

## ***Amyntas carnosus* (Goto & Hatai, 1899) redescribed on its neotype (Oligochaeta: Megadrilacea: Megascolecidae)**

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Japanese/Korean *Amyntas carnosus* (Goto & Hatai, 1899) is redescribed from a newly designated Neotype (Tokyo NSMT An435). An annotated synonymy is presented that nominally includes: *kyamikia* Kobayashi, 1934, *monstrifera* Kobayashi, 1936, *sangyeoli*, *youngtai*, *kimhaeiensis*, *sinsiensis* and *baemsagolensis* - all Korean names by Hong & James, 2001, and Taiwanese *monsoonus* James *et al.*, 2005. However, Chinese *A. pingi* (Stephenson 1925) (syn. *fornicata* Gates, 1935) is maintained separately, at least for the present, until its comprehensive review, possibly extending to DNA barcode differentiation.

Keywords: Asian taxonomic housekeeping, invasive earthworm synonyms, pheretimoid

### **INTRODUCTION**

Morphological classification of earthworms depends on correct counting of segments. Much confusion has surrounded Japanese *Amyntas carnosus* (Goto & Hatai, 1899) due to its poor original account and subsequent mis-descriptions. The main problem was that the spermathecal pores were initially described in 5/6/7/8 but the spermathecae were stated to be in 7, 8 and 9, suggesting they exited in 6/7/8/9; yet one set was missed and exits were actually in 5/6/7/8/9. Related to this error, the genital markings were miscounted in 7 and 8 while being in 8 and 9, and dorsal pores were said to be in 13/14 rather than correctly in 12/13 (The spermathecal diverticula bulb was also seemingly broken off in Goto & Hatai's fig. 5). These facts were determined by Kobayashi (1936a) and by Ohfuchi (1937) who both worked on Japanese/Korean fauna with tacit support from Dr Shinkishi Hatai, the original author. However, Gates (1939, 365p.) rejected this data for no valid reason. Next Sims & Eason (1972) and then Easton (1981), who was mainly concerned with Japanese fauna, apparently missed these references and retained *carnosus*, albeit with a question mark, under *A. gracilis* (Kinberg, 1867) having spermathecal pores in 5/6/7/8. Unaware of the Korean reviews but realizing that Easton (1981) was mistaken, Blakemore (2003) formally restored Japanese *A. carnosus* while adding some provisional synonyms that had accrued subsequently. These were further refined in revisions of the Japanese/Korean and Taiwanese faunas by Blakemore (2004; 2007; 2008). Seemingly confusion yet reigns: In particular, Shen *et*

*al.*'s (2005, 95p. fig. 1) account of *A. carnosus* from Taiwan seems to be based on some other taxonomic entity, as flagged by Blakemore *et al.* (2006, 228p.).

As a first step reviewing regional fauna before publishing "new" names, it is essential both to read the literature and to attempt to determine the fate of type specimens - from earliest reports onwards. Extensive searches of Japanese collections eventually uncovered a few of Goto & Hatai's syntypes (see Blakemore & Ueshima, 2011), but types of *A. carnosus* are not known. This paper presents a species redescription based on a formal Japanese Neotype of *A. carnosus* in order to objectively clarify its taxonomic status compliant with current ICZN (1999) recommendations.

### **MATERIALS AND METHODS**

The Neotype was contained within an historical 1920s collection from Saito Ho-on Kai Museum, Sendai (where Dr Shinkishi Hatai worked as director) that was transferred in 2006 to the National Museum of Nature & Science (NMNS) in Tokyo, and where the cataloguing of its > 1,200 earthworm specimens has been compiled and kindly made available by curator Dr Toshiaki Kuramochi. The taxonomic determination herein follows the style, systematics, methodology and conventions in Blakemore (2000; 2002; 2010c). Small tissue samples were taken from non-essential posterior segments as per Blakemore *et al.* (2010a) for DNA analyses and (CO1) barcoding, but results thus far have been unsuccessful on this older material.

## TAXONOMIC RESULTS

Annelida Lamarck, 1802: Oligochaeta Grube, 1850: Megadrilacea Benham, 1890: Megascolecidae Rosa, 1891 *sensu* Blakemore, 2000.

*Amyntas* Kinberg, 1867.

### *Amyntas carnosus* (Goto & Hatai, 1899)

*Perichaeta carnosus* Goto & Hatai, 1899: 15, 24, figs. 4, 5. [From Tokyo. Described on two specimens - see Note below. Types not known despite extensive searches by current author for 10 yrs in Japan (cf. Blakemore & Ueshima, 2011)].

*Amyntas hawayanus* (part.): Beddard, 1900: 645; Gates, 1932: 433.

*Pheretima carnosus*: Michaelsen, 1900: 260; Chen, 1936: 274 (when describing *P. pingi chungkingensis*, that possibly merits elevation to species level, remarked that *P. pingi* Stephenson, 1925 was probably a synonym of *carnosus*); Kobayashi, 1936a: 115, tab. 1, text figs. 1-3 (syns. *pingi*, *kyamikia*), 1938: 161; Ohfuchi, 1937b: 56, fig. 9, Pl. 1, 4; Kobayashi, 1938: 161; ?Chen, 1959: 9, fig. 9 (part. syn. *pingi*); Gates, 1972: 149; Ishizuka, 2001: 75, fig. 32; Nakamura, 1999: 27 (name misspelt “canosa”).

*Pheretima kyamikia* Kobayashi, 1934: 1, figs. 1-3. [From North Korea. Types unknown, but a non-type specimen from “(Tetsugen) Kogen-do” sent by S. Kobayashi was added in synonymy of *P. pingi* by Gates (1939: 465). Kobayashi’s (1934: fig. 1) is the same as Chen’s (1959: fig. 9i variation) for *carnosus* (syn. *pingi*). Named for Korean vernacular “kyamiki” meaning “dog bait” or “useless as fishbait”].

*Pheretima monstifera* Kobayashi, 1936b: 168, fig. 11. [From Seoul and other localities. Agreeing with Kobayashi (1936a: tab. 1, and text-figs. 1XII & 2I)]. **Syn. nov.**

*Amyntas carnosus*: Sims & Easton, 1972: 235 [lapsus in *A. hawayanus* (= *gracilis*) group]; Blakemore, 2003: 13 +43 addendum (syns. ?*distichus*, *kyamikia*, ?*youngtai*, *sangyeoli*); 2004; 2007; 2008 (syns. ?*pingi*, *kyamikia*, ?*youngtai*, *sangyeoli*); Shen *et al.*, 2003: 484 (syn. *sangyeoli*); [?non Shen *et al.*, 2005: 95; nec. Tsai *et al.*, 2009: 38; nec. Chang *et al.*, 2009: 32, fig. 12].

*Pheretima diffringens* (part.): Gates, 1972: 149.

*Amyntas gracilis* (part.): Easton, 1981: 50.

*Amyntas youngtai* Hong & James, 2001b: 269, fig. 1A-C. [From Jeju (=Quelpart), Korea - the same place whence Kobayashi (1938: 161) had already recorded *A. carnosus* - apparently from some other locations too. Types put in Korean Institute of Biodiversity Research (KIBIO), Jeonbuk National University, but details are unclear. Uncertainty due to segmental miscounts between authors’ fig. 1 and somewhat confused descrip-

tion but, nevertheless, it mostly agrees, at least with Kobayashi (1936a: tab. 1 and text-figs. 1VII & 2X)].

*Amyntas kimhaeensis* Hong & James, 2001b: 270, fig. 2A-C. [From Korea. Type in Korea. Description of spermathecal pores and figures do not quite correspond, yet apparently agreeing at least with Kobayashi (1936a: text-figs. 1XI or XII & 2II)]. **Syn. nov.**

*Amyntas sangyeoli* Hong & James, 2001b: 271, fig. 3A-C. [Korean types, materials and type-material locations seem rather confused. Markings near male and spermathecal pores, and the spermatheca exactly the same as Goto & Hatai’s corrected figures from 102 years earlier, as well as those of Kobayashi (1934; 1936a), Ohfuchi (1937), Chen (1936; 1959), etc. dating from ~69 years ago].

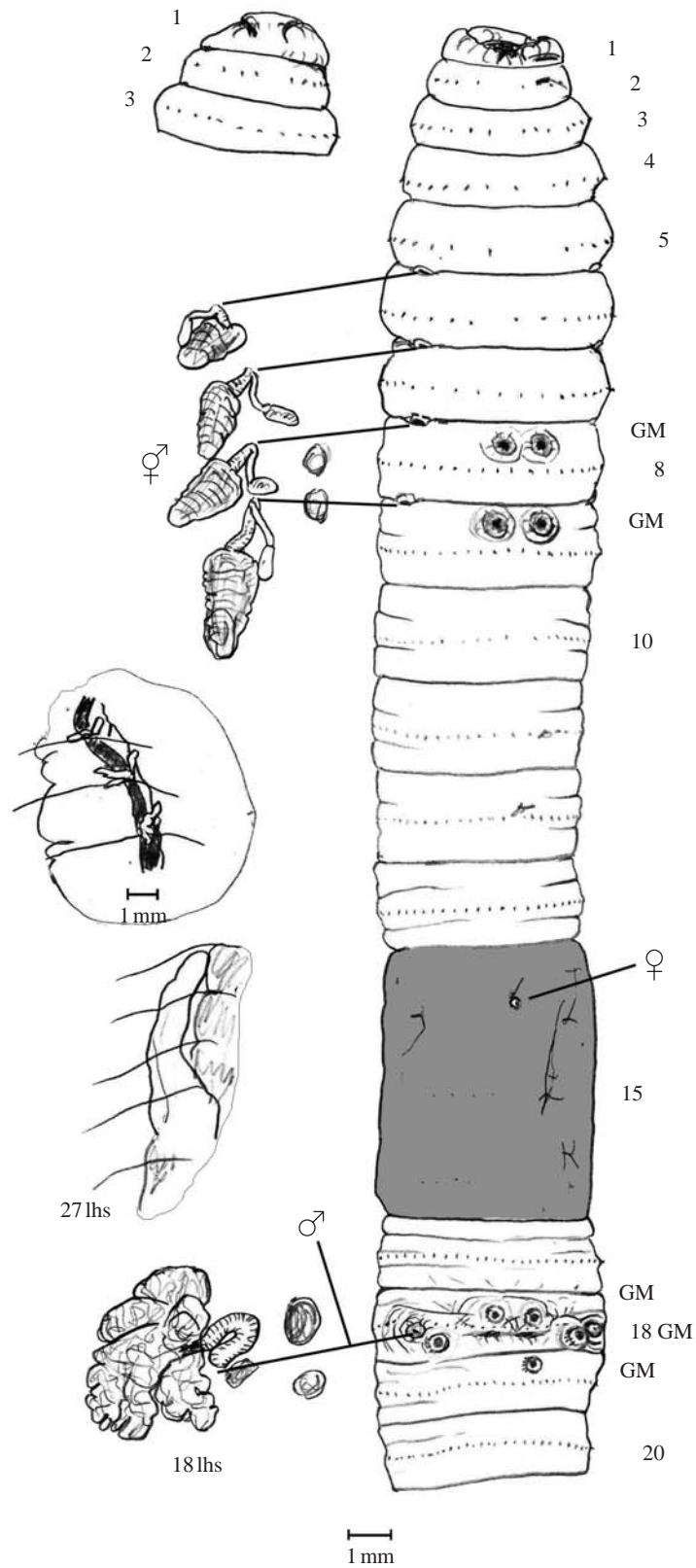
*Amyntas sinsiensis* Hong & James, 2001b: 272, fig. 4A-C. [From Korea. Types? Agreeing both with *A. monstiferus* and Kobayashi (1936a: text-figs. 1I or II or IV & 2I)]. **Syn. nov.**

*Amyntas baemsagolensis* Hong & James, 2001b: 274, fig. 5A-C. [From Korea. Types? Agreeing both with *A. sinsiensis* and Kobayashi (1936a: text-figs. 1I & 2I)]. **Syn. nov.**

?*Amyntas monsoonus* James *et al.* 2005: 1012. [From Taiwan. Cf. regarded as a junior synonym of *A. tungpuensis* Tsai *et al.*, 1999 by Tsai *et al.* (2009). Probable instant synonymy of all nine “new” species was already suggested to the authors in manuscript review, prior to publication in a referee’s report sent to journal editor 8.I.2004 (as online in Blakemore, 2010b and as attached in Appendix), but this advice was manifestly ignored. Their named specimen agrees somewhat with Kobayashi’s (1936a: text-figs. 1XVII & 2I) and Chen’s (1959: fig. 9 variations)].

**Note.** Goto & Hatai (1899: 15) said: “Two specimens presenting a difference of some importance in the genital papillae around the male pores. We shall base our description on the larger specimen, which is also provided with more genital papillae.” They then proceeded to poorly describe both specimens that they said were otherwise identical and thereby commenced introduction of 100+ years of confusion and uncertainty. These two original syntypes are not traceable in any known Japanese collection (as already noted).

**Material inspected.** Tokyo, NMST An435, formol preserved Neotype (Fig. 1) labeled “*Ph. carnosus* (Goto and Hatai) [Kanji for Sendai-city] 1923-1925” part of Saito Ho-on Kai Museum Collection, possibly inspected and labeled by Dr Hatai who was original author, or one of his students e.g. Shinryo Ohfuchi. The date precludes it being a syntype. One mature specimen with tip of tail missing, previously undissected and here figured and dissected with small tissue samples taken to attempt DNA



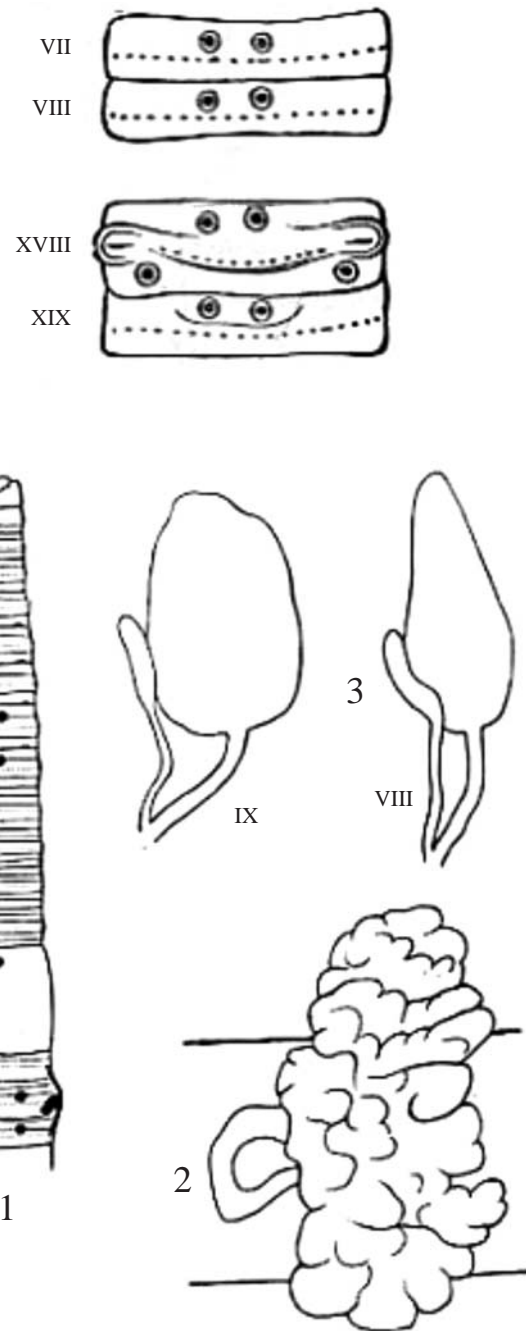
**Fig. 1.** *Amynthus carnosus* (Goto & Hatai, 1899) NSMT An435 Neotype showing prostomium, ventral view of body with spermathecae and prostates *in situ* (GM=Genital Marking with internal glands); also septal glands on dorsal blood vessel and intestinal caecum (lhs=left side).

barcoding.

**Diagnosis.** Size 110-247 mm. Spermathecal pores in 5/6/7/8/9 or rarely in 6/7/8/9 (Goto & Hatai confused them in 5/6/7/8). Dorsal pores typically from 12/13. Genital markings typically closely paired mid-ventral and pre-setal in 8-9 and often also in 18-19 with other pairs just posterior (and sometimes anteriorly) median to the male pores; some variation apparently acceptable, including complete absence of markings. Intestinal caeca simple.

**Distribution.** Japan (Goto & Hatai, 1899; Kobayashi, 1936a; Ohfuchi, 1937; Easton, 1981 - from Kyushu to Tohoku and Hokkaido from reports he quotes by Kobayashi, 1936, 1941 and Yamaguchi, 1962); Korea and Jeju-do (=Quelpart) Island (Kobayashi, 1936a; 1936b; 1937; 1938); China (Chen, 1959); claimed from Jiangsu, Zhejiang, Anhui, Shandong, Hong Kong, Sichuan, and Beijing [from Chinese Agricultural Academy of Science website: [www.agrionline.net.cn/zhuanti/index.htm](http://www.agrionline.net.cn/zhuanti/index.htm) (2005), whence *Pheretima carnosus* (sic) is dubiously described with either three or four pairs of spermathecae in 5/6/7/8, 8/9, possibly including *P. pingi* subspecies]; Vietnam (unconfirmed as *P. pingi*). Relatively recently *A. carnosus* was (?mis-)described from Taiwan by Shen *et al.* (2005); this requires confirmation as noted by Blakemore *et al.* (2006: 228).

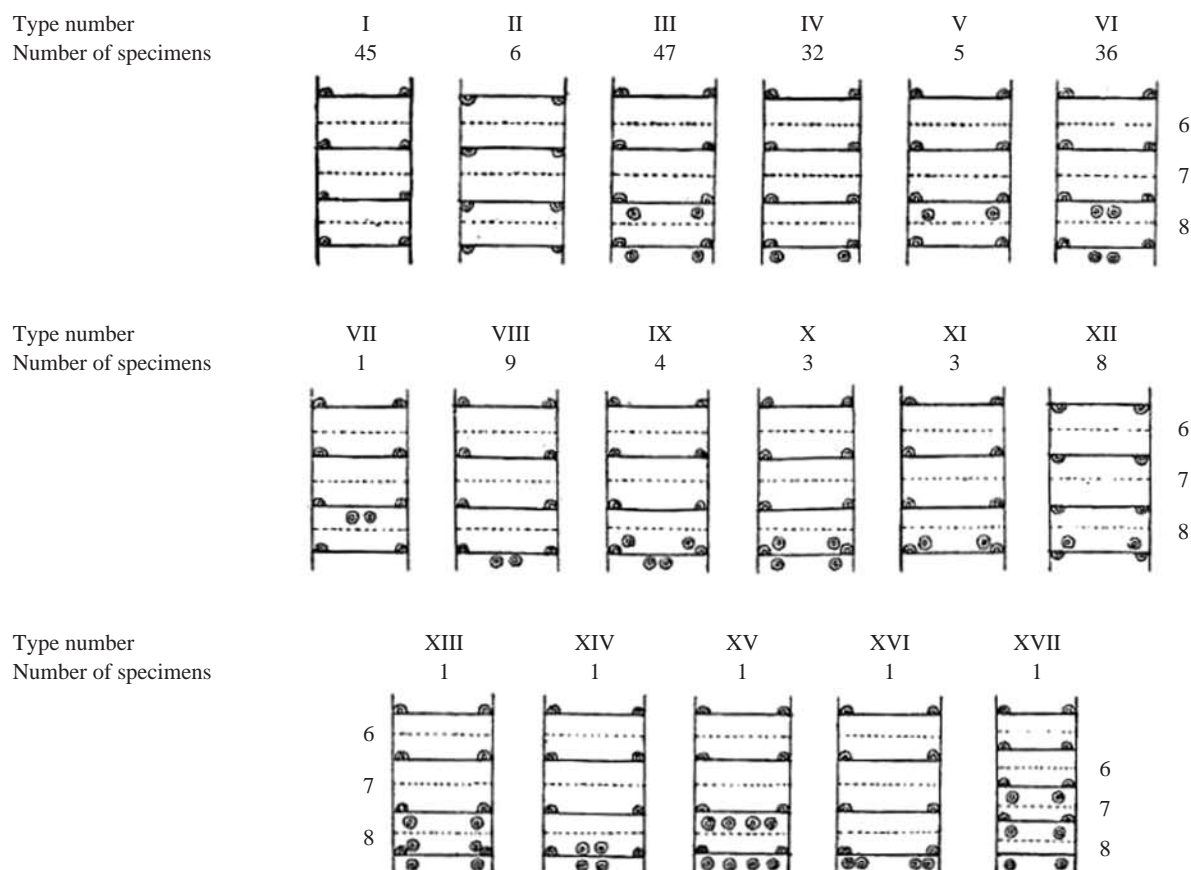
**Description** (Neotype compared to the original descriptions and synonymy above, excluding typical *A. pingi* characteristics). Body length 180+ mm (cf. 143-153 by Goto & Hatai or 110-247 by Kobayashi, 1936a), segments 111+ (cf. 106-126 by Goto & Hatai or 110-179 by Kobayashi). Dark brown dorsum with darker clitellum. First dorsal pore 12/13 (cf. 13/14 Goto & Hatai lapsus, or 11/12/13 in some other accounts). Setae 24-69. Spermathecal pores wide in 5/6/7/8/9 (initially confused by Goto & Hatai as 5/6/7/8). Genital markings closely paired pre-setally in 8 and 9 (7 and 8 according to Goto & Hatai, lapsus - Fig. 2), in 18 and often in 19; other markings just anteroventral to superficial male pores in 18 postsetally (neotype in agreement except that 19rhs pre-setal is unilateral - Fig. 1); in Goto & Hatai's second specimen and 50% of Kobayashi's material both these mid-ventral pairs in 18 and 19 were absent and sometimes no markings were near male pores either, while a few other specimens lacked markings entirely or had extra markings in 18. Considerable variation was permitted in both preclitellar and postclitellar marking locations by Kobayashi (1936a) - Fig. 3. Sessile glands correspond to the markings internally. No accessory pore glands noted, neither near to spermathecal nor to male pores (cf. Shen *et al.*, 2005). Internally the pharyngeal mass extends to 4 and tufted meroic nephridia are in 5 and 6. Septa 8/9/10 are aborted or 8/9 sometimes retained and displaced by gizzard (Kobayashi, 1936a: 116); 10/11/12 and sometimes 12/13 are strong; thereafter membranous. Spermathecae in 6-9, the



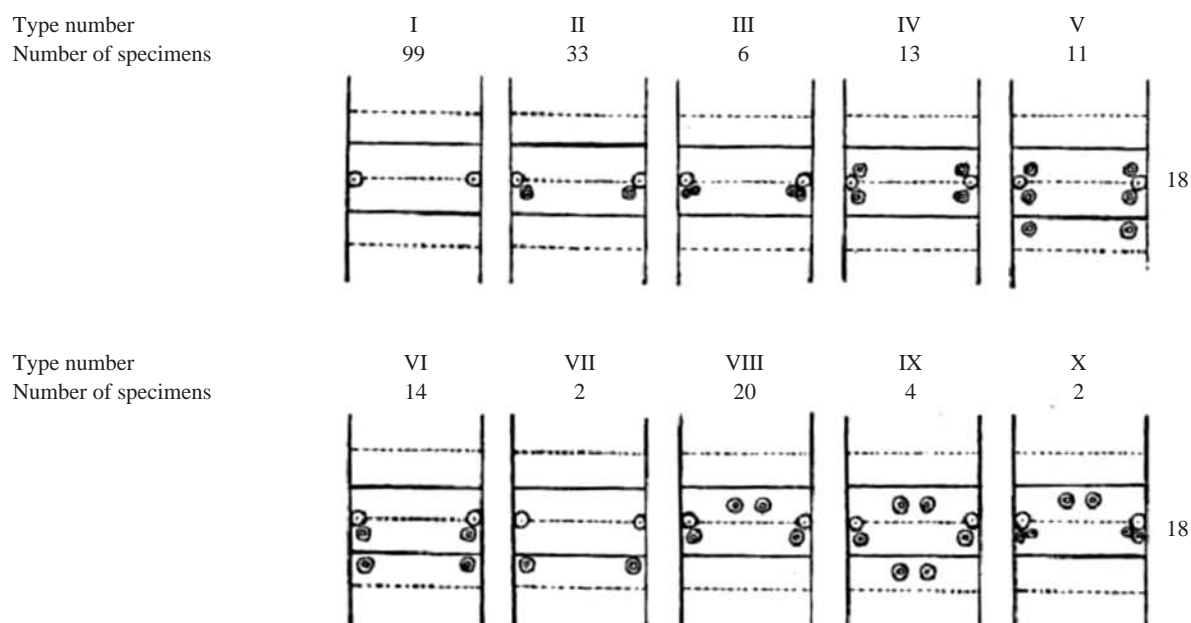
**Fig. 2.** *Amynthes carnosus*: upper Goto & Hatai's original fig. 4; lower *Ph. kyamikia* Kobayashi, 1934, figs. 1-3 (as exactly similar in syns. *youngtai* and *sangyeoli*).

first pair often smaller (and sometimes absent) the last two pairs after septum 7/8; with diverticula about half the length of duct plus ampulla. Last hearts in 13. From ca. 15/16 distinct paired septal glands on dorsal blood vessel occur (Fig. 1). Seminal vesicles with dorsal appendages in 11 and 12. Ovaries in 13 with vestigial ovisacs on posterior of 13/14. Intestine origin in 15 with simple caeca





Text-fig. 1. Seventeen types of the preclitellar genital papillae.



Text-fig. 2. Ten types of the postclitellar genital papillae.

**Fig. 3.** Variation in genital markings and spermathecal pores from Kobayashi (1936: text-figs. 1-2) showing permissible variations as determined by his detailed study.

from 27 extending forward to 24 or 23. Gut contains yellow soil in Neotype, i.e., low organic content suggesting a geophagous diet.

## DISCUSSION

Regarding distributions, the exact Tokyo type-locality is not known; however, the authors worked from the First-High-School which was in Ueno (if they collected there) that later became integrated as the Komaba campus of The University of Tokyo (Todai). Searches found no further old or new material, neither in the collections (cf. Blakemore & Ueshima, 2011), in the grounds (Todai campus and Ueno Park) which surely will have changed greatly since 1899, nor in wider surveys around Tokyo. Kobayashi (1936a: 136) described two specimens from Morioka that were sent to him from the Saito Ho-on Kai collection (with the tacit agreement of S. Hatai) and another 204 samples from Korea. He thought this species was introduced to Japan from either China or Korea, or from both of them, although it might equally be endemic to both Japan and Korea (where it has garnered many synonyms) or to China. If it truly occurs in Taiwan, it might be an introduction there. Alternatively, as Chen (1936: 275) first suggested when describing *P. pingi chungkingensis*, were *Amyntas pingi* (Stephenson, 1925) synonymous with *A. carnosus*, then this taxon might be more prevalent in China and its centre of origin more obscure. Gates (1943) described a single specimen of *Pheretima pingi* from 3,000-5,000 ft at Kuatun, Fukien China. However, genital markings of his specimen were nearly coincident with the spermathecal and male pores plus another two pairs just median to the male pores, one presetal and one postsetal, the latter in contact with, but distinct from, the male porophore; thus it is questionably whether it is either *A. pingi* or *A. carnosus*.

Synonyms are debatable too. Inclusion of *A. pingi* requires caution as it is, on average, a larger worm with several other differences that presently exclude it from *A. carnosus* proper, pending further study based on British Museum types (Blakemore in prep., cf. Gates, 1939). Kobayashi (1936a) studied 204 Korean specimens of *A. carnosus* allowing up to eight markings in some of 7, 8-9 and six or fewer in 18-19 that he thought encompassed the variations found in *A. pingi*. Several of his specimens lacked markings entirely: 51 (of 204) from the preclitellar region, and 99 (from 204) from the male pore region (see Fig. 3). Two of Kobayashi's Korean *carnosa* were sexthecal with spermathecal pores in 6/7/8/9 only.

Kobayashi's (1936b) subsequent octothecal species, *Pheretima monstifera* (= *Amyntas monstiferus*) was said to be easily distinguished by its larger size (235 mm) and genital papillae in 8. Yet he had already described

body length of 111-247 mm and shown eight of his 204 specimens of *carnosa* to have markings in segment 8 (Kobayashi, 1936a: fig. 1XII), corresponding to those shown for *monstifera* by Kobayashi (1936b: fig. 11.2). Since the characteristics of *monstifera* are enveloped it now enters the ambit of *A. carnosus* synonymy based on acceptance of Kobayashi's (1936a) account.

Hong & James (2001: 271, fig. 3) started to describe their *A. sangyeoli* directly above fig. 2 of an allegedly different other species but they appeared to count the segments correctly in their fig. 3 (cf. their fig. 1) as they described a "sp. nov." in exact agreement with both *A. carnosus* (Goto & Hatai, 1899) and with Kobayashi (1934)'s *P. kiamikia* from Korea that also did not differ from Kobayashi's and Ohfuchi's redecriptions of *A. carnosus* (with spermathecae correctly located in 5/6/7/8/9 as in their own *Amyntas youngtai* - despite its figured segments miscounted). It thus appears that Hong & James have ignored previous Japanese or Korean papers crucial to Korean earthworm taxonomic study. Rather than being "sp. nov." their *A. youngtai*, *A. kimhaeensis*, *A. sangyeoli*, *A. sinsiensis* and *A. baemsagolensis* are all similar and mainly mutually compared, yet comply with variations allowed by Kobayashi (1936a) in his redecription of *A. carnosus* from Korea. The latter two synonymous names appear to be mere redecriptions of Kobayashi (1936b)'s Korean "*Amyntas monstifera*" (sic=*A. monstiferus*) and thus join it as new combinations in *A. carnosus*.

The *A. sangyeoli* synonym was independently determined by Shen *et al.* (2003: 484, tab. 2) nearly 10 years ago. Unfortunately, web searched still hit student guides, and field reports from Korea retaining the *sangyeoli* and other junior synonyms [e.g. [http://data.gbif.org/species/search.htm?c\[0\].s=1&pageno=2&c\[0\].o=465&c\[0\].p=0](http://data.gbif.org/species/search.htm?c[0].s=1&pageno=2&c[0].o=465&c[0].p=0) and <http://geoworm.cccb.re.kr/renew/index.php>] and are yet quoted as if valid in Agricultural research papers e.g., Na *et al.* (2010). This should be immediately corrected.

Apart from its smaller size and absence of markings, Korean *A. sangumburi* Hong & Kim, 2002 is similar but it is currently *incertae sedis* as its segments are also miscounted in these authors' fig. 4; despite this it seems conspecific with *Amyntas toriii* (Ohfuchi, 1941). Moreover, *Amyntas monsoonus* James *et al.* 2005: 1012 from Taiwan is perhaps in the ambit of *A. carnosus* as it has the same classical markings in 7-9, but its spermathecae are in 6/7/8/9, as permitted some of Kobayashi (1936a)'s specimens, leading him, and the current revision, to accept this as a rare interspecific variation. *A. monsoonus* is, nevertheless, most often regarded as a junior synonym of *A. tungpuensis* Tsai *et al.*, 1999, e.g. by Tsai *et al.* (2006; 2009) (cf. Appendix). Further basic work is required to determine these affinities.

Shen *et al.*'s (2005: 95, fig. 1) account of *Amyntas carnosus* from Taiwan seems to be based on some other

taxon as the genital makings and spermathecae differ considerably from those in the current and past accounts. For instance, markings are small and numerous around the spermathecal pores, and the spermathecal diverticula are long and dilated, looking more paprika-like. Thus identification is suspect. Chang *et al.* (2009: 64, fig. 28) also showed markings (e.g. in 19) that differ from 'typical' *A. carnosus* but resemble Shen *et al.*'s (2005) version which, as noted above, is questionable. Possibly confusion is with Kobayashi (1936a: 129)'s "Spermathecal papillae" - by which he means merely small pads - surrounding the spermathecal pores and not necessarily separate gland pores which are not typically found near the spermathecal nor male pores in *A. carnosus* proper. If they were present, Kobayashi or Ohfuchi would presumably have noted this. Nevertheless, Chen (1959: fig. 9) shows a composite gland on a spermathecal pore of his "*carnosa*" (syn. *pingi*). Similarly, Gates' (1939, 1943) concept of *A. pingi* seems somewhat removed from the present idea of *A. carnosus* so its identity and therefore its combination in prior *A. carnosus*, requires consideration. Both listings are provisionally excluded from *A. carnosus* and *A. pingi* is retained separately.

There is residual possibility that the genital marking variation in *A. carnosus* allowed for by Kobayashi in his detailed and most thorough account is excessive, rather representing a congeries of morphs, if not separate species, varying somewhat from the typical form described herein. However, this has yet to be proven by rigorous study and, meanwhile, numerous new names have been needlessly added. The prior taxon *Amyntas divergens* (Michaelsen, 1892) as well as other components of the *A. corticis* (Kinberg, 1867) species-complex have been mutually confused with *A. carnosus* during their long and chequered histories. Comparable parts of the *A. corticis* and *A. exiguus* (Gates, 1930) spp-complexes are provided for by Blakemore (2002, 2006, 2008, 2010c) with the proviso that DNA analyses may ultimately decide boundaries.

That mtDNA COI barcoding was so far unsuccessful for the Neotype is disappointing, but not critical as many other historical types are preserved in formaldehyde and we can hope that technology will soon allow extraction of their DNA. In the meantime, the fixing of the morphology of its name-bearing type will now facilitate routine testing from morphologically compliant specimens whether from Taiwan, Japan, Korea or elsewhere.

Article 75 of ICZN (1999) concerns designations of Neotypes with the express purpose of clarifying the taxonomic status (or type-locality) when objective identity is in doubt, as is clearly the case with *A. carnosus* (Goto & Hatai, 1899). Other qualifying conditions are met in relevant statements expressed in the body of this paper above. One lesser concern is the type-locality which in this

case was Tokyo; and while it is not ideal that the current specimen was labelled as from "Sendai", this probably has little bearing when this species distribution is known to extend from Hokkaido to Kyushu and Korea. Moreover, it is felt that the opportunity to designate a specimen that was most likely identified as the nominal taxon by its original author (Dr Hatai) is an overriding consideration within the spirit and brief of the ICZN Article 75 guidelines.

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