A Comparative Study of Accumulation of Cadmium and Lead in the Tapeworm *Postgangesia inarmata* (De Chambrier; Alkallak and Mariaux, 2003) and some Tissues of the Catfish *Silurus glanis* in the Governorate of Nineveh, North Iraq

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ABSTRACT

The present study included estimation of the accumulated concentration of cadmium and lead by using atomic absorption spectrometer, in the tissues of the cestode Postgangesia inarmata De Chambrier, AlKallak and Mariaux, 2003 and some organs of its final host, the catfish Silurus glanis, such as liver, kidneys, intestine, gills and muscles. The fishes were collected from Mosul dam in Ninevah governorate. The results showed a significant difference (0.05) in the accumulation concentration of cadmium and lead in the liver, kidneys, intestine, gills and muscles of the infected and uninfected fishes. The accumulation concentration of cadmium and lead in the cestode was 24.24 and 787.87 µg/g, respectively.

Key words: Heavy metals, *Silurus glanis, Postgangesia inarmata*.

دراسة مقارنة للتراكم الحيوي للكادميوم والرصاص في الدودة الشريطية *Postgangesia inarmata* (De Chambrier; Alkallak and Mariaux, 2003) وبعض أنسجة أسماك الجري *Silurus glanis* في محافظة نينوى، شمال العراق

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الملخص

تضمنت الدراسة الحالية تعيين التركيز التراكمي للعنصرين الثقيلين الكادميوم والرصاص باستخدام جهاز طيف الامتصاص الذري، في أنسجة الدودة الشريطية *Postgangesia inarmata* De Chambrier, AlKallak and Mariaux, 2003 وبعض من أعضاء مضيفها النهائي من أسماك الجري *Silurus glanis* التي اصْطيدتْ من نهر دجلة في منطقة سد الموصل، محافظة نينوى.

أظهرت النتائج الحالية وجود فروقات إحصائية عند مستوى معنوية (0.05) في تراكيز كل من الكادميوم والرصاص في كل من الكبد، والكليتين، والأمعاء، والغلاصم والعضلات للأسماك المصابة وغير المصابة بالديدان الشريطية، وبلغ تركيز الكادميوم والرصاص في الدودة الشريطية 24.24 و787.87 ميكروغراماً/غرام على التوالي.

الكلمات المفتاحية: العناصر الثقيلة، أسماك الجري *Silurus glanis*، الديدان الشريطية *Postgangesia inermata*.

Introduction

The metals of the elements are naturally present in the aquatic system due to the environmental conditions, erosion, differences of chemical, geological and biological properties as well as increased growth in the industrial and agricultural activities and these result in a lot of environmental wastes (Wepener *et al.*, 2001; Lynch and Braith, 2005; Selda and Ismail, 2007; Shahat *et al.*, 2011). The presence of non-essential trace metals such as cadmium and lead in fresh waters, even with low concentrations, depending on the sediment surface and the nature of the rock base (Viarengs, 1985), is considered as one of the important pollutants in water media, which have a vital role to the living bodies (Munger *et al.*, 1999). The accumulation of these pollutants has a toxic effect on the aquatic organism, and hence affects the balance of the ecosystems and the diversity of living organisms, including fish (Cicik and Engin, 2005; Farombi *et al.*, 2007; Eira *et al.*, 2009).

Fishes are considered as vital indicators to the occurrence of pollutants in the aquatic systems (Sures, 2001; 2003; 2004; Al-Weher, 2008) due to the presence of dangerous pollutants such as cadmium and lead, which lead to undesirable changes in chemical, physical or biological properties of the aquatic systems, and hence cause damages in humans, animals and plants (Hodges, 1977; Eissa *et al.*, 2011). This has led several researchers to be involved in exploring and conducting studies in this respect (Pagenkopf 1983; Van Aardt and Erdman, 2004; Abu-Hilal and Ismail, 2008; Al-Weher, 2008; Ismail and Abu-Hilal, 2008).

The internal parasites, which infect fishes, have been used as vital signs, which brought the attention of researchers, particularly with the increasing growth and development of humanitarian activities, including industrial and agricultural activities. The relationship between fish parasites and pollution has been studied. A parasite in its natural place within the host is an important factor affecting the occurrence of pollution by heavy metals (Mackenzic *et al.*, 1995; Sures *et al.*, 1997a, b; Palikova and Barus, 2003; Selda and Ismail, 2005; Popiolek *et al.*, 2007; Selda and Ismail,2007; Sures, 2008; Eira *et al.*, 2009; Shahat *et al.*, 2011).

The present research is a comparative study to detect the concentration of both lead and cadmium in the tissues of the tapeworm *P. inarmata* and tissues of its final host, the catfish *S. glanis*. This study is considered as the first investigation in this field in Nineveh governorate.

Materials and Research Methods

Fish sampling was done during the period from February 2009 till May 2010. Fisherman from Tigris River in Mosul Dam area, Nineveh Governorate, caught fifty specimens of *S. glanis*. These fishes ranged from 205-600 g in weight and 30-40 cm in total length.

The samples were brought to the laboratory on the same day by cork containers containing ice. The cestode *P. inarmata* De Chambrier, Al-Kallak and Mariaux, 2003 and samples of liver, kidneys, gills, muscles and intestine were removed separately according to FAO methods (Dybem, 1983). The weight of samples (fish organs and the cestode) is that weighed 0.1 g and adds 1ml of high purity nitric acid (65%) (Lamphere *et al.*, 1984). The samples were placed in the digested tubes by homogenizer, to complete their digestion, the tubes were heated to 70ºC over night then diluted with distill water, and analyzed to estimate the concentration of cadmium and lead in the samples mentioned above by atomic absorption spectrometer.

Results

The results showed that cadmium concentration in the liver, kidneys, muscles, gills and intestine of non-infected fishes reached 77.77, 38.88, 50, 166.66 and 50 µg/g, respectively of the weight of these organs, respectively, while the concentration in these organs in the infected fishes reached 66.66, 38.88, 88.88, 61.11 and 66.66 µg/g, respectively as shown in Table (1). Significant difference was noticed only in values of livers as livers of non-infected fishes showed higher values.

Lead concentration in the liver, kidneys, muscles, gills and intestine of non-infected fishes reached 1194.44, 333.33, 1000, 1388.88 and 1111.11 µg/g, respectively against 833.33, 722.22, 333.33, 833.33 and 111.11 µg/g, respectively for the infected fishes as shown in Table (2). Significant differences were noticed in values of livers and kidneys, as higher values were noticed in livers of non-infected fishes and kidneys of infected fishes.

The concentration of cadmium and lead in tissues of the tapeworm *P. inarmata* reached 24.24 and 787.878 µg/g, respectively of the body weight of the worm as shown in the Table (3).

Table (1) Concentration of cadmium (µg/g) of the weight of five organs of non-infected and infected *S. glanis* with the tapeworm *P. inarmata*.

Fish group	Accumulated concentration of cadmium in fish organs (µg/g)				
	Liver	Kidneys	Muscles	Gills	Intestine
Non- infected fishes	77.77*	38.88	50	166.66	50
Infected fishes	66.66	38.88	88.88	61.11	66.66

* Significant difference (0.05) between the two groups of fishes.

Table (2) Concentration of lead (µg/g) of the weight of five organs of non-infected and infected *S. glanis* with the tapeworm *P. inarmata*.

Fish group	Accumulated concentration of lead in fish organs (µg/g)				
	Liver	Kidneys	Muscles	Gills	Intestine
Non- infected fishes	1194.44*	333.33	1000	1388.88	1111.11
Infected fishes	833.33	722.22*	333.33	833.33	111.11

* Significant difference (0.05) between the two groups of fishes.

Table (3) Concentration of cadmium and lead (µg/g) of body weight in the tissues of the tapeworm *P. inarmata*.

Cestoda	**Cadmium**	**Lead**
Postgangesia inarmata	24.24	787.878

Discussion

The relationship between parasitism and pollution is not simple but is an intrinsic relationship and the phenomenon has two factors. The internal parasites decrease the sensitivity and resistance of hosts to toxic pollution resulting in the decrease or increase in the spread of parasites through its impact on their life cycles, content of the intermediate hosts and the phases of a free Living (Eissa *et al.*, 2011). The results of the present study showed that the highest concentration of cadmium and lead is in gill and liver of fish *S. glanis*. This result was in accordance with the recorded studies of Al-Tai (2007) and Abu-Hilal and Ismail 2008; Ismail and Abu Hilal 2008, as it represents the liver as one of the most important organs affected by the heavy metals such as cadmium and lead (Dudley *et al.,* 1982; Sures *et al.*, 1997a; Turcekova *et al.*, 2002; Palikova and Barus 2003) through the presence of mitaluthionen in the kidney of the organism, which plays an important role mediated by its effectiveness during the processes of metabolism and removal of toxic substances detoxification (Hogstrand *et al.*, 1991), also agreed with (Mayer *et al.* 1991; Vinodhini and Navayanan, 2008) to infer from these results that the cadmium and lead are among the most heavy metals that accumulate in the gill, which is considered more vulnerable to contaminants of water, and is due to the anatomical and tissue structure which its surface area may allow water and pollutants to enter and thus lead to an increase in the accumulated concentrations. It was noted that the concentration in accumulation of heavy metals varies depending on the mode of exposure, duration and physiological status of the organism (Chowdhury *et al*., 2005) as well as the physiological status, structure and effectiveness of the tissues and organs of the organism (Radhakrishnan, 2009; Jayakumar and Paul, 2006). The present study agreed with the results of Sures *et al.* (1997a). They show the presence of lead in the intestines of fish infected and none infected with parasites, reflecting the fact that the intestine is an important center for the accumulation of some elements because of exposure to the toxic and their interaction and its union with mitaluthionen in kidney and through the blood to reach the liver. Sures (2008) and Shahat *et al.*(2011) confirmed the number of factors that influence the occurrence of pollution elements at different levels of physiological status of tissues and tissue structure and function, as well as the existence of the so-called composite or legends in the tissues of the organs, and that may be because of the hepatitis intestinal enterohepatic which works to remove toxic substances. These studies together show their failure to get exact results (Sures *et al.*, 1997a), and perhaps the quality of community water-dwelling organisms, including fish, and includes water from waste and pollutants from varying topographic areas surrounding aqueous media that can be added to the totality of the factors mentioned in previous studies. More over the importance of the liver and gill and their role in the life of the organism, one can mention that the possibility of the use of heavy metals in them as an indicator of the concentration of vital elements in the aqueous medium. Giesy *et al.* (1977) indicated that some of the fish and the type *Gambusia affinis* are very sensitive to concentrations of low-cadmium, 0.01-3.70 mg/ liter, and the ability of internal parasites on the deposition of heavy metals varies depending on the species and larvae stages of parasites. The presence of the parasite with multiple stages inside hosts and during life cycle is one of the factors affecting the occurrence of pollution elements (Shahat *et al*., 2011). To be sure, subsequent studies of the types of parasites and larval stages, genus and different of animal phylum will show a new facts in the use of parasites as indicators of the vitality of pollution. The results of the current study and on the concentration of cadmium in the tapeworm *P. inarmata* was less than it is in the organs of final host of the fish, to confirm what was stated and documented by a number of studies (Sures *et al.*, 1994; Palikova and Barus, 2003; Eissa *et al.*, 2011; Shahat *et al.*, 2011). It would be useful to make studies expended to the types of fish that inhabit hosts in aqueous media selected.

The results of the present study for the concentration of lead in tissues tapeworm *P. inarmata* was higher than in the final organs hosts, except in gill and liver, as it showed similarity with those reported by the study of Torres *et al.* (2010), as concluded of the highest concentration of lead in the tapeworm *Raillietina microcantha* than it is in the hosts in spite of the difference of final hosts inhabited form the current study, it also recorded the highest concentration of cadmium and lead in the worm *Philometra ovata* than it is in the hosts (Tenora *et al.*,2000), as well as study Turcekova *et al.* (2002) that the concentration of cadmium and lead in cestodes and acanthocephala is higher than in the liver and muscles of the final host *Perca fluviatilis.* Perhaps the different ecosystems and the nature of the pollutants and the duration of exposure to contaminants as well as the nature of the diet of fish and other hosts each of this is responsible for the emergence of pollution elements in the tissues of internal parasites. The current results also showed that the concentration of lead in the muscles of infected fish is less than in the other organs and tapeworms. These conclusions are in accordance with Abu-Hilal and Ismail (2008) and Ismail and Abu-Hilal (2008) who recorded less concentration of heavy metals in fish muscle. Sures *et al.,* (1997a, b) showed concentration of lead and cadmium in the tissues tapeworms *Bothriocephalus scorpii* and *Monobothrium wageneri* is higher than the concentration accumulation elements mentioned in the muscles, liver and intestines of fish species *Tinca tinca*. The difference of concentration accumulation of heavy metals in the body of the fish may be the influence of many factors including physiological status of fish through the toxic effect on events physiological blood and tissues, as well as the effectiveness of critical elements in the systems of aqueous media, as well as the type of metal content and the nature of the compound and the characteristics of the chemical (Gunkel, 1994; Selda and Ismail, 2007; Eira *et al.*, 2009; Eissa *et al.*, 2011). The conclusions of the present study is an extension of the findings of previous studies, in this regard Popiolek *et al.*(2007) proposed that the difference in the levels of pollution elements in cestodes depend on the installation of the tegument and complex life cycles including intermediate hosts and their sensitivity to pollution elements, perhaps the different habitat of the parasite inside the host and method of feeding as well as the size and species of the parasite affect the level of pollution in the cestodes (Selda and Ismail, 2007); Eira *et al.*, 2009). The present study concluded the role of parasites, especially cestodes as indicators of biological contamination by heavy metals. Selda and Ismail (2005) concluded that the role of parasites, such as cestodes, invertebrates that are indicators of pollution in the ecosystems. The present study confirms the concentration of heavy metals accumulation in both external and internal parasites and stages larval, because it is regarded as the factors affecting the pollution elements. The presence of high concentrations of heavy metals in the parasites reflect the length of exposure since the phases of larval or since the time of parasitism. It also identifies the accumulation concentrations in muscles of fish and should be taken into account and that because of its negative impact on people's health consumers and the health of the fish itself, as well as other organs that has not been addressed in the current study and its relationship with weight and length and age of fish, and by conducting more studies to include the types of fish and the factors surrounding such as changes in the aqueous systems media for fish and physiological changes and their nutrition and metabolic processes according to the seasons. Also the detection and investigation of endoparasites, which were regarded as biomarkers and influential factors in the incidence of contamination and therefore detection of heavy metals, these as vital indicators of pollution. Sures *et al.*,(1997a) stated that the relationship of parasitism and pollution of the heavy metals as the measure of a sensitive and non-directly that is reflecting the impact of health on the health of fish through the role of parasites in the reduced elements of the tissue organs of his host. This study recommends identifying the relationship between pollution of heavy metals and the surrounding represented in water aqueous media, which requires extensive studies to include water aqueous medium with the effect of temperature and salinity, which effect on the rate of pollution in the selected ecosystem area.

REFERENCES

1- **Abu-Hilal, A.H., Ismail, N. S. (2008).** ***Heavy metals in eleven common species of fish from the Gulf of Aqaba, red sea.*** **Jordan J. of Biological Sciences, Vol. 1, No.1, 13-18.**

2- **Al-Weher, S. M. (2008).** ***Levels of heavy metal Cd, Cu and Zn in three fish species collected from the Northern Jordan valley, Jordan.*** **Jordan of Biological Sciences, Vol. 1, No.1, 41-46.**

3- **Al-Taee, Sh, Kh. (2007).** ***Pathology study of expremantal cadmium toxicity in common carp fish (Cyprinus carpio L.).*** **Master Thesis, Faculty of Veterinary Medicine, University of Mosul, Iraq.**

4- **Chwdhury, M., Baldisserotto, B., Wood, C. (2005).** ***Tissues specific cadmium and metallothionin levels in rainbow trout chronically acclimated to water borne on dietary cadmium.*** **Arch. Environ. Contamtoxical, Vol. 38, No.3, 381-390.**

5- **Cicik, B., Engin, K. (2005).** ***The effects of cadmium on levels of glucose in serum and glycogen reserves in the liver and muscles tissues of Cyprinus carpio L., 1758.*** **Turk. J. Vet. Amim. Sci., Vol.9, 113-117.**

6- **De Chambrier, A., AlKallak, S.N.H., Mariaux, J. (2003).** ***A new tapeworm Postgangesia inarmata n. sp. (Eucestoda: Proteocephalidea, Gangesiinae) parasitic in Siluris glanis (Siluriformes) from Iraq and some comments on the Gangesiinae Mola, 1929.*** **Systematic Parasitology, Vol. 55, 199-209.**

7- **Dudley, R., Svoboda, D., Klaassen, C. (1982).** ***Acute exposure to cadmium causes sever liver injury in rats.*** **Toxically. Appl. Pharmacology, Vol. 65, 302-312.**

8- **Dybem, B. (1983).** ***Field sampling and preparation subsamples of aquatic organism for analysis metals and organochlorides*****. FAO. Fisher. Tech., Pap. Vol., 212, 1-13.**

9- **Eira, C. Torres, J., Miquel, J., Vaqueiro, J., Soares, A., Vingada, J. (2009).** ***Trace element concentrations in Proteocephalus macrocephalus (Cestoda) and Anguillicola crassus (Nematoda) in comparison to their fish host, Anguilla anguilla in Ria de Aveiro, Portugal.*** **Science of the Total Environment, Vol.407, 991-998.**

10- **Eissa, I. A., Zaki, M. S., Noor El Deen, A., Ibrahim, A. Z., Abdel Hady, O. K. (2011).** ***Field study on cadmium pollution in relation to internal parasitic diseases in cultured Nile Tilapia at Kafr El-Sheikh governorate.*** **Journal of American Science, Vol. 7, No. 4, 650-660.**

11- **Farombi, E., Adelowo, O., Ajimoko, Y. (2007).** ***Biomarkers of oxidative stress and heavy metal as indicators of environmental pollution in African catfish (Clarias gariepinus) from Nigeria Ogun River.*** **International J. Environ. Res. Pub. Health, Vol. 4, No. 2, 158-165.**

12- Giesy, J., Leversee, G., Williams, D. (1977). ***Effects of naturally occurring aquatic organic fractions on cadmium toxicity to Simcocephalus serrulatus (Daphnidae) and Gambusia affinis (Poeciliidae).*** **Water Research, Vol, 11, 101-110.**

13- Gunkel, G. (1994). Bioindication in aquatischen okosystemen. Fishcher, Jena Stuttgart.

14- Hodges, L. (1977). Environmental pollution. 2nd Lowa State University by Holt Rinehart and Winston. New York, Chicago, San Francisco, Toronto, USA. pp. 420-430.

15- Hogstrand, C., Lithner, G., Haux, C. (1991). ***The importance of metallothionein for the accumulation of copper, zinc and cadmium in environmentally exposed perch, Perca fluviatilis.*** **Pharmocol. Toxicol., Vol. 68, 492-501.**

16-Ismail, N. S., Abu-Hilal, A. H. (2008). ***Heavy metals in three commonly available coral reef fish species from the Jordan Gulf of Aqaba, Red Sea.*** **Jordan J. of Biological Sciences,Vol.1, No.2, 61-66.**

17-Jayakumar, P., Paul. V. I. (2006). ***Patterns of cadmium accumulation in selected tissues of the cat fish Clarias batrachus (Linn.) exposed to sub lethal concentration of cadmium chloride.*** **Veterinary Arhiv., Vol. 76, No. 2, 167-177.**

18-Lamphere, D. N., Dorn, C. R., Reddy, C. S., Meyer, A. W. (1984). ***Reduced cadmium body burden in cadmium exposed calved fed supplemental zinc.*** **Environment Research, Vol. 33, 119-129.**

19-Lynch, E., Braith, R. (2005). ***A review of the clinical and toxicological aspect traditional (herbal) medicines adult related with heavy metals.*** **Exp. Opin. Drug Saf, Vol. 4, No.4, 769-778.**

20-Mackenzie, K., Williams, H., Williams, B., McVicar, A., Siddall, R. (1995). ***Parasites as indicators of water quality and the potential use of helminth transmission in marine pollution studies.*** **Advance Parasitology, Vol., 35, 85-144.**

21-Mayer, W., Kretschmer, M., Hoffman, A., Harish, G. (1991). ***Biochemical and histochemical observation on effects of low level heavy metal load (lead, cadmium) in different organ systems of the fresh water crayfish, Astacus astacus L. (Crustacea: Decapoda).*** **Ecotoxicology Environment Safe, Vol. 21, 137-156.**

22-Munger, C., Hare, L., Craig, A., Charest, P-M. (1999). ***Influence of exposure time on the distribution of cadmium with the cladoceran ceriodaphnia.*** **Aquatic Toxicology, Vol.44, 195-200.**

23-Pagenkopf, G. (1983). ***Gill surface interaction model for trace metal toxicity to fish, role of complication,pH, water hardness.*** **Environment Science Technology, Vol., 17, No. 6, 342-347.**

24-Palikova, M., Barus, V. (2003). ***Mercury content in Anguillicola crassus (Nematoda) and it is host Anguilla anguilla.*** **Acta Veterinary BRNO Vol. 72, 289-294.**

25-Popiolek, M., Okulewicz, A., Dobick, W., Nowak, R. (2007). ***Heavy metal concentration in plerocercoids of Triaenophorus nodulosus (Pallas, 1781) (Cestoda: Triaenophoridae) and in different organs if their host-perch Perca fluviatilis (L.).*** **Wiadomosci Parazytologiczne, Vol. 53, No.1, 21-24.**

26-Radhakrishnan, M. (2009). ***Effect of cadmium on catalase activity in four tissues of freshwater fish Heteropneustes fossilis (Bloch.)*** **The Internet Journal of Veterinary Medicine, Vol., 7 No. 1, 39-47.**

27-Selda, T. O., Ismail, K. (2005). ***Comparative study on the accumulation of heavy metals in different organs of tench (Tinca tinca L., 1758) and plerocercoid of its endoparasite Ligula intestinalis.*** **Parasitology Research,Vol.97, 156-159.**

28-Selda, T. O., Ismail, K. (2007). ***Accumulation of some heavy metals in Raphidascaris acus (Bloch, 1779) and its host (Esox lucius L., 1758).*** **Turkiye Parazitoloji Dergisi., Vol., 31, No. 4, 327-329.**

29-Shahat, M., Amer, O., Abdallah, A., Abdelsater, N., Moustafa, M. (2011). ***The distribution of certain heavy metals between intestinal parasites and their fish host in the river Nile at Assuit province, Egypt.*** **The Egyptian J. of Hospital Medicine (April 2011), Vol., 43, 241-257.**

30-Sures, B. (2001). ***The use of fish parasites as bionindicators of heavy metals in aquatic ecosystems a review.*** **Netherlands Aquatic Ecology , Vol., 35, 245-255.**

31- Sures, B. (2003). ***Accumulation of heavy metals by intestinal helminthes in fish: an over view and perspective.*** **Parasitology Vol., 126, 53-60.**

32-Sures, B. (2004*).* ***Environmental parasitology: relevancy of parasites in monitoring environmental pollution.*** **Trends Parasitology, Vol., 20, No. 4, 170-177.**

33-Sures, B. (2008). ***Environmental parasitology: Interactions between parasites and pollutants in the aquatic environment.*** **Parasite, Vol., 15, 434-438.**

34- Sures, B., Taraschewski, H., Jachwerth, E. (1994). ***Lead content of Paratenuisentis ambiguus (Acanthocephala), Anguillicola crassus (Nematodes) and their host Anguilla anguilla.*** **Dis Aquat Organ, Vol., 19. 105-107.**

35-Sures, B., Taraschewski, H., Rydio, M. (1997a). ***Intestinal fish parasites as heavy metal bioindicators: A comparison between Acanthocephalus lucii (Palacanthocephala) and the Zebra Mussel, Dreissena polymorpha.*** **Bull. Environment Contamination Toxicology, Vol., 59, 14-21.**

36-Sures, B., Taraschewski, H., Siddall, R. (1997b). ***Heavy metals concentration in adult acanthocephalans and cestodes compared to their fish host and to established free-living bioindicators.*** **Parassitologia, Vol. 39, 213-218.**

37-Tenora, F., Barus, V., Kracmar, S., Droracek, J. (2000). ***Concentration of some heavy metals in Ligula intestinalis plerocercoids (Cestoda) and Philometra ovata (Nematode) compared to some their hosts (Osteichthyes).*** **Helminthologia,Vol. 37, 15-18.**

38-Torres, J., Foronda, P., Eira, C. (2010). ***Trace element concentration Railletina microcantha in comparison to its definitive host, the feral pigeon Columba livia in Santa Crazy de tenerile (Canary Archipelago Spain).*** **Arch. Environ. Contam. Toxicology, Vol., 58, 176-182.**

39-Turcekova, L., Hanzelova, V., Spakulova, M. (2002). ***Concentration of heavy metals in perch and its endoparasites in the polluted water reservoir in eastern Slovakia*****. Helminthologia, Vol., 39, No. 1 23-28.**

40-Van Aardt, W., Erdman, R. (2004). ***Heavy metals (Cd, Pb, Cu, Zn) in mudfish and sediments from three hard-water dams of the mooi river catchments,*** **South African water, Vol., 30, 211-218.**

41-Viarengs, A. (1985). ***Biochemical effect of trace metals. Mar. Poll. Bull.*****, Vol., 16, No. 4, 153-158.**

42-Vinodhini, R., Narayanan, M. (2008). ***Bioaccumulation of heavy metals in organs of fresh water fish Cyprinus carpio (Common carp).*** **Internet J. Environment Science Technology, Vol., 5, No. 2, 179-182.**

43-Wepener, V., Vanvaren, J., Dupreez, H. (2001). ***Uptake and distribution of a cooper, iron and zinc mixture in gill, liver and plasma of a fresh water teleost, Tilapia sparmanii.*** **Water SA., Vol., 27, No. 1, 99-108.**