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HEAVY METALS ACCUMULATION IN THE SYSTEM RATTUS NORVEGICUS – HYMENOLEPIS DIMINUTA FROM INDUSTRIAL AREA IN BULGARIA

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ABSTRACT

Rat intestinal parasites have attracted great interest as bioindicators for environmental quality since they can bioconcentrate several heavy metals to much higher concentrations than the tissues of the hosts. Our aim was to assess the potential of the cestode *Hymenolepis spp.* as a bioindicator for heavy metal pollution in an industrial area of the town of Maglizh, Bulgaria. The level of Zn, Mn, Cu, Pb and Cd was detected in the livers of rats and in the cestode. A bioconcentration factor (BF), Concentration parasite/Concentration liver, was determined.

A high BF was observed for Cd, Pb and Mn. The results revealed that *Hymenolepis spp.* has much great ability to bioaccumulate heavy metals compared with their final hosts. Therefore, the system *Rattus norvegicus-Hymenolepis spp*. could be a very useful tool for environmental monitoring of the terrestrial areas.

Key words: heavy metals, rat, *Hymenolepis* spp.

Introduction

The helminths may act as bioindicators of pollution with heavy metals in their environment. A high accumulation potential of different parasite taxa were identified as useful sentinels for chemical pollution. Parasites are often able to take up metals at much higher levels and can bioconcentrate pollutants presented in very low concentrations in the environment (Sures et al, 2017). Many studies have showed that fish acanthocephalans, cestodes and nematodes have high capacity to accumulate Cu, Pb, Cd and Mn (Sures et al, 1999, Gabrashanska and Nedeva, 1996). Few studies have been done on the bioaccumulation of heavy metals in helminths from terrestrial animals (Sures et al, 2017; Jankovska et al. 2008). Some endoparasites in mammals have the capacity to accumulate toxic metals much higher than their hosts living in polluted areas (Lotfy et al, 2013). The widespread wild rats are frequently infected with cestodes which are the most abundant gastrointestinal parasites (Teimoori et al. 2014). The common host-parasite system *Rattus norvegicus*/ *Hymenolepis diminuta* was used in our study on the pollutants in an industrial area.

Our aim was to assess the potential of the cestode *Hymenolepis spp.* as a bioindicator for heavy metal pollution in an industrial area of the town of Maglizh, Bulgaria. The level of **Zn**, **Mn**, **Cu**, **Pb** and **Cd** was detected in the livers of rats and in the cestode. A bioconcentration factor (BF) (Concentration parasite/Concentration liver) was determined.

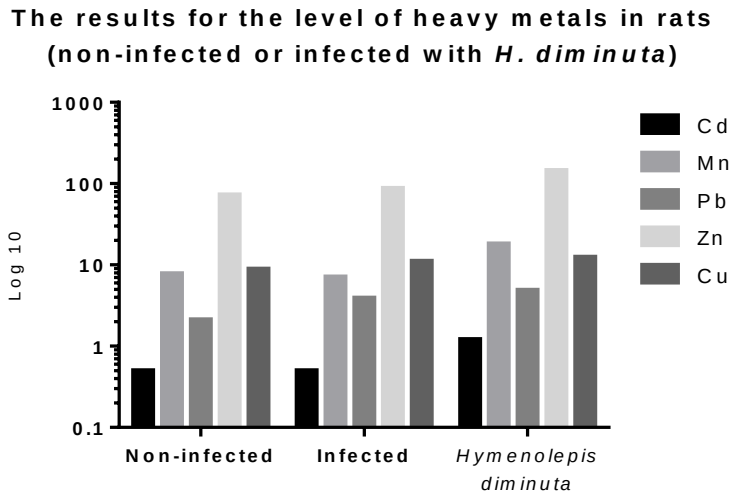
Materials and methods

Collection of rats and isolation of cestode. 21 adult rats (*Rattus norvegicus*) were captured using traps placed in the selected area near the town of Maglizh, Bulgaria. Rats infected only with cestodes (12 numbers) and those without any parasites (6 numbers) were investigated. The rest rats

were with a mixed infection and were excluded from the study. Their livers were removed and studied for heavy metal content. The most abundant endohelminth in the captured rats was *Hymenolepis diminuta* (Cestoda). The levels of Zn, Mn, Cd, Cu and Pb were determined in the liver of rats (infected with *H. diminuta* and non-infected) and in the tissue of *H. diminuta*. Metal analysis was done by ICP – OES Prodigy 7 Teledyne Leeman Labs, USA. The bioconcentration factor of heavy metals in helminths was calculated according to the formula proposed by Sures et al (1999). A bioconcentration factor (BF) – Concentration parasite/Concentration liver was used.

Results

The results for the level of heavy metals in rats (non-infected or infected with *H. diminuta*) and tapeworm are presented in graph (microg/g)



The average concentration of the above metals in the studied host-parasite system was in descending order as follows:

Non-infected rats Zn > Cu > Pb > Mn > Cd

Infected rats Zn > Cu > Pb > Mn > Cd

H. diminuta Zn > Pb > Cu > Mn > Cd

The BFs were as follows Zn – 2.01; Cu – 1.39; Pb – 2.30; Cd – 1.21; Mn – 2.32.

Taking in consideration that cestodes are more abundant in terrestrial mammals than are acanthocephalans (and thus potentially more useful in passive as well as active biomonitoring) we opted for a common animal rat and its common tapeworm *H. diminuta* to be used in our study. Tapeworms decreased only the level of **Cu**, **Pb** and **Zn**. The tapeworm can accumulate **Pb**, **Zn** and **Mn** in high extend. The effect of the tapeworm presence on the bioaccumulation some heavy metals in the host tissue liver can serve as an important tool in monitoring environmental pollution.

Discussion

The present results revealed there were significant differences in the levels of studied metals between infected and non-infected rats well as between cestodes and their hosts. The concentration of **Cd**, **Pb**, **Zn**, were lower in the non-infected rats compared with infected. The content of **Mn** was similar in the infected and un-infected hosts. The concentration of **Cd**, **Pb**, **Zn**, **Mn** were significantly higher in cestodes than those in their host. These findings may indicate the possibility of the cestodes *Hymenolepis diminuta* can accumulate some metals and are suitable species as bioindicators for environmental pollution with the metals. Our results are agreed with those of previous studies (Sures et al 2017, Cadkova et al. 2014; Jankovska et al. 2008; Gabrashanska and Nedeva 1996). The mechanism whereby cestode-infected animals accumulate less heavy metals than parasite-free ones is not known. It may be due to their lower metabolic activities or due to a fact that the tapeworms and acanthocephalus (*Cestoda* and *Acanthocephala*) are lacking digestive tracts and using their teguments for absorbing substances from the host digestive tract (Jankovska et al. 2008).

The higher bioaccumulation factors in heavy metals exposed tapeworms observed in our study are in good agreement with the previous field studies (Jankovska et al. 2008). The studies showed elevated tapeworm BF-s in animals living in polluted areas (Cadkova et al.2014). Our studies support the hypothesis that cestodes with a relatively large absorbance surface have reached high BF-s.

It is known that cestodes take up bile salts produced in the liver through the hepatic intestinal cycle and use them for their eggs formation (Jankovska et al. 2008). According Sures (2003) and Jankovska et al (2008) the mechanism which enables cestodes to absorb metals from the host intestinal lumen is the presence of bile acids, forming organo-metallic complexes, that are easily absorbed by the worms due to their lipophilicity.

Our results revealed that the concentration of some heavy metals in the infected hosts are lower than those found in non-infected hosts. The high BF-s in *Hymenolepis diminuta* proposed that these tapeworms have the ability to remediate some toxic metals from their hosts. Basing on the results we conclude that some intestinal cestodes could be used as a bioremediation tool by absorbing the heavy metals from their hosts as well as they be used as bioindicators of pollution in their environment. Data about the level of heavy metals in the surface water slightly exceed the limits of level of **Mn**, **Zn**, **Cd**, **Pb** but not that of **Cu** in the studied area (Kovacheva et al. 2019). According the above authors detected level of **Zn** was 0.106, of **Cd** - 0.118 and of **Pb** – 155 mg/l. The host -cestode system *Rattus norvegicus/ Hymenoleps diminuta* reflected

Conclusion

Concentrations of heavy metals around a town located near to a plant were determined in subweb a host-parasite system *Rattus norvegicus – Hymenoleps diminuta*. A high ratio C parasite/C host was indicative of acute pollutant exposure or long/chronic exposure of the pollutant correlated with high concentration in both the host and parasite. Parasite infections have been attributed to man-made impact and environmental changes in terrestrial habitat. The position of parasite as a trophic consumer can infer details about the chemical state of the environment as a consequence of food web biomagnifications. The host-helminth system wild rat/*H. diminuta* reflects the content of heavy metals in the terrestrial environment and could be used as a bioindicator for heavy metal pollution. The content of toxic metals is lower in the infected hosts. The high BF-s for **Pb**, **Mn**, **Cd** and **Zn** indicates that even small amount of metals in the environment may result in significant

uptake by the tapeworms. Despite the fact that almost of heavy metal values may not indicate a severe risk of toxic effects on wildlife but after a long period of time could exert an impact on individuals, communities and ecosystems in the studied area.

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