AES BIOFLUX

Advances in Environmental Sciences - International Journal of the Bioflux Society

Nickel accumulation levels in habitat and tissues of *Turbo coronatus* (Gastropoda, Turbinidae) near Kish Island, Persian Gulf

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Abstract. In order to examine nickel accumulation levels in tissues of *Turbo coronatus* and its habitat in Persian Gulf waters (Kish Island), sampling was done in study stations during the summer 2011 and winter 2012. After sampling the tissues of *T. coronatus* were separated and chemical digestion was done on hard tissue, soft tissue, algae and sediment of its habitat. Nickel accumulation levels in tissues were measured by using graphite furnace atomic absorption instrument and also ICP-AES machine was used to measure the levels of nickel in sediment samples. Based on the obtained results, the highest levels of nickel in hard tissue, soft tissue, algae and sediment in summer were 1.330±0.033 ppb, 6.112±0.100 ppb, 9.200±0.461 ppb, 5.533±0.461 ppb, and in winter were 3.960±0.409 ppb, 4.867±0.176 ppb, 2.467±0.272 ppb, 2.933±0.384 ppb, respectively. The statistical analysis showed that there were no significant differences in nickel levels in hard tissue, soft tissue and sediment between two seasons ($p > 0.05$), but significant difference observed in levels of nickel in algae between two seasons ($p < 0.05$). The obtained concentrations and analysis done indicate that based on the international standards, the amount of nickel was lower than the standard levels.

Key Words: algae, Kish Island, nickel, *Turbo coronatus*, hard tissue, soft tissue.

Introduction. An increase in the amount of released pollution in marine environments during the recent decade has been investigated in many studies. One of the main issues attracting the attention of most researchers is the heavy metal pollution and their effect on the environment (Henry et al 2004; Yilmaz et al 2007). Heavy metals entered marine environments through various anthropogenic resources such as petrochemical wastewaters, agricultural and mineral run-offs, oil transportation and urban wastewaters (Karadede et al 2004). According to the fact that all essential and nonessential metals can be toxic, this amount of bioaccumulation is usually determined by measuring metals accumulated by living organisms which are the main aim in biological control (Zhou et al 2008; Rainbow 2007). Marine organisms including fish, clams (mollusk) barnacles and the other aquatic animals accumulate the present pollutants in the environment in their different tissues according to the concentration of the present metals in water, period of exposure to the polluted environment and the other environmental factors of the water such as salinity, pH, hardness and temperature (Kalay et al 1999; Canli & Atli 2003; Saei-Dehkordi et al 2010; Saei-Dehkordi & Fallah 2011; Mortazavi & Sharifian 2012; Tripathy & Mukhopadhyay 2015). Biological and ecological factors such as size, sex (Al-Yousuf et al 2000), ecological needs, habitat, feeding habits (Bustamante et al 2003) and season (Navarro et al 2006) have different and significant effects on bioaccumulation and bioavailability of the metals.

The Persian Gulf is a shallow basin with an average depth of 35-40 meters and an area about 240 km^2. This region is connected to trans-boundary waters via the Hormuz Strait (Anon 1995; Banat et al 1998; Saeidi et al 2008). Replacement time of the water in this basin is between 3 to 5 years showing pollutants remain in the Persian Gulf for a significant time. The north parts of the Persian Gulf are under the influence of the pollutants more due to shallow depth, limited rotation, salinity and high temperature (Saeed et al 1995; Sheppard et al 2010).

Turbo coronatus is a vegetarian gastropod species and feed on macro-algae of the region (Mahmood Freije & Nedham Awadh 2010; Afsar et al 2013). Because of lack of mobility, lack of the ability of metabolizing oil hydrocarbons and heavy metals and accumulation of these pollutants in its soft tissue, *T. coronatus* is considered as a biological index. No studies concerning the pollution of heavy metals have been carried out on this species and its environment in rocky areas of Kish Island. Thus, this study is aimed at investigating and comparing bioaccumulation of nickel in soft and hard tissues of *T. coronatus* and its environment.

Material and Method

Study aerya. Kish Island is situated in the 26º29´-26º35´N and 53º53´-54º04´E point in the South of Iran among the Persian Gulf waters (Figure 1).

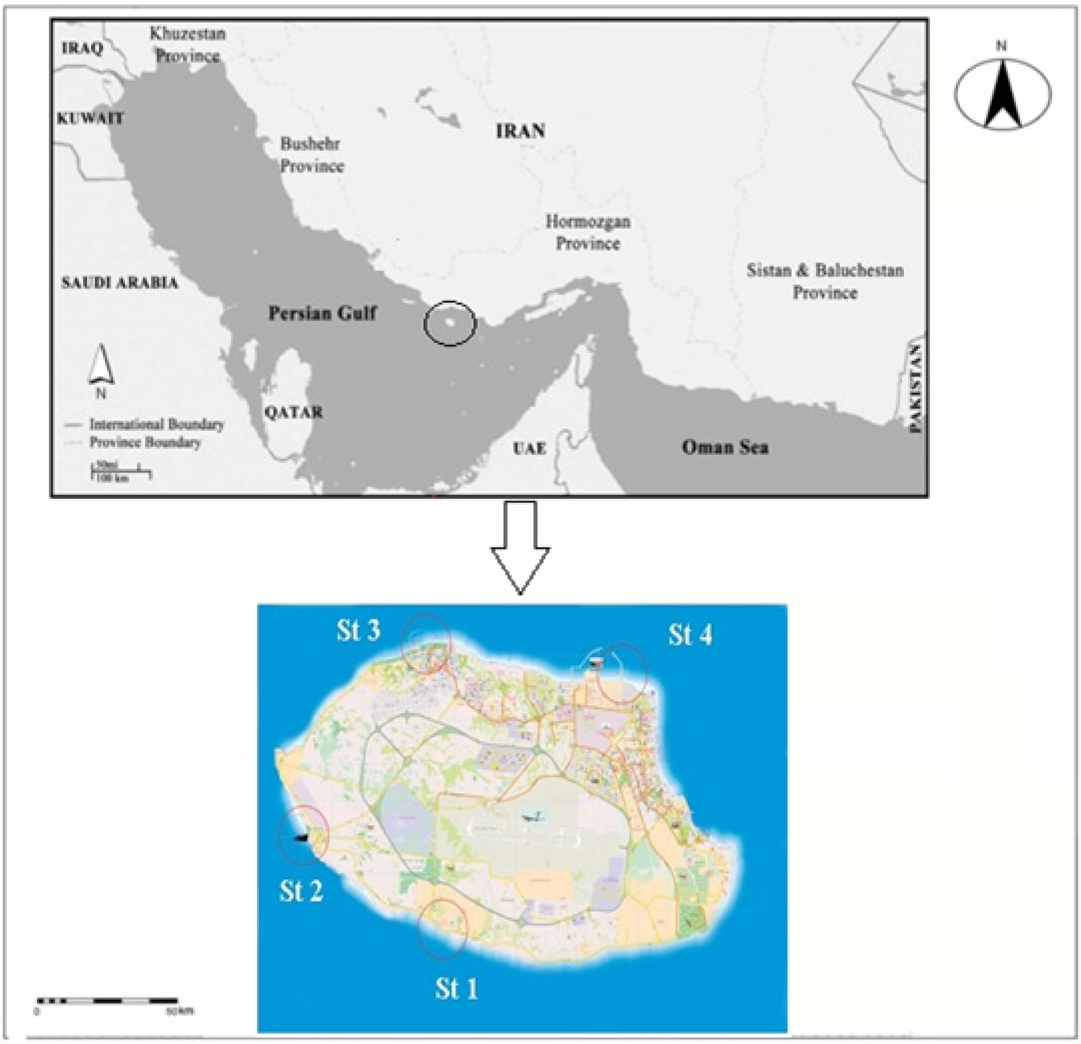

Figure 1. Location of the sample areas (original drawing).

Sampling. Samples related to the study including snails of *T. coronatus* species, algae and sediments were prepared to do this research in Kish Island region during summer 2011 and winter 2012. Sampling was done using quadrate (25×25 cm) based on the present methods at different sources (Eleftheriou & McIntyre 2005; Kohan et al 2012). The sampler collects a piece of sediment with an area of 626 cm^2, a thickness of 5-15 cm weighing about 600-2000 g. Also we collected the algae in habitat of the snails for this study through the sediments. Then samples were placed in plastic bags and were placed in an icebox full of ice, then transported to the laboratory. Samples were kept in a temperature of -30 °C in the laboratory by the time they were analyzed. Geographical specifications of the sampling regions are demonstrated in Table 1.

Table 1

Geographical specifications of the sampling regions

Station	*Conditions*	*Geographical location*	*Coast type*
1	Hospital wastewater entrance	53°58´E, 26°34´N	rocky
2	High urban density and urban wastewater discharge	53°55´E, 26°34´N	rocky
3	Traffic location of oil ships and tourism use	53°54´E, 26°31´N	rocky
4	High human density	53°55´E, 26°20´N	rocky

Sample preparation. At first all laboratory containers which were going to be used were placed in nitric acid for 24 hours and then were washed with distilled water and finally they were placed in an oven in a temperature of 80°C to be prevented from any pollution. Tissue samples were transported to a very clean container (washed using nitric acid) and were placed in an oven in a temperature of 80°C for 18 hours to be completely dried. Acid digestion was done in order to release all metal joints. In this respect 1 g of the dried and uniform sample was transported to a beaker and 10 mL concentrated nitric acid was added in order to digest the contents of the container and the samples were placed in the room temperature for 30 minutes for primary digestion. Then samples were heated in a temperature of 90°C in a heater situated under the hood having heat steam system to be dried. When the samples got cold and reached the room temperature, they were transported to a 25 mL container and were reached the necessary volume, then they were passed through 45 mm Whatman filter paper. Finally samples were transported to lidded polyethylene container in order to inject into the machine. Also 8 mL of 65% nitric acid, 5 mm of 37% hydrochloric acid and 1.5 mL of 40% hydrofluoric acid were used in order to digest sediment samples. Graphite furnace atomic absorption machine was used in order to measure the amount of nickel metal in tissue samples and also ICP-AES machine was used to measure the amount of nickel metal in sediment samples (MOOPAM 1999).

Statistical analysis. One sample Kolmogorov-Smirnov test was used in order to know the accuracy of normality of the data. In order to see relation between heavy metals and station, One Way Sample T-test in SPSS®18 was used. Data were represented as Mean ± SD (ppb) with a 95% confidence interval.

Results

Hard tissue. According to the obtained results in this research, the highest and the lowest rate of nickel in hard tissues of *T. coronatus* in winter season were in stations number 2 and 4 equaled 3.960±0.409 (ppb) and 0.600±0.150 (ppb) respectively (Table 2). Also, the highest and the lowest rate of nickel in hard tissues in summer season were in stations number 4 and 1 equaled 1.330±0.033 (ppb) and 0.200±0.057 (ppb) respectively (Table 3). Generally speaking, no significant differences were observed between the rate of nickel in hard tissues of *T. coronatus* during winter and summer seasons ($p > 0.05$).

Soft tissue. Based on the obtained results in this study, the highest and the lowest nickel rate in soft tissues of *T. coronatus* during winter season were in stations number 2 and 4 equaled 4.867±0.176 (ppb) and 1.967±0.348 (ppb) respectively (Table 2). Moreover, the highest and the lowest rate of nickel in soft tissues during summer season were in stations number 3 and 2 equaled 6.112±0.100 (ppb) and 3.767±0.057 (ppb) respectively (Table 3). No significant differences were generally observed between the rate of nickel in soft tissues of *T. coronatus* during winter and summer seasons ($p > 0.05$).

Algae. According to the obtained results in this study, the highest and the lowest nickel rate in algae present in the environment of *T. coronatus* during winter season were in stations number 1 and 3 equaled 2.467±0.272 (ppb) and 1.133±0.318 (ppb) respectively (Table 2). Furthermore, the highest and the lowest rate of nickel in algae during summer season were in stations number 4 and 3 equaled 9.200±0.461 (ppb) and 7.567±0.560 (ppb) respectively (Table 3). Significant differences were generally observed between the rate of nickel in algae present in the environment of *T. coronatus* during winter and summer seasons ($p < 0.05$).

Sediment. Based on the obtained results in this research, the highest and the lowest rate of nickel in sediments present in the environment of *T. coronatus* during winter season were in stations number 3 and 2 equaled 2.933±0.384 (ppb) and 2.233±0.145 (ppb) respectively (Table 2). In addition, the highest and the lowest rate of nickel in sediments during summer season were in stations number 1 and 2 equaled 5.533±0.461 (ppb) and 1.467±0.318 (ppb) respectively (Table 3). No significant differences were generally observed between the rate of nickel in sediments present in the environment of *T. coronatus* during winter and summer seasons ($p > 0.05$).

Table 2

Mean concentration of nickel (ppb) in hard tissue, soft tissue, algae and sediments present in the environment of *T. coronatus* in the study stations during winter season

	Station	*Nickel concentration (ppb)*	*±SD*
Hard tissue	1	0.633	0.088
	2	3.967	0.409
	3	2.433	0.536
	4	0.600	0.152
Soft tissue	1	3.167	0.176
	2	4.867	0.176
	3	3.933	0.218
	4	1.967	0.384
Algae	1	2.467	0.272
	2	2.200	0.208
	3	1.133	0.318
	4	2.100	0.321
Sediment	1	2.800	0.200
	2	2.233	0.145
	3	2.933	0.384
	4	2.633	0.328

Table 3

Mean concentration of nickel (ppb) in hard tissue, soft tissue, algae and sediments present in the environment of *T. coronatus* in the study stations during summer season

	Station	*Nickel concentration (ppb)*	*±SD*
Hard tissue	1	0.200	0.057
	2	1.133	0.202
	3	0.567	0.240
	4	1.033	0.033
Soft tissue	1	5.200	1.242
	2	3.767	1.431
	3	6.112	0.100
	4	6.000	0.529
Algae	1	8.667	0.425
	2	8.000	0.472
	3	7.567	0.560
	4	9.200	0.461
Sediment	1	5.533	0.166
	2	1.467	0.318
	3	1.833	0.218
	4	2.067	0.318

Discussion. Aquatic animals are one of the important food resources for human beings and are considered as one of the indicators determining pollution in their habitat. That is why they should be paid special attention in order to control ecosystem pollution and also to control the food quality. Heavy metal concentration in these aquatic animals depends on different factors such as food habits and behaviors trophic status, metal resources, distance from the pollution resource, bio-magnification and bio-diminishing of the metals, food availability, temperature, physical and chemical properties, water and seasonal changes (Belinsky et al 1996; Olsson 1998; Shah & Altındağ 2005; Fatih Fidan et al 2008).

Nickel is widely dispersed in the environment and its concentration is dependent on fossil fuels and its extraction from oil fields and refineries. In other words it can be stated that high concentration of nickel in sediments mainly results from human resources such as the traffic of ships, boats, oil tankers, crude oil, industrial and urban wastewaters (De Astudillo et al 2005; Pourang et al 2005; Beg et al 2001).

Nickel toxicity is divided into four groups: (1) allergy (2) cancer, (3) respiratory disorders (which all these three cases are often result from industrial activities), and (4) iatrogenic poisoning (Amundsen et al 2007).

According to the carried out analyses, mean concentration of nickel in all study stations was lower than the international permissible levels (FAO 1976). But lower rate of this metal in water of this region doesn't mean that wastewater entrance and the environment pollution are not problematic, since the other heavy metals are not investigated. On the other hand the rate of these metals in soft tissue, hard tissue, sediments and algae shows different accumulation and bad effects on the environment of the organisms as well as human beings in the long term by increasing these pollution accumulations in algae and sediment and the other living organisms.

Algae can show polluted and unsuitable conditions during the time due to their constant nature. By investigating and comparing metals present in algae which are near the pollution center or algae growing farther, heavy metals existing in that pollutant resource can be shown (Beg et al 2001).

Various species of algae show different reactions to various heavy metals. Even the same species in different locations which are different from the view point of different environment parameters also show different reactions to heavy metal accumulation (Harte et al 1991). Thus, it is impossible to compare the accumulation of heavy metal concentration in algae reported from the other marine environments with the results of the others including the study of Moghdani et al (2014). But due to the lack of information and research background in this respect and restriction of the data, we can't represent a suitable comparison concerning the past and present of Kish Island, but the amount of metal absorption concentration in a particular sex or species which is common in different countries can be compared and they can be investigated concerning the rate of pollution by special metals. In recent research and in many carried out researches the rate of metals fluctuates irregularly in water and algae monthly and no clear pattern is found for it, and it is maybe due to fluctuation of wastewater entrances or water rotations because of different reasons such as wind flow or it is maybe because of recent algae growth in each month. According to shipping lines, the other factor causing an increase in pollution in this region is discharge of unimproved wastewaters of the ships which may consist of water polluted by oil engine room and oil leaked from the other parts of the oil tankers which yearly about 1 to 10 million tons of oil materials enter the sea through wastewaters and natural or intentional leakage (Sheykhvand 2013).

Conclusions. As previously mentioned, lower rate of this metal in water of this region doesn't mean that wastewater entrance and the environment pollution are not problematic and based on the obtained concentrations and the performed comparisons it was specified that all stations have some heavy metal pollution. Therefore, based on this research finding, and because nickel is one of the metal that is used in oil instalation, we can conclude that the Persian Gulf environment has oil contamination. So its effects on fishes and other aquatic species and if they are used by human beings, it will certainly cause some harm for them.

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Received: 11 January 2015. Accepted: 19 February 2015. Published online: 21 February 2015.
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How to cite this article:
Sheykhvand N., Entezami M. S., Moghdani S., 2015 Nickel accumulation levels in habitat and tissues of *Turbo coronatus* (Gastropoda, Turbinidae) near Kish Island, Persian Gulf. AES Bioflux 7(1):82-89.