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CADMIUM AND LEAD CONCENTRATIONS IN *CONTRACAECUM RUDOLPHII* (NEMATODA) AND ITS HOST, THE CORMORANT *PHALACROCORAX CARBO* (AVES)

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There are a variety of ways to assess the environmental impacts on parasites (Lafferty D. 1997: Parasitol. Today 13: 251-255). Recent studies on endoparasites of fish have revealed that several helminths (mainly acanthocephalans, and to a lesser degree tapeworms) from the intestine of their definitive hosts bioconcentrate heavy metals above the values detected in host tissues (review in Sures B., Siddall R., Taraschewski H. 1999: Parasitol. Today 15: 16-21). Unfortunately, there are only four studies on parasitic nematodes of fish (Sures B., Taraschewski H., Jackwerth E. 1994: Dis. Aquat. Org. 19: 105-107; Zimmermann S., Sures B., Taraschewski H. 1999: Arch. Environ. Contam. Toxicol. 37: 190-195; Tenora F., Baruš V., Kráčmar S., Dvořáček J., Srnková J. 1999: Helminthologia 36: 79-81; Tenora F., Baruš V., Kráčmar S., Dvořáček J. 2000: Helminthologia 37: 15-18) that have examined the accumulation of lead and also of cadmium, chromium and nickel in *Anguillicola crassus* and *Philometra ovata*, parasitising the swimmbladder or body cavity of the European eel (*Anguilla anguilla*) and the common bream (*Abramis brama*) respectively. Only a few articles have been published on how mammalian nematodes (*Ascaris suum*, *Toxocara canis* and *Protospirula muricola*) accumulate heavy metals (Greichus A., Greichus Y.A. 1980: Int. J. Parasitol. 10: 89-91; Sures B., Jürges G., Taraschewski H. 1998: Int. J. Parasitol. 28: 1173-1178; Tenora F., Kráčmar S., Baruš V., Dvořáček J. 1999: Helminthologia 36: 127). In evaluating the literature it has become apparent that there is still a lack of information concerning heavy metal concentrations in the parasite-host system of nematodes in birds. The aim of this paper is to determine whether bioaccumulation of several heavy metals occurs in the bird roundworm *Contracaecum rudolphii* Hartwich, 1964 (Anisakidae).

In 1997-1998, after dissecting 56 adult specimens of the cormorant (*Phalacrocorax carbo* L.) from ponds near the town of Pohořelice (South Moravia, Czech Republic), 5 birds with massive infections of the nematode *C. rudolphii* were selected. From these birds, five groups (each of n = 10) of adult male nematodes (body length >15 mm), and five groups (each of n = 10) of adult female nematodes (body length >22 mm) were selected. From each bird, pectoral muscle (without skin) and liver tissue samples (each of 80-100 g) were taken and rinsed in double-distilled water for 1 min. Heavy metals (Cd and Pb) were determined in 5 pectoral muscle and 5 liver tissue samples, and in 10 samples of adult nematode specimens. After dry mineralization and dissolution of samples, atomic absorption spectrometry (AAS) was performed using a GBC-932 AA (USA) apparatus in the 1M HNO_3 flame environment (after Baruš V., Tenora F., Kráčmar S., Dvořáček J. 1999: Dis. Aquat. Org. 37: 135-137) at wavelength 228.8 nm for Cd, 283.3 nm for Pb (Regulation No. 222/1996 of the Ministry of Agriculture of the Czech Republic). There were three replicates in each determination. The difference between parallel estimations was lower than 11 relative per cent. Our results on reference material (feed mixtures for poultry for interlaboratory tests of the Central Institute for Supervising and Testing in Agriculture) are in agreement with the certified values. The recovery was for Cd 95.2 ± 2.95 per cent, for Pb 96.1 ± 3.16 per cent (mean ± standard error of the mean; 10 determinations for every component). The content of heavy metals was evaluated in mg/kg of 100% dry matter. The results were assessed with analysis of variance (Snedecor G.W., Cochran W.G. 1967: Statistical Methods. 6th ed. Iowa State Univ. Press, Iowa, 579 pp.).

Cadmium concentrations in *C. rudolphii* (males and females) and in the tissues of the cormorants are presented in Fig. 1. The cadmium burden in host muscle was significantly higher ($P \leq 0.05$) than that in the liver, and significantly ($P \leq 0.01$) higher than in worms. The bioconcentration factor (after Sures et al. 1998, op. cit.; Sures et al. 1999, op. cit.) of Cd between nematodes and host muscle was 0.52 in males and 0.22 in females; respective values for liver tissues were 0.73 in males and 0.32 in females.

Lead concentrations (Fig. 2) compared with the Cd values indicate marked differences. The liver contained approximately half the concentration of lead contained in the nematode samples. Male worms accumulated significantly more lead than females ($P \leq 0.05$). The muscle samples contained significantly higher ($P \leq 0.01$) lead levels than the host's liver and parasite's tissue. The Pb bioconcentration factors between nematode tissue and host muscle were 2.35 in males and 1.81 in females; respective values for liver tissue were 7.25 in males and 5.58 in females.

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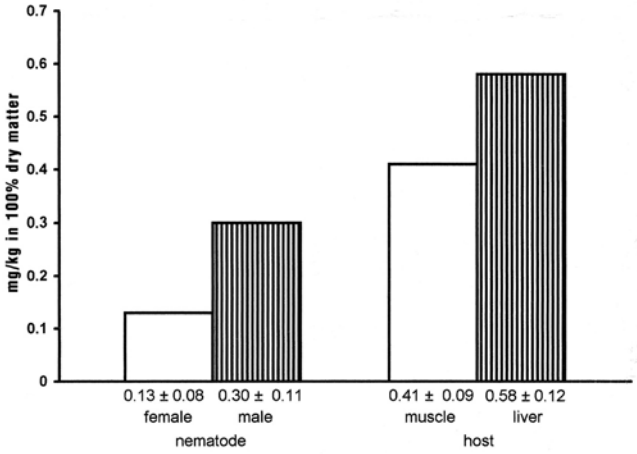

Fig. 1. Contents of cadmium in females and males of *Contracaecum rudolphii* (nematode), and in muscle and liver tissues of *Phalacrocorax carbo* (cormorant); mean values ± SD.

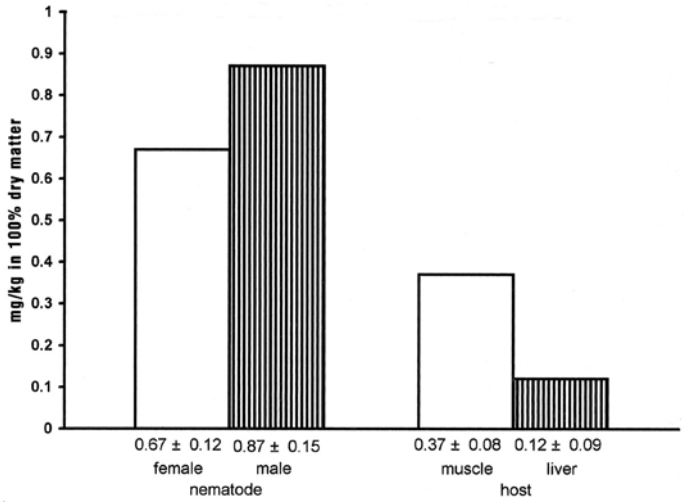

Fig. 2. Contents of lead in females and males of *Contracaecum rudolphii* (nematode), and in muscle and liver tissues of *Phalacrocorax carbo* (cormorant); mean values ± SD.

We only can compare our results with previously published data on the bioaccumulation of heavy metals in nematodes parasitising mammals, as data on nematodes parasitising birds are absent (Sures B. et al. 1999, op. cit.). An earlier study (Greichus and Greichus 1980, op. cit.) reported the heavy metal concentration in the worm *A. suum* as being approximately the same or a little higher than those in the host's (pig) tissues. Sures et al. (1998, op. cit.) state that in *A. suum*, the heavy metal (Pb, Cd) concentrations in the parasite's biomass are lower than those in the host's tissues. Though significant, the Pb accumulation found by us was moderate (bioconcentration factors ranged from 1.81 to 7.25).

The Cd concentrations in the definitive host's tissues were significantly higher ($P \leq 0.05$) than that in *C. rudolphii* (both in males and females). This suggests that the bioaccumulation of this heavy metal is not generally manifested in this parasite-host system.

Previously published data (Sures et al. 1998, op. cit.) documented a relatively low level of Cd accumulation in the parasite *A. suum* when the highest Cd level was found in the host's kidneys, followed by liver and the nematodes. The Cd burdens of the liver and in the female ascarids were each significantly higher than those determined for the intestine and muscle of pigs (Sures et al. 1998, op. cit.).

We observed significant differences in the heavy metal burden of lead and cadmium between males and females of *C. rudolphii*. On the contrary, no obvious differences in the same heavy metals accumulation between both sexes of *A. suum* were reported by Greichus and Greichus (1980, op. cit.) and Sures et al. (1998, op. cit.).

For infective larvae of the nematode *C. rudolphii*, fishes are obligatory second intermediate or paratenic hosts, and comprise up to 87% of the definitive host's total food. The Pb and Cd burdens in the definitive host's and also parasite's body tissues found by us indicate that Pb and Cd values (in contrast to mercury) do not rise with increasing trophic levels as was found for carnivorous fishes (e.g., Svobodová Z., Máchová J., Vykusová B., Piačka V. 1996: Metals in ecosystems of freshwaters. Methods edition, Vodňany, no. 49, pp. 1-19; and others). Also, the selection of organs and tissues of definitive hosts compared with those of parasites may be of great importance in heavy metal concentration assessments (see the data by Svobodová Z., Dušek L., Hejtmánek M., Vykusová B., Šmíd R. 1999: Ecotoxicol. Environ. Safety 43: 231-240, from the analyses of mercury content in fish tissues; and the data by Sures et al., 1998, op. cit., from the analyses of Pb and Cd concentrations in organs and tissues of *A. suum*). Our results document that, within the parasite-host system, *C. rudolphii* does not indicate the bioaccumulation level to be appropriate for assessments of environmental pollution by heavy metals (mainly Cd). In contrast to the potential value of fish parasites in monitoring metal contamination of aquatic habitats, the role of mammalian (and also bird) nematodes in environmental impact studies appears to be rather limited (Sures et al. 1999, op. cit.).

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