

Four Unrecorded Species of Tubificid Oligochaetes (Annelida: Clitellata) in Korea

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ABSTRACT

Tubificid oligochaetes are common and frequently dominant in freshwater benthic habitats. They are so tolerant to water pollution that they are often used as biological indicators. Faunistic studies of Korean freshwater oligochaetes have been actively conducted recently. The most well studied oligochaete family in Korea is the tubificids following the naidids. Nine species of tubificids have been reported so far. Nevertheless, many species of tubificids still remain to be discovered in Korea. In this study, we added four species of tubificid oligochaetes to the Korean fauna, including *Linmodrilus profundicola* (Verrill, 1871), *Potamothrix heuscheri* (Bretscher, 1900), *Tubifex blanchardi* Vejdovský, 1891, and *Ilyodrilus templetoni* (Southern, 1909) based on specimens collected from three locations in Korea: Cheonan-si, Geoje-si, and Seocheon-gun. In particular, *P. heuscheri* was first reported in Asia.

Keywords: tubificid, freshwater oligochaete, Korea, *Linmodrilus profundicola*, *Potamothrix heuscheri*, *Tubifex blanchardi*, *Ilyodrilus templetoni*

INTRODUCTION

Many species of Oligochaeta occur in a variety of freshwater environments such as puddles, rice paddies, reservoirs, brooks, rivers, and streams. About 1,700 species are known (Caramelo and Martínez-Ansemil, 2012). Oligochaetes are small-sized worms, ranging from 1 mm to a few centimeters in length. Tubificids are a dominant group found in freshwater benthic habitats among aquatic oligochaetes, and consequently bear ecological importance. Their bodies are red, and their reproductive organs are well-developed during maturity. When alive, their head is in the bottom sediment, usually gregarious in habitat and most commonly found in soft sediments covered with organic matter (Schenkova and Helešic, 2006). Oligochaetes serve as an important source of food for fish and other aquatic animals as well as decomposers. Some oligochaetes have been used to monitor water pollution in rivers and streams (Lin and Yo, 2008). As a result of recent faunistic studies (Park et al., 2013a, 2013b), nine species of tubificids have been described in Korea, including *Branchiura sowerbyi* Beddard, 1892, *Limnodrilus hoffmeisteri* Cleparéde, 1862, *L. claparedeianus* Ratzel, 1869, *L. udekimianus* Clep-

aréde, 1862, *Monopylephorus rubroniveus* Levinsen, 1884, *Bothrioneurum vejdoskyanum* Stolc, 1888, *Rhyacodrilus coccineus* (Vejdovsky, 1875), *Rhyacodrilus sulptensis* Timm, 1990 and *Tubifex tubifex* (Müller, 1774). Of these, *L. hoffmeisteri* and *T. tubifex* have been used in an ecological investigations on agricultural and stream ecosystems (Bae and Lee, 2001; Han et al., 2007). Nevertheless, many species of tubificids still remain to be discovered in Korea because of the many uninvestigated diverse benthic habitats. In this study, four species of tubificids such as *L. profundicola*, *Potamothrix heuscheri*, *T. blanchardi*, and *Ilyodrilus templetoni* are reported new to Korea with diagnosis, remarks and illustrations. Therefore, 13 species belonging to eight genera of tubificids including this study were reported in Korea. Of these, genus *Potamothrix* originated from Ponto-Caspian basin in Europe. In Asian countries, they were described Central Asia and South China (Timm, 2013). *Potamothrix heuscheri* is recorded for the first time in Asia.

MATERIALS AND METHODS

Specimens were collected from March–May 2013 from Gyo-

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chon-ri, Mokcheon-eup, Dongnam-gu, Cheonan-si, Chungcheongnam-do; Sinseong-ri, Hansan-myeon, Seocheon-gun, Chungcheongnam-do; Siljeon-ri, Hacheong-myeon, Geje-si, Gyeongsangnam-do, Korea. Aquatic oligochaete samples were collected using a hand shovel at the edge of a stream covered with fine sand or sediment rich in organic material. In the laboratory, the samples were sorted under a stereomicroscope while the organisms were alive. They were fixed in 5% formaldehyde or 70% ethanol solutions, and the specimens were stained in alcoholic paracamine and mounted whole in Canada balsam following the protocol of Erséus (1994). Identification and measurements were performed using slide-mounted specimens. Figures and pictures were made with a BX41 research microscope (Olympus, Tokyo, Japan) attached to a 650D digital camera (Canon, Tokyo, Japan). Measurements were made with an eyepiece micrometer or by pictures taken and analyzed with InnerView™-i series image analyzing software (Innerview Co. Ltd., Seongnam, Korea). The figures were drawn with a microscope drawing tube. These mounted collections are stored in the Lab of Ecology Genetic (LEG), Department of Science Education, Ewha Womans University. Other materials, preserved in 70% ethanol, were submitted to the National Institute of Biological Resources (NIBR) of the Republic of Korea.

SYSTEMATIC ACCOUNTS

Phylum Annelida
 Class Clitellata
 Order Haplotaxida

Suborder Tubificina
 Family Tubificidae Vejdovský, 1884
 Genus *Limnodrilus* Claparède, 1862

Key to the Korea species of the Genus *Limnodrilus*

1. Thick walled cuticular archtomy and sheaths cylindrical, usually much longer than broad, surrounded by spiral muscles 2
 2. Penial sheath thin-walled, 50–80 times wider than sheath width *L. claparedeianus*
 Penial sheaths up to 7 times longer than broad, mwith hood reflected back over shaft unless forced forward
 *L. profundicola**
 - Length of penial sheath 4 times wider than sheath width
 *L. udekemianus*
- * Species of present study.

¹**Limnodrilus profundicola* (Verrill, 1871) (Fig. 1A–C)

Tubifex profundicola Verrill, 1871: 451.
Tubifex profundicola Verrill. Smith, 1874: 699.vc
Limnodrilus alpestris Eisen, 1879: 10.
Limnodrilus monticola Eisen, 1879: 18.
Limnodrilus alpestris Eisen, Vejdovsky, 1884: 45; Eisen, 1886: 896, Pl. II, fig. 11a–h; Pl. XVII, fig. 11i–k; Pl. XIX, fig. 18; Beddard, 1895: 254; Rybka, 1898: 390; Michaelsen, 1900: 44; 1914: 16, Pl. V, fig. 5; Galloway, 1911: 315.
Limnodrilus monticola Eisen, Vejdovsky, 1884: 45; Eisen, 1886: 896, Pl. XI, fig. 10a–h; Beddard, 1895: 254; Michaelsen, 1900: 46; Galloway, 1911: 315.
Clitellio (*Limnodrilus*) *alpestris* (Eisen). Vaillant, 1890: 428.
Clitellio (*Limnodrilus*) *monticola* (Eisen). Vaillant, 1890: 427.

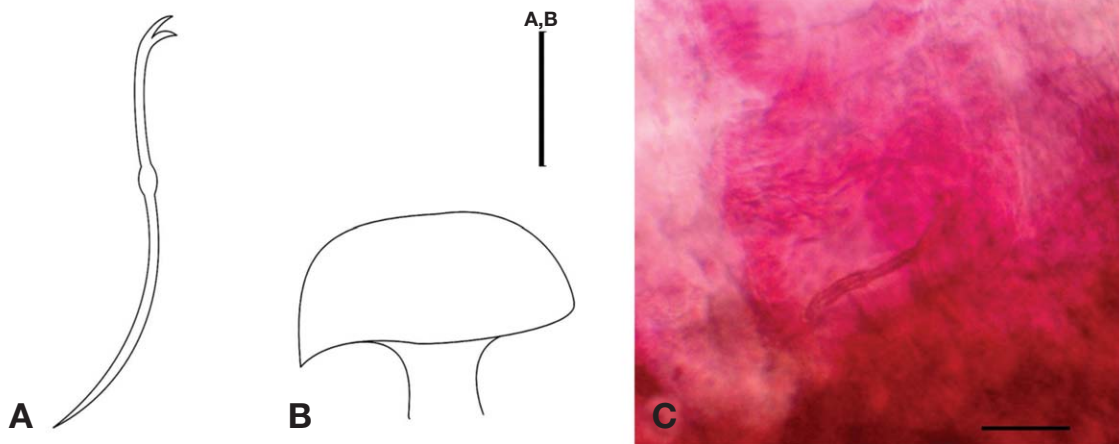


Fig. 1. *Limnodrilus profundicola* (Verrill, 1871). A, Ventral chaeta; B, Penial sheaths; C, Head of penial sheaths. Scale bars: A–C=1 μm.

Korean name: ¹*우산실지렁이

Limnodrilus helceticus Piguët, 1913: 134, figs. 8–10.
Limnodrilus helveticus Piguët, Piguët and Bretscher, 1913: 79, fig. 19b; Hrabě, 1954: 306; Juget, 1957: 3; 1958: 90, fig. 14a, b; Malevitch, 1957: 82; Sokolskaya, 1958: 310; 1961a: 56; 1961b: 85; Brinkhurst and Kennedy, 1962: 185; Moszynska, 1962: 27; Brinkhurst, 1963: 38, fig. 24a–e, 41, fig. 12g.
Limnodrilus profundicola (Verrill). Brinkhurst, 1965: 130, fig. 4k–m.

Material examined. All specimens were collected from Gyocheon-ri, Mokcheon-eup, Dongnam-gu, Cheonan-si, Chungcheongnam-do, Korea, 36° 51'38.93"N, 126° 38'27.29"E, 21 May 2013 (collector Lee J). Small and shallow pools with the bottom covered in sludge such as soft mud and organic matter. CBCA 1305211: mature, mounted on a slide, deposited at LEG. KOSPIV0000193713: mature, preserved in 70 % ethanol solution, deposited at NIBR.

Diagnosis. Length 13.85 mm, width at X 0.76 mm, number of segments 87.

No eye present. Ventral chaetae of anterior segments, bifid, arranged in two rows of 6–8 per bundle, with teeth of equal length (Fig. 1A). Dorsal chaetae with no hair chaeta, similar form to ventral chaetae. Penial sheaths in segment X, up to 7 times longer than broad, with head plate reflected back over the shaft, representing an umbrella or mushroom shape (Fig. 1B, C). Dark chloragogen tissue on oesophagus beginning from VI.

Distribution. Holarctic.

Remarks. *Limnodrilus profundicola* is very similar to *L. hoffmeisteri*. The specimens in this study could clearly be distinguished from *L. hoffmeisteri* according to distinct difference in the shape of the chaeta (Fig. 1A). *Limnodrilus hoffmeisteri* had a curved lower and relatively straight upper tooth, both of which have pointed ends. Identified features of this specimen, such as shape and position of chaetae, penial sheaths were almost similar to those of a previous study (Jaweir, 2011), but penial sheaths had some discrepancies in length ratio. Head plate of penial sheaths of *L. profundicola* has diverse shapes (Brinkhurst, 1986). The specimens we observed showed an exact one of those shapes. This is the first report of this species from Korea.

¹*Genus *Potamothrix* Vejdovsky and Mrazek, 1902

²**Potamothrix heuscheri* (Bretscher, 1900) (Fig. 2A–E)
Tubifex heuscheri Bretscher, 1900: 11, Pl. I, figs. 1–4.
Tubifex heuscheri Bretscher. Bretscher, 1905: 664; Piguët, 1906: 391; 1913: 127, fig. 4a, b.

Ilyodrilus heuscheri (Bretscher). Piguët, 1913: 127; Stammer, 1932: 578; Jaroschenko, 1948: 57; Hrabě, 1950: 280; Juget, 1958: 89, fig. 141; Cekanovskaya, 1962: 260, fig. 159.
Tubifex (Ilyodrilus) heuscheri Bretscher. Piguët and Bretscher, 1913: 69, figs. 14a, 7b.
Ilyodrilus orientalis Cernosvitov, 1938: 545, figs. 16–23.
Ilyodrilus orientalis Cernosvitov. Hrabě, 1950: 279.
Euiyodrilus orientalis (Cernosvitov). Brinkhurst, 1963: 51.
Euiyodrilus orientalis (Bretscher). Brinkhurst and Kennedy, 1962: 184; Brinkhurst, 1963: 49, fig. 34.

Material examined. All specimens were collected from Siljeon-ri, Hacheong-myeon, Geoje-si, Gyeongsangnam-do, Korea, 34° 58'27.35"N, 128° 39'23.65"E, 25 Apr 2013 (collector Lee J). The sampling location was an agricultural waterway and small brook. The location was polluted with sewage and organic matter. GSGJ1304251: mature, mounted on a slide, deposited at LEG. KOSPIV0000193717: mature, preserved in 70% ethanol, and deposited at NIBR.

Diagnosis. Length 8.27 mm, width at X 0.29 mm, number of segments 64.

Prostomium short conical and separated by a distinct furrow. Ventral chaetae in II, 2–4 per bundle, with upper tooth straight, longer than the lower (Fig. 2A, B). Hair chaeta 1–2 per bundle, with pectinate chaetae, with relatively long and straight teeth and several slightly shorter intermediate denticles (Fig. 2C, D). Spermathecal chaetae mostly with narrow, hollow-tipped with parallel edges of the distal grooved portion, and with hooked distal end (Fig. 2E). Chloragogen cells from II onwards.

Distribution. Western Palearctic, East Africa, South America.

Remarks. This specimen had spermathecal chaetae that have a long needle with slightly curved tip, which is characteristic of *P. heuscheri* suggested by Haaren and Soors (2013). This species is usually found in highly polluted environments with low oxygen, or in narrow and shallow freshwater habitats (Milbrink, 1999). The collection site for these specimens coincided with the environment described in previous studies. This species had not been reported in Asia before this study.

Genus *Tubifex* Lamarck, 1816

Key to the Korean species of the Genus *Tubifex*

1. Prostates attached to anterior face of upright atria with broad apically and narrow gradually towards the penial bulbs, vasa deferentia frequently very long 2
2. Chaeta bundle containing all chaeta types, muscular penial bulb present *T. tubifex*
 Chaetae are comparatively straight and thin in both

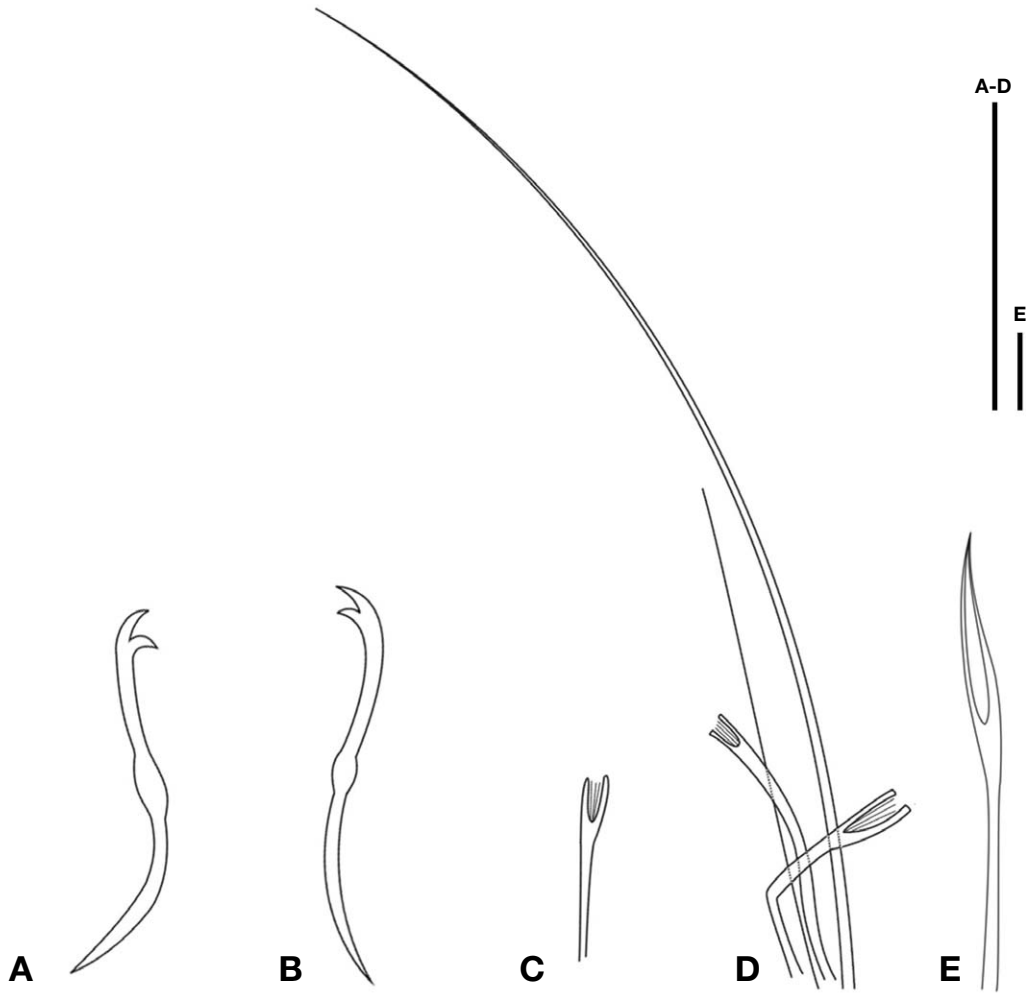


Fig. 2. *Potamothrix heuscheri* (Bretscher, 1900). A, Ventral chaeta III; B, Ventral chaeta VII; C, Dorsal chaeta III; D, Dorsal chaetae VII; E, Spermathecal chaetae. Scale bars: A-E=1 μ m.

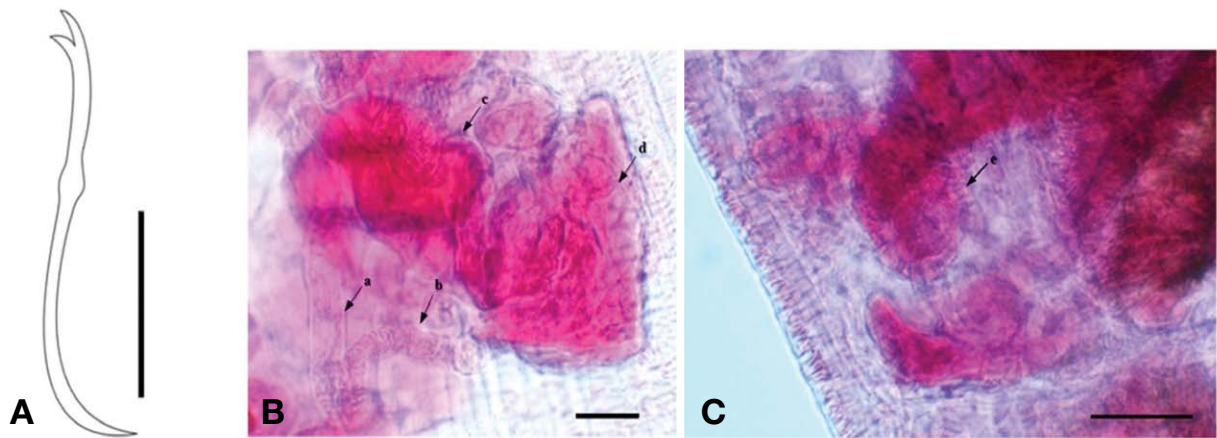


Fig. 3. *Tubifex blanchardi* Vejdovský, 1891. A, Ventral chaeta IV; B, Reproductive organs (a, b, deferent ducts; c, atrium; d, spermathecae sac); C, Sperm duct. Scale bars: A, B=1 μ m, C=5 μ m.

anterior and posterior crotchets, penial with truncated conical, thick-walled. *T. blanchardi**
 * Species of present study.

¹**Tubifex blanchardi* Vejdovský, 1891 (Fig. 3A–C)
Tubifex tubifex f. *Blanhardi* Vejdovsky, 1891

Material examined. The specimen was collected from Sin-

seong-ri, Hansan-myeon, Seocheon-gun, Chungcheongnam-do, Korea, 36° 4'6.54"N, 126° 51'42.94"E, 22 Mar 2013 (collector Lee J). The sampling site was a shallow ditch of rice paddy with soft sediments at the bottom. CNSC130322a1: mature, mounted on a slide, deposited at LEG.

Diagnosis. Length 20.19 mm, width at XI 0.61 mm, number of segments 78.

Ventral chaetae in II, 5–6 per bundle, with slightly longer

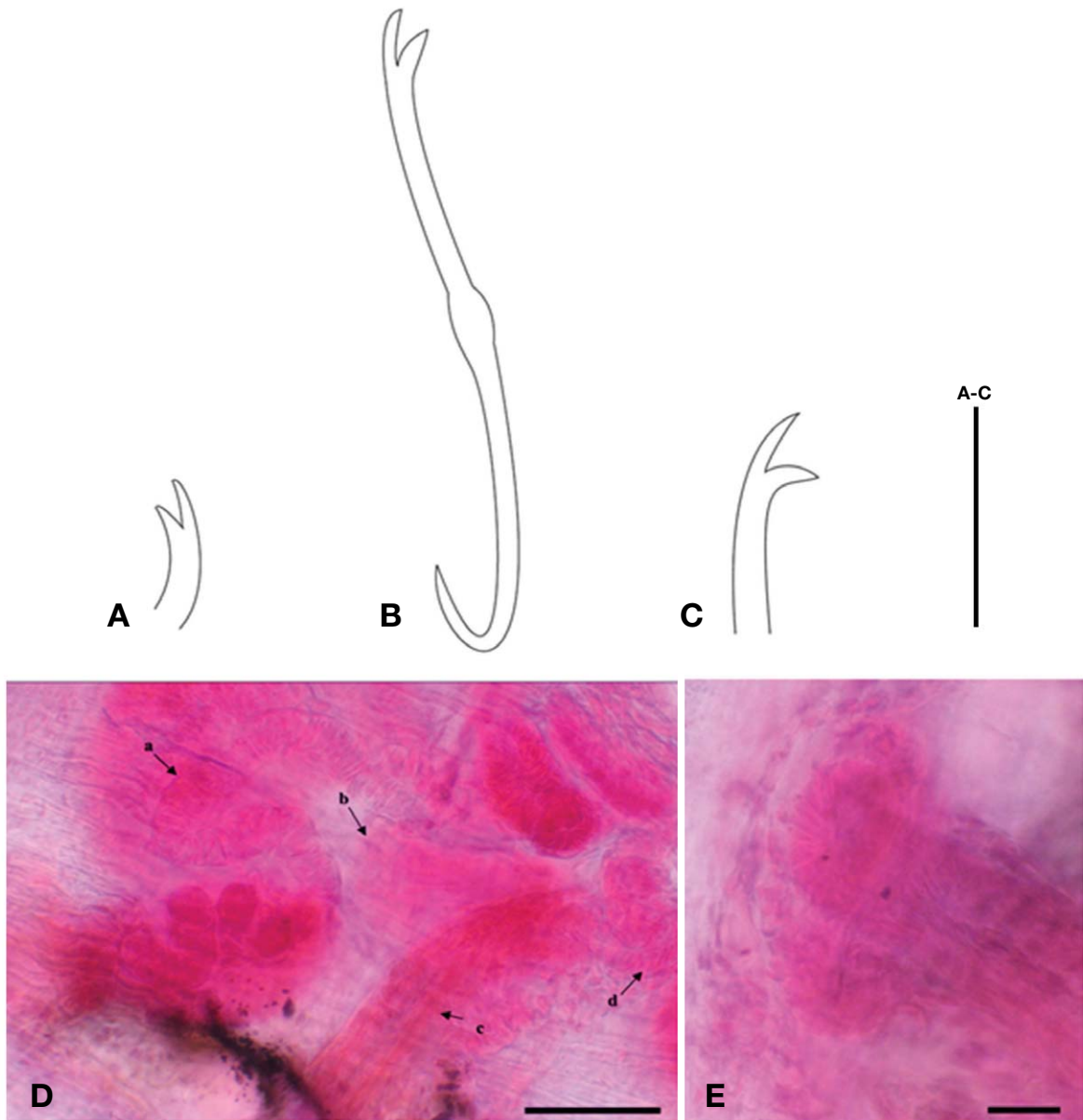


Fig. 4. *Ilyodrilus templetoni* (Southern, 1909). A, Ventral chaeta II; B, Ventral chaeta III; C, Ventral chaeta V; D, Reproductive organs (a, vasa deferentia; b, prostate; c, penial sheath; d, atrium); E, Head plate of penial sheaths. Scale bars: A–C, E=1 μm, D=5 μm.

Korean name: ¹*민털참실지렁이

upper tooth in anterior segments (Fig. 3A). Hair chaetae absent. Clitellum is muff-shaped and extends from mid segment X to the end of segment XII. Sexual organs in XI. Vasa deferentia coiled ducts, thin-walled inside, thick-walled outside (Fig. 3B). Penial with truncated conical, thick-walled inside with glandular cells (Fig. 3C).

Distribution. Europe, North Africa.

Remarks. *Tubifex blanchardi* bears a striking similarity to *T. tubifex*. Until recently, *T. blanchardi* was regarded as an ecological form of *T. tubifex* (Brinkhurst and Jamieson, 1971). *Tubifex tubifex* has hair chaeta and pectinate, but *T. blanchardi* only have bifid chaetae in the dorsal chaetal bundles (Marotta et al., 2009). These external morphological differences enabled us to discriminate this species from *T. tubifex*, although male reproductive organs are similar in these species. This is the first report of this species from Korea.

¹*Genus *Ilyodrilus* Eisen, 1879

²**Ilyodrilus templetoni* (Southern, 1909) (Fig. 4A–E)

Tubifex templetoni Southern, 1909: 140, Pl. VIII, fig. 6a–e; Friend, 1912: 292; Lastockin, 1927: 67; Brinkhurst, 1962: 326, fig. 1n; 1963: 23; 1965: 124, fig. 2e–g; Cekanovskaya, 1962: 275; Hrabě, 1962: 308; Kennedy, 1964: 228.

Tubifex templetoni var *typical* Brinkhurst, 1963: 37, fig. 9d. *Tubifex templetoni* var *walshi* Brinkhurst, 1963: 42, fig. 9c; 1966: 736, fig. 1j–1.

Ilyodrilus templetoni (Southern). Hrabě, 1966: 61, figs. 9–20.

Material examined. All specimens were collected from Sinseong-ri, Hansan-myeon, Seochon-gun, Chungcheongnam-do, Korea, 36° 4'6.54"N, 126° 51'42.94"E, 22 Mar 2013 (collector Lee J). The sampling site was a narrow ditch of rice paddy with soft sediments at the bottom. CNSC130322b1, CNSC130322b2: immature (we observed sexual organs as formation of sexual organs was in progress), mounted on slides, deposited at LEG. KOSPIV0000193718: immature, preserved in 70% ethanol, deposited at NIBR.

Diagnosis. Length 6.99–15.70 mm, width at XI 0.36–0.42 mm, number of segments 102–121.

Ventral chaetae with the upper tooth slightly longer and thinner than the recurved lower tooth with no intermediate tooth, 2–5 per bundle (Fig. 4A–C). Vasa deferentia as long as the atrium. Chitinous penial sheath long, conical in their expanded proximal end in X, disto-lateral opening (Fig. 4D, E). Penial chaetae absent, no spermatozeugmata.

Distribution. Europe, North America, Asia, South Africa.

Remarks. *Ilyodrilus templetoni* is morphologically similar to *Varichaetadrilus harmani*, *T. tubifex* and *Tasserkidrilus* species,

but they can be identified based on the shape of penial sheath. *Tubifex tubifex* has tub-shaped sheaths, *V. harmani* has medially narrowed sheaths, and *Tasserkidrilus* 11 species has long and conical sheaths. The sheaths of *I. templetoni* are long and conical like *Tasserkidrilus* species. However, the proximal end of sheaths is slightly expanded (Fig. 4E), which was suggested as the diagnostic character of *I. templetoni* as well as the characteristic shape of ventral chaetae (Fig. 4A–C) in a previous study (Haaren and Soors, 2013). This species inhabits eutrophic, static, and flowing waters (Uzunov et al., 1988). This is the first report of this species in Korea.

ACKNOWLEDGMENTS

Financial support was provided by the National Institute of Biological Resources (NIBR) of Ministry of Environment, KOREA (NIBR No. 1834-302 and 2013-02-001). It was also supported by the BK21 Plus funded by the Ministry of Education, Korea (31Z20130012990).

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Korean name: ¹*작은참실지렁이속, ²*템플톤작은참실지렁이

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Received May 14, 2014
 Revised September 9, 2014
 Accepted September 11, 2014