Freshwater oligochaetes (Annelida, Clitellata) of Lake Hanka (Russia/ China)

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Key words: Oligochaeta, fauna, new species, Lake Hanka, Amur-Japanese subregion

Abstract

Lake Hanka is a large lowland lake in the Amur River basin, on the border between Russia and China. During a 1996-1997 faunistic survey, about 2500 specimens of oligochaetes were collected from ten qualitative benthic samples taken from the near-shore shallows of the lake and seven samples from the lower course of three inflowing rivers.

In total, 42 taxa (37 nominal species and 5 unnamed taxa) were identified. Of these, 25 belong to the subfamily Naidinae, five to Pristininae, and 12 to other subfamilies within the Tubificidae; the remaining taxa are distributed amongst the Propappidae, Enchytraeidae, and Lumbriculidae. Of the 42 taxa identified during this study, 31 are reported here as new records for the lake.

One species (*Styloscolex hankensis*) is described as new to science, and the morphologies of three others (*Pristina aequidentata*, *Piguetiella amurensis* and *Aulodrilus japonicus*) are discussed. The most common and abundant taxa in the muddy and/or vegetated habitats were *Nais barbata*, *Nais pardalis*, *Limnodrilus hoffmeisteri*, and unidentified juvenile Rhyacodrilinae. *Propappus volki* and *Mesenchytraeus* sp. occurred in large numbers in the unvegetated littoral surf zone with coarse sand or pebbles. In the rivers, the most abundant and diverse oligochaete fauna (with 14 species) was found downstream of a sewage purification station. This was also the only site where the cosmopolitan *Tubifex tubifex* was recorded. Lake Hanka and the adjacent water bodies are inhabited mainly by widely distributed oligochaetes, except for "*Piguetiella*" *amurensis* and *Styloscolex hankensis*, which are endemic to the Amur-Japanese zoogeographic subregion.

Introduction

Lake Hanka (also Khanka in English, Xingkai in Chinese) is a large lowland lake on the easternmost part of the border between Russia and China (at 44º08'-45º05' N, 132-133º E). It lies 69-72 m above sea level, has a water surface of 4070 km^2, and a maximum depth of 6.5 m (mean depth 4.5 m). It drains a watershed of 17500 km^2; the outflowing Sungača River (Songacha He) joins the Ussuri, a tributary of the Amur River. In the geological past (possibly into the early Pleistocene), the watershed also included the neighbouring Razdol'naja River (Suifun or Suifen He), which now discharges separately into the Sea of Japan. The modern Lake Hanka came into being only about 3000 years ago, as a result of the natural damming up of the outflow with sediments. It is fed by precipitation as well as by 24 rivers. The lake is dimictic, frozen from November through April (about 153-160 days). The temperature of the near-shore shallow water can rise above 30℃ on summer days. The water is intensively mixed by the wind, remaining very turbid throughout its ice-free period. Extensive shallow areas of the lake are covered mostly by sand or gravel; the macrovegetation, when present, consists largely of *Phragmites, Zizania, Carex, Potamogeton, Trapa*, and *Lemna*. The bottom of the central zone is covered with aleurite mud. The fish and molluscan fauna are very similar to that occurring in the Amur River (Korotkij, 1990).

In her monograph, Čekanovskaja (1962) (translated as Chekanovskaya, 1981) recorded three species of Oligochaeta (*Branchiodrilus hortensis*, *Aulodrilus pectinatus*, and *Rhyacodrilus coccineus*) from Lake Hanka. Sokol'skaja (1968, 1972, 1980), and Sokol'skaja & Lokšina (1972) listed 15 species and two unidentified forms in the family Naididae from a few places of the lake littoral, adjacent ponds and inflows. Thus the oligochaete fauna of the lake and adjacent water bodies, based upon records in the published literature, includes 17 nominal species and two unidentified forms (Table 1).

Table 1. Oligochaete fauna of Lake Hanka (Russia/China) and the adjacent water bodies

Species *	Literature	New data		
		Samples	Specimens	Habitat, station number
Tubificidae: Naidinae				
Stylaria fossularis Leidy, 1852	X	1	19	Lake: 1
Stylaria lacustris (Linnaeus, 1767)	X			
Arcteonais lomondi (Martin, 1907)		1	1	Rivers: 8
Ripistes parasita (Schmidt, 1847)		1	1	Rivers: 6
Slavina appendiculata (d'Udekem, 1855)	X	5	12	Lake: 1, 2. Rivers: 6, 12
Dero digitata (Müller, 1774)	X	3	32	Rivers: 5, 6, 12
Dero obtusa (d'Udekem, 1855)	X	2	3	Rivers: 5, 9
Aulophorus furcatus (Oken, 1815)	X			
Branchiodrilus hortensis (Stephenson, 1910)	X			
Nais barbata Müller, 1774	X	5	291	Lake: 1, 2. Rivers: 5, 6
Nais bretscheri Michaelsen, 1899	X	1	25	Rivers: 6
Nais communis Piguet, 1906		2	2	Rivers: 5, 6
Nais elinguis Müller, 1774	X			
Nais pardalis Piguet, 1906	X	7	36	Lake: 1, 2. Rivers: 4, 5, 12
Nais variabilis Piguet, 1906	X	2	4	Lake: 1. Rivers: 6
Haemonais waldvogeli Bretscher, 1900		1	1	Lake: 1
"*Piguetiella" amurensis* Sokol'skaja, 1958	X	3	68	Rivers: 6, 8, 9
Piguetiella michiganensis(?) Hiltunen, 1967		1	1	Lake: 2
Specaria josinae (Vejdovský, 1884)		3	4	Lake: 2. Rivers: 8
Uncinais uncinata (Ørsted, 1842)		2	33	Lake: 1
Stephensoniana trivandrana (Aiyer, 1926)		1	3	Rivers: 8
Paranais frici Hrabě, 1941		3	46	Lake: 2. Rivers: 6
Chaetogaster diaphanus (Gruithuisen, 1828)	X	1	29	Lake: 1
Chaetogaster diastrophus (Gruithuisen, 1828)		1	1	Lake: 3
Tubificidae: Pristininae				
Pristina aequidentata (Liang et Xie, 1997)		2	27	Lake: 1
Pristina aequiseta Bourne, 1891		1	1	Lake: 1
Pristina biserrata Chen, 1940	X			
Pristina aequiseta f. *foreli* (Piguet, 1906)		1	1	Rivers: 5
Pristina longiseta Ehrenberg, 1828		1	1	Rivers: 8
Pristina osborni (Walton, 1906)		2	13	Lake: 1, 2
Pristina sp. No 1 (in Sok. & Fin., 1972)	X			
Pristina sp. No 2 (in Sok. & Fin., 1972)	X			
Tubificidae: Rhyacodrilinae				
Rhyacodrilus coccineus (Vejdovský, 1876)	X	2	11	Lake: 1
Rhyacodrilinae spp. juv. (with hair chaetae)		7	33	Lake: 1, 3, 4. Rivers: 8, 9
Bothrioneurum vejdovskyanum Štolc, 1886		3	36	Rivers: 5, 7, 8
Tubificidae: Tubificinae				
Limnodrilus hoffmeisteri Claparède, 1862		7	387	Lake: 1. Rivers: 5, 6, 7, 8, 9
Limnodrilus udekemianus Claparède, 1862		1	71	Rivers: 5
Tubifex tubifex (Müller, 1774)		1	114	Rivers: 5
Spirosperma sp. juv.		1	5	Lake: 1

Continuous table

Species *	Literature	New data		
		Samples	Specimens	Habitat, station number
Haber (?) sp. juv.		2	2	Lake: 1, 2
Tubificidae indet., embryonal from cocoons		1	9	Lake: 1
Aulodrilus japonicus Yamaguchi, 1953		3	56	Rivers: 6, 8, 9
Aulodrilus limnobius Bretscher, 1899		4	10	Lake: 1, 3
Aulodrilus pectinatus Aiyer, 1928	X			
Aulodrilus pigueti Kowalewski, 1914		2	16	Rivers: 8, 9
Propappidae				
Propappus volki Michaelsen, 1916		5	693	Lake: 3, 4. Rivers: 5, 9
Enchytraeidae				
Mesenchytraeus sp. juv.		3	371	Lake: 2, 4
Marionina (?) sp.		1	1	Rivers: 5
Lumbriculidae				
Lumbriculus variegatus (Müller, 1774)		2	15	Lake: 3. Rivers: 5
Styloscolex hankensis sp. n.		1	1	Lake: 1
Total: 50 taxa (42 nominal + 8 unnamed)	19 taxa	17	2486	4 stations in lake, 5 in rivers
Taxa collected during this study: 42 (36 + 6)				
Taxa collected during this study representing new records for Lake Hanka : 31 (25 + 6)				
Lake Hanka taxa reported in the literature, but not collected during this study: 8 (6 + 2)				
* Higher level classification follows that proposed by Envall et al. (2006).				

This paper contributes to our current knowledge of the oligochaete fauna of Lake Hanka on the basis of new material collected in 1996 and 1997.

Material and methods

About 40 qualitative samples of zoobenthos (focusing primarily on aquatic insects) were taken in near-shore littoral areas and from the inflows by the second author over the course of three periods: 8-10 October 1996, 21-23 June 1997, and 23-26 July 1997. Some stations were visited repeatedly. Seventeen of these samples (10 from the lake littoral, and 7 from the inflows) contained oligochaetes, a total of almost 2500 individuals, identified by the first author. Oligochaetes were collected from nine sites (Fig. 1), on one or more occasions (collecting dates noted in parentheses, below):

1. Littoral near the border guard station Vostočnyj on the eastern shore (08.10.96, 09.10.96, 24.07.97). Substrate: mud or muddy sand with reeds.

2. Littoral near the village Kamen'-Rybolov on the western shore (10.10.1996, 21.06.1997, 25.07.97). Substrate: stones and sand.

3. Littoral near the village Troickoe and at the mouth of the Komissarovka River (Xintu He) on the western shore (25.07.97). Substrate: coarse sand.

4. Littoral near the village Turij Rog on the western shore (26.07.97). Substrate: stones and sand, without the macrovegetation.

5. Spasovka River (Santaheza), downstream of the sewage purification ponds of the town Spassk-Dal'nij (09.10.96). Substrate: gravel and stones.

6. Spasovka River, village Novosel'skoe (09.10. 96, 24.07.97). Substrate: stones or sand with mud and detritus.

7. Spasovka River near the mouth (21.06.97, 23.06.97). Substrate: clay with mud, reeds.

8. Ilistaja River (Lefu) upstream of the Tšernigovka-Vadimovka road bridge (25.07.97). Substrate: mud with sand and rich detritus.

9. Komissarovka River (Xintu He) near its mouth (25.07.97). Substrate: fine sand, *Equisetum*.

The samples were taken with a dip-net (mesh size 15 threads per cm) from a depth of 10-20 cm in the first two seasons and were washed on a soil sieve (25 threads per cm). In July 1997 samples were collected with Levanidov's benthometer (a modification of the Surber sampler, with a sampling area of 40×30 cm, mesh size = 25 threads per cm) from a depth of 50 cm. The samples were fixed and preserved either in 75% ethanol, or in 4% formalin. Sorting of the samples was done in the laboratory using a dissection microscope with 10-25× magnification.

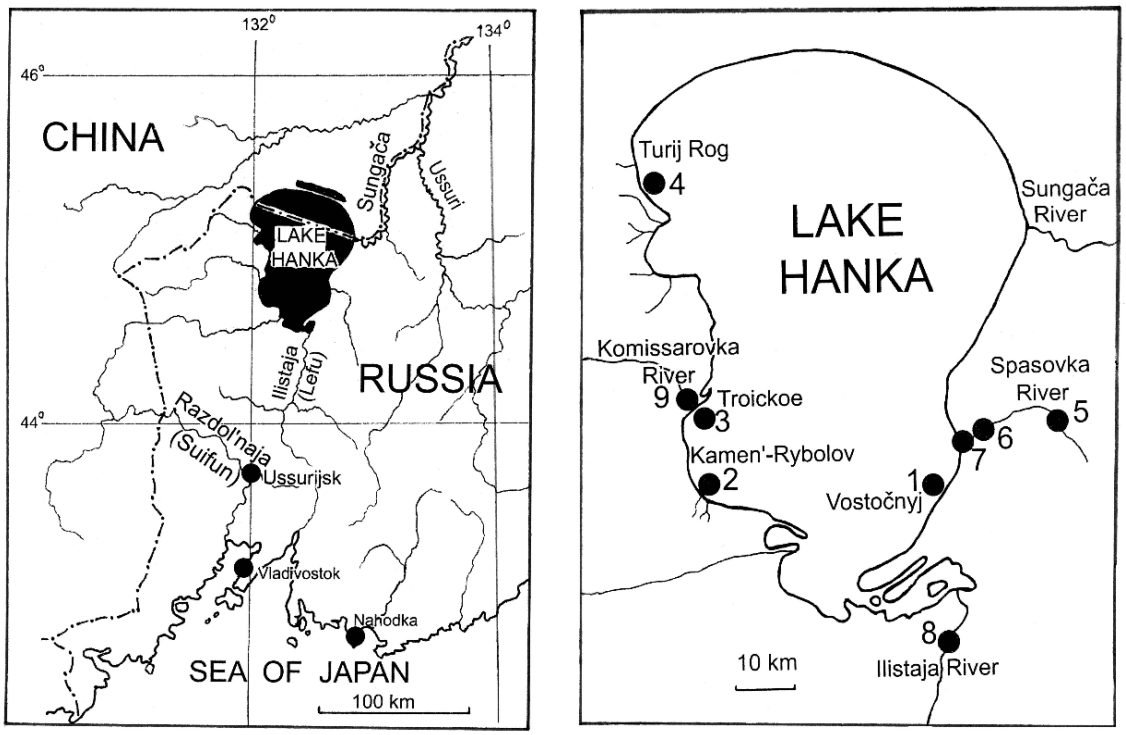

Figure 1. Location of Lake Hanka (left) and the sampling stations in the lake (right)

Faunistic results

Oligochaete specimens collected and identified during this study represent 42 taxa including 35 known nominal species, one species described herein as new to science, and six forms not identified to the species level. Twenty-six species reported during this study represent new records for the lake and its vicinity. The Naidinae were the most diverse group, with 20 species; the Tubificinae were represented with six species and three forms; the Pristininae with four species and one form; the Rhyacodrilinae with two species and one form; the Lumbriculidae with two species; the Enchytraeidae with two forms; and the Propappidae with one species (Table 1). The Naidinae and Pristininae are treated in this paper as separate subfamilies of the family Tubificidae, following the proposal by Envall et al. (2006).

The most frequently collected taxa were *Nais pardalis, Limnodrilus hoffmeisteri* (both observed in seven of the 17 samples), Rhyacodrilinae gen. spp. juv. (likely immature specimens representing several species; seven samples), *Nais barbata*, *Slavina appendiculata*, and *Propappus volki* (each present in five samples). Different Naidinae and Pristininae occurred abundantly in most samples, with a total of 587 specimens. The Tubificinae and *Propappus volki* were represented by a higher number of individuals (670 and 693, respectively) but not so frequently.

Four samples were taken at the only station on the eastern shore of the lake (Vostočnyj), all from mud or muddy sand with reeds, in different seasons. The diverse fauna, altogether 19 taxa, was variable in different samples. The richest sample in July consisted of 12 taxa. *Nais barbata* and *Limnodrilus hoffmeisteri* were most abundant in separate samples. The new species, *Styloscolex hankensis*, was found only here.

Stations 2-4 on the western shore (Kamen' -Rybolov, Troickoe and Turij Rog, with a total of six samples) represented a surf zone devoid of macro-vegetation. The bottom with wave-washed sand and stones revealed a total of 14 oligochaete taxa, and also a number of unidentified *Aeolosoma* sp. (Polychaeta: Aphanoneura). The maximum number of oligochaete taxa per sample was only eight. Large numbers of *Propappus volki* and *Mesenchytraeus* sp. were observed in a few samples, while the abundance of the other taxa was low.

The rivers (stations 5-9, with seven samples), apparently all more or less enriched through human activity, also revealed a diverse fauna, except the site located near the mouth of the Spasovka River – a site

with a clay substrate. In total, 26 taxa were found in the river samples, with a maximum of 14 taxa identified in two samples – one from the Spasovka River below the waste purification ponds, and the other from the Ilistaja River. Tubificinae were more abundant (although not more diverse) than Naidinae here, *Limnodrilus hoffmeisteri* being usually the dominant species. The only site where *Tubifex tubifex* and *Limnodrilus udekemianus* were found, both in large numbers, was downstream of the sewage purification ponds. The species *Aulodrilus japonicus*, *A. pigueti*, *Bothrioneurum vejdovskyanum*, "*Piguetiella*" *amurensis*, and *Stephensoniana trivandrana* occurred only in the riverine samples.

Systematics

Styloscolex hankensis Timm, n. sp. (Figures 2 & 3)

Holotype: Oligochaeta collection of the Centre for Limnology at Lake Võrtsjärv, Estonia, No 29, cross sections of the anterior 13 segments stained after Mallory (Roskin, 1957), on three slides; and posterior end mounted as whole on the fourth slide.

Type locality: Lake Hanka (Russia), eastern shore at border guard station Vostočnyj, depth 0.1-0.2 m, muddy sand with reeds, 24.07.1997. Collected by T. Všivkova.

Etymology: The specific epithet, *hankensis,* is derived from the name of its type locality.

Description: The single specimen available was 13.5 mm long and up to 0.5 mm thick (but 0.95 mm, when compressed under the cover glass), and consisted of 55 segments. Posterior region tapering to 0.3 mm. Prostomium conical, 0.4 mm long and 0.4 mm wide. Intersegmental furrows weakly developed (Figure 2a). Chaetae paired, sigmoid, simple-pointed; on mid-body and in the anterior ventral bundles 120-170 μm long and 7-9 μm thick; those of the posterior segments and in the anterior dorsal bundles smaller, 90-120 μm long and 5-7 μm thick (Figure 2c). Oesophagus sinuate and covered with chloragogen tissue from VI on; beginning of intestine obscure. Nephridia observed in VI, IX, XII (all paired) and VII (unpaired). Transversal vessels in anterior region simple; those in tail segments blind and branching; not seen in midbody.

Clitellum weakly developed, beginning in VII, with glandular epithelium up to 20 μm thick; posterior edge inconspicuous. Genital pores paired, inconspicuous: spermathecal pores behind the ventral chaetae of VII, male pores behind the ventral chaetae of VIII, and female pores in 10/11.

Testes in VIII; one of them partially pressed forward into VII. No filiform spermatozoa seen in body cavity, but posterior sperm sacs with granular content were observed in X. Large, compact ovaria in X; egg sacs reaching up to XIII contained numerous small, unripe eggs.

Male funnels in VIII, large, sacculate. Vas deferens 15 μm wide, not specifically studied, falling into the thinner distal end of atrium. Atria tubular, much longer than body diameter, reaching from VIII backwards up to the end of IX, 23-30 μm wide (but 65-140 μm when including the prostatic cells), with spacious empty lumen. Atrial epithelium about 7 μm thick, muscular layer very thin; dense layer of prostatic cells mostly 25-35 μm high. Distal end of atrium tapers before falling into penial sac (Figure 3e, f).

Penial sacs in VIII; their irregularly bulblike proximal portion 140 μm long and 80 μm wide in cross sections, the short tubular distal portion tapering from 48 to 19 μm, with a 9 μm thick wall. In the proximal portion a doubly folded (N-like), 16 μm wide channel containing thin, doubly folded penis in thin penial sheath. The channel is lined with a chitinous layer similar to the material of penial sheath. Sheath is 12-14 μm wide, and penis itself is only 7-8 μm wide; neither of them reaches the external male pore in the sectioned holotype (Figure 3a-d).

Female funnels not studied. Spermathecae as one pair in VII, empty, at least 270 μm long. Ampulla 135 × 50 μm wide on a section, with epithelium 18-25 μm and muscular layer 3 μm thick. Duct tapers gradually (Figure 2b).

Remarks. The single specimen of *Styloscolex hankensis* had not yet copulated. Not all essential characters were observed, e.g., the blood vessels in the midbody, the course of the vas deferens, and the shape of the spermatheca when filled. However, the presence of a "sterile" segment between the testicular and ovarial segments, and the long chitinous penial sheaths, support its affiliation to the nominotypical subgenus from the genus *Styloscolex* Michaelsen, 1901.

To date, eleven species in the subgenus *Styloscolex*

have been described (Timm, 1994a; Semernoy, 2004); of these, seven have a similar allocation of the reproductive system (spermathecae in VII, testes and atria in VIII, ovaria in X): *S. asymmetricus* Izossimov, 1962; *S. baicalensis* Michaelsen, 1901; *S. burowi* Semernoy, 2004; *S. chorioidalis* Izossimov, 1962; *S. japonicus* Yamaguchi, 1937; *S. kolmakovi* Burow, 1931; and *S. solzanicus* Hrabě, 1982. Most of these seven species also share a prolonged or even a tubular shape of the atrium. Six of these species are only known from Lake Baikal, and *S. japonicus* is known only from Hokkaido Island. However, all of them have a straight, apparently more or less rigid penial sheath, while the sheath of the new species is very long, highly elastic, and doubly folded. In six of the seven species, the spermathecal ampulla is distinctly separated from the duct. Gradual transition from the ampulla to the duct, like in the new species, is described only in the Baikalian *S. solzanicus*. However, the latter displays an incomplete prostatic cover on the atria, and short conical penes. *Styloscolex japonicus*, the only species among the seven known from outside Lake Baikal, is characterized by the male pores on large papillae, and spindle-shaped, muscular atria.

The distribution range of the genus *Styloscolex* includes Northeastern Asia from Lake Baikal to Japan and the Chukchi Peninsula, as well as the Alaska Peninsula in North America. This is the first finding of the genus in the Primorskij Region of Russia.

Pristina aequidentata (Liang et Xie, 1997), n. comb. (Figure 4)

Pristinella aequidentata: Liang & Xie (1997): 393-394, figure 3.

?*Pristina* sp. No 1: Sokol'skaja & Lokšina (1972): 100-101, figure 3.

Twenty specimens, two of them with clitellum and one with half-developed genitalia, were identified in two samples taken from the lake littoral at the station Vostočnyj.

Because the original description of *Pristinella aequidentata* was brief, we present herein additional information for this taxon. To date, this species was known only from southern China. Reunion of the genus *Pristinella* with *Pristina* by Collado & Schmelz (2000) was the reason of the new combination.

Length of two intact and non-budding individuals 2.8-2.9 mm when preserved; segment number 33-34. Three individuals with a budding zone 1.7-1.9 mm long; anterior zooids with 14 segments (Figure 4c, d). Maximum diameter of immature specimens (in VI) compressed under the cover glass, 0.15-0.19 mm; clitellar region 0.24-0.25 mm wide. Tail region gradually tapering.

Prostomium bluntly conical, with basal diameter slightly larger than the length. Peristomium very short, narrower than II. Body wall smooth and transparent. Ventral chaetae uniform along the whole body, sigmoid, bifid with equal teeth, nodulus slightly distal; 36-58 μm long and mostly 4 (sometimes 5-6) per bundle in forebody, 36-43 μm long and 2-4 in the posterior region (Figure 4e). No modified genital chaetae. Dorsal bundles of the anterior and middle regions consisting of 4-6 hair chaetae and a similar number of needle chaetae arranged alternately in fan-like bundles; the number deminishing to 2-3 in the posterior region. Hair chaetae thin and smooth, mostly 100-140 μm long but 80-100 μm on II and in the posterior region. Needle chaetae 35-52 μm long, as sigmoid bifids with equal teeth, similar to ventral chaetae but thinner and with finer teeth (Figure 4f).

Well distinguished pyriform stomach (with a blunt anterior end) in VIII, its wall consisting of fine brown cells. The post-stomach digestive tract continues as wide irregular intestine filled with detritus and diatoms. Loops of transversal vessels observed in V-VII (Figure 4b-d).

Clitellum in VIII-½IX, thick, masking the internal reproductive organs (Figure 4a). In an individual devoid of clitellum, an unpaired ovary is attached to 7/8 with a narrow stem, while its large, pyriform posterior portion fills most of coelom in IX (Figure 4b). No spermathecae observed; this may serve as an indirect proof of parthenogenesis.

The new material reveals smaller segment number of the first zooid, in comparison with that in the original species description (14 instead 17-19), and shorter dorsal chaetae; nodulus of the ventral chaetae is always distal while described as proximal by Liang & Xie (1997). The number of each kind of chaetae can reach up to 6 per bundle (up to 5 in the original description).

The shape and high number of needle chaetae,

somewhat similar to those in *Specaria josinae* Vejdovský, is unusual among the *Pristina* except those in *P. acuminata* Liang, 1958. However, the latter has distinctly longer upper tooth both in the dorsal and ventral bifid chaetae, while the hair chaetae are serrated. The body length of *P. acuminata* is also considerably larger (3-11 mm). The segment number of the first zooid (12-14) given by Liang (1958) for *P. acuminata*, is similar to that in the new material (but not in the original description) of *P. aequidentata*. Dorsal needles with equal teeth are known also in *Pristina osborni* Walton (although distinctly shorter), and in *P. bilobata* Bretscher. However, they have only 1-2 hair and needle chaetae per bundle, like most other nominal *Pristina* spp. described thus far.

Pristina aequidentata can be identical with *Pristina* sp. No 1, described briefly by Sokol'skaja & Lokšina (1972) – a description based on observations made on a single specimen. The only difference between these two taxa seems to be in the number of dorsal chaetae: up to 5 hairs but only 1-2 bifid needles in *Pristina* sp. No 1.

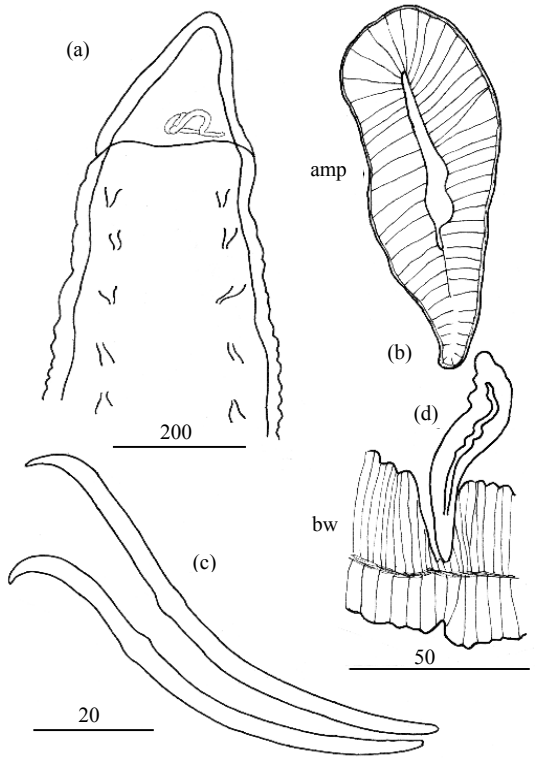

Figure 2. Styloscolex hankensis sp. n. (a) anterior end in ventral view. (b) spermatheca after a cross section. (c) bundle of chaetae. Amp – ampulla, bw – body wall, d – duct. Scales in µm

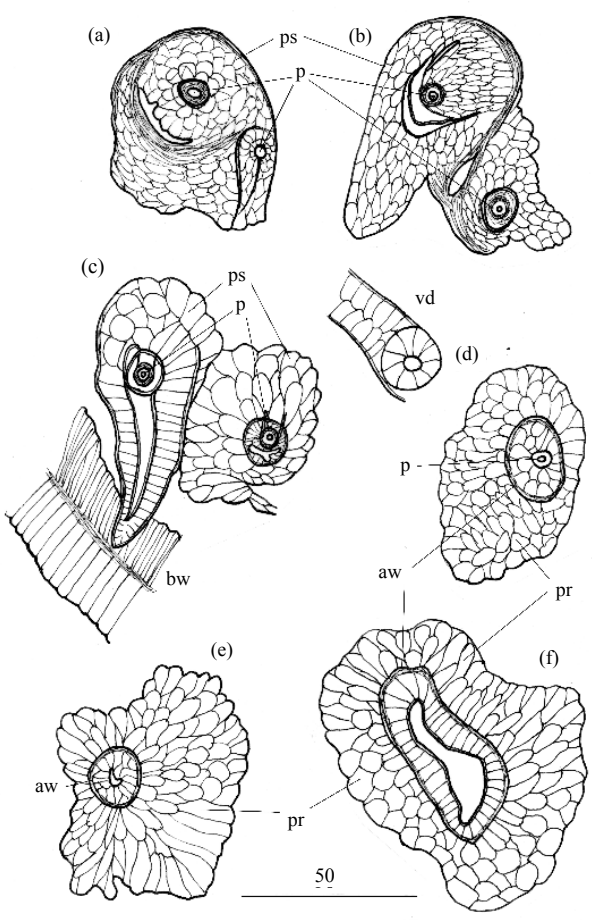

Figure 3. Styloscolex hankensis sp. n., penial sac and atrium after cross sections of the segments VIII and IX, from front to back. (a, b) anterior portion of penial sac, with penial sheath cut in two places. (c) distal portion of penial sac on the left, together with penis and sheath, directed down to male pore; and the proximal portion, on the right, proceeding backwards. (d) the most proximal portion of penial sac in transition to atrium but containing yet the inner end of penis; and vas deferens approaching the beginning of atrium. (e, f) cross sections of tubular atrium. aw – atrial wall, bw – body wall, p – penis, pr – prostatic tissue, ps – penial sac, vd – vas deferens. Scales in µm

Remarks on two other species

"*Piguetiella*" *amurensis* Sokol'skaja, 1958 is a species with an obscure generic position, according to Timm (1997). The new material from the rivers around Lake Hanka demonstrated a chaetal apparatus identical with the former descriptions, including the variable backward shift of the beginning of dorsal chaetae (Figure 5a, b, d-f). Intact specimens were up to 3 mm in length. The first zooid before the budding zone consisted of 17-18 segments. Small pigment spots were observed in the body wall of the anterior – most segments and the prostomium of some specimens. In some mounted individuals, a network of fine,

anastomosing transversal vessels was visible in several anterior segments, II-VII (Figure 5a, b). One caudal piece mounted with the dorsal side upward, displayed a pair of small triangular, gill-like lobes in its slightly dilated anal opening, reminiscent of the branchial fossa of *Dero* spp. (Figure 5c).

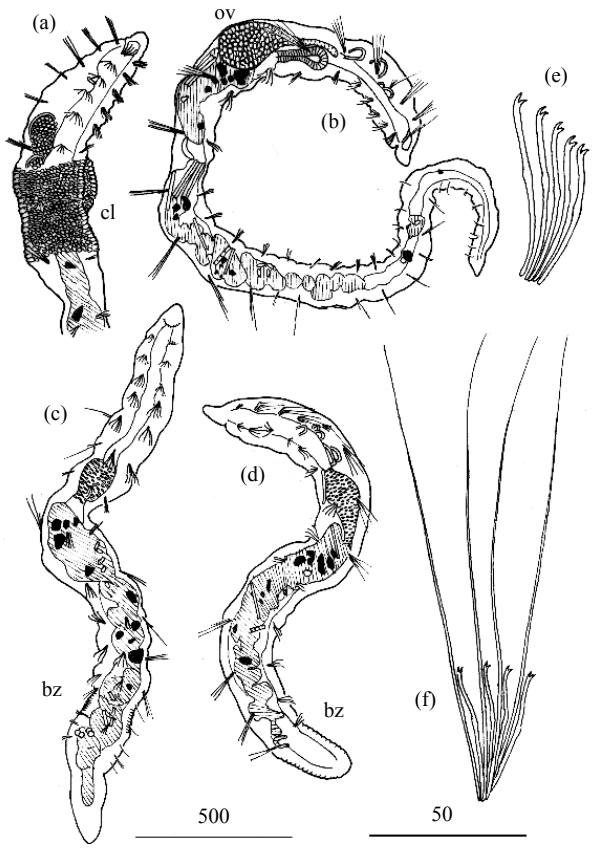

Figure 4. *Pristina aequidentata* (Liang et Xie). (a) mature, clitellate specimen. (b) submature specimen). (c, d) immature specimens with the budding zone. (e) bundle of ventral chaetae. (f) bundle of dorsal chaetae. bz – budding zone, cl – clitellum, ov – ovary. Scales in μm

Aulodrilus japonicus Yamaguchi, 1953 can be easily confused with *A. pluriseta*. The peculiar structure of the dorsal sigmoid chaetae, with their upper tooth split into a transversal row of very fine denticles (Figure 6b, c), is characteristic of *A. japonicus*, and the genitalia of *A. japonicus* are located more posteriorly than in *A. pluriseta* (Finogenova & Arkhipova, 1994). These denticles are hardly visible even at the highest magnification, while the genital organs seldom occur in *Aulodrilus*.

Differences in the digestive tract distinguish these two species, even when observed in the immature state and at lower magnification; this good identification character was long ago highlighted by Yamaguchi (1953) and Hrabě (1981), but has been ignored by more recent authors.

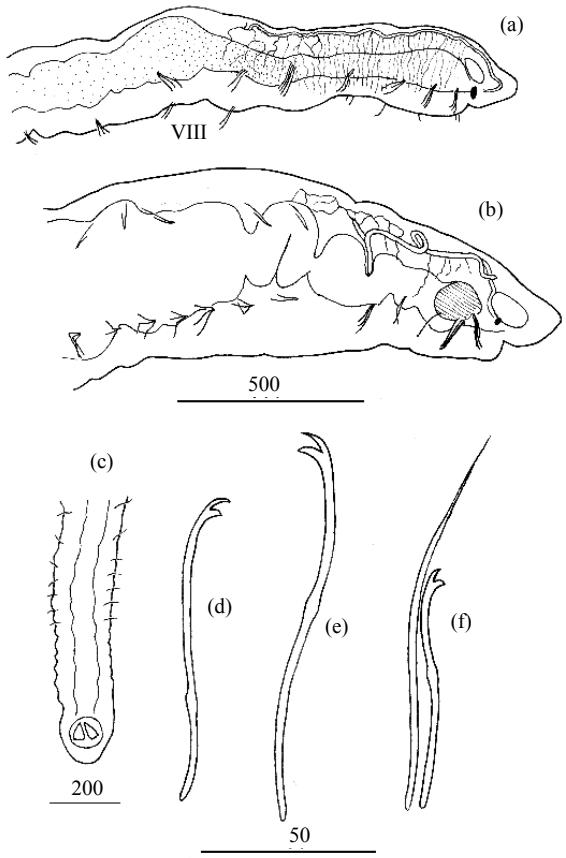

Figure 5. "*Piguetiella*" *amurensis* Sokol'skaja. (a, b) anterior ends. (c) posterior end with gill-like lobes in anus. (d) anterior and (e) posterior ventral chaeta. (f) bundle of dorsal chaetae. VIII – segment containing stomach.

The wide midgut of *A. pluriseta* usually begins in VIII (seldom in IX as seen by me in some specimens from Karelia). The oesophagus is covered with the chloragogen tissue in the two last segments, VI-VII, like in most other tubificines. In *A. japonicus*, the wide midgut begins either in X or XI, while the dark chloragogen tissue on the oesophagus occupies only one segment, IX or X, respectively (Figure 6a). This difference seems to be in correlation with the more posterior position of the genitalia in *A. japonicus*, compared with *A. pluriseta* (male pores either in X or VIII).

Discussion

The present paper extends the taxon list of Naididae (treated as tubificid subfamilies of Naidinae and Pristininae in this paper, in accordance with Envall et al., 2006) of Lake Hanka, as presented by Sokol'skaja

(1961, 1968, 1972) and Sokol'skaja & Lokšina (1972), from 17 to 32 (Table 1).

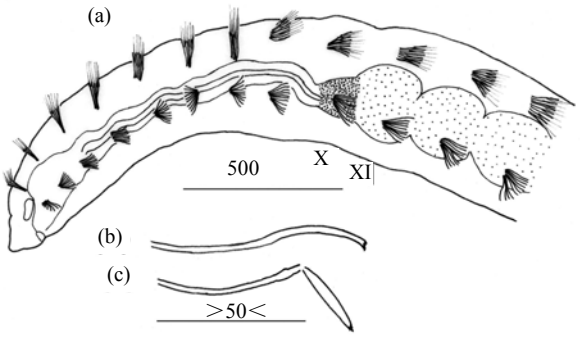

Figure 6. *Aulodrilus japonicus* Yamaguchi. (a) anterior end. (b) dorsal chaeta from side. (c) broken dorsal chaeta displaying distal dilation, and an obscure transversal row of denticles on tip. X – segment with chloragogen-covered oesophagus, XI – segment with the beginning of midgut. Scales in μm

At the same time, 6 or 7 of these taxa recorded in the above papers were not found in the new material (the identity of *Pristina aequidentata* with the *Pristina* sp. No. 1 is possible). A few naidids have since been recorded by the same authors from other regions of the Primorskij Region, but not from Lake Hanka or its adjacent waters, including *Chaetogaster limnaei* Baer, 1927; *Vejdovskyella comata* (Vejdovský, 1884); *Nais behningi* Michaelsen, 1924; and *Dero* sp. (with pectinate chaetae, in Sokol'skaja & Lokšina, 1972). Timm (1990, 1997) added *Pristinella* (=*Pristina*) *jenkinae* (Stephenson, 1931) and *Vejdovskyella simplex* Liang, 1958 to this list.

Among the 18 taxa of non-naidine and non-pristinine oligochaetes occurring in Lake Hanka, only two had been previously reported in the literature; one of these (*Aulodrilus pectinatus*) is lacking in the new material. In the neighbouring parts of the Primorskij Region, samples of the total oligochaete fauna have been identified from the Razdol'naja (Suifun) River in the town of Ussurijsk, and from some submountanous streams – all belonging to the catchment basin of the Sea of Japan (Timm, 1990, 1994b, 1995, 1997; Timm & Rodriguez, 1994). These samples revealed a total of 27 tubificid (s.s.), propappid, enchytraeid, lumbriculid, and haplotaxid species, significantly more than the 16-18 taxa known from Lake Hanka. This reflects, at least in part, the limited material collected from this lake during this study. Moreover, some species inhabit only torrential streams or springs; several of them may be endemic to a single small river basin. The limited oligochaete material from Lake Hanka collected to date has revealed a new lumbriculid species *Styloscolex hankensis;* while this new taxon may be endemic to the region, it is improbable that its present 'endemicity' is exclusive to the geologically young Lake Hanka.

The cosmopolitan tubificid, *Branchiura sowerbyi* Beddard, 1892 – common in most subtropical waters but also present much farther north in the Amur River – has not yet been collected from Lake Hanka. The reason for this could be low winter temperatures (mitigated by the huge water mass in the Amur).

The naikos (lakelets and ponds) in Japan, connected with Lake Biwa, are hydrologically similar to the Lake Hanka basin. Lake Biwa also was associated with the Palaeo-Amur river system in the geological past, and is remarkably similar to Lake Hanka, especially with respect to their Trichoptera fauna (Morse et al., 2001).

Lake Biwa presently enjoys a much milder, subtropical climate. Forty-four oligochaete taxa were identified in the extensive collections from naikos by Ohtaka & Nishino (2006), most of them belonging to the Naidinae; included were several tropical species in the genera *Allonais*, *Aulophorus*, and *Pristina*, none of which have been reported from Lake Hanka. No endemic species were found in the naikos surveyed by Ohtaka & Nishino.

The Amur-Japanese freshwater zoogeographical subregion, although transitional between the Holarctic Region and the Sino-Indian Region, has been treated, in its entirety, as part of the latter by Starobogatov (1970) and Timm (1980). The main evidence supporting this view pertains the fish and molluscan fauna. Among the oligochaetes, *Branchiura sowerbyi*, *Branchiodrilus hortensis*, *Pristina aequidentata*, and *Stephensonia trivandrana* certainly belong to the Sino-Indian fauna (although *B. sowerbyi* and *S. trivandrana* have been distributed almost worldwide by man), while many common Holarctic species are either lacking from or poorly represented in the subregion, e.g., *Spirosperma ferox* Eisen, 1979 and *Stylodrilus heringianus* Claparède, 1862. The cosmo-

politan *Tubifex tubifex* may be a recent invader in the subregion, at least around Lake Hanka where it was only found at one, organically enriched, riverine station.

About 25 oligochaete species are endemic to the subregion (Timm, 1997). Only of one of them, "*Piguetiella*" *amurensis*, was found in Lake Hanka. The new species *Styloscolex hankensis* may complement the list of endemics. *Aulodrilus japonicus*, described originally from this subregion (Yamaguchi, 1953) and common in the rivers around Lake Hanka, has been reported from Europe including the Czech Republic (Hrabě, 1981), the Neva Estuary and the Rybinsk Reservoir in Russia (Finogenova & Arkhipova, 1994; Arhipova, 2005), and The Netherlands (Van der Hoek & Verdonschot, 2005). It can often be confused with a related species, *A. pluriseta* (see above). Considering that Van der Hoek & Verdonschot (2005) stated *A. japonicus* to be even more common than *A. pluriseta* in The Netherlands, specimens in collections of the Centre for Limnology (Estonia), those previously identified as *A. pluriseta*, were again carefully reviewed by the first author. It became evident that specimens collected from several places in Estonia (Lake Peipsi and the Koiva River) and from the Razdol'naja River near Ussurijsk, Primorskij Region of Russia – originally identified as *A. pluriseta* (as reported in Timm, 1997) – had been misidentified and are in fact *A. japonicus*.

Aulodrilus pectinatus, previously recorded from Lake Hanka by Čekanovskaja (1962) and Chekanovskaya (1981), has not since been reported from the lake. The above record may be based on a misidentification of *A. japonicus* – obscure fine denticles are present in the dorsal chaetae of both species.

To date, the zoobenthic community in the open-water areas of Lake Hanka has not been studied, but we suspect that these areas may be inhabited by only a few, widely distributed tubificid species. The occurrence of endemic oligochaetes is not expected there, because of shallow depths and the limited age of the lake.

Acknowledgements

The research has been partially supported by the Core grant # 0362482s03, entitled "Formation and changes of the biological diversity under the human impact in different lake types (Estonia – Denmark – Netherlands)". The first author is indebted to Prof. Yanling Liang for a valuable discussion on *Pristina* spp. The authors thank Drs. Mark J. Wetzel and Steven V. Fend for their diligent reviews and many valuable suggestions. Mrs. Ester Jaigma kindly corrected the English text of the manuscript**.**

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