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Effect of *Acanthocephalus lucii* Infection on Total Mercury Concentrations in Muscle and Gonads of Fish Host (*Perca fluviatilis*)

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Abstract The samples from 13 perches (*Perca fluviatilis*) – muscle with skin and bones; fish gonads; and acanthocephalan parasites were analysed for mercury (Hg). Hg concentrations were present in all analysed samples. There were found no statistically significant difference in Hg concentration in fish tissues between perches either with or without infection by the acanthocephalan parasite, *Acanthocephalus lucii*). In this study there was no evidence that acanthocephalan worms accumulate mercury from hosts. For this reason, *A. lucii* is not a suitable bioindicator for mercury pollution.

Keywords Mercury · *Perca fluviatilis* · Parasites · Bioindicators · *Acanthocephalus lucii*

The relationship between pollution and parasitism in aquatic organisms and the potential role of parasites as water quality indicators have received increased attention over the past two decades. Under natural conditions, no organism is affected by only parasites or pollution alone. Parasites are ubiquitous. They occur in virtually all food webs at all trophic levels. It is known that intestinal parasites of fishes, especially acanthocephalans (Sures 2003, 2008a, b) and, to a lesser degree, cestodes (Jankovská et al. 2010a, b; Sures et al. 2002; Turčeková et al. 2002), are able to accumulate some heavy metals to a very high degree (Sures 2004), and in this way, decrease heavy metal concentrations in host tissues.

Methylmercury is a component of total mercury in the body. The methylation of inorganic mercury in the aquatic environment and subsequent bioaccumulation and biomagnification of this compound are greater in animals found near the top of the food chain (i.e. predatory animals). Therefore, there are elevated levels of methylmercury in the muscle tissue of predatory fish (Ryman et al. 2008). Muscle tissue is the primary storage site of mercury in fish. The majority of this mercury (≥95 %) is in the form of methylmercury (Bloom 1992).

This study examined the inter-relations between free living fish (*Perca fluviatilis*), its acanthocephalan parasites (*Acanthocephalus lucii*) and mercury accumulation in fish muscle and gonadal tissues.

Materials and Methods

Thirteen specimens of european perch (*P. fluviatilis*) naturally infected with the adults of the intestinal acanthocephalan parasite *A. lucii* (Fig. 1; Table 1) were sampled in the Jevanský potok stream (Fig. 2) about 30 km from Prague in autumn 2010, and were frozen immediately. After the fish were brought to the laboratory, they were necropsied and acanthocephalans were removed from the gut (no other intestinal helminths were found).

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Fig. 1 Microphotograph of *A. lucii* from perch (*P. fluviatilis*). The parasite was observed by Olympus BX51 microscope via differential interference contrast at a total magnification of ×100. This *picture* was taken by Olympus E-410 camera and the benchmark was created by integrated computing system (QuickPhoto Micro 2.2) (original photo by J. Vadlejch co-author)

Table 1 Size and weight of perches (n = 13), and number of acanthocephalans (*A. lucii*) fished from the stream Jevanský potok (CR)

Fish number	Body length (mm)	Weight (g)	Sex	Number of *A. lucii*
1	225	164.0	F	0
2	230	168.5	F	1
3	225	169.4	F	0
4	235	200.4	F	3
5	240	201.2	F	5
6	*230*	*202.0*	*M*	*1*
7	220	175.5	F	3
8	235	129.8	F	3
9	235	189.9	F	0
10	215	164.4	F	2
11	235	182.2	F	5
12	220	152.8	F	0
13	225	176.0	F	12
Mean	**228.5**	**175.1**		**2.692**
SD	±0.75	±20.77		

The mean values are highlighted in bold

Thorny headed worms (*A. lucii*) were found in the digestive system of some perch during helmitologic dissection. Fish tissue samples (muscles with bone and skin; gonads) and worms were taken with the aid of stainless steel scissors and forceps which had been previously cleaned with redistilled water. Tissue samples and parasites were frozen at −26°C in polypropylene containers until further processing using an Advance Mercury Analyser (AMA 254, Altec, Ltd., Czech Republic).

Results and Discussion

Mercury was present in all analysed samples (Tables 2, 3). Perch infected with *A. lucii* (n = 9) had slightly higher mean Hg concentrations (0.12 ± 0.02, 0.013 ± 0.004 and 0.010 ± 0.005 mg Hg/kg dw of fish muscle; gonads and acanthocephalan parasites—Table 2) than their uninfected conspecifics (Table 3, n = 4). However, the differences between Hg concentrations in tissues of fishes with or without acanthocephalan infection were not statistically significant (Fig. 3).

These study results show that the concentrations of mercury, contrary to lead (Jankovská et al. 2011), are higher (not significantly) in fishes with acanthocephalan parasites (*A. lucii*). However, there is no evidence, that thorny headed worms accumulating Hg from their hosts, as they do with lead (Jankovská et al. 2011; Sures and Siddall 1999, 2001, 2003) and cadmium (Sures and Taraschewski 1995; Schludermann et al. 2003). The measured values indicate that acanthocephalan parasites are not suitable for monitoring mercury in our environment like sentinel organisms because *A. lucii* did not accumulate Hg significantly from the host body to its body. Also Turčeková and Hanzelová (2004) reported that endoparasites accumulated mercury in very low concentrations. Palíková and Baruš (2003) in their study with mercury content in *Anguillicola crassus* (Nematoda) and its host *Anguilla anguilla*, also described that the swimbladder nematode (*A. crassus*) contained low mercury levels (0.050–0.183 mg/kg ww), compared to muscles (0.162–0.827) and the liver (0.175–1.430) of the fish definitive host (*A. anguilla*).

Fig. 2 The stream Jevanský potok (GPS: N 490 57′47 E 140 48′43) flows in Central Region and is situated 450 m far from the nearest road (http://cs.wikipedia.org/wiki/Jevanskýpotok)

Table 2 Hg concentrations (mg/kg) in fish tissues and parasites

Fish number	Muscle (mg/kg)	Gonads (mg/kg)	*A. lucii* (mg/kg)	Number of parasites
2 F	0.1494	0.0099	0.0005	1
4 F	0.0903	0.0113	0.0045	3
5 F	0.0884	0.0091	0.0130	5
6 M	***0.1119***	***0.0231***	***0.0066***	1
7 F	0.1027	0.0106	0.0133	3
8 F	0.1106	0.0136	0.0.0174	3
10 F	0.1324	0.0126	0.0061	2
11 F	0.1311	0.0170	0.0130	5
13 F	0.1218	0.0136	0.0149	12
Mean	**0.1154**	**0.0134**	**0.0099**	
SD	0.019	0.004	0.005	

The mean values are highlighted in bold

The male sex values are highlighted in bold and italics

Interesting results have emerged with fish gonads. The mean Hg concentration in perch gonads was 0.13 mg/kg (Table 2). Most of the gonads were females and only one was male. In female gonads (spawn), the mean Hg concentration of 0.012 mg/kg was approximately one-half that in the male gonads (0.023 mg/kg). It can suggested that Hg accumulation is higher by male gonads (milt) than female spawn. Further studies with a larger number of samples are needed to determine if this diference is real.

Tolerable intake of methylmercury for humans is 1.6 μg/1 kg bw/week, ie. 80–160 mg/person (50–100 kg)/week (http://www.agronavagator.cz). The 13 perch in this study each weighed approximately 175 g, of which 100 g was pure muscle. Therefore, the muscle tissues of each perch in our study contained an average of 11.54 μg of total Hg (100 g × 0.1154 μg/g).

According to Czech assessment values (Palíková and Baruš 2003; Mikula 2004) a mercury content in predatory fish muscle tissues >0.6 mg/kg significantly exceeds accepted hygienic limits. None of the specimens from our study exeeded these limits.

Table 3 Hg concentrations (mg/kg) in muscle and gonad tissues of fish not infected by acanthocephalans

Fish number	Muscle (mg/kg)	Gonads (mg/kg)
1 F	0.0961	0.0126
3 F	0.0822	0.0080
9 F	0.139	0.0145
12 F	0.0851	0.0081
Mean	**0.10**	**0.011**
SD	0.022	0.003

The mean values are highlighted in bold

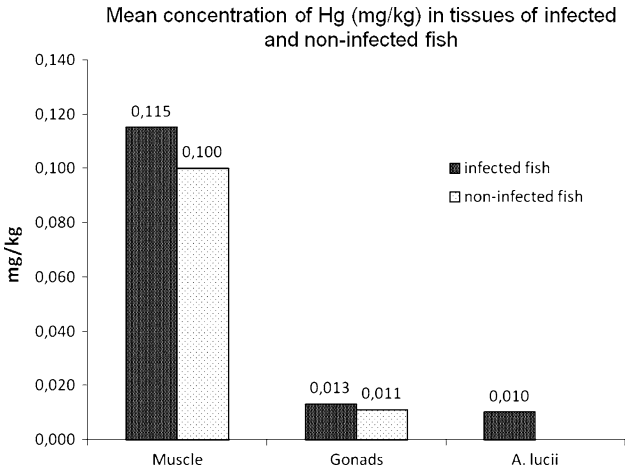

Fig. 3 The mean concentration of Hg (mg/kg) in tissues of infected and non-infected fish

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References

Bloom NS (1992) On the chemical form of mercury in edible fish and marine invertebrata tissue. Can J Fish Aquat Sci 49:1010–1017

Jankovská I, Miholová D, Langrová I, Bejček V, Vadlejch J, Šulc M (2010a) Influence of parasitism on trace element contents in tissues of red fox (*Vulpes vulpes*) and its parasites *Mesocestoides* spp. (Cestoda) and *Toxascaris leonina* (Nematoda). Arch Environ Contam Toxicol 58:469–477

Jankovská I, Vadlejch J, Száková J, Miholová D, Kunc P, Knížková I, Langrová I (2010b) Experimental studies on the lead accumulation in the cestode *Moniezia expansa* (Cestoda: Anoplocephalidae) and its final host (*Ovis aries*). Ecotoxicology 19:928–932

Jankovská I, Miholová D, Petrtýl M, Romočuský Š, Kalous L, Vadlejch J, Čadková Z, Langrová I (2011) Intestinal parasite *Acanthocephalus lucii* (Acanthocephala) from European perch (*Perca fluviatilis*) as a bioindicator for lead pollution in the stream "Jevanský potok" near Prague, Czech Republic. Bull Environ Contam Toxicol 86:342–346

Mikula P (2004) http://ekolist.cz. Accessed 14 Feb 2012

Palíková M, Baruš V (2003) Mercury content in *Anguillicola crassus* (Nematoda) and its host *Anguilla anguilla*. Acta Vet Brno 72:89–294

Ryman JE, Van Walleghem JLA, Blanchfield PJ (2008) Methylmercury levels in a parasite (*Apophallus brevis* metacercariae) and its host, yellow perch (*Perca flavescens*). Aquat Ecol 42(3):495–501

Schludermann C, Konecny R, Laimgruber S (2003) Fish macroparasites as indicators of heavy metal pollution in river sites in Austria. Parasitology 126:S61–S69

Sures B (2003) Accumulation of heavy metals by intestinal helminths in fish: an overview and perspective. Parasitology 126:S53–S60

Sures B (2004) Environmental parasitology: relevancy of parasites in monitoring environmental pollution. Trends Parasitol 20:70–177

Sures B (2008a) Host-parasite interactions in polluted environments. J Fish Biol 73:2133–2142

Sures B (2008b) Environmental parasitology. Interactions between parasites and pollutants in the aquatic environment. Parasite 15(3):434–438

Sures B, Siddall R (1999) *Pomphorhynchus laevis*: the intestinal acanthocephalan as a lead sink for its fish host, chub (*Leuciscus cephalus*). Exp Parasitol 93:66–72

Sures B, Siddall R (2001) Comparison between lead accumulation of *Pomphorhynchus laevis* (Palaeacanthocephala) in the intestine of chub (*Leuciscus cephalus*) and in the body cavity of goldfish (*Carassius auratus auratus*). Int J Parasitol 31:669–673

Sures B, Siddall R (2003) *Pomphorhynchus laevis* (Palaeacanthocephala) in the intestine of chub (*Leuciscus cephalus*) as an indicator of metal pollution. Int J Parasitol 33:65–70

Sures B, Taraschewski H (1995) Cadmium concentrations in two adult acanthocephalans, *Pomphorhynchus laevis* and *Acanthocephalus lucii*, as compared with their fish hosts and cadmium and lead levels in larvae of *A. lucii* as compared with their crustacean host. Parasitol Res 81:494–497

Sures B, Grube K, Taraschewski H (2002) Experimental studies on the lead accumulation in the cestode *Hymenolepis diminuta* and its final host, *Rattus norvegicus*. Ecotoxicology 11:365–368

Turčeková L, Hanzelová V (2004) The monitoring of mercury content in ecosystems important from the aspects of environmental protection. In: Proceedings of the XIII scientific symposium with international participation on ecology in selected agglomerations of Jelšava-Lubeník and Central Spiš, pp 86–90

Turčeková L, Hanzelova V, Spakulova M (2002) Concentration of heavy metals in perch and its endoparasites in the polluted water reservoir in Eastern Slovakia. Helminthology 39:23–28