack of pseudovesicles in xii and xiii, and prostate glands divided into numerous main lobes, rather than only 2.

Other material collected and identified

GLOSSOSCOLECIDAE

Pontoscolex corethrurus (Müller, 1856)

Nanrenshan, Kending, Pingtung County, Taiwan, 22°05'03"N, 120°50'07"E; 150 m, 19 October 1996 and 13 July 1998, Chung-Chi Huang coll., NMNS 4054-024, 4054-025; Laiyi, Pingtung County, Taiwan, 22°35'08"N, 120°38'55"E; 342 m, 29 July 1999, H.-T. Shih coll., NMNS 4054-026; Siaoliouciou Island, Pingtung County, Taiwan, 22°20'17"N, 120°21'42"E; 18 m, 23 November 1999, H.-T. Shih and Chung-Chi Huang colls., NMNS 4054-027; National Sun Yat-sen University campus, Kiaohsiung City, Taiwan, 22°37'57"N, 120°15'48"E; 70 m, 22 September 1999, H.-T. Shih coll., NMNS 4054-028.

MEGASCOLECIDAE

Pontodrilus litoralis (Grube, 1855)

Pontodrilus litoralis: Easton 1984, p 114.

Marine shoreline near coral reefs, Wanlitong, Pingtung County, Taiwan, 21°59'47"N, 120°42'15"E, 5 January 2000, H.-T. Shih coll., NMNS 4054-029; mangrove area at estuary of Kaoping River, Linyuan, Kaohsiung County, Taiwan, 3 November 1998, Chung-Chi Huang coll., NMNS 4054-030.

Remarks

Based on the most recent information available to us, this is the first Taiwan record of this globally distributed subtropical to tropical species. It is one of the few euryhaline earthworms of the world.

Amyntas corticis (Kinberg, 1867)

Amyntas corticis: Blakemore 2003, p 14.

Nanrenshan, Kending, Pingtung County, Taiwan, 22°05'03"N, 120°50'07"E; 150 m, 20 October 1996, 13 July 1998 and 24 August 1999, Chung-Chi Huang coll., NMNS 4054-031, NMNS 4054-003, NMNS 4054-032; Jioupeng, Pingtung County, Taiwan, 22°06'18"N, 120°50'56"E; 149 m, 29 April 1999, H.-T. Shih coll., NMNS 4054-033; Nanhe, Chunrih, Pingtung County, Taiwan, 22°26'33"N, 120°39'03"E; 133 m, 19 August 1999, Chung-Chi Huang and Jin-Kuan Yang colls., NMNS 4054-034.

Description

Dimensions 96–119 mm by 4.1–4.3 mm at segment x, 3.8–4.0 mm at xxx, 3.6–3.8 mm at clitellum; body cylindrical throughout, segments 110–118. Setae regularly distributed around segmental equators, numbering 36–40 at vii, 40–46 at xxv, size and distance regular; 10–14 setae between male pores; setal formula AA:AB:YZ:ZZ=3:1:1:2 at xxv. Male pores 0.24 circumference apart in eighth setal line. Female pore single in xiv. Prostomium epilobic, with tongue open. Colour unpigmented or slight greenish brown shading on dorsalmost one-third, formalin preservation. First dorsal pore 11/12. Clitellum annular xiv–xvi; setae invisible externally.

Male pores lateral to two pairs small circular genital markings pre-, post-setal in xviii. Spermathecal pores ventral in 5/6/7/8/9, 0.28 circumference apart. Genital markings presetal viii–ix (all), additionally in vii (5), or vii and vi (1); post-setal vii, viii (2) or viii only (2) or none post-setal (3), either in line with spermathecal pores or just median to line of pores (2).

Septa 5/6/7/8 thinly muscular, 8/9, 9/10 absent, 10/11–13/14 thinly muscular; gizzard viii–x. Intestinal origin xvi; lymph glands present from xxvi; typhlosole simple fold one-fifth lumen diameter from xxvii. Intestinal caeca simple, long slender, originating in xxvii, extending anteriorly to xxiii, no incisions. Oesophageal hearts three pairs in xi–xiii, x lacking, commissural vessels vii, ix lateral, viii to gizzard.

Male sexual system holandric, testes, funnels in ventrally joined sacs in x, xi. Seminal vesicles large in xi, xii, with dorsal lobe. Prostates xviii, three to four deeply incised main lobes covering xvi–xx, ducts thick, muscular in long hairpin loop forward to xv, vasa deferentia join at duct–glandular portion junction; vasa deferentia non-muscular; genital marking glands lacking in xviii, small sessile genital marking glands in spermathecal segments.

Ovaries in xiii. Paired spermathecae in vi–ix; ampulla ovoid, diverticulum blunt ovoid, stalk straight; diverticulum axis shorter than ampulla axis; no nephridia on spermathecal ducts.

Remarks

The material is very probably *A. corticis*, a widespread peregrine species or complex of asexual morphs. For a detailed proposed synonymy see Blakemore (2003).

Amynthas gracilis (Kinberg, 1867)

Amynthas gracilis: Blakemore 2003, p 19.

Pheretima hawayana: Gates 1972, p 189.

Caopu, Pingtung County, Taiwan, 8 August 1998, Chang-Yi Tsai coll., NMNS 4054-035. Three adults collected at Gaoshih, Pingtung County, Taiwan, 22°06'49"N, 120°49'41"E; 234 m, 31 May 1999 by H.-T. Shih, NMNS 4054-012.

Description

Dimensions 60–70 mm (estimated; all amputees or fragmented *in vitro*) by 3.5 mm at segment x, 3.8 mm at xxx, 3.8 mm at clitellum; body cylindrical throughout, segments >57. Setae regularly distributed around segmental equators, numbering 24 at vii, 44 at xxv; size larger vi–viii; setal formula AA:AB:YZ:ZZ=2:1:1:3 at xxv. Female pores paired in xiv. Prostomium epilobic, with tongue open. Faint brown anterior dorsal pigmentation diminishing posteriorly. First dorsal pore 11/12. Clitellum annular xiv–xvi; setae invisible externally.

Male pores minute on small circular porophores lateral to paired post-setal genital markings, one pair or if two, the genital markings in transverse line, 15 setae between male pores, pores 0.33 circumference apart on tenth setal line. Spermathecal pores ventral on leading segmental edges 5/6/7/8 at fourth setal line, 0.27 circumference apart.

Septa 6/7/8 muscular, 8/9, 9/10 absent, 10/11–13/14 thinly muscular; gizzard viii–x. Intestinal origin xv; typhlosole lacking. Intestinal caeca simple, originating in xxvii, extending anteriorly to xxiv, six or seven small pockets on ventral margin. Oesophageal hearts three pairs in xi–xiii; hearts x lacking; commissural vessels vii, ix lateral, viii to gizzard.

Male sexual system holandric, testes, funnels in paired ventral sacs in x, ventrally joined sac in xi. Seminal vesicles acinous, large in xi, xii, with small uniform dorsal lobe. Prostates small xviii, three main lobes, ducts straight, muscular, vasa deferentia join duct at duct–glandular portion junction; vasa deferentia non-muscular; stalked genital marking glands xviii.

Ovaries in xiii. Paired spermathecae in vi–viii; ampulla pear-shaped, duct shorter than ampulla, diverticulum chamber small ovate, stalk slender with one or two short kinks, ental third of stalk and chamber iridescent with sperm; no nephridia on spermathecal ducts.

Remarks

This species keys to the peregrine *A. gracilis* (Kinberg, 1867). The only other sixthcal Taiwan *Amynthas* known to date to have the spermathecae located in vi–viii is *A. wangi*

(Shen et al. 2003b). Differences between *A. gracilis* and *A. wangi* are primarily in the male reproductive organs and the locations of genital markings. Genital markings are present in the spermathecal segments in *A. wangi*, but not in this material of *A. gracilis*, and in *A. wangi* on xvii in line with the male porophores, rather than in xviii medial to the male pores. The testes sacs of *A. wangi* are paired, while on the other hand the testes sacs in x of *A. gracilis* are joined ventrally.

Amyntas incongruus (Chen, 1933)

Nanrenshan, Kending, Pingtung County, Taiwan, 28 April 1999, H.-T. Shih coll., NMNS 4054-036.

Description

Spermathecal pores 5/6/7, GMs medial to spermathecal pores; male pores on porophore surrounded by three GMs. Spermathecae adiverticulate. Hearts x–xiii oesophageal; caeca simple, slender, with smooth margins. Testes sacs of x large, enclose hearts, testes sacs of xi enclose all segmental contents; seminal vesicles xi, xii, small; prostate glands large, ducts short, small sessile GM glands on body wall near prostatic duct.

Remarks

This worm's morphology is consistent with the original description, and information given in Gates (1959) for other *A. incongruus* material collected on Taiwan.

Amyntas robustus (Perrier, 1872)

Amyntas robustus: Blakemore 2003, p 24.

Chaishan, near National Sun Yat-sen University, Kaohsiung City, Taiwan, 6 April 1998, Hong-Da Zhu coll., NMNS 4054-037.

Description

Unpigmented, spermathecal pores lateral, male pores on porophores with one genital marking on each, large conical mid-ventral marking on xviii. GMs in vii, ix presetal just median to spermathecal pores. Genital marking glands mushroom-shaped with thick stalks, one or two at each spermathecal duct, one for mid-ventral GM in xviii, two at each prostatic duct.

Male-sterile, lacking iridescence on male funnels. Hearts x–xiii oesophageal; intestinal origin xvi, caeca simple in xxvii. Spermathecae with conical ampulla, diverticulum chamber long ovate, stalk muscular.

Remarks

This is probably the male-sterile *A. robustus*, as most particulars agree with previous data on the species. The only exception is the mid-ventral genital marking on xviii, a condition never seen in material examined by Gates (1972).

Metaphire houletti (Perrier, 1972)

Pheretima houletti: Gates 1972, p 191.

Wutai, Pingtung County, Taiwan, 23 August 1998, Chung-Chi Huang coll., NMNS 4054-038.

Remarks

This is a new record for the Taiwanese earthworm fauna.

Metaphire californica (Kinberg, 1867)

Metaphire californica: Blakemore 2003, p 26.

Laiyi, Pingtung County, Taiwan, 22°31'43"N, 120°40'09"E; 150 m, 28 July 1999, H.-T. Shih coll., NMNS 4054-039.

Polypheretima elongata (Perrier, 1872)

Metapheretima elongata: Sims and Easton 1972, p 205.

Metapheretima elongata: Easton 1976, p 40.

Polypheretima elongata: Easton 1979, p 53.

National Sun Yat-sen University campus, Kaohsiung City, Taiwan, 22°37'57"N, 120°15'48"E; 70 m, 22 September 1999, H.-T. Shih coll., NMNS 4054-040.

Discussion

There is considerable work to be done refining our understanding of relationships within *Amyntas*. If nothing else can be concluded from the new species reported here, it is clear that the species groups relied on for the last 30 years are mainly matters of convenience for purposes of constructing a key to the genus. Gates (1972) emphasized the need for basing classifications on somatic characters as well as sexual, but here we have presented some examples where the two conflict. Do we prefer to give emphasis (implicit weighting) to spermathecal battery over heart configuration—which would place *A. nanrenensis* in the *corticis* species group, excluding *A. monsoonus* with its similar reduction in number of hearts—or unite these three irrespective of their differing spermathecal batteries? Similarly, do we weight andry and prostatic duct structure in preference to hearts, placing the proandric octothecal species reported here together, and consider loss of hearts in *A. chaishanensis* to be homoplasious with respect to *A. nanrenensis* and *A. monsoonus*? On the simple basis of number of shared derived character states, we would favour weight given to andry and prostatic ducts in the latter example.

Two newly discovered *Amyntas* from the Philippines (Y. Hong and S. W. James, unpublished data) are proandric but do not have the same prostatic duct structure as the Taiwan proandric species, and are quadrithecal. The Philippine species have a different and unique structure of the prostatic duct, which is modified to form a sheath over a small penis visible through the outer secondary male pores. Thus when one enlarges the scope of investigation into relationships within the genus, characters that served well locally are not as reliable globally. The massive task of revising *Amyntas* will be made easier if all future

species descriptions are as complete as possible and the describers alert to details in structures too often given brief accounts or no details at all.

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