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Heavy metal concentration in plerocercoids of *Triaenophorus nodulosus* (Pallas, 1781) (Cestoda: Triaenophoridae) and in different organs of their host — perch *Perca fluviatilis* (L.)

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ABSTRACT. **Background**. Heavy metals are at present classified among the most important and dangerous water pollutants. Since over 15 years parasites have been used as a bioindicators of water pollution, e.g. using their ability to accumulate heavy metals. Concentration of four elements (Zn, Cd, Ni, Cu) in selected organs of the perch (*Perca fluviatilis*) and in the tissues of its parasite, plerocercoid of the tapeworm *Triaenophorus nodulosus*, was analysed. **Material and methods**. The fish were subject to full helminthological section, resulting in 66 tapeworm larvae isolated from cysts, located in the liver. Plerocecroids, gills, liver and intestine with duodenum were removed and frozen. Content of heavy metals was determined with atomic absorption spectroscopy method. **Results**. The distribution of the content of Ni, Cd and Zn was similar. In all cases, among all the examined fish organs, the highest mean concentration of the metals was found in the liver, followed by the intestine; it was the lowest in the gills. The mean concentration of the metals in the tapeworm tissues was from 6 to 74 x higher than in the gills, 5-37 x higher than in the intestine and 2.5-28 x higher than in the liver. The concentration of Cu was also the highest in the tapeworm tissues, but its concentration in the fish intestine and liver was nearly the same; it was the lowest in the gills.

Key words: concentration, heavy metals, tapeworm.

Introduction

Heavy metals are at present classified among the most important and dangerous water pollutants. They affect all aquatic organisms, among other fishes and even their parasites, modifying the function of the host-parasite system [1–3]. Attempts are made at employing parasites as bioindicators of water pollution, using their reactions, such as ability to accumulate heavy metals; studies of this kind, with varied success, have been conducted for over 15 years.

Acanthocephalans, or their larval stages — cystacanths — are the most often used model organisms in comparative studies on accumulation of heavy metals in fish parasites and their hosts [4–10]. Less often such studies involve nematodes [11–14], or adult stages of tapeworms [15, 16]. Among larval stages of tapeworms, metal concentration has been studied only in plerocercoids of *Ligula intestinalis* and *Schistocephalus solidus* — parasites of the body cavity or, less often, liver of many species of Cyprinidae and Gasterosteidae [17–20]. In our experiments we used plerocercoids of a pathogenic tapeworm *Triaenophorus nodulosus*, located in cysts within the liver parenchyma. A review of literature indicates that the parasite has not been studied in this respect before.

Material and methods

Host material included 7 specimens of perch — *Perca fluviatilis* L., caught on the 26th of October 2000 in the river Polska Woda, a second order tributary to the Odra River (Lower Silesia; SW Poland). The sample included 3 males and 4 females. The fish length was 133–162 mm (mean 144 mm), weight 27–36 g (mean 30.6 g). The fish were subject to full helminthological section, resulting in 66 live tapeworm larvae isolated from cysts, located in the liver. The length of larvae was from 30 to 75 mm. Plerocecroids without contents of the cysts, were placed in physiological solution and frozen, except a few specimens kept for identification. Gills, liver and intestine with duodenum were removed from each fish, and frozen.

The samples were mineralised with microwave "wet" method, through dissolving in a mixture of nitric and perchloric acid in a high-pressure, closed microwave oven CEM. Content of heavy metals: zinc, cadmium, copper and nickel, was determined with atomic absorption spectroscopy method using Varian SpectrAA FS220 apparatus. The results were verified against certified reference material DOLT-2 (fish liver) — National Research Council of Canada Institute for National Measurement.

Results and Discussion

The prevalence of infection of perch by *T. nodulosus* plerocercoids was 100%. In examined livers 27 cysts (from 1 to 9 in single organ, mean — 3.8) were found. In all isolated cysts 66 plerocercoids (from 1 to 24 in single liver, mean — 9.4) were recorded. The rank of liver's occupation varied from 25 to 40%.

Mean concentrations of each metal in the fish organs and parasite larvae are presented in the Table 1 and the Fig. 1 The distribution of the content of three metals: nickel, cadmium and zinc, was similar. In all cases the fish organ with the highest mean metal content was the liver, followed by the intestine; the gills showed the smallest metal content. The concentration of these metals in the tapeworm tissues was always higher than in any studied host organ. The mean nickel concentration in the tapeworm larvae was 74 x higher than in the gills, 37 x higher than in the intestine and 28 x higher than in the liver; the values for cadmium concentration in the tapeworms were 6 x, 5 x and 2.5 x higher than in the corresponding fish organs. Zinc showed the highest concentration, and its mean content in the tapeworms was 7.5 x higher than in the gills; 6 x higher than in the intestine and 4 x higher than in the liver of the host. The distribution of copper concentrations was slightly different. The level of this metal was the highest in the tapeworms, but it was nearly equally high in the host intestine and liver, and lower in the gills.

It is difficult to compare these results with literature data, since the previous studies used either adult stages of tapeworms or their larvae, located only in the body cavity. In the studies of Tenora et al. [18] the level of lead, chromium and cadmium in plerocercoids of *Ligula intestinalis* was significantly higher (15x, 6x and 2.6x, respectively) than the content of these metals in the host muscles. Similar results were obtained by Tekin-Özan and Kir [20], where the content of copper, iron, zinc and manganese in the same parasite was always higher than that in the liver, muscle and gills of the tench. In contrast, Pascone and Mattey [17] reported a 50% lower concentration of cadmium in plerocercoids of *Schistocephalus solidus*, compared to the tissues of its host — stickleback.

According to Tekin-Özan and Kir [20] and Tenora et al. [18], differences in the level of metal accumulation in tapeworm larvae my depend on their age, peculiarities of tegument structure, as well as the complexity of life cycle, and especially susceptibility of the intermediate host to metal accumulation.

The gradient of metal content in the examined organs of the perch corresponds to the way of penetration of metals into and their circulation in the fish

Table 1. Mean concentrations of heavy metals (in mg/kg wet weight) in selected organs of perch and in plerocecoids of *T. nodulosus*

	Gills Mean — SD	Intestine Mean — SD	Liver Mean — SD	*T. nodulosus* Mean — SD
Cu	1.79 ± 1.61	3.17 ± 2.46	3.04 ± 1.61	3.18 ± 2.46
Ni	0.03 ± 0.02	0.06 ± 0.05	0.08 ± 0.04	2.23 ± 0.39
Cd	0.21 ± 0.18	0.25 ± 0.21	0.52 ± 0.42	1.29 ± 0.96
Zn	12.74 ± 3.42	16.47 ± 7.37	20.30 ± 7.36	95.95 ± 55.15

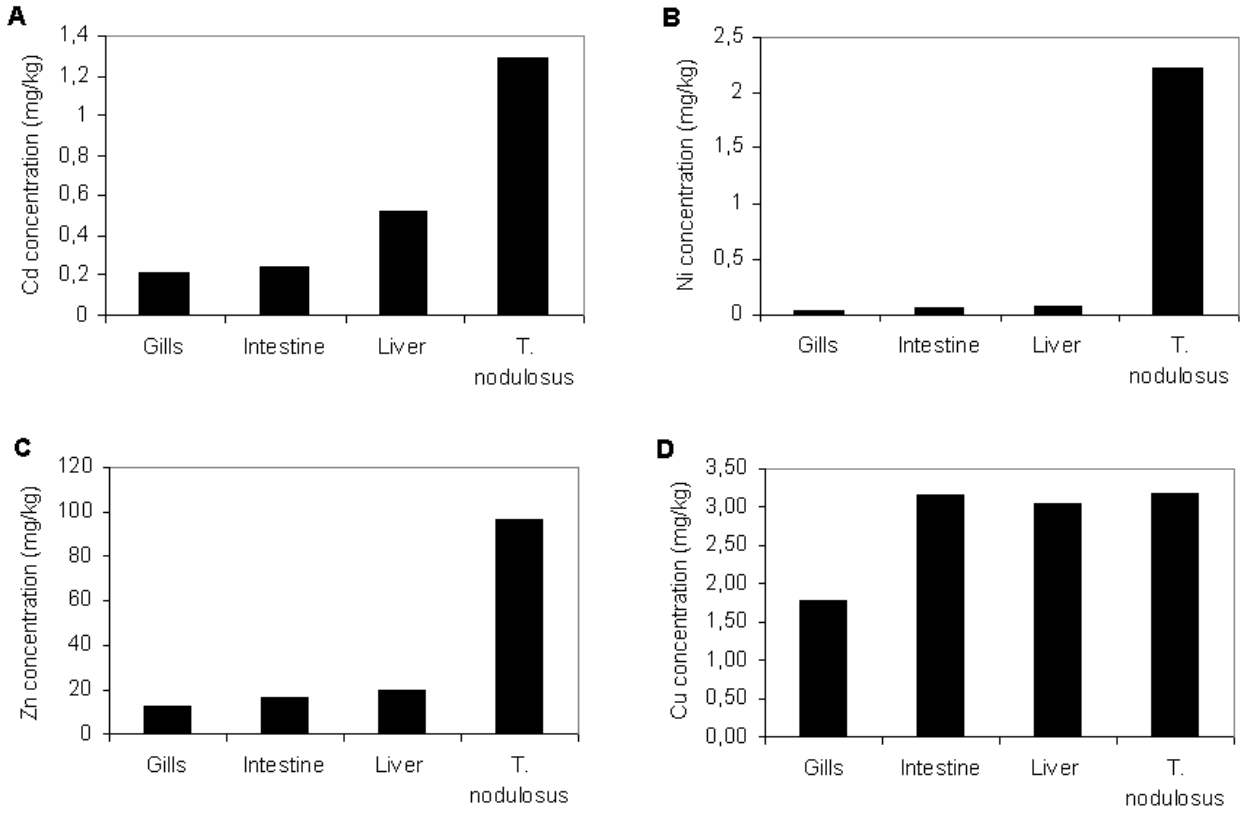

Fig. 1 Concentration of heavy metals in *Triaenophorus nodulosus* plerocercoids and different organs of perch. A — Cd; B — Ni; C — Zn; D

organism. According to Sures and Siddal [6], gills are the main place of metal uptake; ions, diffusing through the gill membrane, are incorporated in erythrocytes and transported to various organs of the fish. Most metals are trapped in the liver, and may be secreted into the intestine with gall. In the intestine, a part of metals (in the form of organometallic complexes) may be reabsorbed by its walls or removed with faeces. The metal concentration was the highest in the plerocercoids, and — among the examined fish organs — in the liver. The liver, playing the most important detoxication role in the organism, is also the greatest receiver of metals from blood circulation system [16]. On the other hand, it is also the habitat of encysted plerocercoids of the tapeworm, which absorb and accumulate metals in their bodies. This would explain the smaller differences in metal concentration between the tapeworm and the liver, compared to those between the tapeworm and the remaining analysed organs.

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