Syst Parasitol (2013) 84:71–79
DOI 10.1007/s11230-012-9390-7

New records of the chaetiferous leech-like annelid *Paracanthobdella livanowi* (Epshtein, 1966) (Annelida: Clitellata: Acanthobdellida) from Kamchatka, Russia

Serge Y. Utevsky · Sergei G. Sokolov · Marina B. Shedko

Received: 31 July 2012 / Accepted: 13 September 2012

Abstract Acanthobdellidans are unique in their organisation and phylogenetic relationships due to having transitional characters that combine features of oligochaetous and achaetous annelids. Alongside the relatively well-studied *Acanthobdella peledina* Grube, 1851, there is another member of the group, *Paracanthobdella livanowi* (Epshtein, 1966), with five rows of chaetae and an anterior sucker. It appears that the anterior sucker is weakly developed in small juveniles but acquires a deep cavity in adults. Smaller individuals of *P. livanowi* can be distinguished from *A. peledina*, which does not possess an anterior sucker, by the varying breadth of their chaetae. The mid-body segment consists of two doubled annuli in juveniles and is quadri-annulate in large individuals. In Kamchatka freshwaters, hosts of *P. livanowi* mostly include *Salvelinus* spp. and more rarely *Gasterosteus aculeatus*, *Oncorhynchus mykiss* and *O. kisutch.* New information on the distribution and the biology of *P. livanowi* is presented.

S. Y. Utevsky (✉)
Department of Zoology and Animal Ecology,
V.N. Karazin Kharkiv National University, pl. Svobody 4,
Kharkiv 61022, Ukraine
e-mail: sutevsk@univer.kharkov.ua

S. G. Sokolov
A.N. Severtzov Institute of Ecology and Evolution RAS,
Leninskiy pr. 33, Moscow 119071, Russian Federation
e-mail: sokolovsg@sevin.ru

M. B. Shedko
Institute of Biology and Soil Science (IBSS), Far Eastern Branch of Russian Academy of Sciences (FEB RAS),
159 Stoletiya Street, Vladivostok 690022, Russian Federation
e-mail: mshedko@ibss.dvo.ru

Introduction

Acanthobdella peledina Grube, 1851 is among the most renowned clitellate annelids due to its transitional morphological characteristics, which place it between achaetous leech-like clitellates and chaetiferous oligochaetes. Acanthobdellidans are considered as the sister group of branchiobdellidans plus hirudinidans (true leeches) (Siddall et al., 2001). Their advanced characters include a constant number of segments, annulation, sucker-shaped extremities, unpaired gonopores, but, on the other hand, they have chaetae located on the five anteriormost segments and a spacious coelom, which can be viewed as primitive oligochaetous characters. The comprehensive classical study on the morphology of *A. peledina* was carried out by Livanow (1906), and a more recent redescription (Purschke et al., 1993) corroborated earlier opinions on a combination of both hirudinean and oligochaetous characters in this species.

The species diversity of acanthobdellidans was reconsidered dramatically by Epshtein (1966), who described another taxon of the group, *Acanthobdella livanowi* Epshtein, 1966, which was subsequently transferred to a separate genus *Paracanthobdella* Epshtein, 1987 by Epshtein (1987). This species is

characterised by the well-developed anterior sucker with a conspicuous deepening between the chaetae. Moreover, *P. livanowi*, as in non-hirudinean clitellates, possesses a prostomium, a lip-like extension located over the dorsal side of the mouth (Epshtein, 1987; Kutschera & Epshtein, 2006).

Despite the fact that acanthobdellidans, a generally recognised 'missing link', are of great importance for comparative morphology and evolutionary studies, little is known about their biology and geographical distribution, since the two species occur in hard-to-reach regions of northern Eurasia and neighbouring territories of North America. There have been no detailed records of the little-studied *P. livanowi* for several decades. This research is aimed at filling a gap in our knowledge of the morphology, the occurrence and the biology of *P. livanowi* in Kamchatka, north-eastern Russia.

Materials and methods

Acanthobdellidans were collected from fish hosts, anesthetised in weak ethanol and subsequently fixed and preserved in 70 and 96% ethanol. Parasitological surveys of fish (226 specimens of six species) were conducted at different times in several water bodies of Kamchatka. In the eastern part of the peninsula, fish were examined in the Kamchatka River basin (the Azabachya River and the rivers that flow into Lake Azabachye: the Snovidovskaya, Kultuchnaya and Rybovodnyi Klyuch) and in two sites at Lake Kronotskoe; and in the western part of the peninsula: in the basins of the River Kol' (River Krasnaya) and the River Bol'shaya (Lake Nachikinskoe) (Table 1). Standard parasitological indices were calculated. Altogether 122 specimens were collected and identified; 53 were examined microscopically and photographed. Squash preparations were made to examine chaetae. The material is stored in the collection of invertebrates of the Department of Zoology and Animal Ecology, V.N. Karazin Kharkiv National University (52 specimens) and the Museum of Nature, V.N. Karazin Kharkiv National University (1 specimen, MNKNU B-1753).

Results

According to published records (Sokolov, 2005; Sokolov & Kuzishchin, 2005; Butorina et al., 2008) and our new findings (Table 1), *Paracanthobdella livanowi* (Epshtein, 1966) is found on adult non-migratory chars *Salvelinus kronocius* Viktorovsky, *S. schmidti* Viktorovsky, *S. albus* Glubokovsky, *S. malma* (Walbaum) and the Nachikinsky char *Salvelinus* sp. (an undescribed species; see Bogutskaya & Naseka, 2004) as well as on parrs (juveniles) of *S. malma*, *Oncorhynchus mykiss* (Walbaum) and the Nachikinsky char. Information on geographical localities, hosts and infection indices are presented in Table 1. The prevalence varied from 4 to 47.6%, and the intensity ranged from 1 to 27.

In Lake Kronotskoe, the acanthobdellidans were attached to the membrane between the fin rays, bases of the fins, opercula, throat pleats and the skin of the belly of *Salvelinus schmidti*, on the throat pleats and the skin of the belly of *S. albus* and on the base of a fin and the belly of *S. kronocius.* In chars of the Kamchatka River basin and Lake Nachikinskoe, the acanthobdellidans were found on the fins and/or at their bases, usually on pelvic and pectoral fins, more rarely on the anal fin, and on the body, except for one specimen found in the gill cavity of *S. malma* from the River Azabachya. In juveniles of *O. mykiss* of the River Krasnaya, the body and fins were infected. Acanthobdellidan bites appear as small red spots on the fish body (Fig. 1).

External characters of all acanthobdellidan specimens collected and examined largely conform with previous descriptions of *P. livanowi* given by Epshtein (1966, 1987) (Figs. 2–5). The individuals vary from 2.00 to 13.30 mm (arithmetic mean, 5.15 mm) in length. In preserved specimens, the body is white or yellowish, and the dorsum is somewhat darker than the venter. Neither coloration pattern nor eyes are preserved. The specimens have unpaired gonopores and a well-developed terminal posterior sucker. The anterior end bears five rows of chaetae, each with four pairs. There is a well-developed anterior sucker separated from the body by a constriction. In smaller individuals, the anterior sucker is less developed, and shovel-like, with no conspicuous deepening between the chaetae. Chaetae of the fifth and fourth rows, as well as internal chaetae of the third row, are broader than other chaetae. The prostomium, located anterior to the mouth, cannot be recognised with certainty in most specimens. Some individuals bear an inconspicuous tubercle prior to the mouth. The complete segment is quadri-annulate. In some juvenile individuals, the complete mid-body segment consists of two doubled

Table 1 Localities, hosts and infection data for *Paracanthobdella livanowi* in Kamchatka (findings of Present study, Sokolov & Kuzishchin, 2005, and Butorina et al., 2008)

Locality and dates	Coordinates	Host species	Host length (cm)	Total number of hosts/number of infected hosts	Prevalence (%)*	Intensity range	Mean intensity*	Mean abundance*
R. Snovidovskaya, August 1998	56°16′09.19″N, 161°72′96.5″E	*Salvelinus malma* (parr)	9.8–17.7	20/1	5	2	2	0.1
R. Kultuchnaya, August 1998	56°13′35.22″N, 161°71′37.72″E	*Salvelinus malma* (parr and adult)	12.0–21.5	18/4	22.2	1–4	2	0.44
Rybovodnyi Klyuch, September 2001	56°11′55.58″N, 161°79′95.6″E	*Salvelinus malma* (parr)	6.5–11.0	16/5	31.3	1–2	1.4	0.44
R. Azabachya, September 2001	56°19′65.58″N, 161°98′07.27″E	*Salvelinus malma* (parr)	9.5–14.0	10/1		1		
L. Kronotskoe, March 2003	54°73′51.27″N, 160°34′03.09″E	*Salvelinus schmidti* (adult)	20.0–42.0	25/1	4	1	1	0.04
		Salvelinus albus (adult)	25.0–45.0	10/2		1		
		Salvelinus kronocius (adult)	39.0–57.8	7/2		1–2		
L. Kronotskoe, July–Aug 2011	54°43′1.20″N, 160°21′36.00″E	*Salvelinus schmidti* (adult)	32.5–44.6	21/10	47.6	1–27	5.6	2.67
		Salvelinus albus (adult)	43.5–66.6	7/2		1		
		Salvelinus kronocius (adult)	58	1/1		1		
R. Krasnaya, August 2003	53°50′29.44″N, 156°08′39.59″E	*Salvelinus malma* (parr)	8.1–12.1	26/9	34.6	1–5	1.9	0.65
		Oncorhynchus mykiss (parr)	6.8–11.7	45/10	22.2	1–4	1.4	0.31
L. Nachikinskoe, October 2004	53°02′13.92″N, 157°83′09.63″E	*Salvelinus* sp. (parr and adult)	11.8–27.5	20/3	15	1–3	1.7	0.25

* Prevalence, mean intensity and mean abundance are calculated only for the host samples greater than 10 individuals

Fig. 1 A specimen of *Salvelinus kronocius* (from Lake Kronotskoe) with multiple wounds on its belly caused by *Paracanthobdella livanowi*

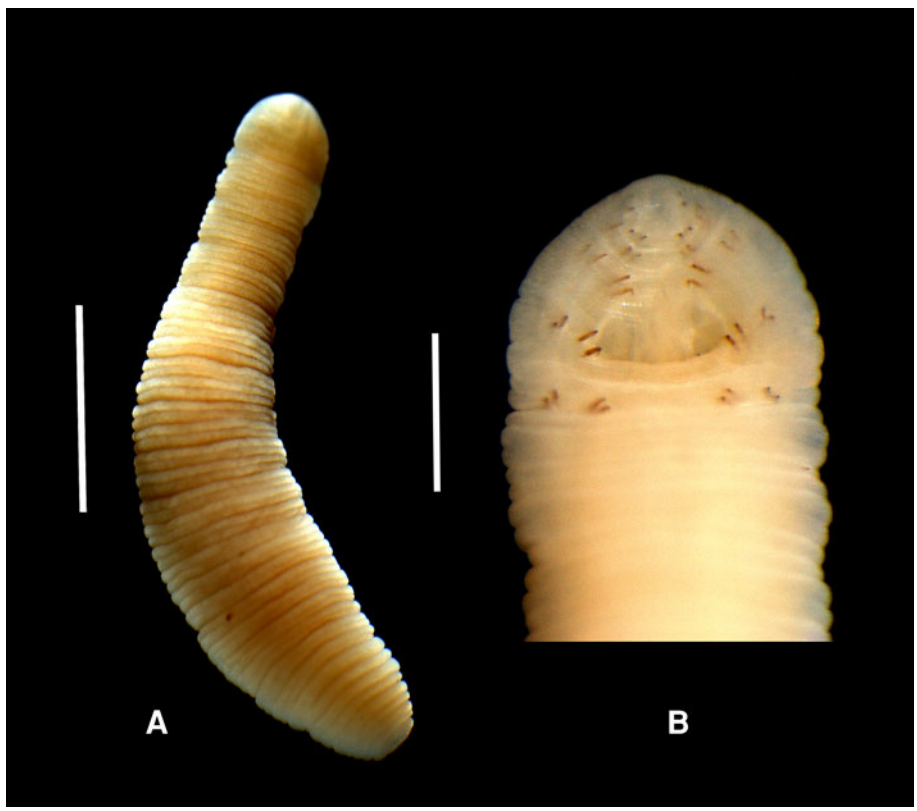

Fig. 2 *Paracanthobdella livanowi*, a specimen (length, 6.85 mm) collected on *Salvelinus malma* from the River Krasnaya (MNKNU B-1753): A, entire specimen, dorsal view; B, anterior end with five rows of chaetae and a cavity between them, ventral view. *Scale-bars*: A, 2 mm; B, 0.5 mm

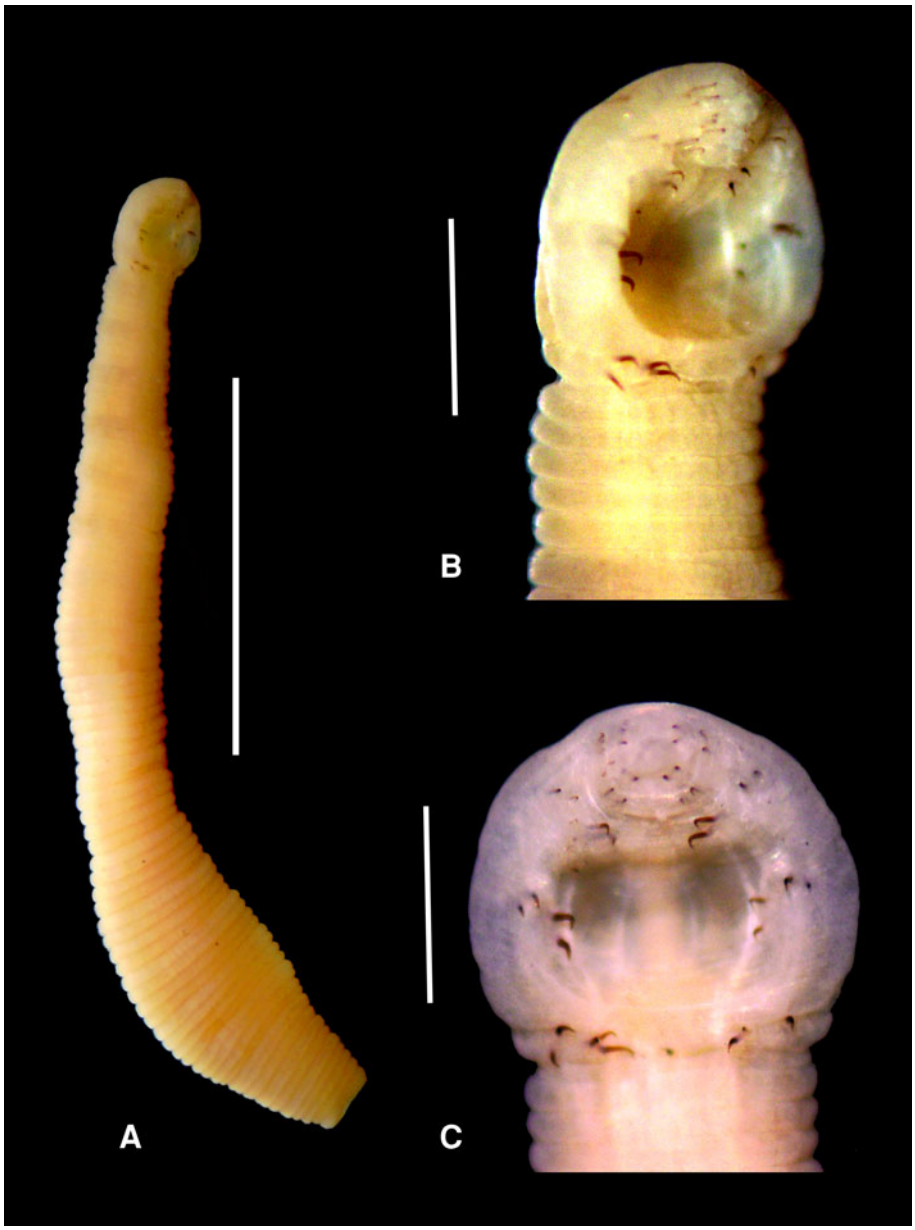

Fig. 3 The largest specimen of *Paracanthobdella livanowi* (length, 13.3 mm) with a well-developed anterior sucker, collected on *Salvelinus albus* from Lake Kronotskoe: A, entire specimen, ventro-lateral view; B, anterior sucker, ventro-lateral view; C, anterior sucker, ventral view. *Scale-bars*: A, 5 mm; B,C, 0.5 mm

annuli. The distinguishing characters found allow us to confidently assign these specimens to *P. livanowi.*

Discussion

The most obvious characteristic of *Paracanthobdella livanowi* is considered to be its well-developed anterior sucker, whereas *Acanthobdella peledina* does not bear a sucker on its anterior extremity (Epshtein, 1966, 1987; Kutschera & Epshtein, 2006). However, it should be emphasised that the shape of the anterior end may vary in *P. livanowi,* so that some individuals may be confused with *A. peledina* because of the lack of a conspicuous depression between chaetae in smaller specimens of *P. livanowi*. Probably, the anterior end of

Fig. 4 A juvenile individual of *Paracanthobdella livanowi* (length, 2.3 mm) found on *Salvelinus malma* from Lake Nachikinskoe, ventral view. The anterior sucker is weakly developed. *Scale-bar*: 1 mm

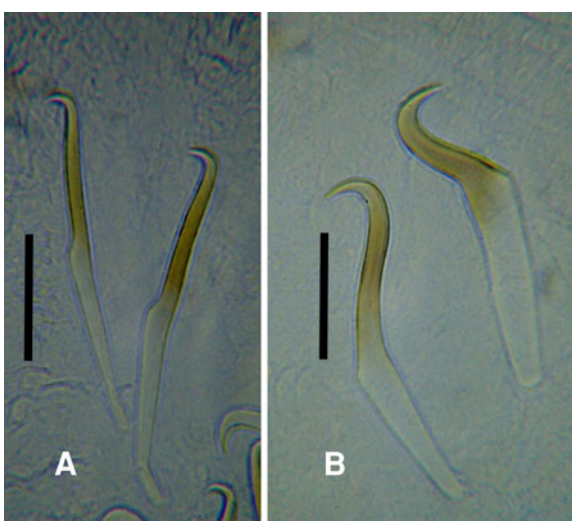

Fig. 5 Chaetae of the first, anteriormost, row (A) and the fourth row (B) of a specimen of *Paracanthobdella livanowi* from Lake Kronotskoe. The chaetae differ distinctly in their breadth. *Scale-bars*: 50 μm

P. livanowi develops from a shovel-like state in juveniles to a sucker with a deep cavity in adults. Individuals of *A. peledina* seem to transform their anterior end to make it sucker-shaped with a depression between the chaetae (see fig. 5 in Epshtein, 1966). However, *P. livanowi* possesses chaetae that vary in their breadth in different rows. This character is crucial for distinguishing the two species (Epshtein, 1966, 1987). The well-developed anterior sucker of *P. livanowi* is clearly demarcated by a constriction and differs from the shallow depression in *A. peledina* (see fig. 6 in Kaygorodova et al., 2012), which differs from the opinion of Brinkhurst & Gelder (1989). Specimens of *P. livanowi* have an inconspicuous prostomium, a lip-like extension located anterior to the mouth. Perhaps, this can be explained by variations in the conditions of fixation and preservation of the specimens. The sizes of specimens collected in different seasons do not exceed 13.3 mm. This corroborates information on the smaller size of *P. livanowi* in comparison with *A. peledina,* which can reach 37 mm in length (Epshtein, 1987).

According to previous records, the hosts of *P. livanowi* are the adult non-migratory chars *Salvelinus krogiusae* Glubokovsky, Frolov, Efremov, Rybnikova & Katugin, *S. malma*, *S. albus*, *S. leucomaenis* (Pallas), a number of ecomorphs (*Salvelinus* spp.) of unclear species identity and juveniles of *S. malma* (Table 2). Records from anadromous chars *Salvelinus* spp. (Butorina & Gorovaya, 2006) are associated with fishes that have remained in freshwaters for some time. Thus, *P. livanowi* is indubitably a freshwater species. There have also been a few records of this acanthobdellidan from the three-spined stickleback *Gasterosteus aculeatus* Linnaeus and parrs of *Oncorhynchus kisutsch* (Walbaum) (Table 2). In addition, *P. livanowi* has been found on a dead *O. nerka* (Walbaum) and in a food bolus of *Coregonus nasus* (Pallas) (Table 2). Pugachev (2004), citing Akhmerov (1954, 1955), lists *O. nerka* and juveniles of *S. malma* from the River Bolshaya and Lake Ushka and the ninespine stickleback *Pungitius pungitius* (Linnaeus) from Lake Ushka as hosts of *P. livanowi.* However, according to the original publication by Akhmerov (1954, 1955), he found all acanthobdellidan specimens (*A. peledina* in his article) free-living. On the whole, taking into consideration the original sources, hosts of *P. livanowi* include 11 species (with ecomorphs of *Salvelinus* spp. of unclear taxonomic identity) of the families

Table 2 Previous records of the distribution and hosts of *Paracanthobdella livanowi*

Locality	Host species	Reference
Chukchi Autonomous District		
Unnamed lake at 108th km of Ekvekinot-Iultin highway	*Coregonus nasus* (in a food bolus)	Lukin, 1976b[2]
As above	*Salvelinus* sp.	Lukin, 1976a[2], b[2]
A water body at Markovo (Anadyr R. basin)	Free-living	Lukin, 1976a[2], b[2]
L. Seutokan	Not specified	Epshtein, 1987
Eastern Kamchatka Peninsula		
R. Kamchatka	*S. albus*	Butorina et al., 1980[2]
R. Kamchatka	*S. malma*	Butorina et al., 1980[2]
R. Adrianovka (Kamchatka R. basin)	Free-living	Epshtein, 1966[2]
L. Ushkovskoe (Kamchatka R. basin)	Free-living	Epshtein, 1966[2]; Akhmerov, 1954[1], 1955[1]; Lukin, 1976a[2]
R. Nikolka (Kamchatka R. basin)	Not specified	Epshtein, 1987
L. Azabachye (Kamchatka R. basin)	Not specified	Lukin, 1976a[2]
L. Azabachye (Kamchatka R. basin)	*Salvelinus* spp.	Epshtein, 1989
L. Azabachye (Kamchatka R. basin)	*S. albus*[4]	Konovalov, 1971[2]; Butorina, 1975[2], 1980[2], 2003
L. Azabachye (Kamchatka R. basin)	*S. malma*[3]	Konovalov, 1971[2]; Makhovenko, 1972[2]; Butorina, 2003
L. Azabachye (Kamchatka R. basin)	*S. leucomaenis*	Konovalov, 1971[2]
L. Azabachye (Kamchatka R. basin)	*Gasterosteus aculeatus*	Konovalov, 1971[2]
R. Ponomarka (flows into L. Azabachye)	*S. malma* (parr)	Butorina & Gorovaya, 2007
R. Azabachya (flows from L. Azabachye)	*S. malma*	Butorina, 1980[2]
R. Azabachya (flows from L. Azabachye)	*Salvelinus* sp. (probably *S. albus*)	Butorina & Gorovaya, 2006
R. Raduga (Kamchatka R. basin)	*Salvelinus* sp. (probably anadromous *S. albus*)	Butorina & Gorovaya, 2006
L. Kursin (Kamchatka R. basin)	*S. malma* and *S. albus* (parr and adult)	Gorovaya & Butorina, 2007
L. Dalnee (Paratunka R. basin)	*Salvelinus krogiusae*[5]	Epshtein, 1966[2]; Konovalov, 1971[2]
R. Paratunka	*Oncorhynchus kisutch* (parr)	Karmanova, 1998
L. Kronotskoe	Not specified	Epshtein, 1987
Western Kamchatka		
R. Kikhchik	Free-living	Epshtein, 1966[2]
R. Karymaysky Klyuch (Bolshaya R. basin)	Free-living	Akhmerov, 1954[1], 1955[1]
Continental seaboard of the Sea of Okhotsk, Taui Bay		
R. Uglekanka (Ola R. basin)	Free-living	Lukin, 1976a[2], b[2]
Not specified	On dead *Oncorhynchus nerka*	Epshtein, 1987
Not specified	*O. kisutsch* (parr)	Epshtein, 1987

[1] *A. peledina* in the original publication; [2] *A. livanowi* in the original publication; [3] lake-river or stream morph of *Salvelinus alpinus* (L.) in publications before 1980; [4] lake or predatory morph of *Salvelinus alpinus* in publications before 1980; [5] chars or lake char *Salvelinus alpinus* in original publications

Salmonidae and Gasterosteidae. Conversely, the host range of *A. peledina* is much wider and includes 25 species of the families Salmonidae, Coregonidae, Thymallidae and Bothidae (Kaygorodova et al., 2012).

Little is known of the life-cycle of *P. livanowi.* We found the acanthobdellidans in early spring (March) and during summer from July to October. In all seasons, individuals of various sizes were present in

samples simultaneously. This species has been also found free-living during the same period (Akhmerov, 1955). Usually the infection intensity is low. The highest value of this index, 27 individuals per fish, was found on *Salvelinus schmidti* from Lake Kronotskoe. In chars of the Kamchatka River basin (*S. albus*, *S. malma* and *Salvelinus* spp.), the intensity was one to two parasites per fish with the prevalence 1.5 to 11.5% (Butorina, 1975, 1980, 2003; Butorina & Gorovaya, 2006; Gorovaya & Butorina, 2007; Makhovenko, 1972). Konovalov (1971) and Epshtein (1989) recorded higher values for the intensity on chars from Lake Azabachye: 1–13 parasites per fish with a prevalence of 19–74%. According to Konovalov (1971), *Gasterosteus aculeatus* was infected with an intensity of one parasite per fish and a prevalence of 20%.

Our observations prove that *P. livanowi* does not attach tightly to its host and falls off easily from caught fish. Large numbers of wounds on the fish body caused by *P. livanowi* with a low infection intensity suggest that the acanthobdellidans stay on their host for a short period of time or, alternatively, a very few acanthobdellidans may crawl about the host body and feed many times. In the latter case, multiple wounds may be caused by small numbers of acanthobdellidans. Interestingly, the well-developed anterior sucker appears not to be associated with a longer period on the fish host as compared to the situation with *A. peledina.* Probably, the anterior sucker has evolved to attach to and penetrate the host's skin but has not resulted in stationary parasitism on the fish host.

The geographical distribution of *P. livanowi* is restricted to fresh waters of Chukotka and Kamchatka and the continental seaboard at the Sea of Okhotsk (Tables 1, 2). The wider range of *A. peledina* includes Fennoskandia and the Kola Peninsula, the lakes of north-western European Russia and Siberia from the River Ob to the River Anadyr in Chukotka and fresh waters of the Baikal region (with the exception of Lake Baikal itself) and Alaska (Lukin, 1976; Sawyer, 1986; Kaygorodova et al., 2012).

Acknowledgements This research was supported in part by the State Foundation of Fundamental Research of Ukraine (DFFD) grant F40/85-2011. Some pictures were made using the facilities and equipment of the Department of Biology, University of Ljubljana, courtesy of Prof. Boris Sket. The study was carried out thanks to cooperative agreement between the Kronotskii State Biosphere Reserve and both IBSS FEB RAS and IPEE RAS.

References

Akhmerov, A. Kh. (1954). [On the parasite fauna of the Kamchatka River.] *Trudy Problemnykh i Tematicheskikh Soveshchaniy ZIN AN SSSR (VII Soveshchanie po Parazitologicheskim Problemam), 4*, 89–98. (In Russian).

Akhmerov, A. Kh. (1955). [The parasite fauna of the Kamchatka River.] *Izvestiya Tikhookeanskogo Nauchno-issledovatelskogo Instituta Rybnogo Khozyaystva i Okeanografii, 43*, 99–137. (In Russian).

Bogutskaya, N. G., & Naseka, A. M. (2004). [*Catalogue of agnathans and fishes of fresh and brackish waters of Russia with comments on nomenclature and taxonomy*.] Moscow: KMK Scientific Press Ltd, 389 pp. (In Russian).

Brinkhurst, R. O., & Gelder, S. R. (1989). Did the lumbriculids provide the ancestors of the branchiobdellidans, acanthobdellidans and leeches? *Hydrobiologia, 180*, 7–15.

Butorina, T. E. (1975). [Dynamics of the parasite fauna of different morphs of chars *Salvelinus alpinus* L. of the Azabachye Lake basin.] *Parazitologiya, 9*, 237–246. (In Russian).

Butorina, T. E. (1980). [Ecological analysis of the parasite fauna of chars (genus *Salvelinus*) of the Kamchatka river.] *In*: [*Population biology and systematics of salmonids.*] Vladivostok: Far East Scientific Centre of the Academy of Sciences of the USSR, pp. 65–81 (In Russian).

Butorina, T. E. (2003). [Parasite fauna, of ecologically equivalent species and ecotypes of Alpine chars in water bodies of Kamchatka.] *Siberian Ecological Journal, 3*, 279–287. (In Russian).

Butorina, T. E., & Gorovaya, O. Yu. (2006). [Application of parasite indicators for examination of chars in the Azabachye Lake basin (Kamchatka).] *Nauchnye Trudy Dal'rybvtuza, 18*, 102–110. (In Russian).

Butorina T. E., & Gorovaya, O. Yu. (2007). [The parasite fauna of brook char (*Salvelinus malma*) from the original location – Ponomarka River in the Azabachye Lake basin.] *In*: [*Conservation of biodiversity of Kamchatka and coastal waters: Materials of VIII International Scientific Conference.*] Petropavlovsk-Kamchatsky: Kamchatpress, pp. 303–307 (In Russian).

Butorina, T. E., Pugachev, O. N., & Khokhlov, P. P. (1980). [Some issues of the ecology and the zoogeography of chars of the genus *Salvelinus* of the Pacific basin.] *In*: [*Population biology and systematics of salmonids.*] Vladivostok: Far East Scientific Centre of the Academy of Sciences of the USSR, pp. 82–95 (In Russian).

Butorina, T. E., Shed'ko, M. B., & Gorovaya, O. Yu. (2008). Specific features of ecology of chars of the genus *Salvelinus* (Salmonidae) from the Basin of Lake Kronotskoe (Kamchatka) according to parasitological data. *Journal of Ichthyology, 48*, 622–636.

Epshtein, V. M. (1966). [*Acanthobdella livanowi* sp. n., a new species of the ancient leeches (Archihirudinea) from waters of Kamchatka.] *Doklady Akademii nauk SSSR, 168*, 955–958. (In Russian).

Epshtein, V. M. (1987). [The Phylum Annelids – Annelida.] *In:* Bauer, O. N. (Ed.) *[Identification key to parasites of the freshwater fishes of the USSR.]* Vol. 3. Leningrad: Nauka, pp. 340–372 (In Russian).

Epshtein, V. M. (1989). [*Chaetiferous, turtle and fish leeches of the fauna of the world (System approach to classification and phylogeny).*] Abstract of Doctoral Dissertation. Leningrad (In Russian).

Gorovaya, O. Yu., & Butorina, T. E. (2007). [The chars parasite fauna of the Kursin Lake in the low reach of the Kamchatka River.] *In*: *Conservation of biodiversity of Kamchatka and coastal waters: Materials of VIII International Scientific Conference*. Petropavlovsk-Kamchatsky: Kamchatpress, pp. 34–37 (In Russian).

Karmanova, I. V. (1998). [Parasites of pacific salmons in the epizootic situation of parasitoses in the Paratunka River basin (Kamchatka).] Dissertation Abstract. Petropavlovsk-Kamchatsky. (In Russian).

Kaygorodova, I. A., Dzyuba, E. V., & Pronin, N. M. (2012). Leech-like parasites (Clitellata, Acanthobdellida) infecting native and endemic Eastern Siberian salmon fishes. *The Scientific World Journal*, Vol. 2012, article ID 652827, 8 pp., doi:10.1100/2012/652827.

Konovalov, S. M. (1971). [Differentiation of local stocks of the red salmon *Oncorhynchus nerka* (Walbaum).] Leningrad: Nauka, 229 pp. (In Russian).

Kutschera, U., & Epshtein, V. M. (2006). Nikolaj A. Livanow (1876–1974) and the living relict *Acanthobdella peledina* (Annelida, Clitellata). *Annals of the History and Philosophy of Biology, 11*, 85–98.

Livanow, N. (1906). *Acanthobdela peledina* Grube, 1851. *Zoologische Jahrbücher. Abteilung für Anatomie und Ontogenie der Tiere, 22*, 637–866.

Lukin, E. I. (1976a). [*Fauna of the USSR. Leeches*, Vol. 1. *Leeches of fresh and brackish water bodies*.] Leningrad: Nauka, 484 pp. (In Russian).

Lukin, E. I. (1976b). [Towards the leech fauna of Chukotka.] *Trudy Biologo-pochvennogo Instituta Dal'nevostochnogo Nauchnogo Tsentra AN SSSR, 36 (139)*, 102–103 (In Russian).

Makhovenko, T. E. (1972). [On peculiarities of the parasite fauna of various morphs of the char of Kamchatka.] *Parazitologiya, 6*, 369–375. (In Russian).

Pugachev, O. N. (2004). [Checklist of the freshwater fish parasites of the northern Asia. Nematoda, Acanthocephala, Hirudinea, Mollusca, Crustacea, Acari.] *Proceedings of the Zoological Institute of the Russian Academy of Sciences, 304*, 250 pp. (In Russian).

Purschke, G., Westheide, W., Rohde, D., & Brinkhurst, R. O. (1993). Morphological reinvestigation and phylogenetic relationship of *Acanthobdella peledina* (Annelida, Clitellata). *Zoomorphology, 113*, 91–101.

Sawyer, R. T. (1986). *Leech biology and behaviour*. Oxford: Clarendon Press, 464 pp.

Siddall, M .E., Apakupakul, K., Burreson, E. M., Coates, K. A., Erséus, C., Gelder, S. R., Källersjö, M., & Trapido-Rosenthal, H. (2001). Validating Livanow: molecular data agree that leeches, branchiobdellidans, and *Acanthobdella peledina* form a monophyletic group of oligochaetes. *Molecular Phylogenetics and Evolution, 21*, 346–3551.

Sokolov, S. G. (2005). [A review of parasites of the mikizha *Parasalmo mykiss* (Osteichthyes, Salmonidae) from Kamchatka peninsula.] *Invertebrate Zoology, 2*, 35–60. (In Russian).

Sokolov, S. G., & Kuzishchin, K. V. (2005). [Parasitological analysis of juvenile Kamchatka steelhead *Parasalmo mykiss*, coho salmon *Oncorhynchus kisutsch*, and dolly varden trout *Salvelinus malma* (Salmonidae, Osteichthyes) from the Krasnaya River (the Kol' River Basin, Western Kamchatka) as an approach for the study of their specific ecological features.] *Journal of Ichthyology, 45*, 328–333.