

Heavy metals concentration in the tissues of perch (*Perca fluviatilis*) and bleak (*Alburnus alburnus*) from Czarna Orawa River, Poland

Włodzimierz Popek, Krzysztof Klęczar, Michał Nowak, and Piotr Epler

Department of Ichthyobiology and Fisheries, University of Agriculture in Kraków, Poland, EU. Corresponding author: M. Nowak, mikhael.nowak@gmail.com

Abstract. Two common fish species, *Perca fluviatilis* and *Alburnus alburnus*, from Czarna Orawa River were examined for concentration of certain heavy metals (Zn, Cu, Cd, Pb) in their tissues. Significant differences between these two species were indicated. It was found that they have accumulated $20.679 \pm 3.151 \mu\text{g/g}$ and $35.109 \pm 9.001 \mu\text{g/g}$ of Zn, $0.3277 \pm 0.1185 \mu\text{g/g}$ and $0.5444 \pm 0.1851 \mu\text{g/g}$ of Cu, $0.6229 \pm 0.0806 \mu\text{g/g}$ and $0.7508 \pm 0.0820 \mu\text{g/g}$ of Cd, and $0.4039 \pm 0.1730 \mu\text{g/g}$ and $0.3710 \pm 0.1179 \mu\text{g/g}$ of Pb, respectively. Results obtained were discussed in the context of previously conducted studies. Increased efforts in order to improve water quality of the Czarna Orawa River system are expected. Also consecutive further studies on other water organisms seem needed.

Key Words: Bleak, Czarna Orawa, heavy metals, perch.

Streszczenie. Dwa pospolite gatunki ryb, *Perca fluviatilis* i *Alburnus alburnus*, z rzeki Czarnej Orawy zostały przebadane pod kątem akumulacji wybranych metali ciężkich (Zn, Cu, Cd, Pb) w tkankach. Pomiedzy gatunkami wykazano istotne różnice. Stwierdzono następujące stężenia metali w tkankach, odpowiednio, okonia i uklei: $20.679 \pm 3.151 \mu\text{g/g}$ i $35.109 \pm 9.001 \mu\text{g/g}$ Zn, $0.3277 \pm 0.1185 \mu\text{g/g}$ i $0.5444 \pm 0.1851 \mu\text{g/g}$ Cu, $0.6229 \pm 0.0806 \mu\text{g/g}$ i $0.7508 \pm 0.0820 \mu\text{g/g}$ Cd oraz $0.4039 \pm 0.1730 \mu\text{g/g}$ i $0.3710 \pm 0.1179 \mu\text{g/g}$ Pb. Otrzymane wyniki zostały skonfrontowane z wcześniejszymi badaniami. Stwierdzono, że w dorzeczu Czarnej Orawy niezbędne jest podjęcie działań mających na celu poprawę jakości wody. Sugeruje się również, że celowe są analogiczne badania dotyczące innych grup organizmów wodnych.

Słowa kluczowe: Czarna Orawa, metale ciężkie, okoń, ukleja.

Rezumat. Două cunoscute specii de pești, *Perca fluviatilis* și *Alburnus alburnus*, din râul Czarna Orawa au fost analizate în ceea ce privește concentrația anumitor metale grele (Zn, Cu, Cd, Pb) în țesuturi. S-au constatat diferențe semnificative între rezultatele acestor două specii, care au acumulat $20.679 \pm 3.151 \mu\text{g/g}$ și $35.109 \pm 9.001 \mu\text{g/g}$ Zn, $0.3277 \pm 0.1185 \mu\text{g/g}$ și $0.5444 \pm 0.1851 \mu\text{g/g}$ Cu, $0.6229 \pm 0.0806 \mu\text{g/g}$ și $0.7508 \pm 0.0820 \mu\text{g/g}$ Cd, și respectiv $0.4039 \pm 0.1730 \mu\text{g/g}$ și $0.3710 \pm 0.1179 \mu\text{g/g}$ Pb. Prezentele rezultate au fost discutate în contextul rezultatelor anterioare, obținute. Sunt necesare eforturi crescute în vederea îmbunătățirii calității apei din rețeaua Czarna Orawa dar, pe de altă parte, sunt necesare în continuare studii aprofundate ale acestor aspecte.

Cuvinte cheie: Czarna Orawa, metale grele, biban, oblete.

Introduction. The Czarna Orawa River system is the only one, beside of Czedaczka Stream, river system flowing to the Danube River drainage within the territory of Poland. Ichthyofauna of the Czarna Orawa River system has been studied for many times (Kulmatycki 1931; Kołder 1964; Skóra & Włodek 1989; Przybylski et al 2002; Nowak et al, in prep.). Irrespective, as far as we are aware, the problem of heavy metals contamination was investigated only one time, in the case of the European minnow *Phoxinus phoxinus* (Linnaeus, 1758) (Popek et al 2008).

It has been established that heavy metals have wide spectrum of negative influence on fish organisms, disrupting endocrine system, and inducing decrease of quantity and quality of offspring (Popek et al 2003, 2004, 2006; Szczerbik et al 2006, 2008).

It is also known that heavy metals can accumulate at different levels in the tissues of organisms of different trophic levels. Thus in the presented study we investigated how

zinc, copper, cadmium and lead accumulate in the tissues of a predatory fish, the European perch *Perca fluviatilis* Linnaeus, 1758, and omnivorous, feeding mainly on planktonic organisms, the bleak *Alburnus alburnus* (Linnaeus, 1758).

Material and Method. In July 2007 15 specimens of each, *P. fluviatilis* and *A. alburnus*, were collected from Czarna Orawa River below of Jablonka City (near the Polish-Slovak border) using a lift net (cf. Popek et al 2008: Fig. 1). All fish were sacrificed by overdose of an anaesthetic (Propiscin) and deep frozen.

In the laboratory fish were homogenised and mineralised in the mixture of HNO₃ and HClO₄ (3:1 vol.) in the temperature of 200°C (Tecator), according to standard procedures (e.g. Szczerbik et al 2006; Popek et al 2008). Concentration of heavy metals (Zn, Cu, Cd, Pb) was measured with atomic absorption spectrometry (ATI UNICAM model 929, Great Britain) using a wavelength of 213.9 nm for zinc, 324.8 nm for copper, 228.8 nm for cadmium, and 217.0 nm for lead. Fish were homogenised *in toto*, without preparation and separation of certain tissues.

Null hypothesis ($H_0: \mu_1 = \mu_2$) was verified using Student's t-test. All calculations were performed by SAS ver. 9.2.

Results and Discussion. Concentration of Zn was in the tissues of both, *P. fluviatilis* and *A. alburnus*, were much higher than of three other metals. It was (arithmetic mean \pm SD) 20.679 ± 3.151 $\mu\text{g/g}$ and 35.109 ± 9.001 $\mu\text{g/g}$, respectively (Figure 1). These values were highly significantly higher than of all other metals ($P < 0.0001$). Also difference between *P. fluviatilis* and *A. alburnus* was highly significant ($P < 0.0001$).

Concentration of Cu was much lower than Zn, amounted 0.3277 ± 0.1185 $\mu\text{g/g}$ in *P. fluviatilis* and 0.5444 ± 0.1851 $\mu\text{g/g}$ in *A. alburnus* (Figure 2). The difference between samples was highly significant ($P < 0.0001$).

Values of Cd concentration were higher than of Cu and Pb, however lower than of Zn in both species. They were 0.6229 ± 0.0806 $\mu\text{g/g}$ and 0.7508 ± 0.0820 $\mu\text{g/g}$, respectively (Figure 2). Differences between samples were significant at level of $P < 0.0001$.

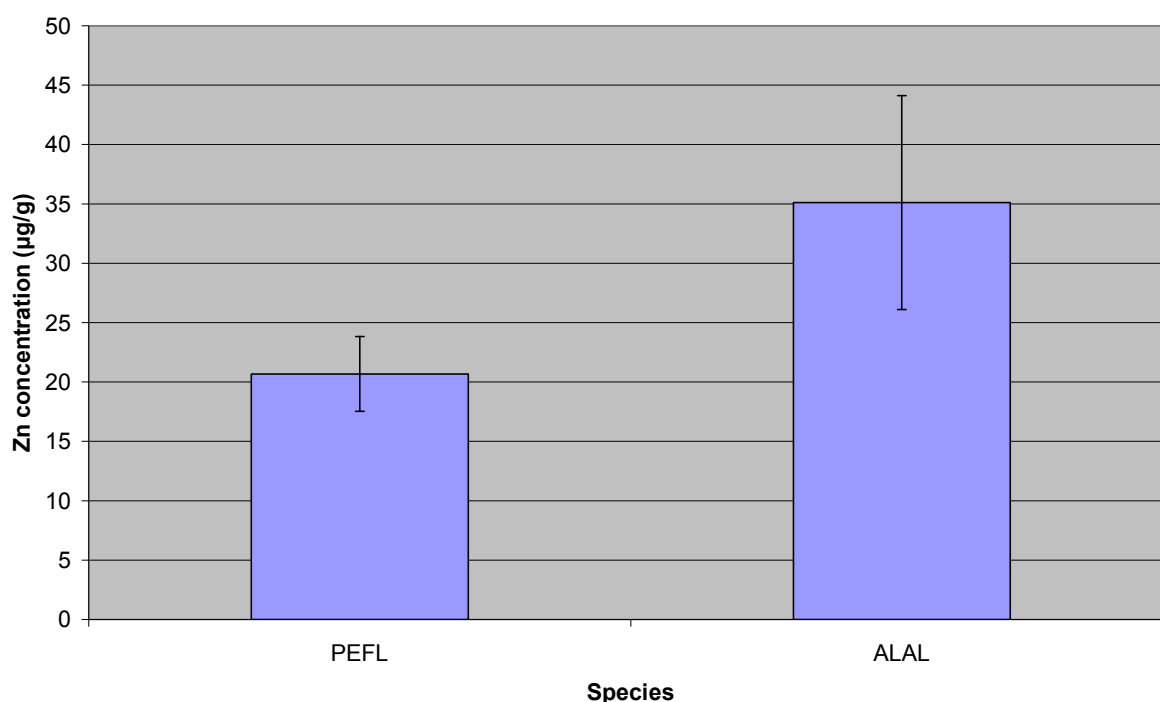


Figure 1. Zn concentration ($\mu\text{g/g}$) in the tissues of *P. fluviatilis* (PEFL) and *A. alburnus* (ALAL) from Czarna Orawa River. Arithmetic mean and its SD are given.

Pb was accumulated in the tissues in similar amounts, i.e. $0.4039 \pm 0.1730 \mu\text{g/g}$ in *P. fluviatilis* and $0.3710 \pm 0.1179 \mu\text{g/g}$ in *A. alburnus* (Figure 2). That slight difference was not significant ($P > 0.05$).

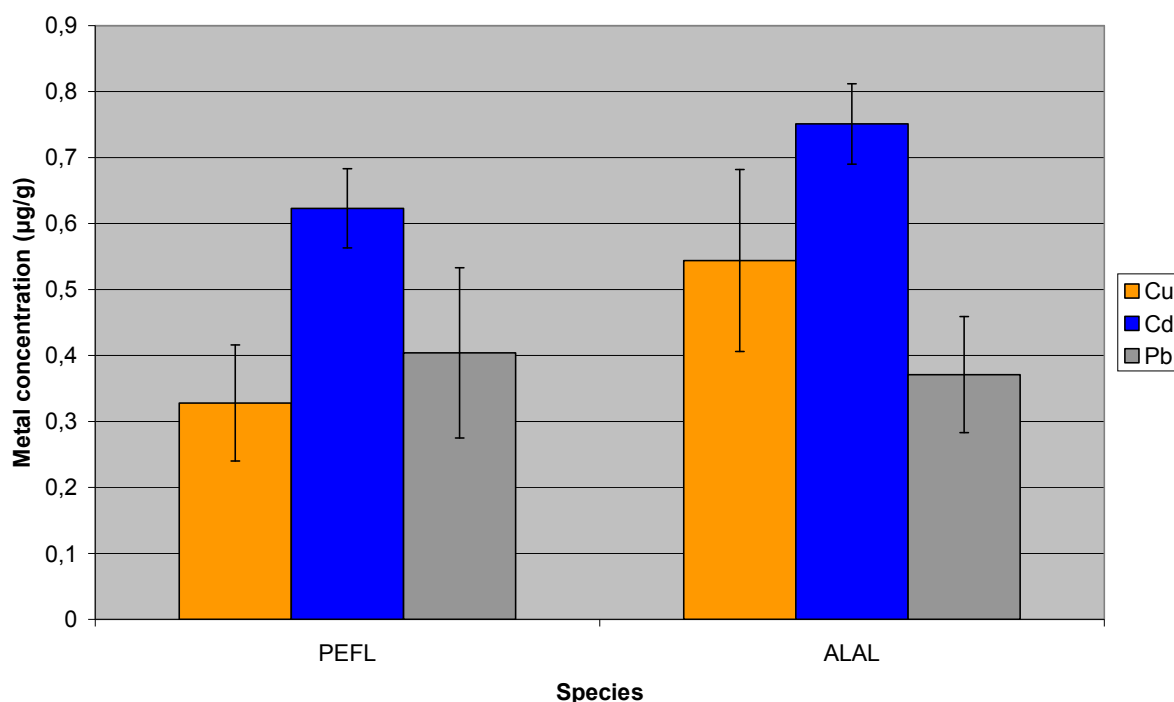


Figure 2. Cu, Cd and Pb concentration ($\mu\text{g/g}$) in the tissues of *P. fluviatilis* (PEFL) and *A. alburnus* (ALAL) from Czarna Orawa River. Arithmetic mean and its SD are given.

As it was shown above concentrations of all heavy metals, beside of Pb, were significantly higher in *A. aburnus* than in *P. fluviatilis*.

When these values are compared with results obtained in previous study (Popek et al 2008) following observations can be made. Concentration of Zn in both, *A. alburnus* and *P. fluviatilis*, was lower than in *P. phoxinus* examined earlier, in which concentration of this metal varied from 40.1720 to 53.3633 $\mu\text{g/g}$. Also concentration of Cu was much lower – in minnows it ranged from 0.6244 to 0.7719 $\mu\text{g/g}$. Surprisingly, it was found that *A. alburnus* accumulated much more Cd than *P. phoxinus*, even when compared to minnows from the lower most sampling site (where concentration was 0.5171 $\mu\text{g/g}$ vs. 0.7508 $\mu\text{g/g}$ in *A. alburnus*). *P. fluviatilis* accumulated less Cd than previously studied minnows. Surprisingly, concentration of Pb was, contrary to three other metals, higher in both, *P. fuviatilis* and *A. alburnus*, than it was indicated in *P. phoxinus* (respectively, 0.4039, 0.3710 vs. 0.2947-0.3081 $\mu\text{g/g}$).

Conclusions. Presented herein results, as well as previous study (Popek et al 2008), suggest that the Czarna Orawa River system is significantly contaminated by heavy metals. It has already been demonstrated that concentration of Zn, Cu, Cd and Pb increased along the river flow, that is, concentrations in upper stretches were significantly lower than in the lower parts of the river, according to examination of a cyprinid fish, *P. phoxinus* (Popek et al 2008). Now it was shown that relatively high amounts of these four heavy metals were accumulated in the tissues of another cyprinid, *A. alburnus*, as well as a percid fish, *P. fluviatilis*.

Lower concentrations of heavy metals in the tissues of the perch rather than bleak can be due to differences in their diet. The perch, despite it is omnivorous, feeds mainly on small fishes and macroinvertebrates which are much less contaminated by heavy metals – contrary to zooplankton which is the main food of the bleak. Nevertheless, it

cannot be concluded definitely prior to investigation of these invertebrates. Thus, further studies are required.

Shown in the current study contamination of two fish species by heavy metals is another contribution to the knowledge about water quality in southern Poland. It should induce intensification of some activities in order to improve water quality and conservation of the Czarna Orawa River system, as it has already been concluded (Popek et al 2008). It is especially important due to fact that it is a NATURE 2000 protected area (PLH120002) (Popek et al 2008).

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Authors:

Włodzimierz Popek, Department of Ichthyobiology and Fisheries, University of Agriculture in Kraków, ul. T. Spiczakowa 6, 30-199 Kraków-Mydlniki, Poland, EU, e-mail: rzpopek@cyf-kr.edu.pl

Krzysztof Kleczar, Department of Ichthyobiology and Fisheries, University of Agriculture in Kraków, ul. T. Spiczakowa 6, 30-199 Kraków-Mydlniki, Poland, EU, e-mail: kkleczar@interia.pl

Michał Nowak, Department of Ichthyobiology and Fisheries, University of Agriculture in Kraków, ul. T. Spiczakowa 6, 30-199 Kraków-Mydlniki, Poland, EU, e-mail: mikhael.nowak@gmail.com

Piotr Epler, Department of Ichthyobiology and Fisheries, University of Agriculture in Kraków, ul. T. Spiczakowa 6, 30-199 Kraków-Mydlniki, Poland, EU, e-mail: rzbieńia@cyf-kr.edu.pl

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