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Effect of Some Heavy Metals on the Walking Activity of River Crab Sesarma Boulengeri: Scale and the Study of Environment and Pollution

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ABSTRACT

The current study looked at the effect of heavy metals on the walking activity of females and males, adults and juveniles, of the river crab, Sesarma boulengeri, as a vital indicator of the aquatic environment when exposed to heavy metals cadmium, copper, and Zinc. In other words, the research relied on a new scientific idea in measuring the walking movement of arthropods from animal crustaceans that can escape from polluted surrounding animals, which is a nice physiological function as a reaction to water pollutants, as well as determining the effect of different concentrations in this movement. Besides, this measurement includes adults and juveniles to clarify the effect on the life stages of this animal and the walking function of these classes. The samples were isolated to males and females, whereby the members of each sex were classified into two size classes depending on the carapace width, which was measured by a vernier. The carapace width of a juvenile size glass is 6-21mm, while a mature size glass has a carapace width of 15-24mm. It was then placed in plastic aquariums for one week at a temperature of 22-24 ℃ to be adapted to lab rotary conditions. At the end of the acclimatisation period, each concentration was used to replicate each of the five samples of males and females separately, and for each adult and juvenile. It was observed through the results of the present study that the effect of heavy metals (Zinc, Cd, and Cu) on the walking movement of river crabs was measured using relative speed as an indicator of the crabs' walking movement. The results show that the movement varies according to the concentrations, for both sexes and life stages of the animal. It also displayed the percentage of walking speed. It was discovered that differences in (3 ppm) were (75, 65, 50, and 44% move/min) and decreases in (5 ppm) were (60, 44, 37, and 27% move/min), whereas at 9 ppm the animals were stooped moving compared to control animals (100%) walking movement.

1. INTRODUCTION

Environmental pollution is one of the risks that threaten the environment. It happens when humans change rivers in the wrong way, such as by using heavy metals and pesticides, breaking health laws, wasting energy, and changing the way things look. This is called an environmental imbalance [1, 2]. It shows how healthy people and animals are, which is the last indicator of how good the water.

According to David and Cosio [3], chemical waste that enters the aquatic environment and accumulates in the tissues of aquatic organisms may endanger aquatic animals' food supply. Also, IM El-Khatib et al. [4] reported that the bad effects were evident on the quality and standards of the environment. Yousif et al. [5] also talked about how the effects of crustaceans and zooplankton on Cu, Cd, and Pb change with the seasons.

The presence of a very small percentage of some heavy metals such as copper, iron, nickel, zing, zing, and cadmium is important for the survival and growth of any organism [6, 7]. Excessive excess above a certain limit leads to physiological and behavioural damage or the destruction of these organisms, according to Rafi et al. [8].

Several studies referred to the effect of these pollutants on aquatic organisms, as they were studies on survival, disruption, physiological, accumulation, and behavioural effects [9-11]. These pollutants are also metabolised in energy centres such as mitochondria, where they play an important role in molecular changes in the synthesis of proteins and cellular changes in the immune and nervous systems [12, 13].

Water penetrates the high tide areas where the animal is located on the river's banks, and this animal is important from every economic standpoint because of its high level of protein as food material, and its larvae and eggs are used as food for fish [14]. Sesarma boulengeri is an arthropod crustacean that lives in the aquatic environment in its first stage and then relocates to the terrestrial environment. It is a semi-aquatic animal and possesses protein stock in the muscles that is used as food for humans, such as shrimp. This animal is found in abundance in the southern part of Iraq on the banks of the Shatt al-Arab, Arabian Gulf, and Oman Gulf, as it was discovered for the first time in the southern part of Iraq in the Shatt al-Arab governorate of Basrah [15]. For various years, numerous documents have indicated the toxic effects of metals on aquatic organisms [15].

Al Aitte [16] reported the cellular responses to toxic metals in marine and riverine life and dandified molecular responses that include reactive oxygen production. Several authors presented stress biomarkers and responses, as well as the cellular system restrictions that they caused. Also, many researchers dealt with the effect and accumulation of some pollutants in the body of the Sesarma boulengeri animal [17], and many pointed to the study of some environmental stress conditions in this animal [18, 19]. That is why the aquatic environment suffers from these pollutants, which have a negative impact on the biota and diversity in the aquatic system.

Based on the above survey, the current study investigated the effect of heavy metals on the walking activity of females and males, adults and juveniles, of the river crab, Sesarma boulengeri, as a vital indicator of the aquatic environment when exposed to cadmium, copper, and Zinc. The format of the article may be broken down into three distinct sections: Section 2, which discusses "materials and methods;" Section 3, which includes "results and discussion;" and Section 4, which includes "conclusion."

2. MATERIALS AND METHODS

2.1 Collection samples

Samples of the river crab Sesarma boulengeri were taken from the bank of the Shatt al Arab and taken to the lab, where they were cleaned of mud and other particles and given a week to get used to the conditions there. The samples were isolated to males and females, whereby the members of each sex were classified into two size classes depending on the carapace width, which was measured by a vernier. The juvenile size class has a carapace width of 6-21 mm, while the large is a mature size glass. The carapace width is 15–24 mm, and it was placed in plastic aquaria for one week at a temperature of 22–24 ℃ to be adapted to lab rotary conditions. At the end of the acclimatisation period, each concentration was tested five times on five separate male and female samples, and each was found to be authentic for adults and juveniles.

The number of samples Each concentration contains three replicates; each replicate contains ten treated samples and a control for the size category and for both sexes; and each sample was measured each concentration, for each size class, and for each sex five times for each of them. A statistical analysis was carried out on the percentage of the walking movement per second and calculated the mean ± S.D. and using the Anova one-way statistical program for the purpose of comparison between locomotor activity and concentrations, the correlation (r) coefficient under the level of $p < (0.05)$.

2.2 Preparation solution

The method of preparing the concentrations for the experiment by stock solution was used. For $ZnCl_2$, $CdCl_2$, and $CuSO_4$, dissolve 50 g of each metal in 1 litre of water. Then the concentrations were prepared (at 1, 3, 5, 7, and 9 ppm, respectively) by passing on the method Sprague [20].

Method for calculating river crab walking movements: At the end of each exposure period (24–96) hours, the experimental individuals were divided into males and females, adults and juveniles. The time it takes for the animal to travel a certain distance in two directions (move/minute) is measured by a stopwatch, and a movement is calculated for every minute of the watch timer. In addition, the average walking movement of the crap for each concentration is calculated, as is Bakhshalizadeh et al. [21] walking activity speed.

3. RESULTS AND DISCUSSION

Many animals' organs have undergone changes due to these pollutants, and these have also contributed to affecting the activities of organisms, including crustaceans such as crabs, shrimp, and others, which constitute a food source for many peoples of the world, as many authors have said [22, 23].

The effect of heavy metals on many aquatic organisms has been studied for the concentrations of different pollutants. It was observed through the results of the present study that the effect of heavy metals (Zinc, Cad, and Cu) on the walking movement of river crabs, where relative speed was measured as an indicator of the crabs' walking movement, varies according to the concentrations for both sexes and life stages of the animal.

Figure 1 shows the different values of the relative speed of walking movement that were recorded for river crabs in the 24-96 hours of exposure and shows the percentage of the walking speed. The differences at 3 ppm were (75, 65, 50, and 44%) move/min, respectively, and the decreases at 5 ppm were (60, 44, 37, and 27%) move/min, while at 9 ppm the animals stooped over compared to the control (100%) move/min walking movement.

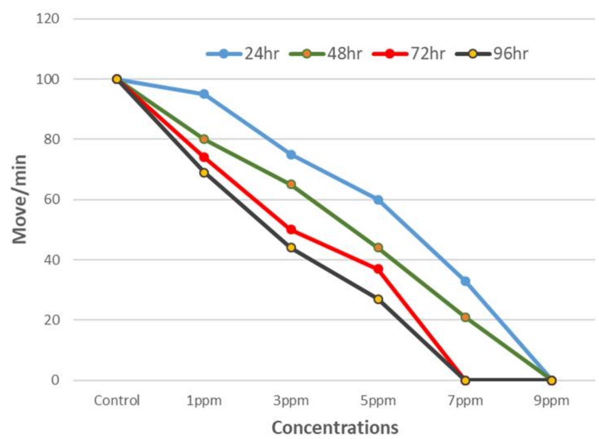

Figure 1. Movement walking of the juvenile male moe/min for the river crab Sesarma boulengeri after exposure to different concentrations for Zinc ppm

According to Figure 2, the percentage of relative speed for walking movement was higher in juvenile males. At 1 ppm and 24 h 96 min of exposure, the juvenile males recorded the lowest value in the relative speed of the animal walking: 55, 46, 39, and 31% move/min, a significant decrease from the males at 3 ppm, who recorded (39, 32, 17, and 0%) move/min, and the lowest speed at 7 ppm was (27, 25, and 0%) move/min.

As for the rest of the periods, movement was completely absent and recorded at 0 moves per minute. Different values of walking movement were also recorded in the concentrations (1, 3 ppm), which decreased with increasing lethal concentrations and exposure time compared with control (100% movement per minute).

The results are illustrated in Figures 3 and 4, where the percentage of relative speed of river crabs recorded differences between adults and juveniles, where males showed decrease activity at 3 ppm were (64, 41, 77, 0 and 0%), move/min, especially in the time periods 24-96 hours of exposure to acute concentrations of heavy metals cadmium, was compared with control (100%).

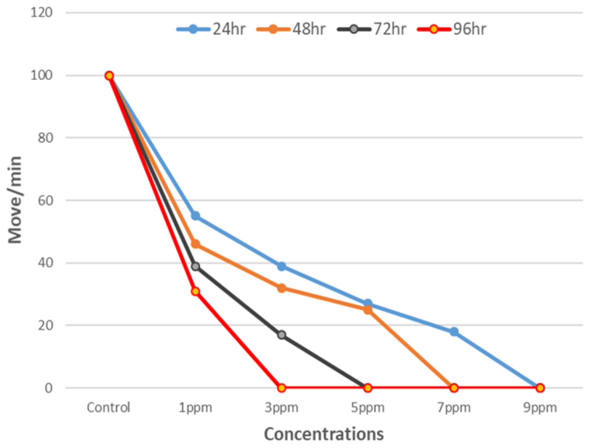

Figure 2. Movement walking of the juvenile male moe/min for the river crab Sesarma boulengeri after exposure to different concentrations for Zinc ppm

In addition, the (5 ppm) concentration was recorded for adult males with a speed walking rate of (40, 18 and 0%) move/min, while the same concentration was calculated in juvenile males at (47.44, 35.0, and 0%) compared to control (100%); also recorded decrease values in 7 ppm were (40, 0 and 0%) move/min.

According to the findings, the decrease in walking movement due to muscle weakness, indicates that Zinc causes damage and has a significant impact on muscle movement as well as the health of the crab population on river banks [24].

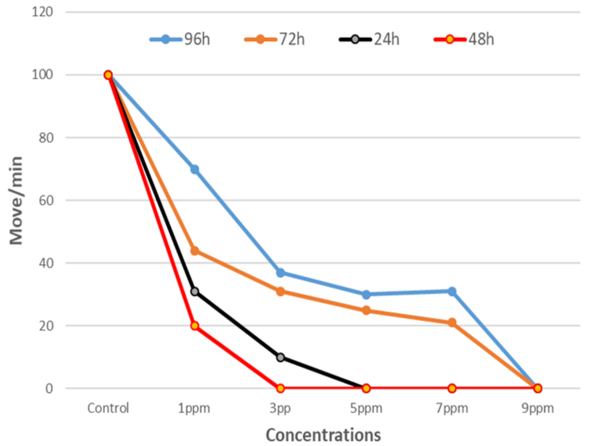

Figure 3. Movement walking of the adult male for the river crab Sesarma boulengeri after exposure to different concentrations for Cad ppm

The reason for this is that animals cannot move their muscles and do not have the ability to do so due to the weakness of the nerve signals received from the brain. The fact that the connection between the muscles and the brain is weak is reflected in this effect due to the toxic effects of chemical pollutants from heavy metals and the inhibition of ATP, which works to supply the muscle cells with energy, and fat that runs out as a result of the intense movement of the animal.

The current study found that the effect of heavy metals on the relative speed of the crabs' walking movement was observed for both sexes, adults and juveniles, and that the effect was seen in all concentrations, particularly high concentrations, which is consistent with what Nwamba et al. [25] discovered, where he emphasised the animal's mechanical movement's weakness by increasing the animal's exposure to pollutants and increase the of Toxin permeability of metals to cell membrane.

Fazio et al. [26] discovered the toxicity of the metals copper, cadmium, Zinc, lead, and iron in Sesarma boulengeri crabs. Jakimska et al. [27] demonstrated cadmium toxicity. Elsagh [28] demonstrated in their research Cadmium-induced inhibition of Na+-K+-ATPase activity in tissues of the crab Scylla serrata.

Figures 5 and 6 show the relative speed of adult and juvenile male river crabs during the experiment, as the adults were more active because movement was absent at high concentrations (7 and 9 ppm) during the exposure periods (48-96 hours) compared to the control (100 ppm).

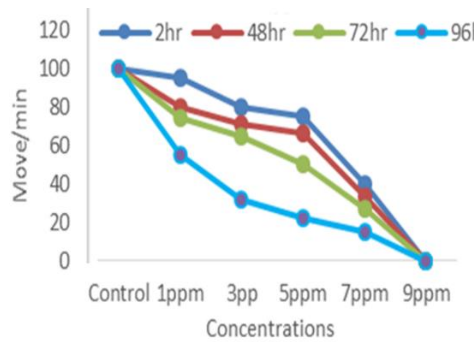

Figure 4. Movement walking of the adult male for the river crab Sesarma boulengeri after exposure to different concentrations for Cad ppm

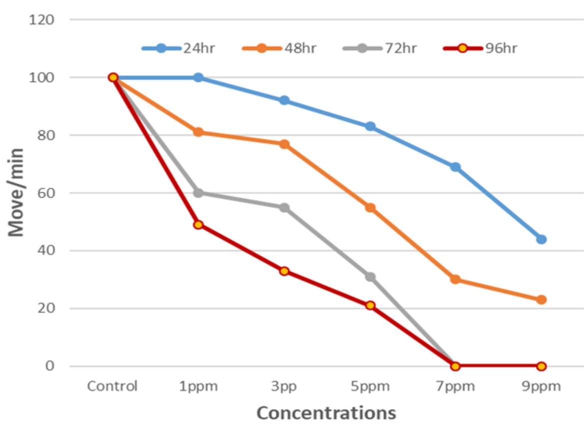

Figure 5. Movement walking of the adult male for the river crab Sesarma boulengeri after exposure to different concentrations for Cu ppm

Moreover, for males recorded in the period 24-96 hours, the percentages with speed (83,55,31 and 21%) move/min were 5 ppm, while the 7 ppm was as follows (65,30.0,0%) move/min, and the 9 ppm was recorded (44,23,0,0%) move/min, as it was clear.

While Figure 6 depicted the relative movement of adult and juvenile male river crabs exposed to acute concentrations of copper (Cu) metal, the highest percentage recorded at 1 ppm amounted to 100% movement per minute, as well as being recorded at 3 ppm (80.41, 40.0% movement per minute), and the movement was absent at 7 and 9 ppm in 48-96 hours, where the males appeared exhaled compared with control (100%) moves/min.

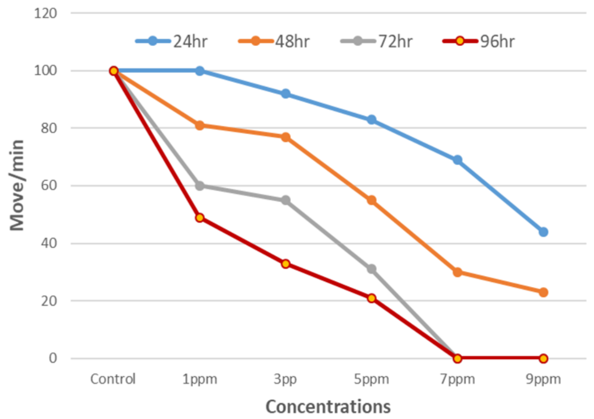

Figure 6. Movement walking of the adult male for the river crab Sesarma boulengeri after exposure to different concentrations for Cu ppm

It was observed through the results of the study (see Table 1) that Zinc metal had an effect on adult female river crabs exposed to concentrations of 1, 3, 5, 7, and 9 ppm. Furthermore, males were recorded over a 24-96-hour period, and the percentages with speed (73, 40, 35, and 33%) move/min were 5 ppm, while the 7 ppm were as follows: 47, 30, 23, and 17 move/min, and the 9 ppm were as follows: 30, 17, 10, and 0% move/min.

Figure 6 showed that adult and young male river crabs that were exposed to high levels of copper (Cu) metal were less active than those that were exposed to low levels of copper (Cu). Compared to other concentrations, the highest percentage (1 ppm) was 100% move/min, and what was recorded at 3 ppm was (84.67, 63, and 45%) move/min. At 9 ppm for 96 hours, there was no movement, and the males seemed tired and unable to move compared to the control (100% move/min).

The effect on the relative speed of river crabs' walking movement, where the lowest percentage of crabs is 10%, this difference in the way people walk is caused by the toxic effects of heavy metals from animal activity, which weaken muscles [29].

The figures also showed that there is variance in the resistance of adults and juveniles, as it was noted in all exposure concentrations that adults are more active than juveniles, and that the relative speed of movement in the experimental samples varies.

As high concentrations of all minerals indicate a lack of walking movement in adults and juveniles, as low values of walking. Because of the anaesthesia caused by toxic substance exposure, the nerve cells are unable to give regular instructions to the muscle until it is completed [30]. The results of the current study are in agreement with the observations made by Saravanan et al. [31].

The current findings also show that females are more resistant and active than males when compared to the control group of 100. Table 2 also shows the relative movement values of juvenile river crabs.

Walking movement values also differ, as females recorded the highest movement values, which were 97, 95, 89, and 77% of a move/min during 24 and 96 hours, respectively. The lowest percentage was (51% move/min) (1 ppm) for female crabs. Also, the weak movement happened at 9 ppm after 48, 72, and 96 hours of exposure. In the control group, there was 100% movement per minute.

As you may have noticed, the correlation coefficient values were different, but the crab moved more slowly when the concentrations were higher. The results indicate that juvenile females are more active than adult females. Female adults recorded zero for 48-96 hours at concentrations of 7 and 9 ppm, whereas juveniles recorded (47, 30, 22, and 17%) with 9 ppm and 24-96 hr (10, 0, 0, and 0%).

The percentage readings are clear in the table, compared to the control (100%) move/min. Also, the negative correlation factor values recorded are found on Table 2. They were observed through the results of the study on the effect of Zinc metal on adult female river crabs exposed to concentrations of 1, 3, 5, 7, and 9 ppm, respectively. When the number of crabs was at its lowest, 7 ppm, over a 72-hour period, the effect on the speed at which river crabs moved was the strongest. In her study on how animals move when exposed to crude oil, Giltz and Taylor [32] found that walking was different for adults and young Sesarma boulengeri. Another study confirmed the value of the crabs' walking speed as well as the differences in biochemical values between males and females exposed to heavy metals [33, 34].

Table 1. Relative speed walking for females in the different concentrations of (Zinc ppm)

Genus		Period of time	Control	1ppm	3ppm	5ppm	7ppm	9ppm	R
Female	Adult	24	100	100	84	73	47	30	-0.89
		48	100	100	67	40	30	17	-0.98
		72	100	89	63	35	23	10	-0.96
		96	100	81	45	33	17	0	-0.95
Female	Juveniles	24	100	90	63	45	37	15	-0.91
		48	100	84	49	29	13	0	-0.07
		72	100	73	44	0	0	0	-0.93
		96	100	51	22	0	0	0	-0.95

Table 2. Relative speed walking for females in the different concentrations of (Cd ppm)

Genus		Period of time	Control	1ppm	3ppm	5ppm	7ppm	9ppm	R
Female	Adult	24	100	97	77	43	47	10	-0.89
		48	100	95	63	39	30	0	-0.98
		72	100	89	54	33	22	0	-0.96
		96	100	77	67	33	17	0	-0.95
Female	Juveniles	24	100	90	63	45	0	0	-0.91
		48	100	84	49	0	0	0	-0.07
		72	100	73	44	0	0	0	-0.93
		96	100	51	22	0	0	0	-0.95

Table 3. Relative speed walking for females in the different concentrations of (Cu ppm)

Genus	Period of time		Control	1ppm	3ppm	5ppm	7ppm	9ppm	R
Female	Adult	24	100	100	100	96	76	64	-0.97
		48	100	100	90	76	51	40	-0.96
		72	100	100	82	47	34	19	-0.98
		96	100	100	77	37	25	10	-0.977
Female	Juveniles	24	100	100	97	88	72	0	-0.98
		48	100	100	88	61	42	0	-0.92
		72	100	100	86	35	0	0	-0.94
		96	100	92	74	25	0	0	-0.90

In comparison to the control, it was (54% movement per minute) during the 726-hour exposure period. It also confirms that the higher the concentrations and the lower the percentage of animals walking, the longer the time exposure. The relative speed ratios in Table 3 showed differences between adult and juvenile females exposed to copper metal concentrations.

Table 3 shows that females recorded remarkable activity in walking movement compared to the same time period (72, 96) hours, where female adults recorded weak movement and the absent value was zero, whereas in juvenile females, which were compared with the control (100%) move/min, the animal walking percentage also varied in other concentrations depending on the period of exposure, but the activity of walking movement was faster in juveniles than adults.

The majority of heavy metals are among the most significant pollutants from factories that discharge them into bodies of water, including rivers, seas, and other surfaces. These toxins are exposed to water organisms in varying amounts, and many of them build up in bodily tissues, which confirms the occurrence of diseases and high mortality rates in aquatic organisms. As a result, they were utilised in the present study, including Zinc, Cad, and Cu. Based on the above tables, the results show that whereas adult males are more resistant and active than adult females and adult juveniles, female juveniles are more resistant and active than male juveniles. Despite the animal's economic value, there aren't many researches in this field, especially on walking, which can help avoid polluted places.

4. CONCLUSION

Most heavy metals are among the most important wastes from factories that throw them into water environments, whether they are rivers, seas, or other surfaces. Water organisms are exposed to these toxins in different amounts, and many of them build up in the body's tissues. This confirms and explains why diseases and high death rates are so common in aquatic organisms. So, they were used in the current study, such as Zinc, Cad, and Cu. According to the findings, adult males are more active than adult juveniles and females, but adult females are more resistant and active than males, and female juveniles are more active than male juveniles. Furthermore, despite the economic importance of this animal, there have been few studies in this line, particularly in the movement of walking, which can avoid polluted areas.

Besides, the current study shows that heavy metals have a clear impact on the vital activity of walking, which reflects the extent of the toxic effect on aquatic organisms. Moreover, the presence of pollutants in the water environment has negative effects and damages the health of the environment, which in turn reflects on the health of humans and the living organisms that reside in this environment, where the current study was conducted to test the activities of the organisms, which is explained by the effect of heavy metals on movement as an indicator of the toxicity of the environment pollution.

This is why the freshwater environment must be preserved. Not throwing the wastes of these factories, especially the chemical ones, because of the severe damage to biodiversity in the environment and the establishment of factories far from the banks of rivers, and burying their waste in healthy, sanitary landfills far from rivers or any body of water are the necessary restrictions according to environmental legislation.

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