한국동물분류학회지 제17권 제2호
The Korean Journal of Systematic Zoology
Vol. 17, No. 2: 185-190 (October 2001)

Identity of Two Earthworms Used in Vermiculture and Vermicomposting in Korea: *Eisenia andrei* and *Perionyx excavatus*

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ABSTRACT

Two vermiculture earthworms, *Eisenia andrei* Bouche, 1972 and *Perionyx excavatus* Perrier, 1872 are newly recorded to Korean fauna. *E. andrei* has no pale stripe on the intersegmental furrow zone and *P. excavatus* has clitellum in xiii-xvii. Descriptions of the species are provided in this paper, including illustrations of the ventral view, male pore region, and spermathecae.

Key words: Taxonomy, Oligochaeta, Lumbricidae, Megascolecidae, vermiculture, Korea

INTRODUCTION

A variety of organic materials, including sewage, sludge, cattle and pig manure, household and landscape wastes, and pharmaceutical by-products, have been used in vermiculture and vermicompost. In Korea, farmers and others have used earthworms for these purposes since 1970. However, these vermiculture earthworms have not been fully identified taxonomically and merely supposed to be as *Lumbricus rubellus* Hoffmeister, 1843, which was not yet recorded in Korea.

In this paper, we confirm the identity of two species, *Eisenia andrei* Bouche, 1972 and

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Perionyx excavatus Perrier, 1872. These species are newly recorded from Korea. They are common earthworms for breeding farms as are *Lumbricus terrestris* (Linnaeus, 1758), *L. rubellus, Eudrilus eugeniae* (Kinberg, 1867), *Eisenia hortensis* (Michaelsen, 1890), and *Amynthas corticis* (Kinberg, 1867). No earthworms native to Korea are known to be used in earthworm breeding.

Specimens were collected in breeding farms in Korea from 1997 to 1998. All examinations were carried by dorsal dissection under a microscope. Illustrations were made with a drawing tube.

DESCRIPTIONS

Family Lumbricidae Claus, 1876 낚시지렁이과

Genus *Eisenia* Malm, 1877 낚시지렁이속

***Eisenia andrei* Bouche, 1972** 붉은줄지렁이 (신칭) **(Fig. 1, A)**

Eisenia fetida andrei Bouche, 1972, p. 381.

Eisenia andrei Sims and Gerard, 1985, p. 79.

Material examined. 47 clitellate, 5 aclitellate, earthworm breeding farm, Paltan-myon, Hwaseong-gun, Gyonggi-do, 9 April 1998, Y. Hong; 50 clitellate, 15 aclitellate, earthworm breeding farm, Yeoju-gun, Gyonggi-do, 9 April 1998, Y. Hong; 25 clitellate, 6 aclitellate, earthworm breeding farm, Gimje, Jeollabuk-do, 1 Nov. 1997, Y. Hong.

Description. Dimensions 48-95 by 2.8-4.0 mm at segment x, 2.6-3.5 mm at xx, 3.3-4.7 mm at clitellum (xxviii); body cylindrical in cross-section, segments 75-98. Setae closely paired, 8 per segment around equators, size regular; setal formula $DD > CD < AA > AB$, $CD = AB$. Female pore single in xiv. Prostomium epilobous, 1/2 with tongue open. Red brownish or purple dorsally, with no pale tan stripe on the intersegmental furrows; yellowish ventrally, clitellum yellowish, formalin preservation. First dorsal pore 4/5. Clitellum saddle shape (xxiv, xxv), xxvi-xxxii, (xxxi); thick, setae and dorsal pores not visible externally within clitellum. Nephropores unrecognizable.

Male pores near lateral margins of ventrum in xv; on protuberances, pore area slightly depressed between *B* and *C*, with pores centered. Tubercula pubertatis, longitudinal bands, just lateral to *B*, (xxvii, xxix), xxviii-xxx, (xxxi). Genital tumescences present just to *B*, xxiv, xxv, xxvi, xxvii, xxviii-xxxi, xxxii, oval shape, sometimes faint. Spermathecal pores in 9/10 and 10/11, small, near the dorsal pore lines.

Septa usually thin. Lymph glands absent. Typhlosole large and thick in xx. Hearts usual in vii-xi. Nephridial bladders with digitform sac. Male sexual system holandric, testes and funnels in ventral paired sacs in x, xi. Seminal vesicles 3 pairs in ix-xii, sometimes ix, x, xi-xii, Paired spermathecae in ix, x; each ampulla middle voluminous pouch, thick, very short ducts.

Distribution. Cosmopolitan.

Remarks. This species was thought to be *Lumbricus rubellus* by many Korean earthworm farmers and scientists, but it differs in morphological characters. For example, *L. rubellus* has a tanylobic prostomium. Many experimental works using *L. rubellus* have been reported in Korea, but it is clear that *Eisenia andrei* was actually used instead.

E. andrei is almost solid red on the back, with no pale tan stripe on the intersegmental furrow

zone. *E. fetida* has a stripe on the furrow, and this stripe is almost one third the width of a segment. There are no internal characteristics to separate them and this difference is very important. There exist known genetic differences detectable by protein electrophoresis. It would be good to have a simple molecular marker to distinguish them and this technique could establish the correctness or incorrectness of the color difference. Many *Eisenia* cultures are mixed and it may be good to set up separate cultures of red and striped worms to see if they continue to breed independently. *E. fetida* is a common worm in agricultural ecosystems in Korea, sometimes living

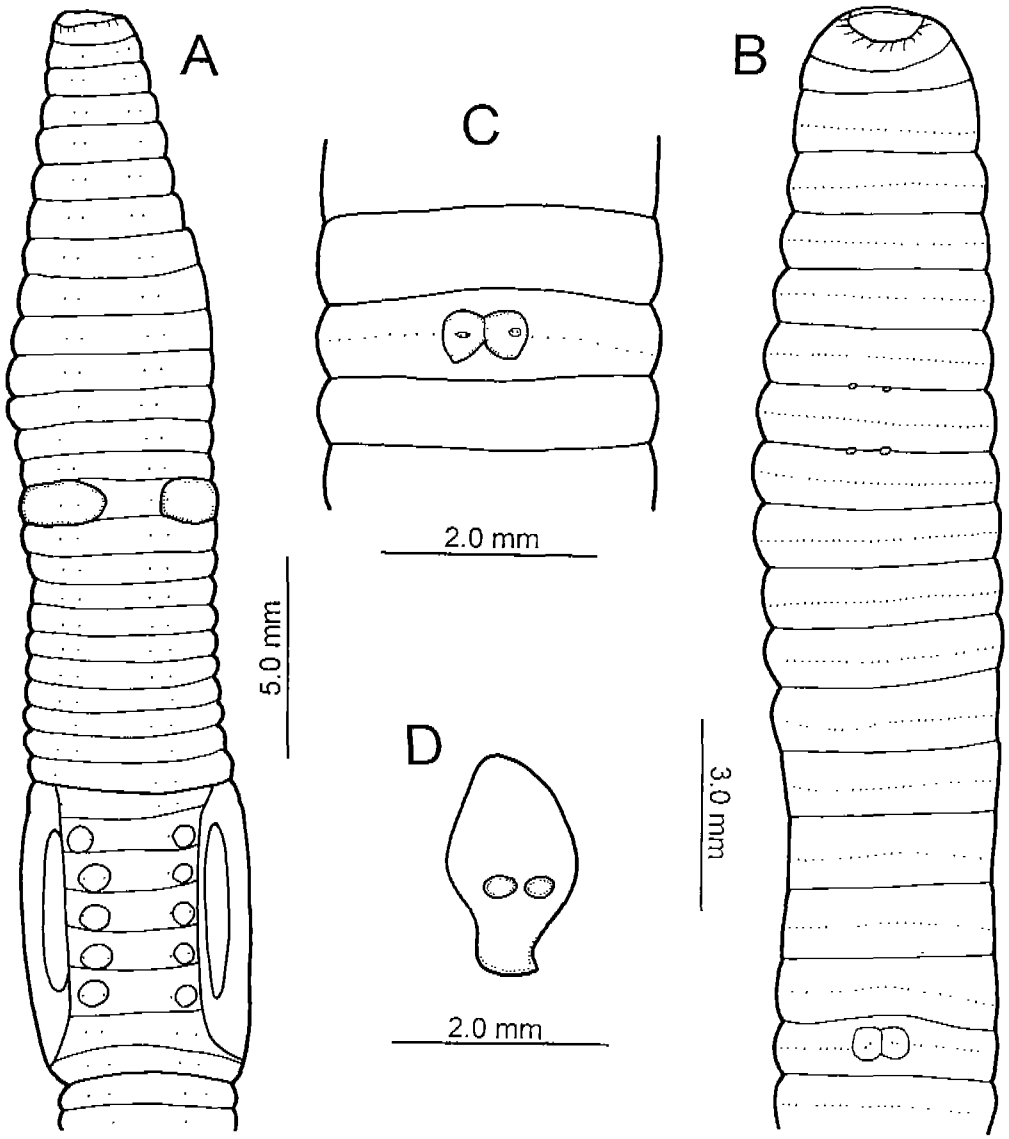

Fig. 1. *Eisenia andrei*. A, ventral view. *Perionyx excavatus*. B, ventral view; C, male pore region; D, spermathecae.

in the farm together with *E. andrei* (see Hong, 2000). *E. andrei* is faster in reproduction. They live in compost heaps, manure piles, man-made accumulations of leaf litter and other organic matter, under fallen leaves of vegetables and plants, under bark of rotten tree stumps, and in decaying fallen leaves, but rarely found in pasture and garden soils. It was widely distributed with a help of man plus dispersal accelerated by wandering.

Family Megascolecidae Rosa, 1891 지렁이과

Genus *Perionyx* Perrier, 1872 팔딱이지렁이속(신칭)

***Perionyx excavatus* Perrier, 1872** 팔딱이지렁이 (신칭) **(Fig. 1, B-D)**

Perionyx excavatus Perrier, 1872, p. 126; Beddard, 1895, p. 436; Michaelsen, 1900, p. 208; Stephenson, 1923, p. 329; Gates, 1972, p. 141.

Material examined. 17 clitellate, earthworm breeding farm, Paltan-myon, Hwaseong-gun, Gyonggi-do, 9 April 1998, Y. Hong; 15 clitellate, earthworm breeding farm, Yeoju-gun, Gyonggi-do, 9 April 1998, Y. Hong.

Description. Dimensions 78-139 by 2.8-3.5 mm at segment x, 2.7-3.5 mm at xxx, 2.8-3.2 mm at clitellum; body cylindrical in cross section, segments 118-171. Setae regularly distributed around segmental equators, numbering 40-49 at vii, 41-46 at xx; 0 between male pores, setal formula $AA : AB : CD : DD \approx 1.5 : 1 : 3 : 4$ at xii, $1 : 1 : 3 : 5$ at xvii. Female pore single in xiv, oval shape. Prostomium epilobous, 3/5 tongue open. Brownish dorsally and yellowish ventrally, clitellum yellowish, formalin preservation. First dorsal pore 4/5 or 5/6. Clitellum annular xiii-xvii; setae and dorsal pore visible externally. Nephropores unrecognizable.

Male pores oval shape, centered on xviii in ventrum, in slightly invaginated area; each with papillae attached to sides, covering 1/2 of segment xviii, each papilla with 2-5 penial setae, slightly within irregular transverse groove, setae with tips bluntly rounded or pointed. Spermathecal pores in 7/8 and 8/9, conspicuous near mV, 0.5 mm distance apart, same as male pores.

Septa 5/6 slightly thickened, 6/7-12/13 thin. Gizzard usually lacking. Intestine beginning at xv, lymph glands not found. Typhlosole absent. Esophageal hearts 3 pairs in x-xii, vii-ix large lateral. Nephridia avesiculate, one pair per segment from vi (or iii). Male sexual system holandric, testes and funnels in ventral paired sacs in x, xi. Seminal vesicles large in xi, xii-xiii (or xiv). Prostates small in xviii; having short ducts, straight, sessile on body wall.

Paired spermathecae in viii, ix; ampulla large pouch with deep milk color, ducts stout and short, diverticulum very small oval shape attached to ampulla, sometimes inconspicuous; no nephridia on spermathecal ducts.

Distribution. Cosmopolitan.

Remarks. The species is common in Asia and is used in vermiculture. The species was not collected from fields, forests, soils, manure heaps, etc. In this study, it was only found on earthworm breeding farms. Although the farmers call *P. excavatus* "Paltakie", which in Korean, means something that can stretch and leap. They can jump like springtails when disturbed.

The number of cocoons produced in a season differs greatly with temperature, but cocoon production can be as high as 1,014 per year. The species preferred a moisture content about 80-85% in organic materials at 25°C (Edwards, 1988). Activity and reproduction, in favorable conditions, are all the year around. As habitats dry out the worms disappear but where they go and

how they hibernate is unknown. Amputation and regeneration are common and these processes are easily induced and rapidly completed, at every point along the body (Gates, 1972). Copulation has never been observed even though many farmers have seen.

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RECEIVED: 16 July 2001
ACCEPTED: 19 September 2001

국내 양식 지렁이 *Eisenia andrei*와 *Perionyx excavatus*의 구분

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요 약

양식 지렁이인 붉은줄지렁이(*Eisenia andrei*)와 팔딱이지렁이(*Perionyx excavatus*) 2종에 대한 기재를 하으며, 이 2종에 대한 국내에서 분류학적 기록은 처음이다. 붉은줄지렁이는 뚜렷한 가로줄무늬가 없으며, 팔딱이지렁이 환대는 13-17마디이다.