METAL CHARACTERISATION OF GREEK COASTAL AREAS USING BIOCONCENTRATION LEVELS IN THE GASTROPOD PATELLA SP.

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Abstract

The concentrations of Cu, Cr, Ni, Zn, Fe and Mn were determined in *Patella sp.* samples collected at nine characteristic Greek coastal areas. The set of data provides global information concerning different and distant sampling sites and gives the possibility to examine *Patella sp.* as a potential sentinel organism.

Key words: metal, gastropod, bio-accumulation, sentinel organism

Metal content of marine mollusks is used wideworld in order to study and monitor metals in the marine environment (1). Among gastropods, *Patella* sp is considered as adequate pollution indicator, since the concentration of the accumulated metals in its tissues is related to the bio-available metal levels in the environment (2). The present work dealing with metal bioaccumulation in the soft tissues of *Patella* sp. collected at different coastal areas aims to provide information on metal levels in an infralittoral species, and moreover to contribute to the characterisation /identification of the Greek coastal zones according to their metallic profile.

Methods and materials

Patella sp. specimens of approximately the same size were collected during the decade 1985-1995 from 9 different coastal areas of Greece. Several pooled samples from each site were analysed for the metals Cu, Cr, Ni, Zn, Fe, Mn by AAS. The methodology was tested by the simultaneous analysis of reference materials.

Results and discussion

The results of the analysis of about 450 samples of *Patella sp.* is presented in Table 1, expressed in Ìg/g dry weight.

Table 1 : Mean metal concentrations and ranges in *Patella sp.* from Greek areas (in Ig/g dry weight).

Area	Cu	Cr	Ni	Zn	Fe	Mn
Kerkyra	7.96±2.13	3.94±1.81		58.5±9.8	1732±654	
N=38	(4.24-14.7)	(1.49-9.17)		(33-75)	(949-3959)	
Lesbos	4.28±3.65	3.65±1.81	9.40±3.52	45.5±4.4	603±230	24.14±20.26
N=7	(0.29-9.26)	(0.87-5.99)	(4.02-15.44)	(42-51)	(442-867)	(12.24-47.53)
Larymna	7.91±4.24	25.22±15.97	15.61±6.97	55.7±15.7	4574±2522	
N=86	(3.3-34.3)	(2.38-77.22)	(5.89-35.25)	(37-97)	(965-11289)	
Lavrio	13.72±2.67	8.98±6.38	6.57±1.85	302.2±64	1256±190	
N=6	(9.68-16.4)	(4.83-21.85)	(3.38-9.8)	(249-412)	(967-1416)	
Milos	9.63±3.87	5.69±4.18	20.20±14.32	45.1±21	291±42	13.14±10.62
N=69	(3.2-21.9)	(1.02-19.08)	(0.33-58)	(5.7-177)	(254-352)	(2.8-57.2)
Pagassitikos	9.23±1.47	7.36±5.45	5.54±6.88	519.5±344	2788±3157	26.10±21.22
N=23	(7.31-12.1)	(1.42-17.95)	(0.72-20.17)	(58-1014)	(56.5-9699)	(2.98-62.35)
Rhodos	6.29±1.41	6.88±2.76	7.13±3.24	164.4±191.9	975±586	6.44±4.38
N=45	(4-10.4)	(1.76-13.98)	(1.59-22.33)	(47.8-631.7)	(158-2218)	(1.73-18.32)
Saronikos	10.42±3.47	6.51±6.31	17.83±10.35	56.9±15.3	710±351	8.23±4.69
N=146	(3.31-35.3)	(0.37-36.21)	(1.74-53.7)	(4.8-138)	(110-2103)	(1.69-27.03)
Sandorini	3.69±1.3	1.01±0.7	5.34±3.12	34.9±15.3	223±70	4.07±2.67
N=4	(2-4.96)	(0.1-1.6)	(2.6-9.17)	(17-50)	(143-311)	(1.4-7.3)

Generally, samples from Lavrio (ancient silver mining site) exhibited the highest Cu and Zn levels. This is obviously due to the by-products of silver extraction -which still remain in the coastal zone of this area and are rich in several metals such as Pb, Zn and Cu (3). Elevated Cu values can be also attributed to the industrial activities of the Lavrio area. The highest Cr, Ni and Fe concentrations present in samples from Larymna bay (Table 1) are in accordance with other studies (4), and are attributed to the ferronickel smelting plant operation. The limpets coming from Saronikos Gulf, as mussels from the same area do (5) contained Ni in high proportions. The data from Sandorini Island show the lowest values recorded in this study indicating a relatively clean marine environment. Finally the samples collected in Pagassitikos Gulf had high Zn and Mn concentrations that are consistent to the high levels in sediments, which in turn are due to human activities. Especially the abundance of Mn was probably related to the biogenic phase of the sediments (6). The abundance of a specific metal as well as the proportion of several metals can characterize a coastal area. The participation of metals in the structure of the sediment minerals theoretically results in their stable proportion in an area. The change of this ratio may be attributed to anthropogenic impact and thus it seems important to study it. In addition the relationship of the bio-accumulated metals could also be of major interest. We should emphasise that the concentration of metals in an organism depends not only on their abundance in the environment but also on the capability of the organism to bioaccumulate them. Thus, the use of a unique sentinel species for the characterisation of an area removes this disadvantage. In Figure 1 are presented the plots of median concentration of pairs of metals in *Patella* samples from different Greek areas. These plots reveal directly the sites of extreme metal levels (ie: Larymna. Lavrio. Pagassitikos)

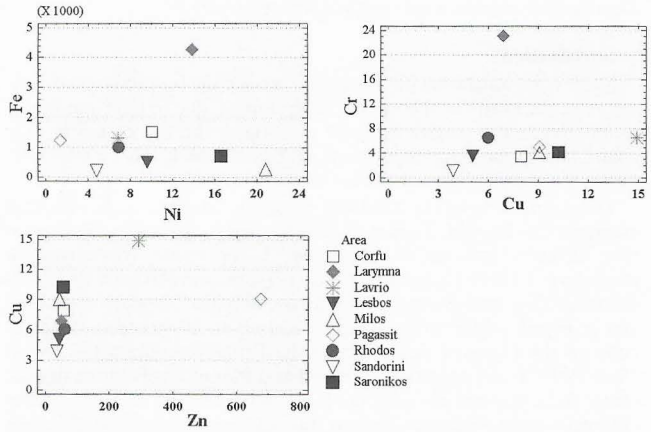

Figure 1. Plot of median concentration values of pairs of metals.

and at the same time identify the specific metal responsible for this differentiation. Finally we performed cluster analysis using the average values of metals in order to classify the studied sampling sites (Fig. 2). We observe that the areas displaying high concentrations for at least one metal distinguish and are accordingly clustered, i.e Lavrio-Pagassitikos due to Zn levels. Milos-Saronikos to its Ni levels, etc. In addition this analysis confirms the information obtained from the plots of Figure 1.

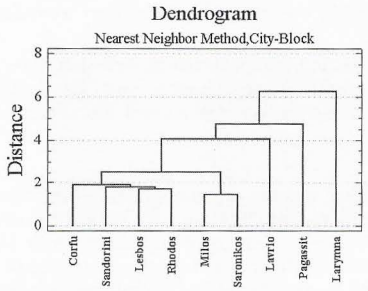

Figure 2. Classification of the Greek coastal areas by cluster analysis.

Conclusions

There is evidence that metal bioaccumulation in *Patella sp.* reflects accurately the metal profile of each coastal zone since in every specific area it provides information on the surrounding environment. Furthermore the data for this particular species agrees well with data concerning other species from the respective area. In conclusion, *Patella sp.* could be a metal pollution sentinel organism for the Greek coastal zone as in most cases has the two basic qualities (7): it reflects the spatial changes of metals in the environment, and provides similar results with other species of the same area.

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