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Heavy Metal concentrations in the Sea Snail *Rapana venosa* (Valenciennes, 1846) from Sinop Coasts of the Black Sea

Karadeniz'in Sinop kıyılarından toplanan deniz salyangozu *Rapana venosa* (Valenciennes, 1846)' da ağır metal konsantrasyonları

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Abstract
The concentrations of copper, zinc, iron, lead, nickel, manganese and cadmium in the living tissue of the sea snail *Rapana venosa* (Valenciennes, 1846) from the Sinop coasts of the Black Sea have been measured by atomic absorption spectrophotometer for monitoring metal pollution in the coastal water. A statistically significant difference in the concentrations of all metals was observed among three sampling stations. The results were compared to those of several bivalves and gastropods documented previous studies and discussed.

Key words : *Rapana venosa,* heavy metal

Introduction

Bivalves and gastropods in mollusc concentrate heavy metals so actively under natural environments through water and/or food that they are available for biomonitor organisms concerning to aquatic metal pollution (Phillips, 1976a,b and 1977a,b; Rainbow, 1993 and 1995). The usefulness of gastropods as biomonitoring organisms concerning heavy metal pollution is substantiated on a few species, such genera as *Patella* (Bat et al., 1998). This species inhabiting predominantly on intertidal zones around the world are very important for monitoring environmental pollution by heavy metals, but not important for sea food resources.

There have been some uncertainty regarding the importance of difference on feeding habits as source of heavy metals for aquatic organisms. It is, however, generally assumed that food is more effective than direct uptake of soluble metal from water in gastropods as well as bivalves. The feeding habit is very important for one of ecological factors and can have a decisive influence on metal contents. The effect of habit on metal contents in whole soft body and its various organs is yet unknown.

Gastropods have been proven especially useful and are commonly employed in the monitoring of metal pollution (Peden *et al.*, 1973; Tunçer and Uysal, 1982 and 1988; Uysal *et al.*, 1986; Uysal, 1992; Pastor *et al.*, 1994;Topçuoğlu *et al.*, 1994) and radioactivity (Bulut et al., 1990) because they are important in food chains and they have a broad geographical range (Fish and Fish, 1996; Sabelli, 1982; Champbell and Nicholls, 1994). In the present study, therefore, the Sea Snail *Rapana venosa* was chosen as a biomonitor of nearshore metal pollution.

Rapana venosa (Valenciennes, 1846) (formerly *Rapana thomasiana thomasiana*) (Mollusca, Gastropoda, Prosobranchia, Muricidae) is of Japan Sea origin (Akıncı *et al.*, 1998a). It is known that the sea snail *Rapana venosa* was introduced into the Black Sea by a ship carrying its eggs attached to its hull in 1946. *Rapana venosa* adapted well to its environment, reproduced and became widespread. In 1950 it depleted the Gudauta oyster bank in the Caucaus and began to feed on the mussels living near the Southern shores of the Crimea and near the Bulgarian coast (from Zaitsev and Mâmaev, 1997). The detail distribution of *Rapana venosa* in the Black Sea coasts of Turkey was studied by Bilecik (1975 and 1990). In 1980s, there was a demand for *Rapana venosa* meat on the international market. Initally, massive commercial catches of the sea snail *Rapana venosa* were undertaken only near the Turkish shores (Zaitsev and Mamaev, 1997). Between 1985 and 1988 2.779.000 kg of *Rapana venosa* meat exported from Turkey to Japan (Bilecik, 1990). Enzymes of hepatopancreas and thromp, insulin, fatty acids and sterols of *Rapana venosa* are well studied (Akıncı *et al.,* 1998a,b; Güven *et a*l., 1999). The

flesh of *Rapana venosa* is also considered as suitable for human consumption (Güven *et al.*, 1999).
Rapana venosa feeds on oysters, mussels and other bivalves. They have changed the biological balance of the infralittoral part which is the most productive part of the Black Sea littoral (Bilecik, 1990; Zaitsev and Mamaev, 1997).

In Sinop, *Rapana venosa* feeds mainly on the bivalve *Mytilus galloprovincialis*. *Rapana venosa* is still being collected by divers and exported to Japan. It is also consumed by local people.

Material and Methods

Sea snails were collected monthly by scuba divers from three stations (Fig.1) in the upper-infra littoral zone of Sinop coasts of the Black Sea, at a depth of 20 meters or less from March 1997 to November 1997.

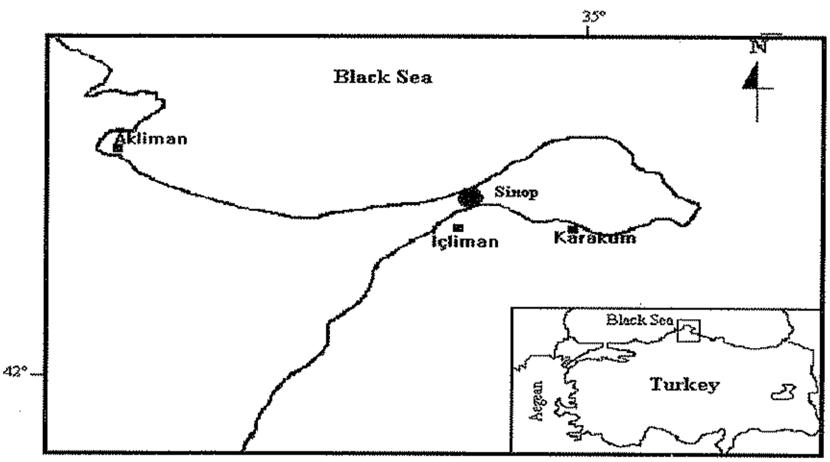


Figure 1. Sampling stations and study area.

At each station 25 snails of 8-12 cm were collected. After collection, the samples were transported to the laboratory. Animals were rinsed with clean seawater and then placed in about 20 litres of constantly aerated clean seawater for 24 hours to allow depuration (Elwood *et al.*, 1976; Flegal *et al.*, 1977; Chapman *et al.*, 1980; Bat *et al.*, 1999). Following elimination of the gut contents the shell valves of snails were shucked off from soft bodies and shell cavity fluids were drained out. Subsequently, whole edible bodies of 25 specimens blotted and homogenized

For the determination of copper, zinc, iron, lead, nickel, manganese and cadmium, 5g of wet samples was placed in flasks and 10 ml of concentrated HNO_3 : $HClO_4$ (5:1) was added to each flask and the solution was evaporated to dryness on a hot plate. After allowing the flasks to cool, 12 ml of N/10 HCl (per 1 g fresh wt) was added to bring the volume to 50 ml and filtered through Whatman filter paper with a pore size of 0.45μm (Bernhard, 1976; Uysal *et al.*, 1986; Tunçer and Uysal, 1988; Öztürk and Öztürk, 1994). The samples were analysed by Atomic Absorption Spectrophotometer (Perkin Elmer Model 2280) using the method described by Bernhard (1976). The data were analysed using single classification of ANOVA (Zar, 1984). The concentrations of the metals in the sea snails were compared among three stations by the use of F values, to determine if a significant difference exists between the stations. All samples were run in triplicate and all values were expressedas μg metal g^{-1} wet wt.

Results and Discussion

Figures 2A-2G show the concentration of heavy metals in the sea snail *Rapana venosa,* from the Sinop coast. The results showed that the calculated F values were greater than the critical F value at the 0.05 level indicating that there was a statistically significant difference between the concentrations of the metals among three stations (Figs. 2A-2G).

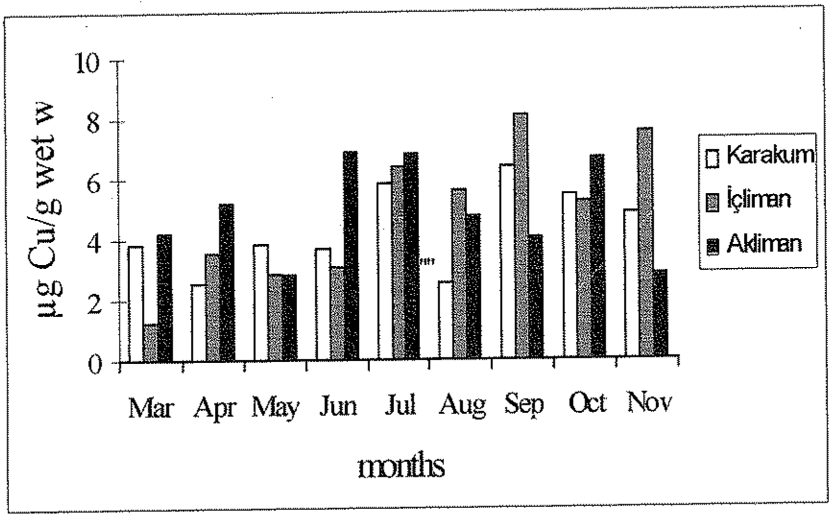
These variations between stations may be due to their different geographic locations. The highest concentration of Cu, Fe and Ni was observed in the samples from İçliman, whereas the highest concentration of Zn, Pb, Mn and Cd was observed in those from Karakum. However, the lowest values of Ni and Cd were measured in Akliman. In terms of geographical locations the highest values appeared to be associated with İçliman and Karakum areas and this may be due to the discharge of untreated domestic wastes, harbour activities, the dumping of ship wastes and other coastal activities.

The orders of the seven metal levels in averages in whole edible bodies of the sea snail *Rapana venosa*, as follows: Zn>Fe>Cu>Ni>Mn>Pb>Cd (Figs. 2A-2G). Öztürk and Öztürk (1994) found that, the levels of Pb and Cd in *Rapana venosa* from the same stations were higher than those in the present study whereas the levels of Zn, Ni and Cu were lower. Regional comparison for the results must be made with caution because of the variations in sampling procedure and methodology. For example, in

Öztürk and Öztürk (1994)'s study no time was allowed to animals to clear their guts.

In the present study, the concentrations of Cu, Zn, Fe, Pb, Ni, Mn and Cd in snails were consistently higher in September, July, August, August, March, May and May, respectively (Figs.2A-2G). Concentrations of heavy metals in soft bodies of marine mollusks are primarily influenced, in general, by the concentrations in sea water, and also by externel and internal factors, such as water temperature, salinity, size or weight, age, stage of reproductive cycle *etc*.

To examine any monthly variations in metal concentrations at each station, F values (at the 0.05 significance level) were used. It was found that all metal concentrations vary significantly from month to month at each station. Seasonal variations in metal concentrations arise from the reproductive cycle which involves the maturation of the gonads and gametes and changes in the availability of food (Bryan, 1976,1984; Phillips, 1977a,b; Mance, 1987; Phillips and Rainbow, 1994). These events involve substantial changes in body weight, water content and general condition of the animal. The loss of gametes leads to a loss in body weight. If the gametes are relatively poor in metals, spawning is associated with an increase in tissue metal concentrations. Moreover, the availability of food directly affects the growth rate of the mussel. Phillips (1976a) observed a weight-dependant variation in concentrations of metals in *Mytilus edulis*. In the environment, smaller and lighter individuals were found to contain significantly higher concentrations of Zn, Cd, Pb and Cu than larger and heavier individuals (Phillips, 1976a). The sea snail *Rapana venosa* grow in the warm season from spring to autumn and their growths are supressed in the winter season by low temperature. In Sinop, their spawning begins in the middle June at *ca.* 20°C and reach maximum in July and August at 24-


10
8
6
4
2
0
µg Cu/g wet w
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Apr
May
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Nov
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Karakum
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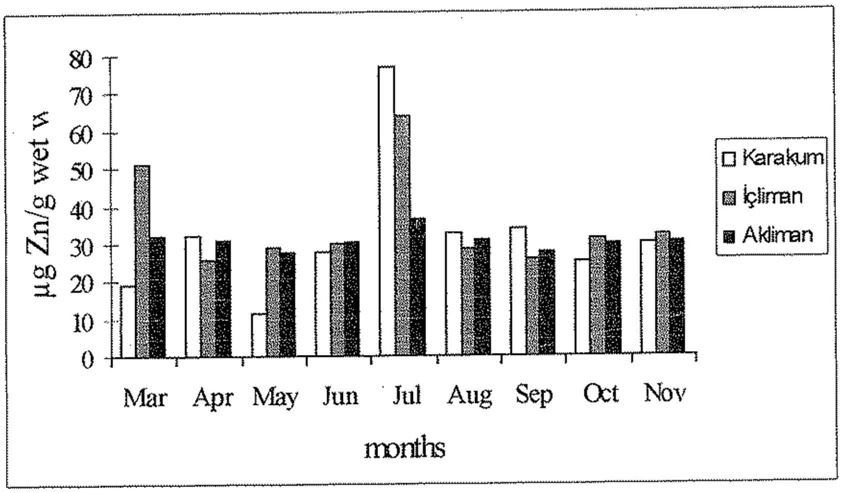
Akliman

2A


80
70
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10
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µg Zn/g wet w
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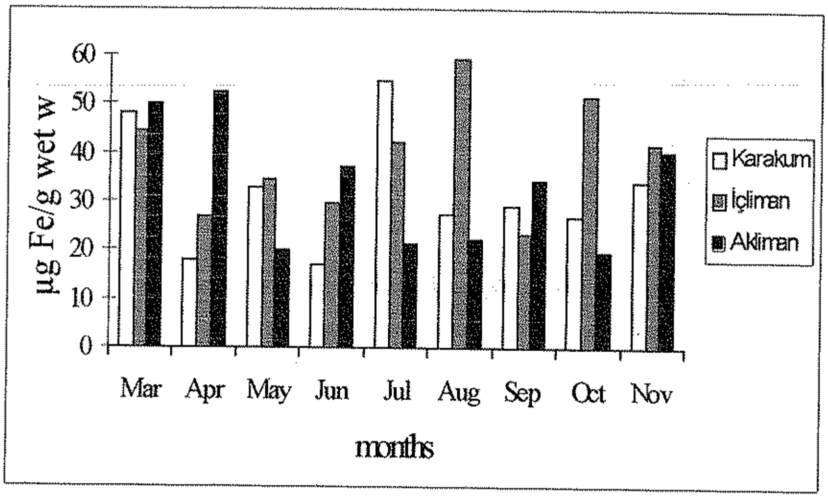
Akliman

2B


60
50
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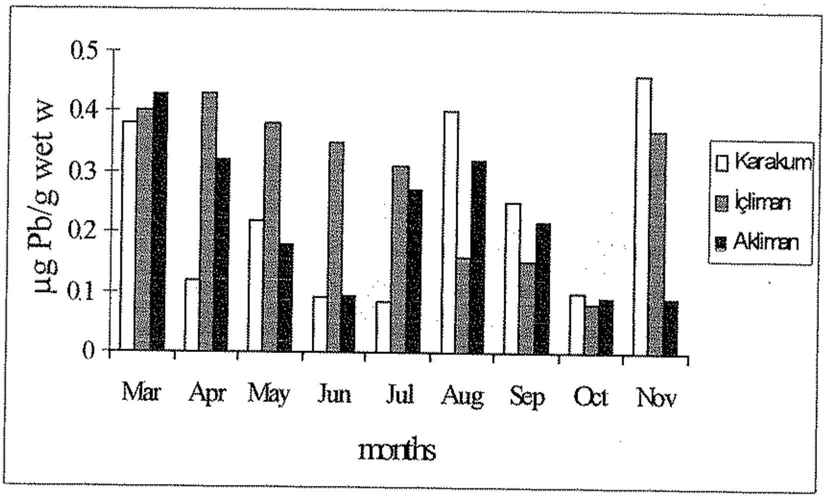
2C


0.5
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µg Pb/g wet w
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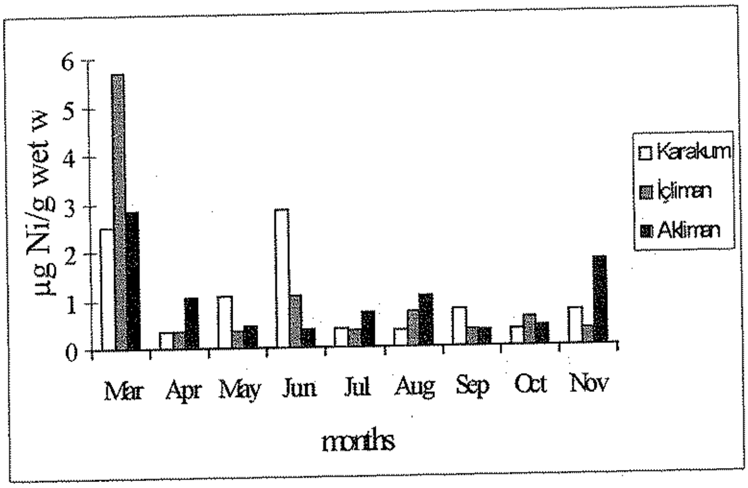
2D


6
5
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µg Ni/g wet w
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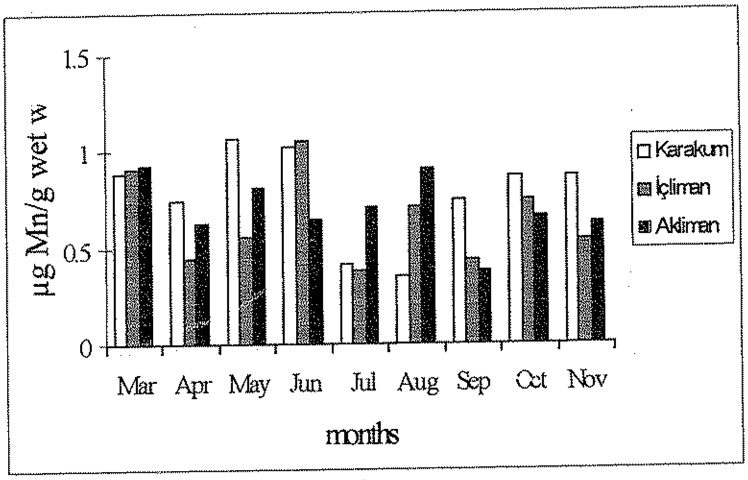
2E


1.5
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µg Mn/g wet w
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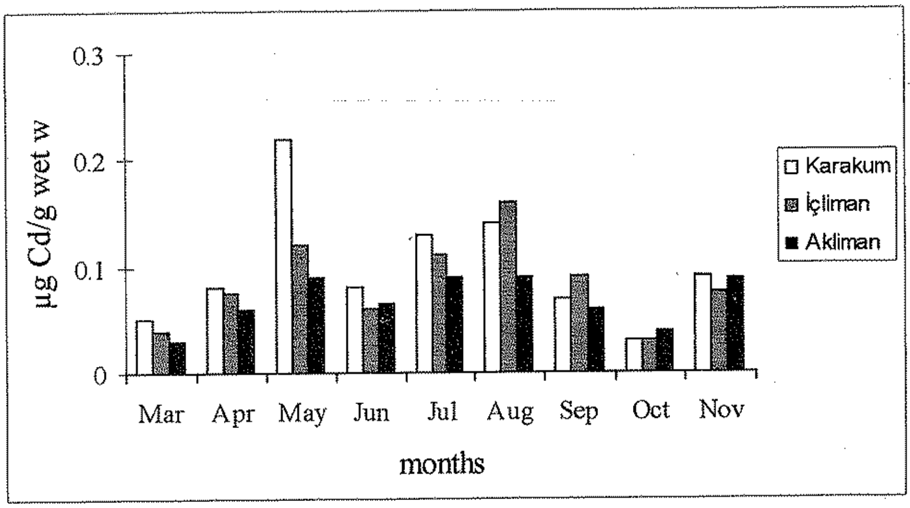
2F



2G

Figure 2. Mean concentrations (µg g^{-1} wet wt) of copper (A), zinc (B), iron (C), lead (D), nickel (E), manganese (F) and cadmium (G) in the sea snail *Rapana venosa* from the Sinop coasts of the Black Sea. (SE= Error bars).

27°C that are the maximum temperatures in the year and ceases in the middle October (unpublished data). In periods of food shortage, the growth rate slows down and as a consequence the concentrations of metal rise. It is possible that the increased concentration noted for metals such as zinc, copper, iron and manganese in spring and early summer reflects an increased requirement resulting from these changes in metabolic activity.

However it should be noted that since the monthly sample size was insufficient to reduce the effect of individual variation, the monthly variation could reflect the wide variability among individuals rather than a change in requirement. Continued monthly sampling and individual tissue analysis are required.

The data presented here were compared with the guidelines (The Food Safety Regulations, 1992; MAFF, 1995) for heavy metals in shellfish. From the public health point of view, the levels of the metals found in this study are generally lower than the permitted levels and those of the previous studies (see Table 1).

Table 1. Concentration ranges of heavy metals in mollusca from different studies (expressed in μg metal g^{-1} fresh wt, unless otherwise stated).

Species	Study area	Fe	Zn	Ni	Cu	Mn	Pb	Cd	References
Rapana venosa	Black Sea Coast, Sinop, Turkey	--	0.215-0.840	0.259-0.604	0.214-1.603	--	0.260-0.979	0.156-0.550	Öztürk and Öztürk, 1994
Rapana venosa *	Bosphorus, Turkey	339±23	83±5	0.99±0.30	82±14	8.3±3.1	3.5±1.3	4.9±01.3	Topçuoğlu *et al*, 1994
Rapana venosa *	Black Sea Coast, Fatsa, Turkey	199±37	49±6	2.17±0.60	57±8	1.9±0.8	3.2±1.2	1.0±0.5	Topçuoğlu *et al*, 1994
Mytilus galloprovincialis	Black Sea Coast, Sinop, Turkey	--	1.023-8.946	0.050-2.797	0.039-1.438	--	1.36-0.32	0.075-0.863	Öztürk, 1991
Mytilus galloprovincialis	Black Sea Coast, Sinop, Turkey	--	1.58-7.28	--	0.10-1.89	--	0.11-1.18	0.03-0.27	Bat *et al.*, 1999

--: not measured

* expressed in μg metal g^{-1} dry w

In the present study, the concentrations of metals found in *Rapana venosa*, would appear to be lower, in general, than those found in other molluscan from different study area. In Table 1, the present results are compared with some of the reported studies from different sea and Black Sea, respectively. Regional comparison for results must be made with caution because of variations in both the quality of analytical data and in sampling procedure. Many more samples must be examined to assess geographical differences. This may also be due to the different feeding habits. For example, the sea snail *Rapana venosa* eats 1 or 2 *Mytilus galloprovincialis* daily in Sinop shores (personal observations). Results of the present study, however, show that the values obtained are acceptable limits when compared with those of similar investigations carried out in the parts of the Aegean Sea and in the Mediterranean (see Table 1). Many of the results in Table 1 show that the highest concentrations have been observed near known sources of anthropogenic inputs.

The data from Table 1 also shows that metal contamination is extensive in the Bosphorus and Black Sea coast of Turkey. Thus, it is suggested that there are differences in inherent response to heavy metals among molluscan species. Topçuoğlu *et al.* (1994) found very high heavy metal levels in the sea snail collected from Fatsa coast and specially Bosphorus. This appears quite reasonable in the light of the available data that a small population of Sinop has not been affected the metal concentrations in the snail of coastal region. Moreover Sinop coasts are unpolluted areas in terms of industry. The radioactivity levels in the sea snail were also found very low levels in Sinop (Bulut *et al.*, 1990). However, the protection of coastal waters from damage due to these metals and other chemicals requires an understanding of the sensitivity of
aquatic organisms to these substances and their ecological requirements, and it is hoped that the sea snail *Rapana venosa* will continue to be employed routinely in monitoring programmes for coastal waters.

Özet

Karadeniz'in Sinop kıyılarından toplanan *Rapana venosa* (Valenciennes, 1846)'ların dokularında bakır, çinko, demir, kurşun, nikel, manganez ve kadmiyum konsantrasyonları kıyısal suların metal kirliliğini belirlemek amacıyla atomik absorpsiyon spektrofotometresiyle ölçülmüştür. Elde edilen ağır metal konsantrasyonları örneklenen üç istasyon arasında istatistiksel olarak farklılık göstermiştir. Sonuçlar önceki bivalvia ve gastropodalarla yapılan çalışmalarla karşılaştırılmış ve tartışılmıştır.

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