

Aquatic Oligochaete (Annelida: Clitellata) Fauna from the Jungnang Stream in Seoul, Korea, with Eight New Korean Records

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Abstract Aquatic oligochaetes were investigated from a small amount of sediment sampled from the Jungnang Stream, an urban stream in Seoul, Korea, in November 2012. Sorted oligochaetes were observed under a light microscope in a drop of carbonated water, and then preserved in 70% ethanol. Some specimens were slide mounted using glycerin and Eupharal. As a result, the following 12 species were identified including 8 new Korean records, *Bothrioneurum vejdoskyanum* Stolc, *Branchiodrilus hortensis* (Stephenson), *Chaetogaster cristalinus* Vejdosky, *Nais communis* Piguët, *Nais pardalis* Piguët, *Dero obtusa* d'Udekem, *Piguetiella denticulata* Liang, and *Haemonais waldvogeli* Brescher and 4 additional known species, *Limnodrilus hoffmeisteri* Claparède, *Branchiura sowerbyi* Beddard, *Chaetogaster diastrophus* (Gruithuisen), and *Stylaria fossularis* Leidy. This study shows how freshwater oligochaetes are diverse even in urban streams in Korea, if a proper sampling and examining method is employed.

Key words: aquatic Oligochaeta, Naididae, Tubificidae, Jungnang Stream, sediment, Korea

INTRODUCTION

Aquatic Oligochaeta, belonging to Annelida, is one of the major groups of benthic macroinvertebrates in terms of biomass and species richness in diverse freshwater habitats, such as streams, rivers, lakes, and wetlands. They also play an important role in recycling substances in benthic environments (Martin *et al.*, 2008). In Korea, however, taxonomic and ecological studies on aquatic oligochaetes have hardly been performed to date and they have not been included as a target study taxon in limnological surveys or biomonitoring. Only 5 papers on the taxonomy of Korean aquatic Oligochaeta have been published in Korea. Rodriguez and Brinkhurst

(1994) described a new genus and species, *Lamprotus orientalis*, from Suyeonggang in Busan. Yoon *et al.* (2000) reported 7 species of Tubificidae and Naididae from several wetlands in Gyeongsangnam-do. Jung (2011, 2012) reported 6 species of Naididae including 2 species new to Korea from streams in Gyeonggi-do. Park *et al.* (2013) reported 12 species of freshwater Oligochaeta including 8 species new to Korea from 72 localities throughout Korea with a checklist and taxonomic keys to all known Korean Oligochaeta taxa. In many previous limnological reports conducted in Korea, oligochaetes have been identified as *Limnodrilus gotoi* Hatai (= *Limnodrilus hoffmeisteri* Claparède) or simply Tubificidae spp. This is caused by the lack of proper taxonomic references.

Most aquatic oligochaetes found in freshwater habitats belong to two families, Tubificidae and Naididae. These families are the two largest groups in microdrile oligochaetes. While 238 Naididae and 684 Tubificidae species

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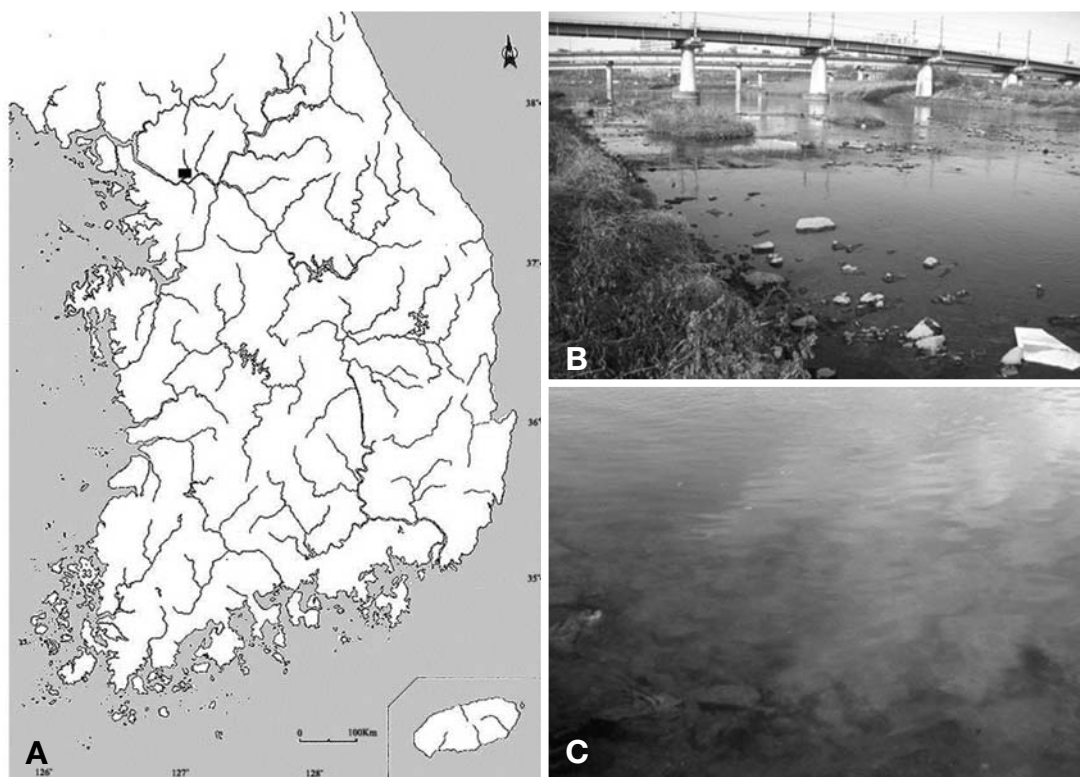


Fig. 1. A. Collecting site (E:127° 03'13.55", N:37° 33'05.46"): Lower Jungnang Stream at Songjeong-dong, Seongdong-gu, Seoul; B. Landscape; C. Microhabitat.

are known worldwide (Martin *et al.*, 2008), 52 freshwater oligochaete species, mostly in the Naididae and Tubificidae, have been reported in China (Timm, 1999) and 54 species in Japan (Timm, 1999). According to a recent checklist, 36 species of freshwater oligochaete belonging to 7 families are known in Korea (Park *et al.*, 2013).

This study aims at an investigation of aquatic Oligochaeta fauna from an urban stream in Korea. We want to show how freshwater oligochaetes are diverse and abundant from sediments of polluted urban streams in Korea.

MATERIALS AND METHODS

Oligochaetes were collected from the lower reach of the Jungnang Stream that runs eastern part of Seoul and empties into the Han River, the largest river system in Korea. The stream is about 20 km in length and the basin area is approximately 288 km². The stream is moderately polluted (monthly average BOD 2.9 ppm in Novem-

ber 2013, from <http://water.nier.go.kr/waterMeasurement>) and the substrates are composed of sand, gravel, cobbles, and boulders.

Collecting was conducted on November 29, 2012 at the Jangangyo (Bridge) site near the stream mouth (Fig. 1A-C). Approximately 250 mL substrates containing aquatic oligochaetes and other benthic macroinvertebrates were sampled with a hand net (mesh size 0.5 mm), preserved in a 500 mL plastic bottle with stream water, and brought to the laboratory keeping benthic macroinvertebrates alive. Transportation to the laboratory took about 20 minutes. Sampled substrates were then kept in a transparent acryl tub (18 × 10 × 13 cm) with aerated tap water. Aquatic oligochaetes were sorted and observed in carbonated water under light microscope (Carl Zeiss AX10 with AxioCc, Germany). After observation, specimens were preserved in 70% ethanol. Some specimens were mounted on slide glasses in glycerin and Eupharal MTNG medium to observe additional taxonomic characters. The specimens were deposited in the Entomological Museum of Korea University, Seoul.

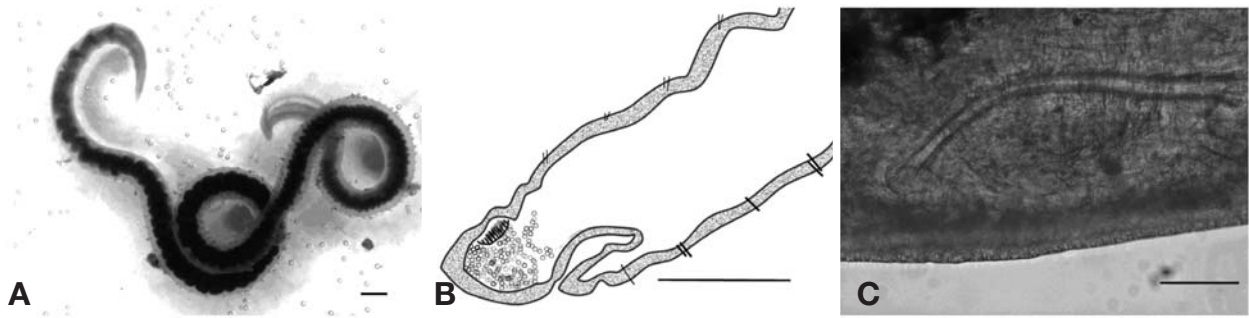


Fig. 2. A. Living specimen ($\times 8$); B. *Bothrionurum vejdoskyanum*, prostomium and coelomocytes; C. *Limnodrilus hoffmeisteri*, penial sheath. Scale bars: 1 mm (A), 200 μm (B, C).

TAXONOMIC ACCOUNTS

Order Tubificida Jamieson, 1984

Family Tubificidae Vejdovsky, 1884

Genus *Branchiura* Beddard, 1892

Branchiura Beddard, 1892.

Type species: *Branchiura sowerbyi* Beddard, 1892.

Diagnosis. Prostate glands diffuse; spermatophore absent; coelomocytes absent. Body posterior part with dorsal and ventral gill filaments (Fig. 2A)

Remarks. This genus contains single species (*B. sowerbyi*) that possesses gill branches.

Branchiura sowerbyi Beddard, 1892 (Fig. 2A).

Branchiura sowerbyi Beddard, 1892.

Material examined. 3 individuals.

Diagnosis. Body relatively large. Prostomium conical. Dorsal anterior chaeta bundles with 1-3 short hair chaetae and 5-10 chaetae; chaetae simple-pointed to short upper tooth bifid. Dorsal posterior chaeta bundles with 1-2 hair chaetae and 6-10 bifid chaetae; upper tooth shorter than lower tooth. Ventral bundles with 6-10 bifid chaetae; upper tooth shorter than lower tooth; chaetae even simple-pointed anteriorly. Dorsal and ventral gill filaments located on body posterior part (Fig. 2A).

Distribution. Nearctic, Palearctic, Afrotropical, Indomalaya, Australasia, Neotropical.

Remarks. *B. sowerbyi* has posterior gills, which is unique within Tubificidae.

Genus *Bothrionurum* Stolc, 1888

Bothrionurum Stolc, 1888.

Type species: *Bothrionurum vejdoskyanum* Stolc, 1888.

Diagnosis. Male pore median; coelomocytes present; spermathecae absent.

Bothrionurum vejdoskyanum Stolc, 1888 (Fig. 2B).

Bothrionurum vejdoskyanum Stolc, 1888.

Material examined. 5 individuals.

Diagnosis. Body cavity with numerous coelomocytes. Prostomium elongated; prostomium dorsal side located on a sensory pit lined with thickened epithelium (Fig. 2B). Beginning of chloragogen tissue on oesophagus obscure. Foremost chaetae upper tooth almost straight, thinner and twice as long as lower tooth. Anterior bundles with 3-5 bifid chaetae. Posterior bundles with 2 bifid chaetae.

Distribution. Nearctic, Palearctic, Afrotropical.

Remarks. This species has a sensory pit at dorsal side of prostomium, which is unique within Tubificidae. Dark chlorogen cells cover oesophagus onward from VI.

Genus *Limnodrilus* Claparède, 1862

Limnodrilus Claparède, 1862.

Type species: *Limnodrilus hoffmeisteri* Claparède, 1862.

Diagnosis. Body cavity without coelomocyte. All chaetae bifid. Spermathecae with spermatopores; vas deferentia long. Small bean shaped atria bearing large prostate glands. Penes elongate with thick cylindrical sheaths.

Limnodrilus hoffmeisteri Claparède, 1862 (Fig. 2C).

Limnodrilus hoffmeisteri Claparède, 1862.

Material examined. 19 individuals.

Diagnosis. Anterior bundles with 3-9 chaetae; upper tooth varying in length from slightly shorter to longer than lower tooth; upper tooth usually thinner than the lower tooth; Posterior bundles with fewer chaetae than posterior ones. Vas deferentia long; atria bean shape.

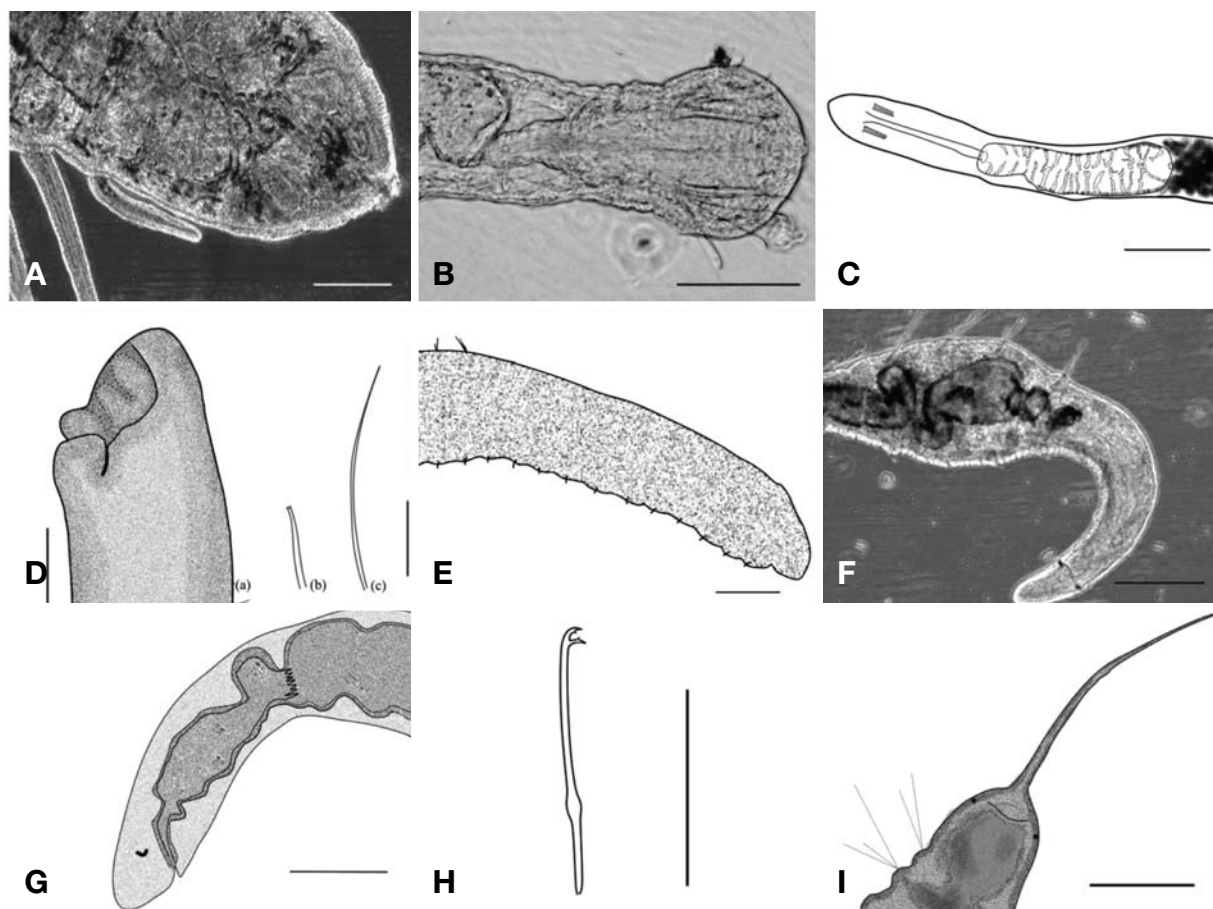


Fig. 3. A. *Branchiodrilus hortensis*, posterior part; B. *Chaetogaster diastrophus*, posterior body; C. *Chaetogaster christallinus*, stomach; D. *Dero obtusa*, (a) branchial disc, (b) dorsal needle VI, (c) dorsal hair VI; E. *Haemonais waldvogeli*, posterior body; F. *Nais communis*, oesophagus; G. *Nais pardalis*, oesophagus; H. *Piguettiella denticulata*, ventral crochet V; I. *Stylaria fossaulus*, prostomium. Scale bars: 200 μm (A, B, C, D-a, E, F, G, I), 50 μm (D-b, c, H).

Penial sheaths up to 10-15 times longer than breadth. Ectal ends slightly flared. Ectal ends either with elaborate hook opening at right-angles to shaft or sometimes hook with scalloped edges (Fig. 2C).

Distribution. Nearctic, Palearctic, Afrotropical, Indomalaya, Australasia, Neotropical.

Remarks. This species has been frequently misidentified as '*Limnodrilus gotoi*' and reported in various limnological surveys in Korea (see Ohtaka, 1985).

Family Naididae Ehrenberg, 1828

Genus *Branchiodrilus* Michaelsen, 1900

Branchiodrilus Michaelsen, 1900.

Type species: *Branchiodrilus semperi* (Bourne), 1890.

Diagnosis. Eyes absent. Branchial process onwards on a number of segments from VI, enclosing dorsal chaetae.

Branchiodrilus hortensis (Stephenson), 1910 (Fig. 3A).

Lahoria hortensis Stephenson, 1910.

Branchiodrilus hortensis (Stephenson): Stephenson, 1912.

Material examined. 5 individuals.

Diagnosis. Prostomium conical. Eyes absent. Forebody transversally striped with dark pigments. Dorsal bundles start from VI onward; mostly included in long, digitiform gills, consisted of 1-5 very long hair chaetae and 1-2 straight simple pointed needle chaetae. Ventral bundle per 3-5 chaetae; all teeth equal in length. Able to swimming.

Distribution. Palearctic, Indomalaya, Australasia.

Genus *Chaetogaster* von Baer, 1827

Chaetogaster von Baer, 1827.

Type species: *Chaetogaster limnaei* (von Baer), 1827.

Diagnosis. Mostly without dorsal chaetae, rarely bifid. First 5 segments fused into head. A pair of ventral bundle in segment II of head part. Pharynx cylindrical, thick-walled. Sometimes short, stunted zooids forming chains.

***Chaetogaster diastrophus* (Gruithuisen), 1828 (Fig. 3B).**

Nais diastrophus Gruithuisen, 1828.

Chaetogaster diastrophus (Gruithuisen): Vejdovsky, 1833.

Material examined. 4 individuals.

Diagnosis. Prostomium conspicuous; conical when preserved, but oval with sensory hairs when alive. In II, 4-8 chaetae per bundle, 70-110 µm long. Onward from VI, 3-7 chaetae per bundle.

Distribution. Nearctic, Palearctic, Indomalaya, Neotropical.

Remarks. This species is smaller than *C. diaphanus* in body length and can be easily recognized by the conical prostomium.

***Chaetogaster cristalinus* Vejdovsky, 1883 (Fig. 3C).**

Chaetogaster cristalinus Vejdovsky, 1883.

Material examined. 1 individual.

Diagnosis. Without prostomium; sometimes a notch on the place. In II, 4-12 chaetae per bundle; 100-140 µm long and less than 2 µm thick. Chaetae bundles onward from VI, 4-6 chaetae per bundle. Stomach surrounded with ca. 20 pairs of distinct transversal blood vessels, but not plexus (Fig. 3C). Mostly zooids form chains.

Distribution. Nearctic, Palearctic.

Remarks. This species is similar with *C. diaphanus*, but can be recognized by the transversal blood vessels and chaetae length.

Genus *Dero* Oken, 1815

Dero Oken, 1815.

Type species: *Dero digitata* (Müller), 1773.

Diagnosis. Eyes, palp and coelomocytes absent; branchial disc present; budding present.

***Dero obtusa* d'Udekem, 1855 (Fig. 3D).**

Dero obtusa d'Udekem, 1855.

Material examined. 31 individuals.

Diagnosis. Dorsal bundles onward from VI; mostly consisting 1 hair chaeta and 1-2 needle chaetae, needle's end slightly notched. Ventral chaetae of II-V consisting 2-6 slender bifid chaetae; bifid chaeta thicker and curved

than dorsal chaetae; ventral bifid chaeta's upper tooth twice longer than lower tooth. Branchial disc short; posterior gills similar length to disc's end.

Distribution. Nearctic, Palearctic, Afrotropical, Neotropical.

Remarks. Branchial disc has 3 pairs of short gills which are shorter than branchial disc.

Genus *Haemonais* Bretscher, 1900

Haemonais Bretscher, 1900.

Type species: *Haemonais waldvogeli* Bretscher, 1900.

Diagnosis. Eyes absent. Dorsal chaetae onward from VI. Chloragogen cells present in all segments.

***Haemonais waldvogeli* Bretscher, 1900 (Fig. 3E).**

Haemonais waldvogeli Bretscher, 1900.

Material examined. 1 individual.

Diagnosis. Dorsal bundle onward from XVII-XX; each bundle consisted one short hair chaeta and one bifid chaeta; bifid chaeta's upper tooth 1.5 times longer than lower tooth. 2-4 ventral bifid chaetae per bundle; ventral chaeta's upper tooth longer in II-XV, onward from XVI, more curved and shorter.

Distribution. Nearctic, Palearctic, Neotropical.

Remarks. Beginning segment of dorsal bundle is a unique key character of this species.

Genus *Nais* Müller, 1773

Nais Müller, 1773.

Type species: *Nais barbata* Müller, 1773.

Diagnosis. Eyes present. Dorsal chaetae onward from VI. Ventral chaetae of II-V differing from other segments.

***Nais communis* Piguet, 1906 (Fig. 3F).**

Nais communis Piguet, 1906.

Material examined. 6 individuals.

Diagnosis. Each dorsal bundle consisted with 1-2 hair chaetae and 1-2 needle chaetae; needle's tip diverging distinct teeth. Ventral bifid chaetae in II slightly thicker and more curved than posterior bifid chaetae. Oesophagus gradually connected to intestine (Fig. 3F).

Distribution. Palaearctic, Afrotropical, Indomalaya, Australasia, Neotropical.

***Nais pardalis* Piguet, 1906 (Fig. 3G).**

Nais pardalis Piguet, 1906.

Material examined. 12 individuals.

Diagnosis. In II-V, 2-5 ventral bifid chaetae per bundle;

ventral bifid chaeta's upper tooth 1.5-2 times longer than lower one. Chaetae onward from VI, mostly 2-5 ventral chaeta per bundle; ventral bifid chaeta thicker and more curved; teeth equally long or upper tooth slightly long and thinner. In VI and some of subsequent segments, often single giant chaeta per bundle; giant chaeta's upper tooth 2-3 times longer than lower tooth. Dorsal bundles consisted with hairs and needles. Each bundle consisted 1-2 quite short hair chaeta and 1-2 needle chaeta; needle's tip short, with distinct teeth. Oesophagus connected to abruptly expanded interstine in VIII; inside of interstine long brown digit-shape cells present (Fig. 3G).

Distribution. Nearctic, Palearctic, Indomalaya, Australasia.

Remarks. Long cells in oesophagus is a useful key character of this species.

Genus *Piguetiella* Sperber, 1939

Piguetiella Sperber, 1939.

Type species: *Piguetiella blanci* (Piguet), 1906

Diagnosis. Dorsal chaetae onward from VI; coelomocyte present; eyes and gills absent.

Piguetiella denticulata Liang, 1997 (Fig. 3H)

Piguetiella denticulata Liang, 1997.

Material examined. 1 individual.

Diagnosis. Body cavity with numerous coelomocytes. Eyes absent. Chaetae all bifid, onward from VI, 3-5 bifid chaetae per dorsal bundle. Nodule on bifid chaetae at 1/3 toward proximal end; teeth of chaetae equally long. 1-2 minute denticles between 2 teeth in some chaetae (Fig. 3H). Ventral chaetae same in shape. Stomach absent.

Distribution. Korea, China.

Remarks. Denticles of chaetae showing in this species is unique in Naididae.

Genus *Stylaria* Lamarck, 1816

Stylaria Lamarck, 1816.

Type species: *Stylaria lacustris* (Linnaeus), 1767.

Diagnosis. Eyes present. Prostomium forming tentacle.

Stylaria fossaulus Leidy, 1852 (Fig. 3I).

Stylaria fossaulus Leidy, 1852.

Material examined. 4 individuals.

Diagnosis. Prostomium formed long tentacle; prostomial lobes absent (Fig. 3I). Eyes present. Dorsal bundles consisted with 1-3 hair chaetae and 3-4 simple pointed

needle chaetae. Ventral bundles consisted with 4-7 bifid chaetae per bundle; bifid chaeta's upper tooth much longer and strongly curved than lower tooth.

Distribution. Nearctic, Palearctic.

Remarks. This species was sometimes treated as a junior synonym of *S. lacustris* (Linnaeus) but *S. lacustris* has a short protruding lobe on both sides of the tentacle.

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