Concentration factors of Stable Silver, Cesium and Scandium in the soft tissues of *Meretrix chionae*

Catherine Papadopoulou and John Andreotis

Nuclear Research Center "Demokritos" Chemistry Department,
Aghia Paraskevi Attikis, Athens, Greece.

The risks of radioactive pollution of the marine environment have increased in recent years due to the offshore siting of nuclear power reactors and fuel reprocessing plants. Artificial radionuclides released into the sea by various sources can be taken up to a high level by marine biota and in this way enter the food chain. This fact necessitated the extension of our knowledge of the characterization of marine species as concentrators of certain specific radionuclides. The most important factor that determines the food chain reconcentration of certain radionuclides by marine organisms is the stable element chemistry of the organism and its environment (Robertson 1971). Moreover the study of the distribution pattern of the elements in various organs of the animal will give us information on the possible hazardous effects of the incorporated radionuclides upon the organism itself.

Cesium isotopes ^{137}Cs and ^{134}Cs are fission products with sufficiently long half-lives to remain in the nuclear waste after many decades. ^{137}Cs follows the behaviour of its stable isotopes.

In the vicinity of nuclear installations, neutron activation products like ^{110m}Ag and ^{46}Sc which originate from the waste discharges, have been found in marine species and sediments (J. Hetherington 1976; Robertson 1971; K.L. Sjöblom, J. Ojala 1981). The presence of Sc in the organisms generally reflected the relative amounts in the sediments.

In an effort to enlarge our knowledge about the concentration of the stable elements in marine invertebrates which can be used as indicator organisms for certain radionuclides, stable cesium, silver and scandium concentration factors were determined in the clam *Meretrix chionae*.

Instrumental neutron activation analysis and gamma-spectrometry were applied for the determination of the above elements in sea water as well as in the tissues of 40 specimens of *M. chionae* collected from the coastal area of Evoikos Gulf in the Aegean Sea.

Concentrations of scandium, cesium and silver in tissues of *Meretrix chionae* are shown in Table I. Concentrations of scandium were significantly higher ($P < 0.05$) in the digestive tract than in the other tissues.

TABLE 1

TRACE ELEMENT CONTENT (µg/g W.W.) IN TISSUES OF MERETRIX CHIONAE

ELEMENT	TISSUES					
	DIGESTIVE TRACT	MANTLE AND GILLS	ADDUCTOR MUSCLE	FOOT	MUSCLES	REST OF BODY
Sc	0.086^{b} ±0.027*	0.014^{a} ±0.0029	0.013^{a} ±0.0019	0.010^{a} ±0.0019	0.0090^{a} ±0.0016	0.036^{a} ±0.0029
Cs	0.021^{a} ±0.0049	0.0098^{bc} ±0.0013	0.0044^{b} ±0.0006	0.0031^{b} ±0.0003	0.0087^{bc} ±0.0006	0.014^{c} ±0.0016
Ag	0.36^{b} ±0.062	0.010^{a} ±0.0023	0.0078^{a} ±0.0013	0.022^{a} ±0.021	0.013^{a} ±0.0009	0.045^{a} ±0.0045

a,b,c MEANS IN A ROW WITH DIFFERENT SUPERSCRIPT LETTERS DIFFER SIGNIFICANTLY ($P<0.05$)

* DATA ARE EXPRESSED AS MEAN ± SE OF 6 COMPOSITE SAMPLES, EACH PREPARED FROM 6 SPECIMENS (TOTAL NO OF SPECIMENS: 36)

TABLE 2

CONCENTRATION FACTORS FOR THE STABLE ISOTOPES OF SCANDIUM, CESIUM AND SILVER IN MERETRIX CHIONAE

ORGANISM	SEA	CONCENTRATION FACTORS		
		Sc	Cs	Ag
MERETRIX CHIONAE	AEGEAN SEA (COASTAL WATERS)			
DIGESTIVE TRACT		2.1	4.2	360
MANTLE AND GILLS		0.3	1.9	10
ADDUCTOR MUSCLE		0.3	0.8	7.8
FOOT		0.2	0.6	22
MUSCLES		0.2	1.7	13
REST OF BODY		0.9	2.8	45
WHOLE BODY*		0.9	1.3	27
SEA WATER (µg/ml)		0.04	0.005	0.001

* DATA EXPRESSED AS MEAN OF 4 SAMPLES

Cesium concentrates mainly in the digestive tract ($P < 0.05$). Significant differences ($P < 0.05$) in cesium concentrations were observed between the rest of the body, adductor muscle and foot. Silver concentrations were significantly higher ($P < 0.05$) in digestive tract in comparison with the other tissues.

The concentration factors of scandium were somewhat higher with the digestive tract showing again the highest value (Table 2). A completely different pattern was seen in silver concentration factors which ranged from less than one to several tens of units. It is noteworthy to point out that all three elements under study show a tendency to accumulate mainly in the digestive tract of *Meretrix chionae*. Mean scandium, cesium and silver concentration factors were 0.9, 1.3 and 27, respectively, in whole bodies of four samples. In general terms these values were more or less of the same order of magnitude when compared to concentration factors of the individual tissues.

Concentration factors of the trace elements studies in tissues of *Meretrix chionae* are generally low with the exception of digestive tract in which the higher values are most likely associated with food intake. Similar findings have also been reported from radiotracer uptake experiments with other invertebrates and radionuclides (G.G. Polikarpov, 1966; S.W. Fowler, 1981).

References

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PAPADOPOULOU, C., ANDREOTIS, J.

"*Concentration factors of stable silver, cesium and scandium in the soft tissues of Meretrix chionae*"

Paper presented by C. Papadopoulou (Greece)

Discussion

A. FRAIZIER: Can you give us an idea of the fluctuation of the stable cesium concentration in sea water?

C. PAPADOPOULOU: At the four sampling sites where we analyzed Cs, the values in water differed by 10-15%.

S. FOWLER: How do you measure the trace element concentration in sea water? Is it total trace element content?

C. PAPADOPOULOU: We measure the total element content in sea water directly by neutron activation analysis.

A. BALLESTER: When you mention digestive tract, do you mean tract plus gut contents or only the animal's tissue?

C. PAPADOPOULOU: We mean the whole digestive tract plus its contents.

M. BRANICA: I agree that ^{137}Cs can follow the behaviour of its stable isotopes, however, I am sceptical about scandium. I think one can expect very different behaviour between the radionuclide and the stable element.