

Checklist of Taiwanese Earthworms (Oligochaeta : Clitellata : Annelida)

by

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Summary

Terrestrial megadrile earthworms variously reported from Taiwan, including Lanyu Island (Botel Tobago or “Orchid Island”), plus newly added *Eukerria saltensis* (Beddard, 1895) and *Dichogaster affinis* (Michaelsen, 1890) [by Shen *et al.* (2008a,b)], now number approximately 81 species with 33 of these, or ca. 40%, non-natives for which 69% are Asiatic Megascolecidae and 21% are Lumbricidae of Holarctic origin. An additional 27 unnamed species have been identified from Ilan county north-eastern Taiwan by Chen *et al.* (2003) that, if published, would bring the total to more than 100 known species. A checklist is provided with confirmation and new records of the exotic lumbricids *Eisenia fetida* (Savigny) and *Eiseniella tetraedra* (Savigny) (R.J.B. pers. obs.).

A 2005 Taiwan earthworm checklist also appears in Chinese in *NOW* journal online here: http://ptrc.npust.edu.tw/download/nalso_ow/2005_9_4.pdf (May, 2005).

Several recent molecular studies, such as those by Chang *et al.* (2008), were not based on type material for any of the species under consideration (including those from Australia) and thus their conclusions must be treated with caution, although these authors at least retained voucher specimens of their material. A brief Discussion and an Addendum are appended.

Keywords: Taxonomy, Biodiversity, Megascolecidae, Lumbricidae, Asian earthworms.

[Includes additions of OCNERODRILIDAE *Eukerria saltensis* by Shen *et al.* (2008a) and OCTOCHAETIDAE *Dichogaster affinis* by Shen *et al.* (2008b); and recent publications by Blakemore *et al.* (2006), Shen & Tsai (2007), Tsai *et al.* (2007), and Chang *et al.* (2007, 2008); at least two other papers are in preparation on Taiwan worms].

Introduction

Since Shih *et al.* (1999) listed and mapped 26 Taiwanese species belonging to 9 genera studies from Taiwan have increased rapidly. Most recently, Shen *et al.* (2005a) claim first Taiwan record of *Amyntas carnosus* and, Shen *et al.* (2005b) report littoral *Pontodrilus litoralis* (Grube, 1855) (Megascolecidae sensu Blakemore, 2000b) from Penghu Island and from southwestern Taiwan shoreline (other specimens pers. obs. by R.J.B. April, 2004). Lately, Chang and Chen (2004, 2005a, 2005b) describe three new *Metaphire* species from Taiwan [one from Ilan formerly a *nomen nudum* in Chen *et al.* (2003: 68), and one a synonym of *M. trutina*] and, latterly, these authors make notes on the status of *M. formosae*. Other new taxa are described as cited above and below.

Eisenia fetida (Savigny, 1826), or rather its species-complex, is used around the world in laboratory for ecotoxicological and other studies (e.g., Wu *et al.*, 2004; and see http://bio.fmipa.ipb.ac.id/LabZoologi/StafZoo/TSP/TSP_cv.html) and as it is also sold as fish bait in Taiwan and maintained in laboratory cultures (Dr J.-H. Chen, pers. comm. and pers. obs. by R.J.B.) – it too can be included on the list. An unconfirmed report from vermiculture operations is for *Amyntas asiaticus* Michaelsen, 1900, e.g., by Kuo (1987) and by Chang (1992) that brings the Taiwan earthworm species total to 81 nominal taxa.

An additional 27 unnamed species have been identified from Ilan County (Chen *et al.*, 2003: 65) that, if published, would raise the count above 100 known species.

Accounts of Taiwanese “red earthworms” used for fish and duck food refer to the microdrile tubificid *Monopylephorus rubroniveus* Levinsen, 1883 rather than a ‘true’ earthworm.

Methods

The list of names is compiled from various sources as mentioned in the Introduction, synonymies and as cited in the References. Nomenclature follows the most recent revisions of Lumbricoidea and pheretimoid taxa by Blakemore (2004a, 2004c, 2005, 2006) and the present taxonomy complies with recommendations and articles of ICZN (1999).

Results: Checklist of described Taiwanese taxa

FAMILIES after Blakemore (2000b, 2002, 2006); remarks and synonyms (syn.) in brackets marked with "?" where there is some uncertainty. Codes: * = exotic/introduced, - = native/endemic, # = uncertain affinities. Taiwan includes Lanyu, Lutaο and Penghu Islands. For common exotics not all synonyms are given here as these may be readily found elsewhere (e.g. Sims and Gerard 1985, 1999; Blakemore 2002, 2003a,b, 2006).

Family MONILIGASTRIDAE

- 1.* *Drawida japonica* (Michaelsen, 1892: 232) (syn. *Drawida grahami* Gates, 1935: 3) cf. *D. barwelli* (Beddard, 1886).

Family OCTOCHAETIDAE Michaelsen, 1900 [sensu Blakemore (2000b: 37) with New Zealand and Australian type-genus *Octochaetus* Beddard, 1893 (see Blakemore, 2000b; 2004b, c, d, 2004e: 124) and including other allied Indo-Australasian genera. In recent revisions, Csuzdi (1996, 2000) placed amphi-Atlantic *Dichogaster* subgenera in his redefinition of ACANTHODRILIDAE subfamily BENHAMIINAE Michaelsen, 1897 that itself possibly merits elevation to family level status as Benhamiidae; however, such decisions are beyond the scope of this current work].

- 2.* *Dichogaster (Diplotheodrilus) bolau*i (Michaelsen, 1891: 9) [many synonyms - see Csuzdi (2000: 60); Blakemore (2002)].
- 3.* *Dichogaster (Diplotheodrilus) saliens* (Beddard, 1893: 683) [syn. *crawi* Eisen, 1900 - see Csuzdi (2000); Blakemore (2002, 2006); Shen & Tsai (2007)].

Family MEGASCOLECIDAE sensu Blakemore, 2000

- 4.- *Amyntas ailiaoensis* James *et al.*, 2005: 1020 in James, Shih, H.-T. and Chang H.-W., 2005. Synonymous to *Metaphire feijani* according to Tsai *et al.*, 2006 and Tsai *et al.*, 2006 and Shen (pers. comm.).
- 5.* *Amyntas asiaticus* Michaelsen, 1900: 13 [a possible misidentification in Taiwan?].
- 6.* *Amyntas aspergillum* (Perrier, 1872: 118) [*Perichaeta takatorii* Goto & Hatai, 1898: 76; *Pheretima paraglandularis* Fang, 1929: 15. Name usually spelt "aspergillum", eg. Beddard (1895: 430; 1900: 632) and Michaelsen (1900: 253), but Sims & Easton (1972: 234) list it as "aspergillus"; Michaelsen (1900: 318) first suggested the *takatorii* synonym].

- 7.# *Amyntas assacceus* (Chen, 1938: 382) **Emend.** (corr. of *asacceus*) [syn. *Pheretima medipusillus* Nakamura, 1999: 2 nom. nov. pro *Pheretima pusilla* Ohfuchi, 1956: 138 (non *Perichaeta pusilla* Ude, 1893: 63 = *A. minimus*); ?*Amyntas proasacceus* (sic) Tsai *et al.*, 2001: 282 in Tsai, C.-F., Shen, and Tsai, S.-C., 2001. **Note:** *assacceus* is the valid spelling of the species name rather than *asacceus* as originally printed in Chen (1938), this as noted by Chen in an attached *corregidum* to his 1938 paper– see Blakemore (2006) for details].
- 8.- *Amyntas bilineatus* Tsai *et al.*, 2007: 357 in Tsai, Shen, Tsai and Lee, 2007.
- 9.- *Amyntas binoculatus* Tsai *et al.*, 1999: 41 in Tsai, C.-F., Shen, and Tsai, S.-C., 1999. [Note: the segments in their Fig. 4A are miscounted].
- 10.- *Amyntas candidus* (Goto & Hatai, 1898: 77).
- 11.* *Amyntas carnosus* (Goto & Hatai, 1999: 15) [syn. *kyamikia* Kobayashi, 1934; ?*pingi* Stephenson, 1925; ?*youngtai* Hong and James, 2001; *sangyeoli* Hong and James, 2001; these synonyms from Blakemore (2003b)]. First Taiwan record by Shen *et al.* (2005a), cf. *A. nanshanensis*, *A. penpuensis*.
- 12.- *Amyntas catenus* Tsai *et al.*, 2001: 279 in Tsai C.-F., Shen, and Tsai, S.-C., 2001.
- 13.- *Amyntas chaishanensis* James *et al.*, 2005: 1021 in James, Shih, H.-T. and Chang H.-W., 2005. [Synonymous to *Metaphire formosae* according to Shen (pers. comm.)].
14. - *Amyntas chilanensis* Tsai *et al.*, 2007: 357 in Tsai, Shen, Tsai and Lee, 2007.
- 15.* *Amyntas corticis* (Kinberg, 1867: 102) [many synonyms - see Blakemore (2002, 2003a,b, 2004c), often misspelt "*corticis*"; Gates (1972: 217) suggested that *Pheretima sheni* Chen, 1935 from Hong Kong may be an athecal morphs of either *A. robustus* or *A. diffringens* (= *A. corticis*), most likely the latter, but C.-F. Tsai (pers. comm.) says it is possibly a Taiwanese native as it is found in natural woodland and should thus be retained].
16. - *Amyntas cruxus* Tsai *et al.*, 2007: 357 in Tsai, Shen, Tsai and Lee, 2007.
- 17.- *Amyntas exiguus aquilonius* Tsai *et al.*, 2001: 277 in Tsai C.-F., Shen, and Tsai, S.-C., 2001.
- 18.- *Amyntas fenestrus* Shen *et al.*, 2003: 487 in Shen, Tsai C.-F., and Tsai, S.-C.,

2003b.

- 19.* *Amyntas gracilis* (Kinberg, 1867: 102) (many synonyms - see Blakemore, 2002, 2003a,b, 2004c).
- 20.- *Amyntas hengchunensis* James *et al.*, 2005: 1015 in James, Shih, H.-T. and Chang H.-W., 2005. In *Metaphire* according to Tsai *et al.*, (2006) and Shen (pers. comm.) and Chang *et al.*, (2008). A probable synonym of *M. formosae* as acknowledged by the authors (James *et al.* 2005: 1016)], or perhaps its sub-species or a sub-species of *M. paiwana* (C.-H. Chang pers. com. and Chang *et al.*, 2008). Name sometimes misspelt “*hengchunesis*” as in the latter publication that was not based on type materials.
- 21.- *Amyntas hohuanmontis* Tsai *et al.*, 2002: 758 in Tsai, C.-F., Shen, and Tsai, S.-C., 2002 (Notes: an athecal morph, possibly a junior synonym of *A. candidus* that has similar markings around the male pores, but there are other differences in first dorsal pore location and septation).
- 22.- *Amyntas huangi* James *et al.*, 2005: 1014 in James, Shih, H.-T. and Chang H.-W., 2005. [A synonym of *Metaphire houletti* according to Shen pers. comm.].
- 23.* *Amyntas hupeiensis* (Michaelsen, 1895: 35) [? *Pheretima hypogaea* Ishizuka, 1999; ? *Pheretima edoensis* Ishizuka *et al.*, 2000. Note: Easton (1981: 53) misspelt the name “*hupiensis*”].
- 24.* *Amyntas incongruus* (Chen, 1933: 270).
- 25.- *Amyntas kaopingensis* James *et al.*, 2005: 1017 in James, Shih, H.-T. and Chang H.-W., 2005. Synonymous to *Metaphire paiwana* according to Tsai *et al.*, 2006 and Shen (pers. comm.)].
- 26.- *Amyntas lini* Chang *et al.* 2007: 234 (cf. *A. wulinensis*).
27. - *Amyntas meishanensis* Chang *et al.* 2007: 234 (cf. *A. wulinensis*).
- 28.* *Amyntas minimus* (Horst, 1893: 66) (*Perichaeta pusilla* Ude, 1893: 63 [non Ohfuchi, 1956 (= *Amyntas assaccus*)]; *Pheretima enchytraeoides* Michaelsen, 1916: 33; *Pheretima humilis* Gates, 1942: 120; *Pheretima zoysiae* Chen, 1933: 288; *Pheretima ishikawai* Ohfuchi, 1941: 248).
- 29.- *Amyntas monsoonus* James *et al.*, 2005: 1012 in James, Shih, H.-T. and Chang H.-W., 2005. Synonymous to *Amyntas tungpuensis* according to Tsai *et al.*,

2006 and Shen (pers. comm.)].

- 30.* *Amyntas morrissi* (Beddard, 1892: 166) [?*Perichaeta barbadensis* (parts ?“a” and “c”) Beddard, 1892 (July): 167; ?*Perichaeta mauritiana* Beddard, 1892: 170 (most likely a variety of *gracilis*); ?*Perichaeta pallida* Michaelsen, 1892 (Sept.): 227; ?*Perichaeta amazonica* Rosa, 1894: 14; ?*Perichaeta sanctijacobi* Beddard, 1895: 61; ?*Perichaeta cupulifera* Fedarb, 1898: 445].
- 31.- *Amyntas nanrenensis* James *et al.*, 2005: 1008 in James, Shih, H.-T. and Chang H.-W., 2005.
32. - *Amyntas nanshanensis* Shen *et al.*, 2003: 482 in Shen, Tsai C.-F., and Tsai, S.-C., 2003b (cf. *A. carnosus*).
- 33.* *Amyntas papilio papilio* (Gates, 1930: 316) [non *Pheretima papilio* : Ohfuchi (1956: 140) misidentification from Ryukyus (?= *A. glabrus* (Gates, 1932))].
- 34.* *Amyntas papulosus* (Rosa, 1896: 525) [*Pheretima papulosa* var. *sauteri* Michaelsen, 1922: 26 (non *P. papulosa* var. "*sauteria*" Ohfuchi, 1956: 164 - misidentification); *Pheretima composita* Gates, 1932: 430; ?*Pheretima rockefelleri* Chen, 1933: 238; *P. hsinpuensis* Kuo, 1985 corr. of "*hsinpuensis*". [First reported from Taiwan by Michaelsen (1922: 36). Gates (1972: 207) thought that the parthenogenetic *rockefelleri* morph (lacking prostates and sometimes with defective spermathecae) was only distinguished by quantitative differences. Recently Shen *et al.* (2003a) disputed their earlier inclusion of *A. rockefelleri* in *A. papulosus*: they retained both taxa and suggested adding *A. hsinpuensis* to synonymy of the former].
- 35.- *Amyntas penpuensis* Shen *et al.*, 2003: 481 in Shen, Tsai C.-F., and Tsai, S.-C., 2003b (cf. *A. carnosus*, *A. corticis*).
- 36.- *Amyntas polyglandularis* (Tsai, C.-F., 1964: 30) (syn. *Amyntas omeimontis polyglandularis*: Sims and Easton, 1972: 244, 258). [Herein, it is returned to specific rank as per Tsai *et al.* (2000a), separated from its previous nominal sub-species on the basis of the simple intestinal caeca. This character it nevertheless shares with the other two subspecies included by Sims & Easton (1972: 258), however the option of renaming it, along with *A. kinabalu* Sims & Easton, 1972: 259, as a subspecies of *Amyntas kinfumontis* (Chen, 1946: 119)

is deferred pending further research].

- 37.* *Amyntas robustus* (Perrier, 1872: 112) [*Perichaeta cingulata* (part) : Vaillant, 1867: 234 (err. non Schmarda, 1861); *Perichaeta masatacae* Beddard, 1892: 761 [note: Sims and Easton (1972: 181; 244), Reynolds and Cook (1976: 134), and Easton (1981: 56) misspell Beddard's species "mastakae", while Michaelsen (1900: 282) has it correctly, as here, as *P. masatacae*]; *Pheretima campestris* Goto & Hatai, 1898: 67 [non Lee, 1952 (= *A. corticis*)]; ?*Amyntas loehri* Michaelsen, 1899: 12 (sometimes misspelt "lohri"); ?*Pheretima lauta* Ude, 1905: 405, 429 [syn. *Pheretima siemsseni* Michaelsen, 1931: 17 (?part.), *Pheretima fokiensis* Michaelsen, 1931: 19 - these synonyms from Chen (1933: 282) and Gates (1935: 15)]; ?*Pheretima zavattarii* Cognetti, 1909: 1 [syn. *zavattarii* : Gates, 1972: 217 (sic lapsus pro *zavattarii*)]; *Pheretima ornata* Gates, 1927: 20; *Pheretima corrugata* Chen, 1931: 131; ?*Pheretima sheni* Chen, 1935: 38 - this last questionable synonym proposed by Gates (1972: 217), cf. *A. corticis*]. [Note: synonymy of *Amyntas lautus* (Ude, 1905) in *A. robustus* was disputed by Tsai et al. (2000a: 286) although they did not mention inspection of types].
- 38.- *Amyntas? sexpectatus* Tsai et al., 1999: 38 in Tsai, C.-F., Shen, and Tsai, S.-C., 1999. [Note: probably belongs in *Metaphire* as its male pores (Tsai et al., 1999: figs. 3A-C) are almost indistinguishable from those found in *Metaphire yeni* Tsai et al. (2000c: figs. 1D,E) and in *Metaphire paiwanna* Tsai et al. (2000c: figs. 2A,B); in each case these figures show porophores contracted and then protruded, as also seen in the type *Metaphire javanica* (Kinberg, 1867) - pers. obs. R.J.B].
39. - *Amyntas shinanmontis* Tsai et al., 2007: 357 in Tsai, Shen, Tsai and Lee, 2007.
- 40.- *Amyntas swanus* (Tsai, C.-F., 1964: 13) [according to the original description, Sims and Easton (1972: 213, 236, 237) divided this taxon between two species-groups: *A. pauxillulus*- group and an *A. swanus*-group. Recently reported from Vietnam].
- 41.* *Amyntas taipeiensis* (Tsai, C.-F., 1964: 12) [? *Pheretima heterogens* Chen and Hsü, 1975 in Chen, Hsü, Yang, and Fong, 1975 - this tentative synonym from Tsai et al., 2000a:288 who regard *A. taipeiensis* as a Taiwan exotic, as do Drs Chen,

- J.-H. and Chang, C.-H. (pers. comm.)].
- 42.- *Amyntas tantulus* Shen *et al.*, 2003: 484 in Shen, Tsai C.-F., and Tsai, S.-C., 2003b.
- 43.- *Amyntas tayalis* Tsai *et al.*, 1999: 36 in Tsai, C.-F., Shen, and Tsai, S.-C., 1999.
- 44.- *Amyntas tessellatus tessellatus* Shen *et al.*, 2002: 2, 7 in Shen, Tsai, C.-F., and Tsai, S.-C., 2002.
- 45.- *Amyntas tessellatus paucus* Shen *et al.*, 2002: 2, 7 in Shen, Tsai, C.-F. and Tsai, S.-C., 2002.
- 46.- *Amyntas tungpuensis* Tsai *et al.*, 1999: 34 in Tsai, C.-F., Shen, and Tsai, S.-C., 1999.
- 47.- *Amyntas uvaglandularis* Shen *et al.*, 2003: 479 in Shen, Tsai C.-F., and Tsai, S.-C., 2003b.
- 48.- *Amyntas wangi* Shen *et al.*, 2003: 489 in Shen, Tsai C.-F., and Tsai, S.-C., 2003b.
- 49.- *Amyntas wulinensis* Tsai *et al.*, 2001: 285 in Tsai C.-F., Shen, and Tsai, S.-C., 2001.
- 50.* *Duplodicrodrius schmardae schmardae* (Horst, 1883: 194) (*Perichaeta trityphla* Beddard, 1896: 205; *Pheretima kikuchii* Hatai & Ohfuchi, 1936: 767).
- 51.- *Metaphire bununa bununa* Tsai *et al.*, 2000: 1736 in Tsai, C.-F., Tsai, S.-C., and Liaw, 2000c [originally published as *M. bununa typica* et "*M. bunuma*" Tsai *et al.*, 2000: 287 (lapsus)].
- 52.- *Metaphire bununa glareosa* Tsai *et al.*, 2000: 1738 in Tsai, C.-F., Tsai, S.-C., and Liaw, 2000c [originally published as *M. bununa glareosus* ("glareosus" is Latin adjective = "gravelly") here corrected to *glareosa*; possibly meriting separate species status (C.-H. Chang pers. com.)].
- 53.* *Metaphire californica* (Kinberg, 1867: 102) [*Perichaeta ringeana* Michaelsen, 1890: 10; *Perichaeta hesperidum* Beddard, 1892: 169; *Perichaeta guarini* Rosa, 1894: 13; *Pheretima browni* Stephenson, 1912: 274; *Pheretima modesta* Michaelsen, 1927: 88; *Pheretima molesta* Gates, 1931: 420 nom. nov. pro. *P. browni* Gates, 1931: 372 (non Stephenson, 1912 = *M. californica*); ?*Pheretima sakaguchii* Ohfuchi, 1938; ?*Pheretima sonaiensis* Ohfuchi, 1956].
54. - *Metaphire feijani* Chang and Chen, 2004: 219, fig. 1.
55. - *Metaphire formosae* (Michaelsen, 1922: 39). [Notes: This new combination and

the removal from its synonymy of *M. yuhsii* (Tsai, 1964) is by Chang and Chen (2005b) and pers. obs. by R.J.B. cf. Chang & Chen (2005a) where it is maintained in *Amyntas*].

56. * *Metaphire houlleti* (Perrier, 1872: 99) [*Perichaeta campanulata* Rosa, 1890: 115; *Perichaeta udekemi* Michaelsen, 1890: 240; *Perichaeta guillelmi* Michaelsen, 1895: 32; *Pheretima crescentica* Fedarb, 1898; *Pheretima wimberleyana* Stephenson, 1925: 62 (name misspelt "wimberlayana" by Sims and Easton 1972: 246 and by Reynolds and Cook 1976: 190); *Pheretima houlleti tortuosa* Gates, 1926: 454; *Pheretima houletti* var. *rugosa* (sic lapsus pro *houlleti*) Gates, 1926: 459; *Pheretima campanulata* var. *penetrans* Gates, 1931: 435; *Pheretima campanulata* var. *meridiana* Gates, 1932: 457; ?*Pheretima yapensis* Ohfuchi, 1941]. Notes: *Pheretima houlleti bidenryoana* Ohfuchi, 1956 subspecies is now included in synonymy of *A. flavescens* (Goto & Hatai, 1898); more detailed synonymies are given in Blakemore (2002, 2003a,b, 2004c) where it is noted that the name sometimes is misspelt "houletti". This new Taiwan record is by Shen *et al.* (2005).
- 57.- *Metaphire nanaoensis* Chang and Chen, 2005a: 1473, fig. 3. [Formerly a *nomen nudum* also misspelt as "*nanaoensis*" from Ilan cited in Chen, *et al.* (2003: 58)].
- 58.- *Metaphire paiwana liliumfordi* Tsai *et al.*, 2000: 1734 in Tsai, C.-F., Tsai, S.-C., and Liaw, 2000c.
- 59.- *Metaphire paiwana paiwana* Tsai *et al.*, 2000: 1732 in Tsai, C.-F., Tsai, S.-C., and Liaw, 2000c (published as *M. paiwana typica*).
- 60.* *Metaphire posthuma* (Vaillant, 1869: 228) (*Perichaeta affinis* Perrier, 1872: 106).
- 61.- *Metaphire puyuma* Tsai *et al.*, 1999: 42 in Tsai, C.-F., Shen, and Tsai, S.-C., 1999.
- 62.- *Metaphire tahanmonta* Chang and Chen, 2005a:1475, fig. 4.
- 63.- *Metaphire taiwanensis* Tsai *et al.*, 2004: 878 in Tsai, C.-F., Tsai, S.-C., and Shen, 2004a.
- 64.- *Metaphire trutina* Tsai *et al.*,2003: 84 in Tsai, C.-F., Chen, Tsai, S.-C., and Shen, H.-P., 2003b (*Metaphire yuanpowa* Chang and Chen, 2005a: 1470 , fig. 2. **Syn. nov.** Pers. comm. C.-H. Chang 29/3/2005, and pers. obs. R.J.B.).
- 65.- *Metaphire yeni* Tsai *et al.*, 2000: 8 in Tsai, S.-C., Shen, and Tsai, C.-F., 2000b.
- 66.- *Metaphire yuhsii* (Tsai, 1964: 5) **Emend.** Blakemore, 2005 (corr. of "*yuhsi*").

[Previous synonymy of this name in *Metaphire formosae* (Michaelsen, 1922) by Tsai *et al.* (2000a: 286) who spelt the name "yushi" but, because it was a stated patronym for Dr Yu-Hsi, it was corrected to *yuhsii* by Blakemore (2005). Sometimes also misspelt "yushii". This new combination and re-elevation to specific status is by Chang & Chen (2005b) and pers. comm.].

67.* *Perionyx excavatus* Perrier, 1872: 208 (*Perionyx gruenewaldi* Michaelsen, 1891: 33; ?*Perionyx koboensis* Stephenson, 1914: 391; *Perionyx fulvus* Stephenson, 1916: 322; ?*Perionyx turaensis* Stephenson, 1920: 216).

68.* *Pithemera bicincta* (Perrier, 1875: 1044) [?*Perichaeta violacea* Beddard, 1895: 407; ?*Pheretima aimerikiensis* Ohfuchi, 1941: 302 - this synonymy from Blakemore (2003a,b)].

69.- *Pithemera lanyuensis* Shen and Tsai, C.-F., 2002:2 in Shen and Tsai, C.-F., 2002b.

70.* *Polypheretima elongata* (Perrier, 1875: 124) (*Perichaeta biserialis* Perrier, 1875: 1044; *Perichaeta acystis* Beddard, 1895: 423 [nom. nov. pro *biserialis* : Beddard, 1890 (non Perrier, 1872)]; *Perichaeta monocystis* Horst, 1899: 202 (lapsus pro *acystis* Beddard, 1895); *Pheretima aelongata* Gates, 1926: 444 - misspelling or illegal emendation).

71.* *Pontodrilus litoralis* (Grube, 1855) [syn. *marionis*; *bermudensis*, *matsushimensis*, *albanyensis*, *cygni*, *indica*, *gracilis*; full synonymy in Blakemore (2002)]. This new Taiwan record is by Shen *et al.* (2005b) (and Taiwan specimens from Drs. Chen, J.-H. and Chang, C.-H. pers. obs. by R.J.B. April, 2004). Note previous records from Japan, Hainan and Hong Kong in Easton (1984: 115).

Family GLOSSOSCOLECIDAE

72.* *Pontoscolex corethrurus* (Müller, 1856: 113) [*Pontoscolex arenicola* (part.) Schmarda, 1861: 11 (residue = *Diachaeta littoralis* Beddard, 1892); *Urochaeta dubia* Horst, 1885: 7; *Urochaeta australiensis* Beddard, 1891: 278; *Pontoscolex hawaiiensis* Beddard, 1895: 660; *Pontoscolex corethrurus mexicana* Eisen, 1896: 8; *Urochaeta hystrix* Perrier, 1872: 142].

Family LUMBRICIDAE

73.?* *Aporrectodea caliginosa* (Savigny, 1826: 180) [many synonyms for this species-complex, see Blakemore (2002, 2004a); the Taiwan report by Kobayashi

(1940, 1941) was thought by Gates (1972: 80) and Shih *et al.* (1999) to actually be either *Ap. tuberculata* or *Ap. trapezoides*, both of which have been variously combined within the *Ap. caliginosa* species-complex].

- 74.* *Aporrectodea trapezoides* (Dugès, 1828: 289) [many synonyms - see Blakemore (2002; 2004a); this taxon claimed by Tsai *et al.* (2000a: 286, 289) and recently confirmed from Chiayi County by H.-P. Shen and C.-H. Chang (pers. com. November, 2004)].
- 75.?* *Aporrectodea tuberculata* (Eisen, 1874: 43) [originally *Allolobophora turgida tuberculata* Eisen, 1874 [non Tzelepe, 1943 (= *Spermophorodrilus tzelepei* Blakemore, 2004a: 78 nom. nov.), nec *Eophila antipae* var. *tuberculata* Cernosvitov, 1935].
- 76.* *Bimastos parvus* (Eisen, 1874: 46) [*?beddardi* Michaelsen, 1894: 182 non Ribaucourt, 1896: 53 (= *Aporrectodea trapezoides*); *parva udei* Ribaucourt, 1896: 80 [non Sapkarev, 1972 (= *Serbiona joncesapkarevi* Blakemore, 2004a: 78 nom. nov.)]; *consticta geminata* Friend, 1897: 1; *?longicinctus* Smith & Gittins, 1915: 548 Note: Drs. S. James and Cs. Csuzdi (pers. comms.) believe all three taxa: *parvus*, *beddardi* and *longicinctus* merit separate species status, although Easton (1981: 41; 1983: 475) had the former two taxa in synonymy and Gates (1972: 86, 88) had all three in synonymy saying they "intergrade without known ways of delimiting each from the others"]. Taiwan report by Kobayashi (1938) and by interception from Gates (1972: 87), also identified from there by current author.
- 77?* *Eisenia andrei* Bouché, 1972 – presence inferred by Chang *et al.* (2007: 232), but not proven (see *E. fetida* below and Blakemore, 2006 for discussion).
- 78.* *Eisenia fetida* (Savigny, 1826: 182) [many synonyms for this species-complex - see Blakemore (2002, 2003a,b, 2004a); some authors include *E. andrei* Bouché, 1972 as either a synonym, morph, ‘variety’, sub-species, or maintain it as a separate species; *E. nordenskioldi* (Eisen, 1874) is also debatably within the *E. fetida* complex]. **New confirmation for Taiwan:** pers. obs. in culture in Taipei University; presently unknown from the field.
- 79.* *Eiseniella tetraedra* (Savigny, 1826: 183) (syn. *quadrangularis* Risso, 1826; *amphisbaenus* Dugès, 1828; *agilis* Hoffmeister, 1843; *tetraedrus luteus* Eisen,

1871; *dubius* Michaelsen, 1890; *tetragonurus* Friend, 1892; *macrurus* Friend, 1893; *flavus* Friend, 1893; *tetraedrus bernensis* Ribaucourt, 1896; *tetraedrus novis* Ribaucourt, 1896; *tetraedrus infinitesimalis* Ribaucourt, 1896; *tetraedra hammoniensis* Michaelsen, 1900; *mollis* Friend, 1911; *intermedia* Jackson, 1931; *tetraedra popi* Zicsi, 1960; *tetraedra phorogenesisa* Qiu & Bouche, 1998: 104, *tetraedra proporandra* Qiu & Bouche, 1998: 105 - for full synonymy see Blakemore, 2002, 2004a). Collected from running water of Chichiawan Stream on Wuling farm, Shei-Pa National Park, NE Taiwan, 2.xiii.2004 by National Chung Hsing University team, i.e. Dr. Sheng-Hai Wu and his collaborators and passed on via National Taiwan University team (J.-H. Chen, C.-H. Chang and S.-C. Chuang) for identification by R. Blakemore (April, 2004).- **New record for Taiwan and for east Asia** (cf. Shen *et al.*, 2005b also published in NOW journal online here: http://ptrc.npust.edu.tw/download/nofw/2005_9_4.pdf).

80.* **Family OCNERODRILIDAE** *Eukerria saltensis* (Beddard, 1895) recent addition by Shen *et al.* (2008a), see also Blakemore (2006) and Blakemore *et al.* (2007).

81.* **Family OCTOCHAETIDAE** *Dichogaster affinis* (Michaelsen, 1890) recent addition by Shen *et al.* (2008b), see also Blakemore (2006) for full synonymy and distribution.

Discussion

Regional comparisons of the various earthworm faunas were summarized by Tsai *et al.* (2000a) and Blakemore *et al.* (2006; 2007). From the current reckoning, there are a total of approximately 81 species described from Taiwan with 33 of these, or ca. 40%, non-natives for which 69% are Asiatic Megascolecidae and 21% are Lumbricidae of Holarctic origin. Total land area of Taiwan is approximately 36,000 sq. km compared to Tasmania that is about double the size (68,000 sq. km) yet has triple the number of described species (228) with only 12% exotic and, of these, 18% Megascolecidae and 61% Lumbricidae (Blakemore, 2000b, 2004d). In comparison, Okinawa and other Ryukyu Islands (4,790 sq. km) have about 26 species with 40% endemic and no known Lumbricidae, while from the whole of Japan including the Ryukyus (377,727 sq. km) only about 80 species are known with 50% endemic

(Blakemore, 2003b). Contrast this with the fauna of New Zealand (267,000 sq. km) that numbers about 200 species with 86% endemic (Lee, 1959; Blakemore, 2004e). Such differences are accounted for by geological and societal histories, current topography and climate, and by the intensity of taxonomic treatment. Interestingly, a recent local Taiwanese transect study by Tsai et al. (2004b) found 34 species consisting of 18-19 natives and 14-15 exotics while a similar study at Lake Pedder in Tasmania (Blakemore, 2000a) found 24 species with 16 natives and 5 exotics plus 3 aquatic microdriles.

Some taxonomic uncertainties remain for the checklist presented here. Although Chen (1936: 271), Ljungström (1971: 27), and Easton (1981) had *Amyntas lautus* (Ude, 1905) and *A. masatacae* (Beddard, 1892) in synonymy of *A. robustus* (Perrier, 1872) this was disputed by Tsai et al. (2000a: 286), although there is no mention of inspection of type specimens held in Hamburg, London, and Paris, thus resolution is yet required based on the types and consideration of parthenogenetic polymorphism. On the other hand, Chen (1933: 282-288, fig 26) thought *Pheretima* (*P.*) *siemsseni* Michaelsen 1931 and *P. (P.) fokiensis* Michaelsen, 1931 were synonymous with *Pheretima lauta* Ude, 1905. Meanwhile, Gates (1935: 7) had *P. lauta*, *P. paraglandularis* and *P. siemsseni* in synonymy of *P. aspergillum*, and Chen (1936: 271, 1946: 136) placed his own *Pheretima corrugata* in synonymy of *P. robusta*, but Chen (1936: 271) deliberately excluded *P. aspergillum* and his *P. corrugata kulingensis* Chen, 1933 subspecies, which presumably qualified for elevation to species level (in *Amyntas*). Michaelsen's *Amyntas loehri* is possibly synonymous with *Metaphire californica* according to Chen (1931: 137) or more likely with *A. robustus* according to Chen (1936: 271) and Gates (1972). However, Chen (1935: 36-37) expressed some doubt about his earlier inclusion of *siemsseni* and *fokiensis* in *P. robustus*.

Regarding *A. papulosus*, Gates's (1972: 206) synonymies of both *Pheretima papulosa sauteri* Michaelsen, 1922 and *Pheretima rockefelleri* Chen 1933 in *A. papulosus* were accepted by Easton (1981: 56), Shih et al. (1999: 436), and Tsai et al. (2000a: 286). The *sauteri* variety was originally distinguished by location of caeca from 29 extending forward to 26 in a single specimen that may have been abnormal (Gates, 1972: 206). More recently Shen et al. (2002: 4; 2003a) and Tsai et al. (2004b: 9-10) disputed inclusion of *A. rockefelleri* in *A. papulosus* and retained both taxa based on

morphometry and distributional records in Taiwan. This too has yet to be confirmed from inspection of type specimens in Genoa Museum (# 44034) with other material in Natural History Museum, London according to Sims and Easton (1972: 181), and in the U.S. National Museum (#20176), respectively.

Tsai *et al.* (2002) described an athecate earthworm of an "*Amyntas illotus* species-group" (now excluding the Japanese and Korean *Metaphire hilgendorfi* / *Amyntas tokioensis* species-complex *s.* Blakemore, 2003a,b). However, in their discussion of phylogeny and biogeography of this athecate species-group they overlooked *A. glabrus* (Gates, 1932) that is widespread in the region, *Amyntas imperfectus* (Ishizuka, 1999), *Amyntas koreanus* (Kobayashi, 1938), *Amyntas soulensis* (Kobayashi, 1938), '*Pheretima*' *pararva* Blakemore, 2003 [nom nov. pro *P. parvula* Ishizuka *et al.*, 2000 non *Perichaeta parvula* Goto & Hatai, 1889 (?= *A. gracilis*), nec *Pheretima parvula* Ohfuchi, 1956 (= *Metaphire parvula*)], and the Sumatran *Pheretima? atheca* (Rosa, 1896) which Sims and Easton (1972: 223) listed as *species incertae sedis* because its lack of spermathecae prevented determination in *Metaphire* or *Pheretima*. They also omitted their own *Amyntas proasacceus* (sic) that Tsai *et al.* (2001: 285) thought to be: "an intermediate form [of *A. assacceus* (Chen)] which evolved from the sixthedral ancestor with bisexual reproduction to the present athecal form with parthenogenetic reproduction". Consequently, *A. proasacceus* is provisionally considered a synonym of *A. assacceus* although there is some argument for retention of this taxon if the characteristics of its peristomium are shown to be other than artefacts of preservation. Alternatively it may be a parthenogenetically degraded morph of some other as yet unidentified taxon, again highlighting the major difficulty in classification of parthenogenetically degraded morphs as discussed by Gates (1972) and Blakemore (2003a,b).

The current review recognizes the rapid advances in understanding of Taiwan and Lanyu earthworm biodiversity in recent years, but there is still need for continued study of the native and exotic fauna, for surveys of the small islands of Penghu and Lutaoo, and for comparison with related species occurring in adjacent countries.

Addendum

Note: [James *et al.* \(2005\)](#) described seven "new" species of *Amyntas* from southern Taiwan. Of these, *Amyntas chaishanensis*, *A. hengchunensis*, *A. kaopingensis*, *A.*

ailiaoensis and *A. huangi* (at least) should be in *Metaphire*. Furthermore, at least six species were found to be synonymous: *A. huangi* to *Metaphire houlleti* (Perrier, 1872), *A. chaishanensis* to *M. formosae* (Michaelsen, 1922), *A. kaopingensis* to *M. paiwana* Tsai, et al., 2000, *A. ailiaoensis* to *M. feijani* Chang & Chen, 2004, and *A. monsoonus* to *A. tungpuensis* Tsai et al., 1999. This synonymy (from inspection of types) was by [Tsai et al. \(2006\)](#) although *A. monsoonus* is probably *A. carnosus* (Goto & Hattai, 1899) (pers. obs.) and, moreover, *M. hengchunensis* is in synonymy or at best a subspecies of *M. formosae* or *M. paiwana* (according to [Chang et al., 2008](#)). Also, as stated by Blakemore (2005) and Blakemore et al. (2006): “[James et al. (2005)] claim first record of *Pontodrilus litoralis*, *Metaphire houlleti* plus new reports of *Amyntas incongruus* and *A. robustus*, although the first two were published by Shen et al. (2005a), *A. incongruus* was recorded from Taiwan by Gates (1959) and *A. incongruus* and *A. robustus* were reported from Taipei by Tsai (1964), as shown by Shih et al. (1999) and Tsai et al. (2000a).”

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[End of Taiwan Checklist].