Two new lumbricid earthworm occurrences for Taiwan: *Eisenia anzac* Blakemore, 2011 and *Eisenia japonica japonica* (Michaelsen, 1891)

台灣兩種新紀錄種正蚓|台日愛勝蚓與日本愛勝蚓

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Abstract

This paper documents the first occurrences of two lumbricid earthworms: *Eisenia anzac* Blakemore, 2011 and *Eisenia japonica japonica* (Michaelsen, 1891) in Taiwan. Both species were found in mountainous areas. The former is distributed in southern and northern Taiwan and possibly a species native to Taiwan. The latter was from Japan and collected in northern Taiwan only.

摘 要

本文描述兩種採自台灣山區之新紀錄種正蚓台日愛勝蚓 *Eisenia anzac* Blakemore, 2011 與日本愛勝蚓 *Eisenia japonica japonica* (Michaelsen, 1891)。兩者均屬於正蚓科 (Lumbricidae) 愛勝蚓屬 (*Eisenia*)。前者於南部及北部山區皆有分布，極可能爲台灣原生種，後者原產於日本，僅見於北部山區。

Key words: *Eisenia anzac*, *Eisenia japonica japonica*, earthworm, Lumbricidae, Taiwan

關鍵詞：台日愛勝蚓、日本愛勝蚓、蚯蚓、正蚓科、台灣

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Introduction

The family Lumbricidae is the most abundant family in Europe and some cosmopolitan species have spread around the world especially with the vermicomposting industry. However, there are a few lumbricid earthworms native to the far East (Blakemore and Grygier 2011). Two of these species, *Eisenia anzac* and *Eisenia japonica japonica*, are documented in this paper and are found for the first time in Taiwan.

Eisenia anzac was first described by Blakemore in 2011 based on a specimen collected on the 25 April 2010 under a tree in a park next to the Commonwealth War Graves Commission Cemetery in Hodogaya-ku, Yokohama-shi, Kanagawa-ken, Japan, and close to a garden of introduced plants (Blakemore and Grygier 2011). *Eisenia japonica japonica* (originally named *Allolobophora japonica*) was first collected on the 29 March 1875 from Enoshima near Yokohama and was described by Michaelsen in 1891. Further specimens from Hakodate, Hokkaido were also inspected by Michaelsen (1892), according to Blakemore (2010) and by Blakemore and Grygier (2011). The species was later found in the Korean Peninsula and Jeju Island as well (Kobayashi 1936, 1941ab; Blakemore 2013; Hong and Csuzdi 2016).

This report brings the list of earthworms in the family Lumbricidae found in Taiwan to seven species with the following five species being recorded previously: *Aporrectodea caliginosa* (Savigny, 1826), *Aporrectodea trapezoides* (Dugès, 1828), *Bimastos parvus* (Eisen, 1874),

Bimastos rubidus (Savigny, 1826) and *Eiseniella tetraedra* (Savigny, 1826) (Chang *et al*. 2009; Shen *et al*. 2013).

The following descriptions are based on 23 preserved specimens of *E. anzac* and four preserved specimens of *E. japonica japonica* deposited at the Taiwan Endemic Species Research Institute, Jiji, Nantou, Taiwan.

Eisenia anzac Blakemore, 2011

Eisenia anzac Blakemore and Grygier, 2011: 267.

Materials examined. － Four clitellate (mature) worms collected on the 15 March 2000 along Road 20 near Kuaigu (elevation 2500 m), Kaohsiung County by C. F. Tsai, S. C. Tsai, H. S. Fang, S. T. Chang, T. J. Lin, H. P. Yang and H. P. Shen (coll. no. 2000-19); one clitellate worm collected on the 1 April 2009 along Jinshuiying Trailhead on the borders of Pingtung and Taitung counties (elevation 1300 m) by T. J. Lin and R. C. Jang (coll. no. 2009-13); three clitellate (one dissected) and an aclitellate worms collected on the 2 April 2009 inside fallen logs along the trail toward Mt. Gutzulun on the borders of Pingtung and Taitung counties (elevation 1300 m) by T. J. Lin and R. C. Jang (coll. no. 2009-16); three clitellate and an aclitellate worms collected on the 2 April 2009 along Jinshuiying Trail between trailhead and trailhead toward Mt. Gutzulun on the borders of Pingtung and Taitung counties (elevation 1300 m) by T. J. Lin and R. C. Jang (coll. no. 2009-17); two clitellate worms collected on the 24 June 2009 along Jinshuiying Trailhead on the borders of Pingtung and Taitung counties (elevation 1300 m) by T. J. Lin and R. C. Jang (coll. no. 2009-29); one clitellate, amputated worm collected on the 25 June 2009 on a tree beside the trail toward Mt. Gutzulun on the borders of Pingtung and Taitung counties (elevation 1300 m) by T. J. Lin (coll. no. 2009-31); one clitellate worm collected on the 25 June 2009 along Jinshuiying Trail between an old military camp and trailhead toward Mt. Gutzulun (elevation 1300 m), Taitung County by T. J. Lin and R. C. Jang (coll. no. 2009-34); one clitellate worm collected on the 25 June 2009 along Jinshuiying Trail between trailhead and trailhead toward Mt. Gutzulun on the borders of Pingtung and Taitung counties (elevation 1300 m) by T. J. Lin and R. C. Jang (coll. no. 2009-35); one clitellate worm (dissected) collected on the 14 May 2012 at 40.3 K of Road 7A (elevation 1724 m), Ilan County by H. P. Chen and H. H. Huang (coll. no. 2012-20); one clitellate worm collected on the 24 July 2012 near a small waterfall along a hiking trail about 1 km north of Siji Forest Road (elevation 1700 m), Ilan County by H. P. Chen and W. J. Chih (coll. no. 2012-85); three semi-clitellate worms collected on the 6 November 2012 just past 12 K of Cueifong Scenic Road (Pingyuan Forest Road) about 4 km away from Cueifong Lake (elevation 2087 m) in the Taipingshan National Forest Recreation Area, Ilan County by T. L. Ai and H. H. Huang (coll. no. 2012-181).

Description. － Length (clitellates) 38–67 mm,

diameter 2.6–3.91 mm. Segment number 90–124. Body cylindrical with a flattened posterior end. Prostomium epilobous. First clear dorsal pore in 4/5, occasionally in 3/4. Clitellum XXII–XXX or XXIII–XXX, saddle-shaped. Tubercula pubertatis as conical papillae in XXVI, slightly encroaching onto adjacent segments XXV and XXVII. Setae lumbricine (eight setae per segment), closely paired. Spermathecal pores absent. Female pores minute, lateral to seta b, one pair in XIV. Male pores small, one pair in XV. Live worms with dark purplish red dorsum, pale ventrum and dark orange clitellum.

Calciferous gland in XII. Crop in XV–XVI, gizzard in XVII–XVIII. Hearts in VII–XI. Nephridia holoic, bladders elongated sausage-shaped. Spermathecae absent. Testes and iridescent sperm funnels in X–XI. Seminal vesicles paired, small on anterior faces of septa 9/10 and 10/11, larger on posterior faces of septa 10/11 and 11/12. Ovaries small in XIII.

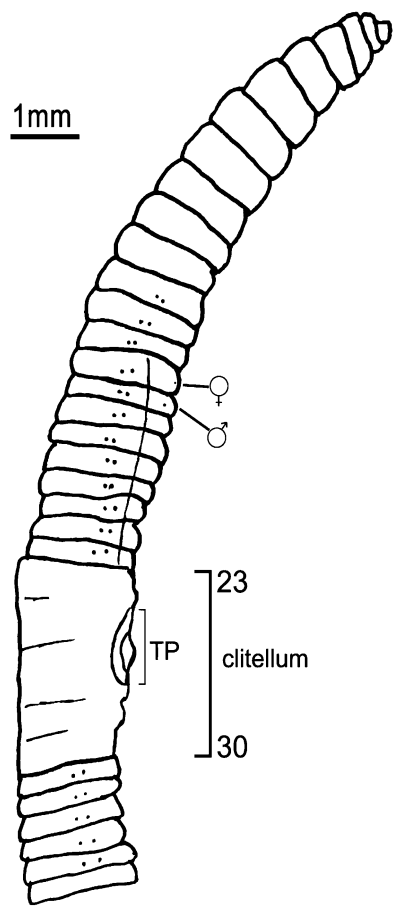

Fig. 1. *Eisenia anzac* Blakemore: Right-lateral view of preclitellar and clitellar region (♀, female pore; ♂, male pore; TP, tuberculum pubertatis).

Remarks. — The study of the Taiwanese earthworm fauna started in 1898 (Goto and Hatai 1898) and was slow with only 26 species recorded prior to 1999 (Tsai *et al*. 2009). It was not until the end of the 20th century that great progress was made (Tsai *et al*. 2009) and 107 species have been reported to date (Shen *et al*. 2018). As for Japan, its earthworm study began in 1883 (Horst 1883) with three following revisions made by Easton (1981) and Blakemore (2003, 2012a). Easton (1981) lists 73 valid species plus 26 names placed in synonymy with question marks (Blakemore 2003), and Blakemore (2012a) reports a total of 96 earthworm species from Japan. Although the earthworm study in Japan is much more comprehensive than in Taiwan, *E. anzac* was discovered not long ago from a man-made habitat in Yokohama in 2010 (Blakemore and Grygier 2011). Blakemore and Grygier (2011) guessed that the provenance of *E. anzac* is Europe, and this species is possibly incidentally introduced with plants indirectly from Canada, India, or Australia/New Zealand within the last 60 yrs. However, their guess is unlikely due to the absence of *E. anzac* in any of the aforementioned areas or countries. In contrast, the first specimens of *E. anzac* were collected in southern Taiwan as early as 2000, and *E. anzac* was found in subsequent collections in mountainous areas at elevations of 1300–2500 m in both southern and northern Taiwan. Additionally, all the localities in southern Taiwan are either in a nature reserve or in the national park, and some of these sites are quite remote. It seems that *E. anzac* is rare in Japan but not uncommon in Taiwan. Therefore, it is likely that *E. anzac* is a species native to Taiwan. It is possible that the distribution range of *E. anzac* might extend to Japan, or this species was accidentally brought to Japan during 1895–1945 when Taiwan was ruled by the Japanese government.

According to Csuzdi *et al*. (2017), with the exception of a few Central European species, *Eisenia* is primarily a temperate Asian genus originally from Central and Northeast Asia. The finding of *E. anzac* in Taiwan extends the area of endemic lumbricid earthworms further south and raises interesting biogeographic questions.

Eisenia japonica japonica (Michaelsen, 1891)

Allolobophora japonica Michaelsen, 1891: 6; 1892: 230; Kobayashi, 1936: 183; 1938: 414; 1941b: 378.

Helodrilus (Allolobophora) japonicus – Michaelsen, 1900: 481.

Allolobophora japonica f. *typica* – Kobayashi, 1941a: 151.

Eisenia japonica – Gates, 1975: 1; Easton, 1981: 43; Blakemore, 2003: 10; 2010: 659; 2012a: 17; Blakemore and Grygier, 2011: 270.

Eisenia japonica japonica – Blakemore, 2012b: 109; Hong and Csuzdi, 2016: 4.

Materials examined. — two clitellate worms (one dissected) collected on the 25 July 2012 along Siji Forest Road less than 1 km away from

Lintzu waterfall (elevation 2035 m), Ilan County by H. P. Chen and W. J. Chih (coll. no. 2012-89); two clitellate worms (one dissected) collected on the 6 November 2012 near 6 K of Cueifong Scenic Road (Pingyuan Forest Road) (elevation 1993 m) in the Taipingshan National Forest Recreation Area, Ilan County by T. L. Ai and H. H. Huang (coll. no. 2012-182).

Description. — Length (clitellates) 46–58 mm, diameter 2.6–3.12 mm. Segment number 94–115. Prostomium epilobous. First clear dorsal pore in 4/5. Clitellum XXIV–XXXI, saddle-shaped. Tubercula pubertatis raised area in XXV–XXIX with two distinctive sucker-like structures more ventrally on XXVII and XXIX. Setae lumbricine (eight setae per segment), closely paired. Spermathecal pores small, paired in 9/10/11, in line with seta c. Female pores minute, lateral to seta b, one pair in XIV. Male pores small slits, one pair in XV. Live worms rather transparent, preserved specimens with greyish body, pink head and white clitellum.

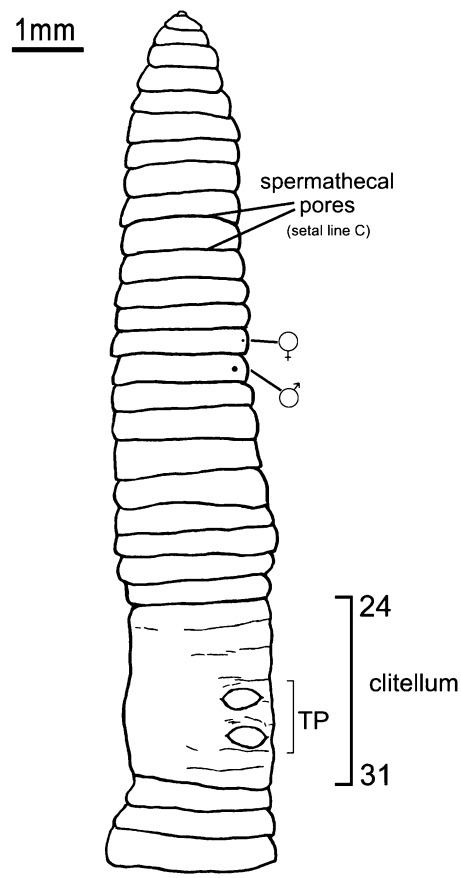

Fig. 2. *Eisenia japonica japonica* (Michaelsen): Right-lateral view of preclitellar and clitellar region (♀, female pore; ♂, male pore; TP, tuberculum pubertatis).

Calciferous glands in XI–XII. Crop in XV–XVI, gizzard in XVII–XVIII. Hearts in VII–XI. Nephridia holoic, bladders sausage-shaped. Spermathecae small, two pairs in X and XI. Testes with iridescent sperm funnels, two pairs in X and XI. Seminal vesicles paired, small in IX and X, larger in XI and XII. Ovaries small in XIII.

Remarks. — *E. japonica japonica* is widely spread in Japan from Kyushu to Hokkaido (Kobayashi 1941b) and in Korea (Kobayashi 1936, 1941ab; Blakemore 2013; Hong and Csuzdi 2016). This species was only found in northern Taiwan. It might have been unintentionally introduced from Japan during the Japanese colonial period in Taiwan.

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