Original Article

Extinction of Japan's first formally described earthworm *Amynthas japonicus* (Horst, 1883) (Annelida, Oligochaeta, Megadrilacea, Megascolecidae).

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Abstract. *Amynthas japonicus* (Horst, 1883) was one of three native earthworms first described from Japan in Dr P.F.B. von Siebold's collection from around 1820s (Edo period). While the other two species are relatively well known and their current distributions mapped, the species of concern has not been found since. An expedition organized to collect earthworms from the probable Nagasaki type-locality failed to find this worm. This, coupled with review of surveys by other workers, shows that this species has not been recorded for nearly 200 years and is either particularly rare or, more likely, extinct. Its current IUCN Redlisting as Data Deficient but "*Possibly extinct*" should now be reclassified as "*Extinct*". This is the first earthworm and second invertebrate extinction from Japan. An updated checklist of known Japanese native earthworms is appended.

Key words: megadrile earthworms, conservation, invertebrates

Introduction

Scientific study of earthworm species in Japan extends back two hundred years to the first specimens collected during the Edo period by Dr. Philipp Franz Balthasar von Siebold when based in Nagasaki that were later named by R. Horst in material shipped to Leiden Museum, Holland (Table 1).

Table 1. Japan's earliest earthworm species

Original species name	Current combination (per ICZN 1999)
Megascolex sieboldi Horst, 1883: 191	*Metaphire sieboldi* (Horst, 1883)
Megascolex japonicus Horst, 1883: 192	*Amynthas japonicus* (Horst, 1883)
Megascolex schmardae Horst, 1883: 194	*Duplodicodrilus schmardae* (Horst, 1883)

One of these species – *Amynthas japonicus* (Horst, 1883) – has not been seen subsequently, so its ecology and conservation status are indeterminate. In nearly two centuries since this species was collected, Japan has seen major changes such as the Meiji Restoration in 1868 (150 years ago), and the US Occupation. Implications of this are likely loss of habitat due to urbanisation, industrialization and the spread of intensive, agrichemical farming. Nagasaki, if this was the type-locality, was also heavily bombed during WW2. But surveys prior to this, in the 1930–1940s, had failed to locate it in south-west Japan (Kobayashi 1941a, b, c), including around Nagasaki and Tsushima (where von Siebold obtained some of his insect specimens). The other two species described by Horst (1883) are both fairly widely distributed in south-western Japan: distinctively blue-coloured *Metaphire sieboldi* (from Shizuoka to Shikoku and all of Kyushu) and *Duplodicodrilus schmardae* which is mainly confirmed from Kyushu [but some records, including from China, may be misidentifications of *Metaphire californica* (Kinberg, 1867) as noted by Blakemore (2016a)]. Both are reported from Kyushu and from around Nagasaki city (Easton 1981, Blakemore 2003, 2016a, Minamiya 2018) and this convergence suggests a probable type-locality of some, if not of all three, species. Thus an expedition was organized in 2018 in an attempt to relocate and redefine the conservation status of the earthworm in question.

Methods

In addition to field searches around Tokyo and Kanto region of Japan from 2001 to date, directed eco-taxonomic surveys (as per Blakemore 2016a) were conducted by the author on Shikoku, in the Kinki region (Shiga ken) and on Okinawa between 2003–2016 and, specifically, in the Narutaki home and garden of von Siebold and in the parks and mountains (e.g. Mt. Inasa) at Nagasaki city, Kyushu

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in late summer 2018. Colleagues (Drs. Tomas Pavlicek and Patricia Cardet) performed additional collection in the Shikoku, Shiga and Kyushu region including on Yakushima Island from Sept.–Oct. 2018. Moreover, inspections of earthworm in historical museum collections from Sendai and in Tokyo were made (Blakemore & Ueshima 2011; Blakemore 2012a, 2016b). Newly collected specimens are mainly deposited in Lake Biwa Museum (LBM Misc. Inverts.) and Kanagawa Prefectural Museum of Natural History (KPMNH) (KPM-NJL000069–77) . Unfortunately, the type specimen in Leiden is too fragile to loan (Naturalis curator J. Bleeker pers. com.) and funds were unavailable for travel thus its inspection was not possible at this time.

Results

Synonymy:

Amynthas japonicus (Horst, 1883) (Fig. 1).

Megascolex japonicus: Horst, 1883: 192 [from "Japan", coll. von Siebold; type RNHL 1809].

Perichaeta japonica: Benham, 1886: 241; Beddard, 1891: 272, 1895: 426.

Amyntas japonicus: Beddard, 1900: 634.

Pheretima japonica: Michaelsen, 1900: 279, 1903: 97, 1922?

Amynthas japonicus: Sims & Easton, 1972: 237; Easton, 1981: 54; Blakemore, 2003: 21, 2008: 65.

Amynthas? *japonicus*: Blakemore, 2012b: 18.

Description: Length 220 mm. Setae about 66 per segment. Prostomium occupies half the first segment and tapers anteriorly. The first dorsal pore is in 11/12. Spermathecae are in 6/7/8. Female pore is distinct (on 14). Male pore on 18 is depressed and extends in a J-shape from 17–18. Internally septa 8/9 is wanting (around gizzard). Spermathecae are present in 7 and 8 with a conical or "racket"-shaped, ampulla and duct and thin diverticulum about half the length of the sac. Seminal vesicles are in 11 and 12. The prostate gland is on an S-shaped duct joined by vas deferens and large glandular portion occupying three segments (17–19) suggesting the specimen was fertile rather than parthenogenetic. Meroic nephridia are particularly dense on septa 5/6/7 and the body wall of 7–9. Intestinal caeca were not noted.

Distribution: Given as "Japan (von Siebold)". Resurvey has failed to locate this species. Specific survey by the author (11–13th September, 2018) were of the Narutaki gardens of von Siebold's house that is now a museum, the adjacent stream that flows from the surrounding forested hills, at Mt Inasa on the opposite West side and from other likely 'hot-spots' around the city. Wider survey by colleagues Drs T. Pavlicek and P. Cardet from 3rd Sept. – 8th Oct., 2018 included Kobe, Kagoshima, Yakushima, Ibusuki, Kumamoto, Shimane and Shiga. Although several specimens were collected of earthworms of families Moniligastridae, Lumbricidae and Megascolecidae [some new, some known including a new Japanese record of exotic *Amynthas minimus* (Horst, 1893) KPM-NJL000069], the specific earthworm was not found.

Fig. 1. Type RNHL 1809 of *Amynthas japonicus* in Leiden (courtesy of J. Bleeker Sept., 2016). This is the only known specimen and image of this Japanese species (cf. ***M. sieboldi*** – http://www.geocities.jp/at_mocha/mimizu/sieboldi-3.html).

Discussion

The species of our concern was collected by von Siebold while he was based at Dejima Island and Narutaki, Nagasaki between 1823–1829 (Fig. 2) although it is not known whether the specimen was collected by him nor where exactly it was obtained. It has male pore characteristics similar to some species described from Ryukus as was noted by Blakemore (2003) who also questioned whether this qualified it for inclusion in genus *Metaphire* prompting Blakemore (2012b) to list it as *Amynthas*? *japonicus*.

Extensive earthworm surveys at the most likely origins in Kyushu (probable type-locality) and Shikoku (possible type-locality) conducted in 1930s–1940s (Kobayashi 1941a,b,c), and in parts of northern Kyushu between 1967–2002 (Yasuaki Sugi 2012, 2014, and pers. comm. 2015), also failed to relocate this species. Threats to the species are as noted by Blakemore (2018a,b), urbanization is shown in Figures 3–4. Due to this and to the historical likely

loss of species' habitats, it should be listed as critically endangered if not already extinct (EX). If so, this is the first earthworm and second invertebrate extinction in Japan. Of two previous extinct Coleoptera beetles listed (Ministry of Environment 2018), one was subsequently rediscovered (Sugaya *et al.* 2017), the other – *Rakantrechus elegans* Ueno, 1960, also from Kyushu – is defined as "Extinct (EX): species thought to be extinct in Japan" which is now also the current status of *A. japonicus*. Equally worrying, in Japan as elsewhere, is almost total extinction of support for earthworm eco-taxonomy that surprisingly boasts no full-time researcher at any museum or institution.

Fig. 2. von Siebold ca. 1820s (nl.wikipedia.org/wiki/Philipp_Franz_von_Siebold CC-BY).

Fig. 3. Historical Nagasaki (with Dejima island) around the time of collection (from Siebold's Nippon, 1897; archive.org/details/nipponarchivzur00siebgoog Wikipedia CC-BY).

Fig. 4. Contemporary view of same landscape showing urbanization (2018 author's image).

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摘　要

ロバート J. ブレクモア , 2019. 日本で初めて正式に記載されたヤマトミミズ *Amynthas japonicus* (Horst, 1883)（環形動物門，貧毛綱，Megadrilacea 目，フトミミズ科）の絶滅状況 . 神奈川県立博物館研究報告（自然科学）, (48): 55–60.［Blakemore, R. J., 2019. Extinction of Japan's first formally described earthworm *Amynthas japonicus* (Horst, 1883) (Annelida, Oligochaeta, Megadrilacea, Megascolecidae). *Bull. Kanagawa prefect. Mus.* (*Nat. Sci.*), (48): 55–60.］

ヤマトミミズ *Amynthas japonicus* (Horst, 1883) は、1820 年代収集されたシーボルトのコレクションに基づき記載された日本在来のミミズ 3 種のうちの 1 種である。ヤマトミミズ以外の 2 種は比較的よく知られていて、現在の分布もよく判っているのに対して、ヤマトミミズは初出以降、全く記録されていない。タイプ産地と考えられる長崎で採集を試みたが、ヤマトミミズを採集することはできなかった。これに加えて既存の調査結果を精査した結果、ヤマトミミズはほぼ 200 年もの間にわたって記録がなく、非常に珍しい種類であるかあるいはおそらく絶滅してしまったということが示唆された。現在、ヤマトミミズは IUCN レッドリストでは「DD データ不足」（"絶滅した可能性あり"）と位置づけられているが、これは「EX 絶滅」と再位置づけするべきと考えられる。本種は、記録に基づけば、日本からの最初のミミズの絶滅種であり、無脊椎動物としても 2 番目の絶滅種と考えられる。本稿では、最新の情報に基づく現在の日本のミミズの分類のチェックリストを付記した。

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Appendix – Updated checklist of Japanese native earthworms (as per IUCN Redlist 2018).

Several species names proposed by Mr Kotaro Ishizuka between 1999–2001 have now been determined by this author to be non-compliant with ICZN (1999: Art. 11.4 and/or 11.5) since unofficial, para-taxonomic, vernacular names were simultaneously applied to binomials that intermittently replaced these. Many names were also homonyms (later validated with replacement names), or instant synonyms, or were subsequently mis-spelled. Resolution of these intended taxa has also been particularly difficult even after nearly 20 years of study (Blakemore 2003, 2012b; Minamiya 2018). This task made more difficult by concealment of crucial type material from classical collections of Goto & Hatai (see Blakemore & Ueshima 2011; Blakemore 2012a, 2016b) with several of their species names still uncertain after nearly 120 years (some possibly extinct, but too taxonomically unresolved to determine the true status).

Family	Genus	species	Authority
Moniligastridae	*Drawida*	*companio*	Blakemore, 2014
Moniligastridae	*Drawida*	*eda*	Blakemore, 2010
Moniligastridae	*Drawida*	*hattamimizu*	Hatai, 1930
Moniligastridae	*Drawida*	*japonica*	(Michaelsen, 1892)
Moniligastridae	*Drawida*	*keikiensis*	Kobayashi, 1938
Moniligastridae	*Drawida*	*koreana koreana*	Kobayashi, 1938
Moniligastridae	*Drawida*	*koreana nanjiro*	Blakemore, 2014
Moniligastridae	*Drawida*	*koreana shindo*	Blakemore, 2014
Moniligastridae	*Drawida*	*moriokaensis*	Ohfuchi, 1938
Moniligastridae	*Drawida*	*nemora*	Kobayashi, 1936
Moniligastridae	*Drawida*	*ofunatoensis*	Ohfuchi, 1938
Moniligastridae	*Drawida*	*tairaensis*	Ohfuchi, 1938
Criodrilidae	*Criodrilus*	*bathybates*	(Stephenson, 1917)
Lumbricidae	*Eisenia*	*anzac*	Blakemore, 2011*
Lumbricidae	*Eisenia*	*japonica japonica*	(Michaelsen, 1891)*
Lumbricidae	*Eisenia*	*japonica hiramoto*	Blakemore, 2012*
Lumbricidae	*Eisenia*	*japonica vaga*	Blakemore, 2013*
Lumbricidae	*Helodrilus*	*hachiojii*	Blakemore, 2007
Megascolecidae	*Amynthas*	*ambiguus*	(Cognetti, 1906)
Megascolecidae	*Amynthas*	*carnosus*	(Goto & Hatai, 1899)
Megascolecidae	*Amynthas*	*flavescens*	(Goto & Hatai, 1898)
Megascolecidae	*Amynthas*	*fuscatus*	(Goto & Hatai, 1898)
Megascolecidae	*Amynthas*	*glabrus*	(Gates, 1932)
Megascolecidae	*Amynthas*	*gomejimensis*	(Ohfuchi, 1937)
Megascolecidae	*Amynthas*	*habereri*	(Cognetti, 1906)
Megascolecidae	*Amynthas*	*ishikawai*	(Ofuchi, 1941)**
Megascolecidae	*Amynthas*	*japonicus*	(Horst, 1883)
Megascolecidae	*Amynthas*	*koreanus*	(Kobayashi, 1934)
Megascolecidae	*Amynthas*	*kunigamiensis*	(Ishizuka & Azama, 2000)
Megascolecidae	*Amynthas*	*masatakae*	(Beddard, 1892)
Megascolecidae	*Amynthas*	*micronarius*	(Goto & Hatai, 1898)
Megascolecidae	*Amynthas*	*noninvistus*	Blakemore, 2010
Megascolecidae	*Amynthas*	*nonmontanus*	Blakemore, 2010
Megascolecidae	*Amynthas*	*nonmonticolus*	Blakemore, 2010
Megascolecidae	*Amynthas*	*nonsetosus*	Blakemore, 2010
Megascolecidae	*Amynthas*	*nonsilvestris*	Blakemore, 2010
Megascolecidae	*Amynthas*	*obscurus*	(Goto & Hatai, 1898)
Megascolecidae	*Amynthas*	*obtusus*	(Ohfuchi, 1957)
Megascolecidae	*Amynthas*	*oyuensis*	(Ohfuchi, 1937)
Megascolecidae	*Amynthas*	*palarvus*	(Blakemore, 2003)
Megascolecidae	*Amynthas*	*phaselus maculosus*	(Hatai, 1930)
Megascolecidae	*Amynthas*	*phaselus phaselus*	(Hatai, 1930)

Appendix. continued.

Megascolecidae	*Amynthas*	*scholasticus*	(Goto & Hatai, 1898)
Megascolecidae	*Amynthas*	*shimaensis*	(Goto & Hatai, 1899)
Megascolecidae	*Amynthas*	*tappensis*	(Ohfuchi, 1935)
Megascolecidae	*Amynthas*	*tokioensis*	(Beddard, 1892)
Megascolecidae	*Amynthas*	*vittatus*	(Goto & Hatai, 1898)
Megascolecidae	*Amynthas*	*yamade*	Blakemore, 2010
Megascolecidae	*Amynthas*	*yambaruensis*	(Ishizuka & Azama, 2000)
Megascolecidae	*Amynthas*	*yamizoyamensis*	(Ohfuchi, 1935)
Megascolecidae	*Amynthas*	*yunoshimensis*	(Hatai, 1930)
Megascolecidae	*Duplodicodrilus*	*acinctus*	(Goto & Hatai, 1899)
Megascolecidae	*Duplodicodrilus*	*schmardae macrochaeta*	(Michaelsen, 1899)
Megascolecidae	*Duplodicodrilus*	*schmardae schmardae*	(Horst, 1883)
Megascolecidae	*Manus*	*koellikeri*	(Michaelsen, 1928)***
Megascolecidae	*Metaphire*	*agrestis*	(Goto & Hatai, 1899)
Megascolecidae	*Metaphire*	*communissima*	(Goto & Hatai, 1899)
Megascolecidae	*Metaphire*	*hataii*	(Ohfuchi, 1937)
Megascolecidae	*Metaphire*	*hilgendorfi*	(Michaelsen, 1892)
Megascolecidae	*Metaphire*	*levis*	(Goto & Hatai, 1899)
Megascolecidae	*Metaphire*	*megascolidioides*	(Goto & Hatai, 1899)****
Megascolecidae	*Metaphire*	*parvula*	(Ohfuchi, 1956)
Megascolecidae	*Metaphire*	*riukiuensis*	(Ohfuchi, 1957)
Megascolecidae	*Metaphire*	*ryunome*	Blakemore, 2012
Megascolecidae	*Metaphire*	*sieboldi*	(Horst, 1883)
Megascolecidae	*Metaphire*	*servina*	(Hatai & Ohfuchi, 1937)
Megascolecidae	*Metaphire*	*soulensis*	(Kobayashi, 1938)
Megascolecidae	*Metaphire*	*tanbode*	Blakemore, 2010
Megascolecidae	*Metaphire*	*tosaensis*	(Ohfuchi, 1938)
Megascolecidae	*Metaphire*	*vesiculata*	(Goto & Hatai, 1899)
Megascolecidae	*Metaphire*	*yamadai*	(Hatai, 1930)
Megascolecidae	*Metaphire*	*yezoensis*	(Kobayashi, 1938)

Notes: Some natives and all exotic or introduced species are described in Blakemore (2016a).

**Eisenia anzac* and *E. japonica* sub-sp. have recently been located on Taiwan (see Sherlock *et al.* 2018 - https://tesri.tesri.gov.tw/files/tesri_protect/tesri_journal_20180205083841/Taiwan%20J.%20Bio%202018.1.1.1-8.pdf; accessed 13th December, 2018).

***A. ishikawai* is restored from synonymy of *A. mimimus* that is, however, retained as an exotic record as noted herein from the recent collection in Nagasaki (specimen KPM-NJL000069).

****Manus koellikeri* was fairly widely distributed and a dominant species on Tsushima (Kobayashi 1941c) but in 2015 Dr Y. Sugi reports its current status as "*Disappearing*" (http://slidegur.com/doc/3973948/i-ask-dr.-blakemore; accessed 13th December, 2018). This species may thus be classed as "*Endangered*".

**** Full redescription and DNA barcoding of *M. megascolidioides* is in Blakemore (2016b).