ASSIMILATION AND RETENTION OF HEAVY METALS AND RADIONUCLIDES IN SEASTARS

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From both ecological and toxicological viewpoints, it is important to understand the transfer and cycling of trace elements and contaminant heavy metals and radionuclides through marine food chains. Studying these aspects in the natural system or using elevated concentrations of the target elements under simulated conditions usually entails greatly perturbing the elemental composition of the water, subsampling from a large population of organisms, and carrying out lengthy chemical separations for eventual elemental and/or radionuclide analyses. The use of high specific activity or carrier-free gamma-emitting radiotracers of these elements circumvents these problems and allows rapid radioanalyses of live organisms or tissues which have been exposed to the contaminants at concentrations more likely to be present in the surrounding waters.

For our studies, we have developed a multi-isotope analytical technique which allows measuring simultaneously seven gamma-emitting radiotracers in the same experimental organisms. Use of this multi-tracer technique reduces inter-experimental variation which occurs between separate treatments labelled with single radioisotopes. This report summarizes results from laboratory radiotracer experiments aimed at quantifying the assimilation and retention of some key heavy metals and radionuclides in carnivorous seastars following contaminant transfer via a typical three-step food chain (phytoplankton - bivalve - seastar).

Carrier-free or high specific activity solutions of the gamma emitters ^{109}Cd, ^{65}Zn, ^{110m}Ag, ^{60}Co (inorganic) and ^{57}Co (cobalamine) were employed in all experiments. In addition, two radionuclides of current interest, ^{241}Am and ^{134}Cs, were also used in the multi-isotope mixture. Mussels (*Mytilus edulis*) were labelled for 96 hours in sea water containing a suspension of phytoplankton cells (*Isochrysis galbana*, 5×10^3 cells/ml) and radiotracers of the selected elements. During this period, the labelling medium was changed every 24 hours. Following the contamination period, the mussels were rinsed and their soft parts removed and counted for radionuclide content. The mussel soft parts were then fed to asteroids (*Marthasterias glacialis*) which promptly ingested the food ration. After radio-labelled feeding, the seastars were periodically whole body counted live over the next several weeks in order to assess excretion rates for the different elements. General experimental protocols, radio-labelling techniques and whole body gamma spectrometric analyses (GeLi detector) of the radiotracers in marine organisms are described elsewhere (GUARY *et al.*, 1982; FISHER *et al.*, 1991; NOLAN *et al.*, 1992).

Assimilation efficiencies of all the elements tested were very high often ranging between 60 and 100% retention of the ingested dose several days after feeding. This was particularly evident for the organic form of cobalt of which 80-100% was retained by the asteroids during the first month of the excretion period. At different times during the experiment, mean percent activity retained was calculated for each radionuclide using 3 to 5 individual seastars, and the resultant excretion patterns examined. In all cases, it appeared that excretion kinetics could be fit to a single exponential model. Therefore, as a first estimation of excretion rates linear regression analysis was applied to the loss curves which extended over a period of nearly 4.5 months. Biological half-lives for radiotracer loss are given in Table 1. In all cases the computed half-times were relatively long ranging from approximately 4 to 100 days. Of particular interest is the long biological half-life of zinc, a biologically essential element active in co-enzyme systems. Although measurements were made for several months, there was some indication toward the end of the experiment that certain elements (e.g. Co org., Zn and Ag) were entering into a much slower loss phase.

Element/ RN	Ag	Cd	Co(in.)	Co(org.)	Zn	^{134,137}Cs	^{241}Am
Tb½ (days)	57	47	40	53	101	78	44

Table 1. Biological half-lives (Tb1/2) of selected elements and radionuclides in the seastar *Marthasterias glacialis* following a single ingestion of radiolabelled food.

Other noteworthy features were the enhanced retention of organic Co over the inorganic form (Fig. 1) and the stronger retention of the monovalent radiocaesium compared to trivalent ^{241}Am. This latter observation merits further investigation particularly in view of the many studies which report longer biological half-lives for ^{241}Am than radiocaesium in marine organisms.

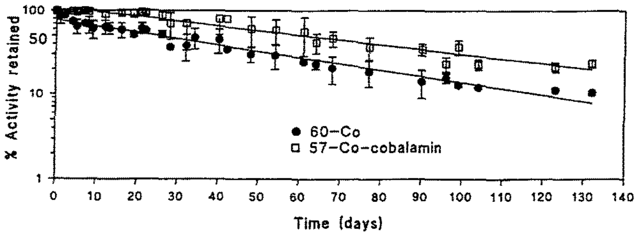

Fig. 1.Long-term excretion of inorganic ^{60}Co and ^{57}Co-cobalamine in seastars following a single ingestion of radiolabelled food. T = 15±1°C; S = 37‰; Bars =±1σ.

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