Levels of some Heavy Elements in Tissues and Shells of Aquatic Mollusca (Viviparous and Anodonta) in Baghdad City, Iraq.

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Abstract. Some heavy elements accumulated levels, such as Lead, Zinc, Copper, Iron, Cobalt, Cadmium and Mercury were measured in molluscs that inhabit the irrigation channel of University of Baghdad in AL-Jadriya districts. The shells and tissues of two Molluscus groups, gastropods genus Viviparous and bivalve genus Anodonta, as well as samples of gastropods eggs and water, were analyzing. The results showed that the highest concentration of Lead, Zinc, Copper, and Iron were recorded in Viviparous shells compared to Anodonta shells, but both Cadmium and Cobalt concentrations were identical in both genera shells, any presence of mercury was not recorded in any of these samples. The tissue samples recorded a rise in Zinc and Copper concentration in Viviparous in comparison with Anodonta, but the Lead, Iron and Cadmium concentrations recorded the highest values in Anodonta. Both elements Cobalt and Mercury concentration showed a similarity in both genera. The gastropods eggs were recorded high concentrations of heavy elements as follows Iron (550.00 ±0.57), Lead (128.00±0.57), Zinc (54. ±000.57), Copper (84.00±0.57), Cadmium (0.300±0.05), Cobalt (0.050±0.01) and Mercury (0.001±0.00) ppm. But water samples showed low concentrations in these elements, Iron (0.200±0.05), Lead (0.033±0.008), Zinc (0.025±0.001), Copper (0.008±0.001), Cadmium (0.004±0.001) and Cobalt (0.001±0.00) ppm.

Key word: Pollution, Heavy Elements, Aquatic Molluscs

1. Introduction
Heavy elements are a major pollutant in aquatic environments if their concentrations are excess natural levels, they led to toxic effects in the living cells physiology, as these elements are divided into two groups, one of which is necessary for the construction of structures and completion of vital organisms’ functions, and the other unnecessary, which has no role in determining functions [18,12]. The increase of both elements groups concentration as more than its critical levels in aquatic systems may have serious effects on aquatic organisms. For example, Zinc is one of the necessary heavy elements that play an important role in the construction of most enzymes, DNA molecule, cell membranes, ribosomes and other vital compounds [2,7], but have been described by the World Health Organization in recent years as common freshwater pollutants because its producing by various anthropogenic activities such as element processing plants, manufacturing electrical appliances factories, domestic and industrial effluents, combustion of fossil fuels and erosion of agricultural soils [21].

Some heavy elements have become highly toxic compounds, which can bioaccumulate in many organisms and thus pass through the food chain to other organisms and humans [17].

Biological monitoring of heavy element pollution is one most important topic in environmental research. Heavy elements can be produced naturally in the aquatic system by its slow filtration from soil or rocks at low levels and do not cause harmful or serious effects to human health. The industry and agricultural development, which causes a rapid heavy elements pollution with high levels, such as Mercury, Chromium, Lead, Cadmium, Copper, Zinc and Nickel [1].

Some heavy elements, including Mercury, Chromium, Cadmium, Zinc, Copper, Lead, etc. may form high toxicity levels of aquatic organisms. For example, Cadmium is the top environmental pollutant due
to its impacts on human health and ecosystem biodiversity and it has a wide study in environmental research [11,19].

In biological monitoring of heavy elements effects in aquatic systems, aquatic organisms take a sample for various biological responses analyses for these effects. So biological indicators are appropriate ways to provide significant assistance for biological monitoring [9].

Bivalve molluscs are detritivores that filter water during feeding, are known to accumulate elements that have harmful effects on other organisms. Scientific organizations of the ocean are suggested using these organisms in the monitoring program to assess spatial and temporal trends of chemicals in polluted estuaries and coastal areas, and also these organisms widely used because of their ability to detect various marine pollutants [3].

The gastropods are also a group of aquatic molluscs similar to bivalve, mostly benthic, but sometimes can swim up to the water surface to obtain food. Gastropods have long known their ability to accumulate naturally in high concentrations of elements [15,20].

One gastropod species *Cipangopaludina cahayensis* tested after exposure to several heavy elements. The test results showed this species is a suitable indicator for estimating toxicity and bioavailability of heavy elements. So, they are very important for the biological monitoring of aquatic pollution.

Other criteria of molluscs such as population density, survival rate, and weight of individuals can also be used to assess the toxicity of the heavy element in aquatic sediments. Also, these results may give confirmation that the molluscs are a special indicator of aquatic pollution [14].

2. Materials and Methods

Samples were collected from different locations within the study area (irrigation channel inside University of Baghdad in Al-Jadriyah district). During April and May 2019, with three replicates of each sample. A number of *viviparous* and *Anodonta* were collected from the study area. In addition to water samples, the body measurements of both genera were taken using the Vernia apparatus according to the method described in [8], the height of the *viviparous* shell reached 6 cm, and the width of the *Anodonta* shell reached 10 cm.

The animals were classified and each soft tissue and shell were weighing 20 grams and 58 grams respectively in *viviparous*, while in *Anodonta* were 38 grams and 57 grams in respectively. The *viviparous* eggs were weighing 2 grams and collected 50 ml of water. All samples were examined according to the method described in [4].

The concentration of heavy elements in these samples was measured by Atomic Spectrophotometer in the Central Laboratory of the College of Science, University of Baghdad.
### 3. Results and Dissection

**Table 1.** The average concentration of heavy elements (Pb, Zn, Cu, Fe, Cd, Co and Hg) (ppm ± S.E) in *viviparous* and *Anodonta*.

| Heavy elements | Pb  | Zn   | Cu  | Fe   | Cd   | Co   | Hg   |
|----------------|-----|------|-----|------|------|------|------|
| **Viviparous eggs** | 128.00 ± 0.57 | 84.00 ± 0.57 | 54.00 ± 0.57 | 550.00 ± 0.57 | 0.300 ± 0.05 | 0.050 ± 0.01 | 0.001 ± 0.00 |
| **Viviparous shells** | 162.00 ± 0.57 | 32.00 ± 1.52 | 9.10 ± 0.06 | 142.00 ± 1.52 | 0.120 ± 0.01 | 0.020 ± 0.00 | 0.00 ± 0.00 |
| **Viviparous tissues** | 38.50 ± 0.29 | 30.00 ± 0.57 | 8.70 ± 0.11 | 84.50 ± 0.29 | 0.150 ± 0.005 | 0.010 ± 0.00 | 0.001 ± 0.00 |
| **Anodonta shells** | 109.00 ± 0.57 | 25.00 ± 0.57 | 9.00 ± 0.29 | 37.50 ± 0.29 | 0.200 ± 0.006 | 0.020 ± 0.005 | 0.00 ± 0.00 |
| **Anodonta tissues** | 54.00 ± 0.57 | 19.00 ± 0.58 | 3.00 ± 0.58 | 234.00 ± 0.58 | 0.230 ± 0.005 | 0.010 ± 0.001 | 0.001 ± 0.00 |
| **Waters** | 0.033 ± 0.008 | 0.025 ± 0.001 | 0.008 ± 0.001 | 0.200 ± 0.005 | 0.004 ± 0.001 | 0.001 ± 0.00 | 0.00 ± 0.00 |
| LSD value *P<0.05* | 1.479* | 2.408* | 1.286* | 2.239* | 0.103* | 0.012* | 0.00* |

When comparing samples taken from *viviparous* and *Anodonta* genera under study, the highest Lead concentration was in shells and eggs of *viviparous* (162.00 ±0.57) and (128.00±0.57) ppm, respectively. But shells and tissues of *Anodonta* were (109.00±0.57) and (54.00±0.57) ppm, respectively, while a tissue sample of *viviparous* recorded the lowest concentration of this element, was (38.50±0.29) ppm.

The highest Zinc concentration recorded in eggs, shells and tissue of *viviparous* was (84.00±0.57), (32.00±1.52), and (30.00±0.57) ppm, respectively, but the lowest rate was recorded in both shells and tissues of *Anodonta* (25.00±0.57) and (19.00±0.58) ppm respectively.

Copper element recorded highest rate (54.00±0.57) ppm in *viviparous* eggs, while the shells of both genera and tissues of *viviparous* were recorded respectively (9.10±0.06), (9.00±0.57), and (8.70±0.11) ppm, the lowest rate was (3.00±0.58) ppm in *Anodonta* tissues.

Iron was recording the highest concentration in both eggs of *viviparous* and tissues of both genera were (550.00±0.57), (234.00±0.58) and (142.00±1.52) ppm, respectively. This element reached (84.50±0.29) and (37.50±0.29) ppm, respectively in *viviparous* tissue and *Anodonta* shells.

Cadmium and Cobalt recorded lower rates compared with other studied elements. The Cadmium rates were (0.300±0.05), (0.230±0.58), (0.200±0.06), (0.150±0.005), and (0.120±0.01) ppm in *viviparous* eggs, *Anodonta* shell and tissues and *viviparous* shell and tissues, respectively. The highest Cobalt concentration was recorded in *viviparous* eggs (0.050±0.01) ppm, but its concentration was similar in shells of both genera (0.020±0.001) ppm. And in the tissues of both genera was (0.010±0.00) ppm. Mercury was recorded (0.001±0.00) ppm in *viviparous* eggs and tissues of both genera.

We observe from the present study results, this group of aquatic invertebrates have the ability to absorb and accumulate different levels of heavy elements, and due to the heavy elements, which is one of the most common pollutants in urban and industrial areas, so present study results provide important information about nature of studied ecosystem and processes taking place in it. Several studies have been built on using aquatic organisms, especially invertebrates as bioindicators of environmental pollution, especially heavy element pollution.

It has been observed in many studies that molluscs have direct contact with contaminated water sites and sediments as a result of their nutritional behavior and lifestyle. They can accumulate high levels of heavy elements in their soft tissues, bivalves belonging to the Unionidae family have a high
bioaccumulation potential for a wide range of contaminants [13]. *Anodonta cygnea* was used to detect Zinc accumulation in its organs such as external shells, foot and digestive system accessory organs liver and pancreas through exposure to zinc. The results showed this genus has a high ability to accumulate elements, and this confirms the using efficiency of these animals as bioindicator for monitoring aquatic pollution [6].

The accumulation of chromium and cadmium was determined in two aquatic molluscs species, bivalve *Caelatura companyoi* and gastropods *Cleopatra bulimoidea*, tissues and shells of both species were examined, and the results showed that both species have the ability to absorb and accumulate both elements at high levels and tolerance high toxicity levels, and also observed highest accumulated concentration of elements in shells of both species compared to soft tissues, we can conclude that molluscs can be used as bioindicators of aquatic pollution, especially with heavy elements[16].

Many researchers have tested bioaccumulation of a number of heavy elements such as Cadmium, Iron, Lead, Zinc, Copper, Manganese, Nickel, Chromium, Cobalt, and Aluminum in several body parts of two bivalve species *diameter Chama Pacifica* and *Ostrea stentina* in Iskenderum Bay on the northeastern Mediterranean [5].

Water samples recorded the lowest heavy element levels, respectively Iron (0.200±0.05), Lead (0.033±0.008), Zinc (0.025±0.001), Copper (0.008±0.001), Cadmium (0.004±0.001) and Cobalt (0.00±10.00) ppm, no mercury concentration was recorded. As we observe from the table (1) there are significant differences between heavy element concentrations of study samples at a probability level of 0.05.

### Table 2. Correlation coefficient value of heavy element concentrations.

| Heavy elements | Hg | CO | Cd | Fe | Cu  | Zn |
|----------------|----|----|----|----|-----|----|
| Pb             | 0.15- NS | 0.66 ** | 0.45* | 0.45* | 0.49* | 0.61** |
| Zn             | 0.49* | 0.91 ** | 0.70** | 0.89** | 0.96** |
| Cu             | 0.43* | 0.89** | 0.61** | 0.90** |
| Fe             | 0.62** | 0.81** | 0.70** |
| Cd             | 0.57** | 0.70** |
| CO             | 0.29 NS |

Nonsignificant: NS (P<0.01) ** (P<0.05) *

The correlation coefficient, the table (2) showed a highly significant correlation at probability level (0.01) between most of the heavy elements, but a significant correlation at probability level (0.05) was shown between Lead with Cobalt, Iron, Copper, and between Mercury with Zinc and Copper, and nonsignificant was showed between Mercury with Lead and Cobalt.

The element pollution index (MPI) calculated to the following formula MPI (mg/Kg) = (Cf1 × Cf2 × ……… × Cf6)1/n Where, Cf = concentration of element n in the sample [10]. This index measured to compare between heavy element concentrations in this study. Its results were in the following order: iron > lead >zinc >copper >cadmium > cobalt >mercury.

The same index also calculated to describe molluscs body part's ability to accumulate heavy elements in the present study and its results were at Table (3).

### Table 3. Element Pollution Index (MPI) values in molluscs body samples.

| Type of Sample | Element Pollution Index (MPI) value |
|----------------|-----------------------------------|
| *Viviparous* shells | 3.88 |
| *Viviparous* tissues | 1.03 |
| *Anodonta* shells | 3.16 |
| *Anodonta* tissues | 1.07 |
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