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Remobilization of Technetium from sediments by Polychaetes at the sediment-water interface *

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ABSTRACT

Literature data indicate that bioturbation strongly affects the recycling of radionuclides through the benthic boundary layer. Technetium bound firmly in reducing sediments may be resolubilized by the biological activities of benthic organisms of the infauna. Results show that transfer of nuclides to fauna ingesting particles is very slow whereas transfer from interstitial water is probably the predominant source of technetium for sediment-dwelling fauna.

INTRODUCTION

In the geobiochemical cycling of many natural and man-made contaminants sediments may be considered as a final sink and/or ultimate pollutant reservoir in the marine environment. In addition to physical processes, bioturbation, generated by biological activities of the sediment-dwelling organisms, seems to be a principle mechanism in transfers and recycling of sediment-associated pollutants through benthic ecosystems (1,2).

Reworking of the upper sediment strata by bottom-dwelling organisms may reach down to 20-30 cm depth also in anoxic environments, thus oxidizing portions of anoxic sediments by pumping oxygen-rich surface water through their tubes. In this way contaminants such as radionuclides, reduced and immobilized in anoxic sediments, may be reoxidized and delivered to the water column.

On the basis of former results on leaching and remobilization of Tc from sediments (3,4) further studies were performed in order to evaluate the influence of biological activities of the infauna on the biogeochemical cycling of Tc with special reference to the sediment-water interface.

EXPERIMENTAL

Two polychaete species were used having different feeding habits which may be important to the distribution and fate of radionuclides in sediments. Nereis sp., a surface deposit feeder, may be especially important in vertical transport processes from the surface to deeper sediment layers, while Marphysa bellii, a subsurface feeder, may play an important role in the remobilization and recycling of radionuclides from sediment to the water column.

Aliquots (~1Kg) of humid sediment was mixed with seawater to gain a slurry to which 12 μCi (444 kBq) Tc-95m were added under strict anoxic conditions and stirred for more than 1 hour sustained by vigorous bubbling of nitrogen through the suspension, then filled equally into five tubes (ø 3.2cm, 35cm length, surface 8cm^2, medium depth of sediment 25cm) and let settle for three days. Only three tubes received Nereis sp. weighing 0.95, 1.17; 1.00, 2.73; and 1.78, 0.54g, respectively. The volume of the seawater overlaying the sediment was about 50ml at the beginning increasing daily because of compacting of the sediment by the activity of the worms. The oxygen content in the water was maintained constant by continous air-bubbling. The whole volume of overlaying water was sampled daily and measured for radioactivity.

RESULTS AND DISCUSSION

The results showed a steady release of radioactivity from the sediment to the water. On the average 0.26-0.36% of the total Tc-95m present were remobilized per day in relation to the polychaete biomass present. In tube 2 with 3.73g FW of worm 0.36% of Tc were released daily while tube 1 (2.12g FW) and tube 3 (2.33g FW) 0.28% and 0.26% of Tc were remobilized per day, respectively. After 49 days the overall percentages of Tc-95m removed were 13.89%, 18.13%, and 13.07% for tube 1,2,and 3, respectively, while in the same period the blank without worms lost only 4.36% of the total Tc which corrispond to 0.089% per day.

After centrifugation of the sediment of the blank the radioactivity content of Tc-95m in the interstitial water was found to be only 0.15-0.21% of the total Tc present in the sediment. Thus, it can be assumed that at the beginning of the experiment all Tc was bound to the sediment. The lost radioactivity from the blank may be explained by diffusion processes in the upper sediment layers and reoxidation in the water column.

At day 28 of the experiment tube 4 received one specimen of Marphysa bellii (2.57g) which removed only 2.21% of the Tc-95m in 20 days, i.e. 0.11% per day. This low value may be due to the lower physiological activity of this polychaete compared to Nereis.

However, concentration factors (CF) calculated at the end of the 49 days period showed a medium value in Nereis of CF 13.5±4.6 while Marphysa reached a CF of 80.6. This higher CF may result from direct uptake of Tc-95m from the sediment since Marphysa ingests very often sediment and produces fecal pellets consisting totally of sediment grains. Transfer factors (TF) of Tc-95m from sediments to worms were low and confirmed data from the literature (5,6,7). Nereis showed medium values of TF 0.25 while in Marphysa the TF was about four times higher, i.e. TF 1.112 confirming a higher sediment bound nutrition than in Nereis sp..

So far, the results of the laboratory experiments let presume that in areas of high polychaete population densities where Tc results bound in the upper 20cm of the sediment, a considerable amount of the radionuclide may be remobilized by the biological activities of the infauna.

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Trivalent Cr-51 bioaccumulation study in two Mollusc species

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ABSTRACT. The uptake and elimination of Cr-51 in the trivalent form by the molluscs Venerupis sp. and Mytilus sp. were studied. The uptake experiments lasted 20 days and the concentration factors (K) found were 55 for Mytilus sp. and 47 for Venerupis sp, while the biological half life values were 36.3 and 42.5 days respectively. The distribution pattern of Cr-51 in the body of both mollusc was also determined.

INTRODUCTION. Large amounts of chromium are used in industry and sources to the environement include metal plating, fossil combustion ore refining, leather industry and others. The presence of Cr-51 in the marine environment has been reported by several investigators (1). Radioactive chromium is derived from nuclear tests and from the disposal of radioactive waste of atomic plants. Moreover Cr-51 is one of the corrosion products of nuclear power ships. The ability of certain marine species to concentrate Cr-51 in the trivalent or hexavalent state has been reported (2,3,4). In order to extend our knowledge on the acummulation of Cr-51 by various mollusc species we studied the Cr-51 biokinetics in Venerupis sp. and Mytilus galloprovincialis. The species chosen have a commercial value and are used for human consumption.

EXPERIMENTAL. Venerupis sp. and Mytilus sp. were collected from Salamis Island in Saronicos Gulf (Greece). Sea water was also taken from the same area. Two uptake experiments were performed (n=10) for each species at a temperature (about 20 Centigrade) and salinity (38‰) using the gamma emitting radioisotope Cr-51, H.L. 27.8 d. as chromium chloride (40 uCi Cr-51/18 l sea water). The experiments lasted 20 days. In order to determine the distribution of Cr-51 accumulated in the body of the molluscs certain individuals from each species were dissected at the end of the uptake experiments and the Cr-51 activity in the different parts of their body was counted. The elimination of Cr-51 in the two mollusc species was studied in order to determine the biological half life. Moreover leaching experiments were performed by placing the shells in 0.5 N HCL.

RESULTS AND DISCUSSION. The concentration of Cr-51 in Mytilus sp. reached a stable level within 10 days from the begining of the uptake experiment and in Venerupis sp. within 8 days; the concentration factors were found to be K=55 and K=47 respectively. The distribution of Cr-51 in the whole body of Mytilus sp. and Venerupis sp. is given in Table 1.

TABLE 1. Distribution pattern of Cr-51 radioactivity (%), in the whole body of the two molluscs after 20 d. exposure

Organism	Shell	Soft parts	Byssus	Body fluid
Mytilus sp.	35.2	33.8	23.5	7.5
Venerupis sp.	58.9	29.4	-	11.7

In the soft tissues of the species studied the distribution pattern of Cr-51 was found to be as follows: Mytilus sp. (Visceral mass 82.6%, muscle 1.7%, foot 0.6%, gills 10.1% and mantle 5.0%). Venerupis sp. (Visceral mass 85.5%, muscle 2.7%, foot 0.7%, gills 3.1%, mantle 3.8%, ventral siphon 1.8% and dorsal siphon 2.4%). The biological half life in Mytilus sp. was found to be 36.3 d. and in Venerupis sp. 42.5 d.

Medium concentration factors for both mollusc species were found. In Venerupis sp. the larger part of the accumulated whole body radioactivity was found in the shell. This is in agreement with previous data concerning another mollusc species (3). However in Mytilus sp. only 35.2% of the Cr-51 activity was found in the shell, while a considerable part of the radioactivity was found in the byssus. Viscera found to be an important deposition site of Cr-51. This is in accordance with our previous data refering to the accumulation of trivalent chromium in viscera of the mollusc Venus verrucosa (3).

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