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Distribution of Technetium in *Mytilus edulis*

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The artificial element 43, technetium, is a metal which was virtually absent from the natural environment prior to the nuclear age. The most important isotope, from the radioprotection point of view is Tc-99, which decays to stable Ru-99 with a half-life of 2.1 x 10^5 years. Once in the aquatic environment, Tc-99, which is highly soluble and mobile, would probably remain available for quite a long time.
It was, thus, of interest to improve our knowledge on the biological behaviour of technetium in aquatic organisms. The mussel, Mytilus edulis, is a choice organism for investigating not only the uptake and loss processes, but also the tranfer along the food chain.
In previous studies, we have shown that technetium was accumulated mostly in the hepatopancreas (Verthé et al., 1984 ; Bouquegneau et al., 1985). On the other hand, it is well known from the literature that mussels are capable of synthesizing metal-binding proteins when they are exposed to heavy metals such as cadmium, copper and mercury (Noël-Lambot, 1976 ; Frazier, 1986 ; Viarengo et al., 1980 ; Roesijadi, 1982).
In our recent investigations we have observed that in mussels exposed to technetium (Tc-95m) for about three weeks, an important accumulation occurred in the hepatopancreas, where more than 50% was present in the cytosol compartment. However, analysis of cytosol fractions by column chromatography and by the Cd-109 saturation method (Nolan and Shaikh, 1986) did not reveal the presence of metallothioneins in animals supplied for about two weeks with 200 µg l^{-1} Tc-99. By contrast, cadmium, at the same concentration (200 µg l^{-1}), showed a good inductive capacity of the synthesis of metallothioneins (both Cd-BP20 and Cd-BP10 ; Frazier, 1986).

Our results suggest that, in contrast to cadmium, technetium is incapable of inducing the synthesis of metallothioneins, at the concentration of 200 µg l^{-1}. It would be of interest to investigate whether at higher concentrations, technetium has an inductive capacity and whether this element can bind to metallothioneins previously induced by other metals present in the marine environment. Another important question to be resolved is whether technetium can be sequestered in intracellular granules, as shown for other metals (Fowler, 1987 ; Chassard-Bouchaud et al., 1989).

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Chromate Bioavailability in Two Benthic Invertebrates

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The accumulation and elimination of hexavalent Cr-51 in the molluscs Venerupis aureus and Mytilus galloprovincialis was studied. The uptake experiments lasted 27 days and the concentration factors found were 4.3 for Venerupis sp. and 6.1 for Mytilus sp. while the biological half lives were 96.8 and 51.1 days, respectively. The distribution of Cr-51 in the body of both species was also determined.

Chromium is released into the atmosphere because of ferrochrome production, ore refining, combustion of coal, etc., and eventually finds its way into the sea. Moreover the discharge of effluents by the plating, tanning and textile industries is another source of chromium into the marine environment. The presence of radioactive Cr-51 in the marine environment has been pointed out by several investigators (POLIKARPOV, 1966). Cr-51 is derived from nuclear tests and from the disposal of liquid radioactive waste of atomic plants and is also a corrosion product of nuclear power ships. It has been reported that certain marine organisms are able to concentrate Cr-51 in the trivalent or hexavalent state (CHIPMAN, 1966, PAPADOPOULOU et al. 1986, PAPADOPOULOU and STAMOULI, 1989). In order to extend our knowledge on the accummulation of Cr-51 by various edible mollusc species we studied the bioavailability of hexavalent Cr-51 in Venerupis aureus and Mytilus galloprovincialis. The uptake of trivalent Cr-51 in the same mollusc species has been investigated in a previous paper (STAMOULI and PAPADOPOULOU, 1988).

Several individuals of Venerupis aureus and Mytilus galloprovincialis were sampled from Salamis Island in Saronikos Gulf (Greece). Sea water was also taken from the same area. Two uptake experiments were performed for each species (n=10) at a temperature ≈20°C and salinity 38‰ using the gamma emitting radioisotope Cr-51 (H.L. 27.8 d) as sodium chromate (40 µCi/18 l sea water). The experiments lasted 27 days. In order to determine the distribution of Cr-51 in the body of the molluscs certain individuals from each species (n=4) were dissected at the end of the uptake experiments and the Cr-51 activity in the different parts of their body was counted. In the remaining animals of each species (n=6) the elimination of Cr-51 was studied in order to determine the biological half life. Moreover leaching experiments were performed by placing the shells in 0.5N HCL.

In the first days of the uptake experiments the rate of accumulation was rather fast but gradually it became slower for both mollusc species. The concentration factors after 27 days reached the values K=4.3 in Venerupis sp. and K=6.1 in Mytilus sp. The distribution of Cr-51 in the whole body of both molluscs is given in Table 1.

TABLE 1. Distribution pattern of Cr-51 radioactivity (%) in the whole body of the two molluscs after 27 d exposure

Organism	Shell	Soft parts	Byssus	Body fluid
Mytilus sp.	33.8	36.8	22.6	6.8
Venerupis sp.	12.3	48.3	-	39.4

In the soft tissues of the species studied the distribution pattern of Cr-51 was found to be as follows: Mytilus sp.: Visceral mass 53.5%, muscle 7.4%, foot 0.9%, gills 28.8% and mantle 9.4%. Venerupis sp. : Visceral mass 34.2% muscle 15.4%, foot 1.7%, gills 17.2%, mantle 16.3%, ventral siphon 7.4% and dorsal siphon 7.8%. The biological half life in Mytilus sp. was found to be 51.1d and in Venerupis sp. 96.8d.

Low concentration factors were found for both mollusc species. It should be noted that in our previous paper concerning the uptake of trivalent Cr-51 by the same species (STAMOULI and PAPADOPOULOU, 1988) medium concentration factors were found (K=55 for Mytilus sp. and K=47 for Venerupis sp.) These results are comparable to those obtained in another mollusc species, Venus verrucosa, where also low concentration factors were found for the uptake of hexavalent Cr-51 (K≈2) but medium for the uptake of trivalent Cr-51 (K≈65) (PAPADOPOULOU et al., 1986, PAPADOPOULOU and STAMOULI, 1989). In Venerupis sp. only a small part of the accumulated whole body radioactivity is found in the shell (12.3%), in contrast to the results concerning the trivalent Cr-51 (STAMOULI and PAPADOPOULOU, 1988) where the larger part of the radioactivity (58.9%) was detected in the shell; in Mytilus sp. the fraction of hexavalent Cr-51 found in the shell (33.8%) is comparable to that of trivalent Cr-51 (35.2%). Among the soft tissues of both mollusc species viscera displays the greater ability to accumulate the hexavalent Cr-51.

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