

Checklist of the pathogens of lamprey species of Poland

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Abstract

This is a checklist of 51 pathogens of lamprey species found in Poland, including European river lamprey *Lampetra fluviatilis* (Linnaeus, 1758), European brook lamprey *Lampetra planeri* (Bloch, 1784), Ukrainian brook lamprey *Eudontomyzon mariae* (Berg, 1931), Danubian brook lamprey *Eudontomyzon vladykovi* Oliva and Zanandrea, 1959 and sea lamprey *Petromyzon marinus* Linnaeus, 1758.

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INTRODUCTION

The lampreys occurring in the Palearctic faunal region represent 5 genera from the family Petromyzontidae. The lampreys found in Europe represent 10 species (Kottelat and Freyhof 2007), with 5 species found in Poland. The anadromic European river lamprey *Lampetra fluviatilis* (Linnaeus, 1758) was noted in the Baltic Sea and in the rivers all over the country, in greater numbers in the northern regions (Terofal and Militz 1997, Filipiak and Raczyński 1999). The European brook lamprey *Lampetra planeri* (Bloch, 1784) is found not very often in brooks and streams (Więcaszek et al. 1999), while the sporadically noted non-parasitic Ukrainian brook lamprey *Eudontomyzon mariae* (Berg, 1931), was recently found at new sites in the catchment area of the Vistula and Odra Rivers (Marszał et al. 1993). The Danubian brook lamprey *Eudontomyzon vladykovi* Oliva and Zanandrea, 1959, occurring in the catchment area of the Danube River (Froese and Pauly 2008) in Poland was found at two sites in Czarna Orawa (Marszał et al. 1993). A typically marine lamprey (sea lamprey) *Petromyzon marinus* Linnaeus, 1758 was occasionally recorded in the Baltic Sea at the coast of Poland; in the mating season it enters the Vistula and Odra Rivers and through their tributaries it reaches the Bug River (Więcaszek et al. 1999).

The objective of the study was to sum up the current state of knowledge on the pathogens of lamprey species noted in Poland.

RESULT AND DISCUSSION

Parasitic examinations of the representatives of family Petromyzontidae were rather scarce. Only 11 of the 39 known lamprey species were studied. Altogether 79 pathogenic and parasitic species were found in lampreys, of which 51 are mentioned in Table 1. The majority of literature on the parasites in lampreys comes from the countries of the former USSR (Dogel' and Petruševskij 1933, Gecevičute 1974, Vismanis et al. 1981) where the lampreys have had economic importance (Filipiak and Raczyński 1999). For the same reasons the parasite fauna of the freshwater population of *Petromyzon marinus* from the US Great Lakes, in which lampreys destroyed valuable fish species, was well-described (Renaud 1997, Psuty 1998). Important contributions in the knowledge of lamprey parasites were provided by the study of ammocoetes *Eudontomyzon mariae* and *Lampetra planeri* by Zehnov (1956, 1958) and the study of larvae and adult individuals by Moravec (1976, 1979) and Moravec and Malmquist (1977). Most examinations were performed on adult lampreys caught during their spawning season migrations, mainly representing the species *Lampetra fluviatilis*. Such examination does give reliable results, especially for

Table 1

Potential pathogens checklist of 4 species of Polish waters lampreys.

Parasite	<i>L. fluviatilis</i>	<i>L. planeri</i>	<i>E. mariae</i>	<i>P. marinus</i>	Author
<i>Pseudomonas fluorescens</i> Migula, 1895				x	Wilson, 1967
<i>Aeromonas hydrophila</i> (Chester, 1910) Stanier, 1943				x	Wilson, 1967
<i>Bartonella pavlovskii</i> Epschtein, 1935	x	x	x	x	Epštejn, 1935, Zehnov, 1957 Zehnov, 1957, Epštejn, 1935
<i>Saprolegnia parasitica</i> Cooker, 1923				x	McLain, 1951
<i>Ichthyophthirius multifiliis</i> Fouquet, 1876				x	McLain, 1951
<i>Trichodina</i> sp.				x	Guilford, 1954
<i>Diplostomum petromyzifluviatilis</i> Diesing, 1850	x	x	x		Sweeting, 1976, Gintovt, 1969, Zehnov, 1958
<i>Diplostomum phoxini</i> (Faust, 1918) Arvy et Buttner, 1987	x				Getsevičute, 1974
<i>Diplostomum</i> spp.	x	x	x		Dogel and Petruševkij, 1933, Zehnov, 1958, Zehnov, 1958
<i>Diplostomum spathaceum huronense</i> (LaRue, 1927) Hughes, 1929				x	Wilson and Ronald, 1967
<i>Neodiplostomum hughesi</i> Markevič, 1934		x	x		Zehnov, 1958, Zehnov, 1958
<i>Tetracotyle</i> spp. I, II, III, IV		x	x		Zehnov, 1958, Zehnov, 1958
<i>Brachyphallus crenatus</i> Odhner, 1905	x				Šulman, 1957
<i>Hemirurus appendiculatus</i> (Rudolphi, 1802) Looss, 1899	x				Daves, 1946
<i>Orientocreadium pseudobagri</i> Yamaguti, 1934		x	x		Zehnov, 1958 Zehnov, 1958
<i>Sphaerostomum bramae</i> (Müller, 1776) Lühe, 1909	x				Šulman, 1957
<i>Podocotyle lepomis</i> (Dobrovolny, 1939) Yamaguti, 1954				x	Wilson and Ronald, 1967
<i>Apophallus</i> sp.			x		Zehnov, 1958
<i>Metorchis</i> sp.			x		Zehnov, 1958
Acanthocolpidae metacercariae			x		Zehnov, 1958
<i>Distomum inerme</i> Linstow, 1879	x				Bittner and Sprehn, 1928
<i>Distomum semiflavum</i> Linstow, 1880	x				Bittner and Sprehn, 1928
<i>Eubothrium crassum</i> (Bloch, 1779) Nybelin, 1922	x				Jääskeläinen, 1921
<i>Eubothrium</i> sp.				x	Guilford, 1954
<i>Bothriocephalus</i> sp.	x				Jääskeläinen, 1921
<i>Ligula intestinalis</i> (L., 1758) Gmelin, 1790		x			Reichenbach-Klinke and Elkan, 1965
<i>Diphyllbothrium</i> sp.	x				Jääskeläinen, 1921

continued

Parasite	<i>L. fluviatilis</i>	<i>L. planeri</i>	<i>E. mariae</i>	<i>P. marinus</i>	Author
<i>Trienophorus nodulosus</i> (Pallas, 1781) Rudolphi, 1819	x				Jääskeläinen, 1921
<i>Trienophorus crassus</i> Forel, 1868				x	Guilford, 1954
<i>Scolex pleuronectis</i> Müller, 1788	x				Joyeux and Baer, 1936
<i>Proteocephalus percae</i> Müller, 1780	x				Jääskeläinen, 1921
<i>Proteocephalus exiguus</i> La Rue, 1911				x	Guilford, 1954
<i>Proteocephalus laruei</i> Faust, 1920				x	Bangham, 1955
<i>Anisakis simplex</i> (Rudolphi, 1809)	x				Present study
<i>Hysterothylacium aduncum</i> (Rudolphi, 1809)	x			x	Moravec 1994, Polyanskij, 1955
<i>Raphidascaris acus</i> (Bloch, 1779) Ralliet and Henry, 1915		x			Moravec 1994
<i>Truttaedacnitis stelmioides</i> (Vessichelli, 1910) Petter, 1974/ <i>Cucullanus truttae</i> A.L. Fabricius, 1794	x	x	x	x	Getsevičute, 1974, Moravec, 1976, Zekhov, 1956, Wilson and Ronald, 1967
<i>Cystidicola farionis</i> Fischer, 1798	x			x	Hardisty and Potter, 1971, Guilford, 1954
<i>Gordius aquaticus</i> Linnaeus, 1766	x	x	x		Malmquist and Moravec, 1978, Malmquist and Moravec, 1978, Zekhov, 1956,
<i>Neoechinorhynchus cylindratus</i> (Van Cleave, 1913) Van Cleave, 1919				x	Guilford, 1954
<i>Echinorhynchus gadi</i> Müller, 1776	x				Grabda and Grabda, 1954
<i>Metechinorhynchus salmonis</i> (Müller, 1784) Petročenko, 1956	x			x	Jääskeläinen, 1921, Appy and Anderson, 1981
<i>Metechinorhynchus leidyi</i> (van Cleave, 1924) Golvan, 1969				x	Guilford, 1954
<i>Corynosoma semerme</i> Forsell, 1904	x				Jääskeläinen, 1921
<i>Corynosoma strumosum</i> (Rudolphi, 1802) Lühe, 1904	x				Jääskeläinen, 1921
<i>Piscicola geometra</i> (Linnaeus, 1761)	x				Vismanis et al., 1981
<i>Piscicola milneri</i> (Verill, 1847) Ryerson, 1915				x	Applegate, 1950
<i>Piscicola zebra</i> Moore, 1898				x	Moore, 1898
Unionidae larvae	x				Grabda and Grabda, 1954
<i>Anodontooides ferrussacianus</i> Lea, 1834				x	Wilson and Ronald, 1967
<i>Argulus foliaceus</i> (Linnaeus, 1758)	x	x			Vismanis et al., 1981 Gadd, 1904
<i>Ergasilus sieboldi</i> von Nordman, 1832	x				Gecevičute, 1974
<i>Ergasilus caeruleus</i> Wilson, 1911				x	Wilson and Ronald, 1967

diadromous species, as the change in the environmental conditions together with the cessation of food intake leads to a reduction in the number of external and alimentary tract parasites. For the species *Lampetra planeri* and *Eudontomyzon mariae*, in which adults do not feed at all and live for a relatively short time, the majority of data on parasites come from investigation of ammocoetes. In diadromous lamprey species, the marine and freshwater parasites can occur side by side, it also happens that the freshwater parasites (in particular those not living in the alimentary tract) survive the period of the lamprey feeding in the seas. According to Jääskeläinen (1921), who studied the freshwater population of *L. fluviatilis* from Lake Ladoga, the typical freshwater parasites can exist along with the marine ones, which managed to adapt to the freshwater conditions.

In Poland the lamprey parasites were studied only in *L. fluviatilis* (Grabda and Grabda 1954) and 3 parasite species were reported (*Diplostomum petromyzifluviatilis*, *Echinorhynchus gadi* and bivalve larvae), of which *Diplostomum petromyzifluviatilis* is typical for this species of lamprey.

Pathogens of adult lamprey

The pathogens of lampreys are characterized by a few features, the most pronounced of which is the sporadic or even accidental character of occurrence. Apart from a few species, the majority of them were found at single sites and by a single author, often at very low intensity and prevalence (even individual parasites in individual lampreys). In the case of 2 specimens of trematode from the genus *Distomum* even the species' existence seems to be questionable. *Distomum* is an old appellation used to describe Digenea with an oral and ventral sucker. The names given above are probably not referable to any described species and may refer to the same worm (Šulman 1957). Next, the presence of *Bartonella pavlovskii*, the bacteria considered specific to lampreys, was confirmed only once in particular species of the host (Šulman 1957, Zehnov 1957). Disregarding the parasite species of sporadic occurrence and those whose presence is questionable, a few parasite species of regular presence are noted in the lamprey: *Diplostomum petromyzifluviatilis*, *Diplostomum* spp. (*D. spathaceum huronense* = *D. huronense* in marine lamprey from Great Lakes and *Diplostomum petromyzifluviatilis* in the other species), *Eubothrum crassum*, *Triaenophorus crassus*, *Proteocephalus* sp., *P. exiguus* (in marine lamprey from Great Lakes), *Truttaedacnitis truttae* (= *Cucullanus truttae*), *Gordius aquaticus*, *Metechinorhynchus salmonis* (in marine lamprey from Great Lakes), *M. leidyi*. It should be emphasized that the larvae of digeneans of the genus *Diplostomum* enter the host organism through the skin, without engagement of the alimentary tract. The larvae of horsehair worm *G. aquaticus* are in the diet of lamprey

accidentally, probably infecting several invertebrates (Perçin-Paçal and Sancar-Baş 2008).

Many of the above mentioned parasite species found in lampreys (Table 1) are also recorded in salmonid fish. Possible explanations are that lampreys often feed on salmonid fish (Appy and Anderson 1981) or that these two evolutionally much distant groups have similar biology and ecology (Marszał et al. 1993). The latter explanation does not exclude the former and even supplies it. The similarities in biology of these two groups include the presence of the anadromic forms maturing and living the most active life in the sea and then migrating in the spawning season up the rivers. They are also similar in terms of the presence of exclusively freshwater forms and the fact that the males and females die shortly after spawning and do not feed during the spawning season migration. The presence of many other species of parasites recorded in the lampreys can be explained by assuming that the infection takes place on the lamprey feeding on the fish and the composition of the parasite fauna depends on the types of locally available hosts. The lampreys from the Riga Bay studied by Vismanis et al. (1981) were infected with *Cystydicola farionis*, occurring in large numbers in the European smelt (*Osmerus eperlanus*) inhabiting this region.

In the alimentary tract of these lampreys fragments of the intestines and air-bladders of the European smelt (sparling) were found. The group of external parasites of the lampreys is rather scarce and the presence of all of them seems accidental. The exception is the freshwater population of the marine lamprey from Great Lakes, in which numerous pathogens were found on the skin, including bacteria, fungi and protozoans. The mechanisms developed by the lampreys for protection against external parasites include excretion of toxic mucus covering cuticle with a thick layer, mode of living of ammocoetes (in deep mud) and the effect of changing environment, known in migratory fish. The observation of a greater number of ectopathogens of *P. marinus* in North America is intriguing. Probably, the lampreys of this species did not manage to develop the protective mechanisms against the pathogens on changing the environment from marine to freshwater. They are also not able to get rid of the parasites in the contact with marine water.

Pathogens of ammocoetes

The majority of data on the parasites of ammocoetes come from the papers by Zehnov (1956, 1958), who studied 180 larvae of *E. mariae* and 452 larvae of *L. planeri*. Also Moravec (1976, 1979) studied the ammocoetes of *L. planeri* and *L. fluviatilis*. However he fixed his attention on identification of the nematode *Truttaedacnitis truttae*, which has been described in the ammocoetes

and young *L. planeri* as *Dacnitis stelmioides*. It should be mentioned that the first who questioned this claim was Törnquist (1931) but his conclusion was based on results obtained for only three females of the nematode.

In the ammocoetes of this lamprey species 13 pathogens were found in Poland, including *Aeromonas* sp., *Bartonella pavlovskii*, *Diplostomum petromyzifluviatilis*, *Diplostomum spathaceum*, *Paracoenogonimus ovaus*, *Orientocreadium pseudobagri* (= *Orientocreadium siluri*), *Aphophallus* sp., *Metorchis* sp., larvae of Acanthocolpidae, *Ligula intestinalis*, *Truttaedacnitis truttiae*, *Gordius aquaticus*, *Argulus foliaceus* (Gadd 1904; Malmquist, Moravec 1976, 1979; Sweeting 1976; Wilson 1967; Wilson and Ronald 1967; Yamaguti 1959; Zehnóv 1956, 1958). These parasites occur also in adult lamprey of *L. fluviatilis* and *P. marinus*. Except for the species *B. pavlovskii* and *A. foliaceus*, all the other parasites of ammocoetes occur in the form of larvae and live in the host in the form of small invasive forms introduced by swallowing or direct penetration. Many individuals were found in the gills, in the muscles surrounding the gills or in the alimentary tract and rarely in the skin. These observations can be explained by the mode of living of the ammocoetes, that are almost completely buried in the bottom mud and the mouth organs take food from the surface of the sediments. Some larvae of the parasites are carried with water near the gills. As the size of the food of ammocoetes is limited, they rarely swallow water crustaceans and arthropods (insects and their larvae), therefore they rarely are infected with parasites that need an intermediate host from these groups.

A very interesting feature of the parasite fauna of the lampreys (Petromyzontidae) is the unexpectedly low number of specific parasites, considering the fact that they make a very old group of hosts; the phenotype of the lampreys is known to have been unchanged for about 350 million years. In contrast, the specific parasitic fauna of the oldest groups of fish (e.g. Acipenseriformes and Elasmobranchii) is very rich (Appy and Anderson 1981). The long-term co-existence favors the evolution of the parasites and the hosts (Combes 1995). Moreover, only *Bartonella pavlovskii* is treated as a relict, while the other parasite species are phylogenetically young and their life cycle is related to other host species, much younger than the lampreys. According to Šulman (1957), the parasite fauna of the lampreys is secondary and young, as it is in the process of formation, as indicated by the small number of parasites along with the sporadic and accidental character of their occurrence. The author suggests that the primary parasite fauna of the lampreys died out as a result of changes in the environmental conditions and the mode of living of the hosts, because the primary lampreys had not been parasites. An interesting characteristic feature is that the only parasite remaining from the old parasite fauna is the blood parasite whose presence is not related to the type of feeding.

Of the other specific parasites *Diplostomum* spp. are also actively introduced to the host, not with the food.

REFERENCES

- Applegate V.C., 1950, *Natural history of the sea lamprey (Petromyzon marinus) in Michigan*, Spec. scient. Rep. U.S. Fish. and Wildl. Serv. Fish, 55: 1 – 237
- Appy R., Anderson R.C., 1981, *The parasites of lampreys*. [in:] *The biology of Lampreys*, Vol. 3, Eds. Hardisty M.W., Potter I.C., London – New York, Academic Press, 1 – 42
- Bangham R.V., 1955, *Studies on fish parasites on Lake Huron and Manitoulin Island*, Am. Midl. Nat., 55: 184 – 191
- Bittner H., Sprehn C., 1928, *Trematodes*. Biologie Tiere Dtl., 27: 1 – 133 (in German)
- Combes C., 1995, *Interactions durable. Ecology and evolution of parasitism*, Paris, Masson, pp. 524 (in French)
- Dawes B., 1946, *The Trematoda*, Cambridge, Cambridge University Press, pp. 644
- Dogel V.A., Petruševkij G.K., 1933, *Parasite fauna of Neva Inlet fish*, Trudy leningr. Obš. Estest., 62: 366 – 463 (in Russian)
- Filipiak J., Raczyński M., 1999, *The lampreys*, Magazyn Przemysłu Rybnego, 2(10): 36 – 8 (in Polish)
- Froese R., Pauly D., Eds, 2008, www.fishbase.org, version 09/2008
- Gadd P., 1904, *Parasitic copepodes in Finland*, Acta Soc. Fauna Flora Fenn., 26: 1 – 60 (in Finnish)
- Gecevičute S., 1974, *The parasite fauna of river lampreys (Lampetra fluviatilis L.) in the lagoon of Kuršū-Marec*, Acta Parasit. Lith., 12: 59 – 62 (in Russian)
- Gintovt F.V., 1969, *Metacercaria from the brain of the European brook lamprey, Lampetra planeri (Bloch.)*, Parazitologija, 3: 539 – 541 (in Russian)
- Grabda E., Grabda J., 1954, *The parasites of river lamprey Lampetra fluviatilis (L.)*, Materials of IV Symposium PTP, Gdańsk, 134 (Abstr.), (in Polish)
- Guilford H.G., 1954, *Parasites found in the sea lamprey, Petromyzon marinus from Lake Michigan*, J. Parasit., 40: 364 – 372
- Hardisty M.W., Potter I.C., 1971, *The biology of lampreys*, Vol. 1, London, Academic Press, 127 – 206
- Jääskeläinen V., 1921, *The nourishment and fish parasites in Ladoga-sea*, Ann. Acad. Sci. Fenn., 14: 1 – 55, (in German)
- Jasiński A., 1977, *The zootomy of vertebrates*. PWN, Warszawa (in Polish)
- Joyeux C.E., Baer J.G., 1936, *Cestodes*. Faune Fr. 30, Paris, Lechevalier, pp. 613
- Kottelat M., Freyhof J., 2007, *Handbook of European freshwater fishes*, Switzerland, Publication Kottelat, Cornol, pp. 646, DOI 10.1007/s10228-007-0012-3
- Malmquist B., Moravec F., 1978, *Gordius aquaticus larvae found in lampreys Lampetra planeri (Bloch) and L. fluviatilis*, Folia Parasit., 25: 40 (Abstr.)
- Marszał L., Penczak T., Zaczyński A., 1993, *The new positions of Ukrainian lampreys, Eudontomyzon mariae (Berg, 1931) in Poland*, Przegl. Zool., 37 (1 – 2): 87 – 91, (in Polish)
- McLain A.L., 1951, *Diseases and parasites of the sea lamprey, Petromyzon marinus in the Lake Huron basin*, Trans. Am. Fish. Soc., 81: 94 – 100
- Moore J.P., 1898, *The leeches of the U.S. National Museum*, Proc. U.S. Nat. Mus., 21: 543 – 63
- Moravec F., 1976, *Occurrence of the encysted larvae of Cucullanus truttae (Fabricius, 1794) in the brook lamprey, Lampetra planeri (Bl.)*, Scripta Fac. Sci. Nat. Ujep Brunensis, Biologia, 6: 17 – 20

- Moravec F., 1979, *Observations on the development of Cucullanus (Truttaedacnitis) truttae* (Fabricius, 1794) (Nematoda: Cucullanidae), *Folia Parasit*, 26: 295 – 307
- Moravec F., 1994, *Parasitic nematodes of freshwater fishes of Europe*, Dordrecht, Boston, London, Kluwer Academic Publisher, pp. 473
- Moravec F., Malmquist B., 1977, *Records of Cocullanus truttae* (Fabricius, 1794) (Nematoda: Cucullanidae) from Swedish brook lampreys, *Lampetra planeri* (Bloch), *Folia Parasit*, 24: 323 – 9
- Polyanskij Ū., 1955, *The fish parasites of Barents Sea*, *Trudy Zool. Inst.*, Tbilisi, 19: 5 – 170 (in Russian)
- Psuty I., 1998, *Lampreys – the most primitive „fishes”*, *Komunikaty Rybackie, IRS, Olsztyn*, 2: 11 – 14 (in Polish)
- Reichenbach-Klinke H., Elkan E., 1965, *The principle diseases of lower vertebrates*. New York, Academic Press, pp. 600
- Renaud C.B., 1997, *Conservation status of Northern Hemisphere lampreys (Petromyzontidae)*, *J. Appl. Ichthyol*, 13(3): 143 – 8 DOI10.1111/j.1439-0426.1997.tb00114
- Šulman S.S., 1957, *The materials on Baltic and White Seas lamprey parasites*, *Izv. gosud. naučno-issled. Inst. Ozern. Reč. Ryb. Hoz.*, 42: 287 – 303, (in Russian)
- Sweeting R., 1976, *An experimental demonstration of the life cycle of a Diplostomulum from Lampetra fluviatilis* Linnaeus, 1758, *Z. Parasitenk.*, 49: 233 – 242
- Terofal F., Militz C., 1997, *Freshwater fishes*. Warszawa, Świat Książki, pp. 287, (in Polish)
- Törnquist N., 1931, *The Cucullanidae and Camallanidae as a contribution to anatomy and histology of Nematodes*, *K. Vetensk-o VitterhSamh. Handl.Göteborg*, 2: 1–41, (in Sweedish)
- Vessichelli N., 1910, *The new Dacnitis parasite of Petromyzon planeri*, *Monitore Zool. Ital.*, 21: 304–7, (in Italian)
- Więcaszek B., Krzykowski S., Antoszek A., Keszka S., 1999, *Principles of systematics of cyclostomates and fishes*, Szczecin, AR, pp. 197, (in Polish)
- Wilson K.A., Ronald K., 1967, *Parasite fauna of the sea lamprey (Petromyzon marinus von Linné) in the Great Lakes region*, *Can. J. Zool.*, 45: 1083–92
- Vismanis K.O., Ēglite R.M., Volkova A.P., 1981, *Parasites and parasitological diseases of the Baltic herring (Clupea harengus membras L.) and the river lamprey (Lampetra fluviatilis L.)*, *Uč. Zap. Latv. Gos. Univ.*, 95–111
- Zehnov M.I., 1957, *Parasite fauna of European brook lampreys and Ukrainian lampreys*, *Doklady Naučnoj Konferencji Veteryjnogo Instituta im. Oktâbra. Vitebsk*, 22 – 23 (in Russian)
- Zehnov M.I., 1956, *The parasite fauna of Lampetra*. *Učenyje zapiski Kazanskogo Gosudarstvennogo Veterinarnogo Instituta* 14: 187 – 192 (in Russian)
- Zehnov M.I., 1958, *The parasite fauna of Lampetra*. Part II. *Učenyje zapiski Kazanskogo Gosudarstvennogo Veterinarnogo Instituta* 16: 137 – 141