Original article

First Records from Japan of European Vermi-composter *Dendrobaena veneta* (Rosa, 1886) and of "Classical" *Lumbricus terrestris* Linnaeus, 1758 (Annelida, Oligochaeta, Megadrilacea, Lumbricidae)

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Abstract. European earthworms *Dendrobaena veneta veneta* (Rosa, 1886) and *Lumbricus terrestris* Linnaeus, 1758 are new records for Japan found in vermi-compost and fishing bait supplies. Both were likely introduced via the USA some years earlier when much stock was shipped to meet Japanese composting needs.

Key words: Annelid, exotic alien invertebrates, megadrile earthworm, vermi-compost

Introduction

In 2019 a local Zama school teacher (C. Vasnick) found some school project compost worms that looked interesting and different to the usual *Eisenia fetida* (Savigny, 1836). Preliminary identification as *Dendrobaena veneta* (Rosa, 1886) was confirmed in 2020 from specimens obtained from bait worm growers (Fig. 1). Online bait catalogue images from at least 2018, and the primary author's collection records from 2001 (Blakemore, 2002) of worms "*sold throughout Japan as fishing bait worms from Kyushu (pers. obs. 11.IX.2001)*", now indicate this new exotic species has likely been introduced to Japan several years earlier. Possibly from China (e.g. www.japanfs.org/ja/news/archives/news_id024010.html) or more likely the USA as, from 1985-1987 alone, Japan reportedly imported 3,000 "mt" (= metric tonnes) of earthworms from the USA for cellulose waste composting (Kale, 1998). It is further likely that the similar and common vermicomposting species, *Dendrobaena hortensis* (Michaelsen, 1890), with which *D. veneta* is often confused, is also present in some Japanese cultures, but this has yet to be demonstrated. The current report provides formal identification and distribution records for *Dendrobaena veneta veneta* with unambiguous support sought from mtDNA barcode analysis.

The research continued in 2021 with *Lumbricus terrestris* Linnaeus, 1758 also found in "Ozeki" (" 大関 ") bait worm boxes that are routinely sent around Japan (Fig. 1).

Materials and methods

Representative specimens (in 70 % EtOH), identified under low magnification using keys and descriptions in Blakemore (2000, 2002, 2020), are deposited in Kanagawa Prefectural Museum: *D. veneta*, is Accession No. KPM-NJL 78 (from compost in garden in Zama, collected November, 2020 by RJB) with small tissue samples sent to Monash University genomics laboratory for mtDNA barcode sequencing (detailed in the Supplementary file); *L. terrestris* specimens deposited in 2021 are KPM-NJL 79–80. Both species are briefly described and compared to similar taxa in the following account.

Results

The current specimen of concern (KPM-NJL 78; Fig. 2) matches with other *D. veneta* reports with a DNA analysis confirmation in the Supplementary file.

Lumbricus terrestris (Accession Nos. KPM-NJL 79–80)

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Fig. 1. Fishing baits as supplied throughout Japan contain a variety of worm specieas including *Eisenia fetida*, *Dendrobaena veneta* & *Lumbricus terrestris* (author's photo).

Fig. 2. *Dendrobaena veneta* (Rosa, 1886) dorsal and zoomed ventral habitus of mature specimen from Zama, Nov. 2020; fixed in 70 % EtOH (KPM-NJL 78 that provided small tissue samples for DNA analysis) (author's photo).

was further identified (Fig. 3).

Discussion

First records from Japan of *Eisenia fetida* were by Michaelsen (1892: 320, 1900: 476). (The primary author's copy of Michaelsen's 1900 monograph is now donated to Kanagawa Prefectural Museum of Natural History library). Its occurrence in Japan extends to before 1876 and likely introduction along with medicinal plants to Koishikawa Gardens, Tokyo with specimens collected there by Dr Franz Hilgendorf.

Michaelsen (1900) described *Dendrobaena veneta* as widespread in Europe and the Middle East (cf. https://www.gbif.org/species/5739805), it is now known from

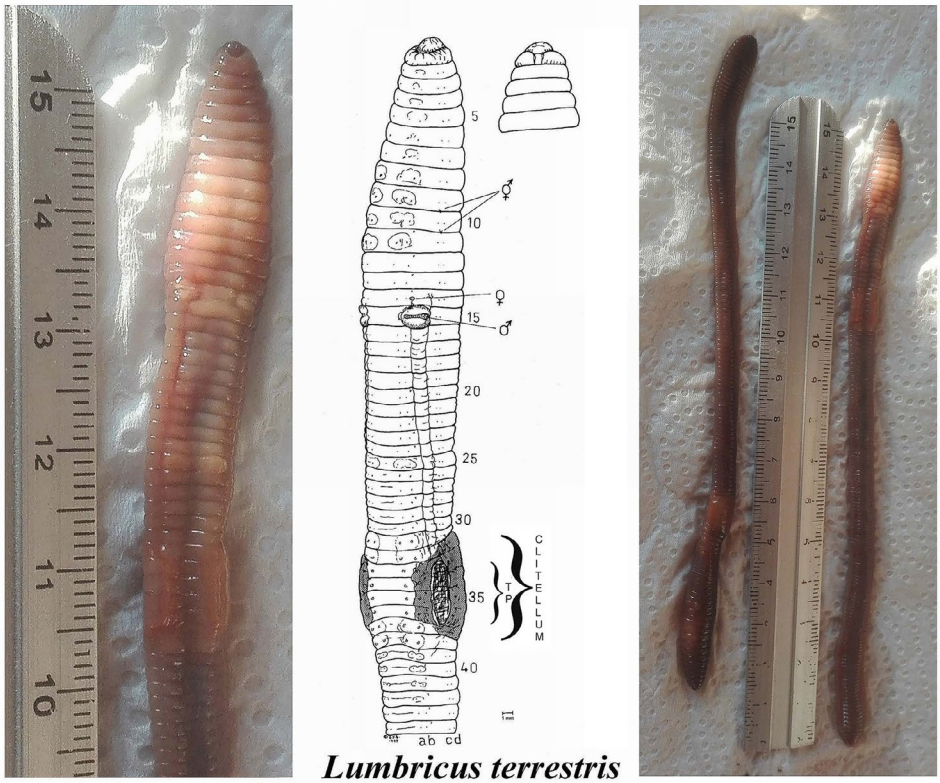

Fig. 3. *Lumbricus terrestris* Linnaeus, 1758 diagram (modified from Blakemore 1997, 2000, 2020, 2021) compared to 2021 KPM specimens (KPM-NJL 79–80).

introduction to the USA, South America (e.g. Argentina, Brazil, Chile), Iran (although its identification there may now be questioned – see Supplementary file), South Africa, China, South Australia (J. Buckerfield, pers. com. 1991) and New Zealand (Blakemore *et al.*, 2007) – the latter both new records for those countries. [In an update to this, an unpublished Australian Museum record online is of *D. veneta* from Lake Taupo, N.Z. from as early as 1935 – https://biocache.ala.org.au/occurrences/8cf893c7-2de7-43cd-9451-372348aba463]. Full eco-taxonomy, synonymy, distribution and DNA data are provided in Blakemore (2020 a copy of which is also donated to KPM library – accession No. KPM-XYZ 99) with a July 2021 update of a claim from Guatamala (https://invertebase.org/stri/collections/list.php?db=23&reset=1&country=Guatemala) and of its compost use in Ethiopia (https://academicjournals.org/journal/AJB/article-full-text-pdf/D3A468E58527).

Dendrobaena hortensis (Michaelsen, 1890) – also reported from South Australia (J. Buckerfield, pers. com. 1991) and Tasmania (Blakemore, 2000) both as new records – is similar in distribution and appearance to *D. veneta* and is differentiated by Briones *et al.* (2009: tab. 3). The taxonomy, morphology and genetic identification of these and related taxa are revised in Szederjesi *et al.* (2019) and Blakemore (2020). In summary:

Length mature > 50mm; pigment always banded …...
.....*Dendrobaena veneta* (Rosa, 1886)

Length < 50mm; pigment more uniform ….
.....*D. hortensis* (Michaelsen, 1890)

Although the epithet "*veneta*" in Latin can mean "sea blue" or "blue-green", the name derives from its type locality of Campo di Marte, Venice (and Rosa noted its colour as being the same as *Eisenia fetida*, i.e., ruddy with yellow intersegmental stripes) hence these two species are easily and often confused. A simple distinction is that the setae are wider in *Dendrobaena veneta* (readily observable in the dark under blue light) also the clitellum tends to be whitish in *D. veneta* but more ruddy in *E. fetida* (Figs. 4–6).

Photo images are also available for comparison on Ben Crabb's website (https://bjc792.wixsite.com/earthworm-images). Note that *E. fetida* often has a yellow caudal tip (rarely reported for *D. veneta*) and exudes fetid-smelling yellow coelomic fluid when distressed or handled, unlike the more placid *D. veneta* (RJB pers. obs.).

Incidentally, confusion by non-specialist growers in a UK report (Katsiamides & Stürzenbaum, 2021) found only one of 25 specimens from five suppliers of "*Eisenia fetida*" was correct (conflation with *E. andrei* Bouché, 1972 or other sub-species notwithstanding), most were *D. veneta.* A similar situation may pertain in Japan as, despite having a lower reproductive rate, *D. veneta* is larger than *E. fetida* and may come to dominate in cultures under certain conditions (RJB pers. obs.).

As well as for fishing bait markets, beneficial human

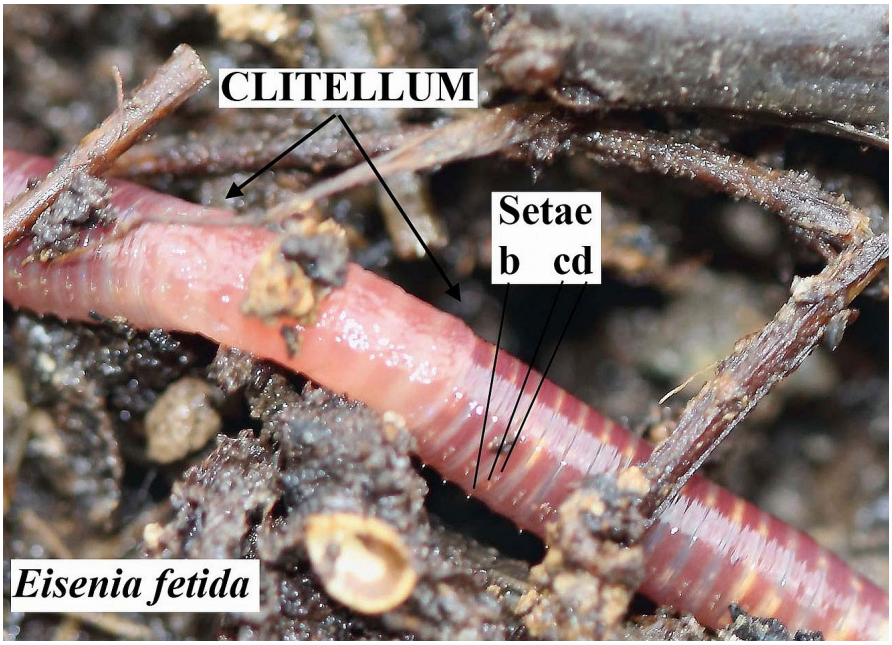

Fig. 4. Striped body and pale or pinkish matured clitellum are shared characteristics, but closely paired setae are distinctive for *Eisenia fetida* as indicated (after Wiki image "*close-up of red wiggler worm [sic] with visible bristles [sic]*" Eisenia_fetida_HC1.jpg).

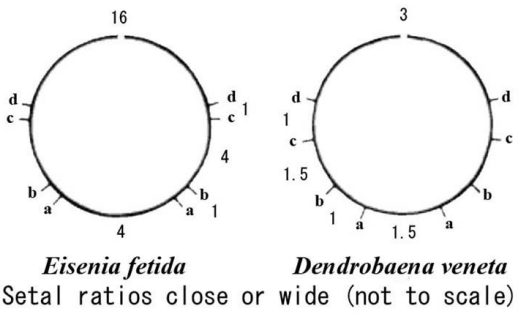

Fig. 5. Setal ratios provide simple differentiation.

uses of *D. veneta* are as an important species for vermicomposting of "wastes" used in organic farming for healthy, pesticide-free foods. A recent publication (Szederjesi *et al.*, 2019) lists its application for "*several cell-biological (Siekierska 2003; Adamowicz 2005), immunological (Molnár* et al. *2015; Swiderska* et al. *2017), soil biological and environmental studies (Marinussen* et al. *1997; Natal-da-Luz* et al. *2011).*" In addition, another 2019 study (Fiolka *et al.*, 2019) found anti-tumor effect from *D. veneta* coelomic fluid on human lung cancer cells as "*an interesting and promising preparation for further biological, chemical, and biomedical research.*" [Cf. medical uses of *Eudrilus eugeniae* (Kinberg, 1867) as summarized in Blakemore (2015)].

The likely origin of the Japanese specimens was via the USA (as noted in Introduction) and the US Government Aphis website (https://www.aphis.usda.gov/) says:- "*Eisenia* (=*Dendrobaena*) *veneta*" and *D. hortensis* are currently the only earthworm species that are permitted for importation into the U.S. under strict conditions from countries other than Canada for release into the environment. Japan has also imported compost worms from Asia or India as other possible sources (e.g. for *E. fetida*, *D. hortensis* or other species?), although the Japanese Ministry of Agriculture Forestry & Fisheries (MAFF – https://www.maff.go.jp/e/) at this time does not restrict *Eisesnia* spp., *Dendrobaena* spp. nor *Lumbricus* spp, import and redistribution into and within Japan. [Email enquiries to MAFF by the primary author in 2021 on any restrictions, on these or other worm species, are unanswered].

Initial preliminary report of *Lumbricus terrestris* from Japan by Blakemore (2021 – https://vermecology.wordpress.com/2021/12/31/lterrestris-in-japan/) is now supported with specimens deposited in KPM. Its full taxonomic description based upon the restored British Museum Neotype plus many other specimens, its ecology and global distribution (with an earlier new report from Tasmania and thus for Australia) are provided in Blakemore (1997, 2000, 2013, 2020). Confirmation of this "classical" species as a new exotic record from Japan is thus also a new record for East Asia (see CABI map in Blakemore, 2021 as also in Supplementary file appended below).

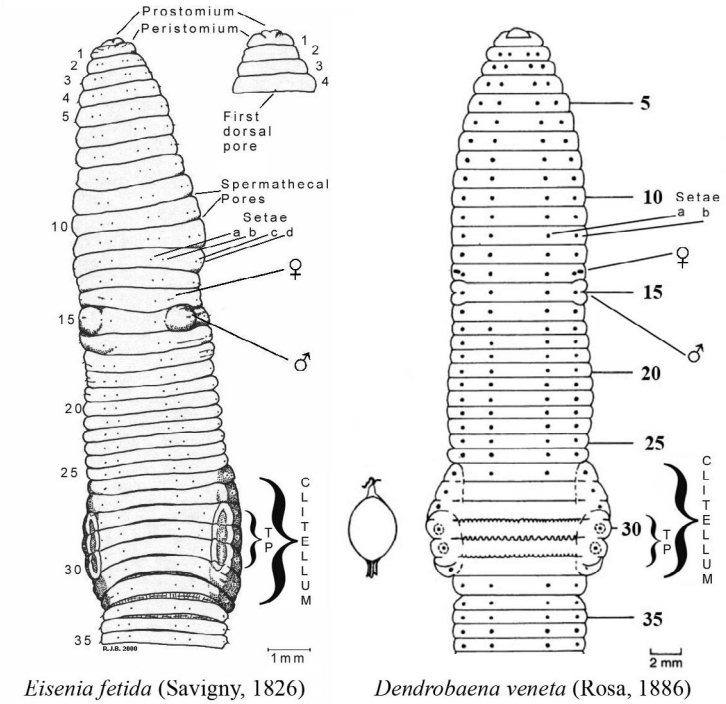

Fig. 6. *Eisenia fetida* (author's camera lucida image) compared to *D. veneta* [after Sims & Gerard (1999: fig. 28) of "*Eisenia veneta*" with its cocoon]. TP = tubercula pubertatis.

This report brings the number of known exotics to more than 42 taxa in Japan (and Okinawa/Ryukyus) which, plus ~80 natives, gives a total tally of approximately 122 earthworm species (Easton, 1981; Blakemore, 2003, 2019, 2021 cf. Minamiya, 2021).

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摘　要

Blakemore, R. J., 佐藤武宏 , C. Vasnick & S. Y. Lim, 2022. ヨーロッパ産ミミズの一種 *Dendrobaena veneta* (Rosa, 1886) と *Lumbricus terrestris* Linnaeus, 1758（環形動物門，貧毛綱，Megadrilacea, ツリミミズ科）の日本からの初記録について . 神奈川県立博物館研究報告（自然科学）, (51): 89–94. [Blakemore, R. J., T. Sato, C. Vasnick & S. Y. Lim, 2022. First Records from Japan of European Vermi-composter Dendrobaena veneta (Rosa, 1886) and of "Classical" *Lumbricus terrestris* Linnaeus, 1758 (Annelida, Oligochaeta, Megadrilacea, Lumbricidae). *Bull. Kanagawa Pref. Mus.* (*Nat. Sci.*), (51): 89–94.]

日本初記録となるヨーロッパ原産のミミズ *Dendrobaena veneta* (Rosa, 1886) と *Lumbricus terrestris* Linnaeus, 1758 が確認された。本種はミミズコンポスト構成種や釣餌として利用されており、日本のコンポストの需要増加を満たすために、数年前より米国を経由して導入されたと考えられる。

Supplementary Materials

Supplementary file.
Appendix with Figs. and Reference online links – https://archive.org/details/appendix_202202.