Selenium Assimilation in a Marine Copepod

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A new method was developed for determining the assimilation efficiency of Selenium in marine animals feeding on Selenium-containing food. The experiments, which employed two gamma-emitting radiotracers–^{75} Se and ^{241} Am– to study the assimilation of Selenium ingested by the marine Copepod Acartia tonsa, indicated that 97% of the ingested Selenium was retained by this animal after gut evacuation. Selenium showed a higher assimilation efficiency in Copepods than any other element, including Sulfur and Carbon.

The assimilation of an element ingested by marine Zooplankton will determine the extent to which that element is biologically usable or toxic and well as the residence time of that element in surface waters. Those elements which show negligible assimilation by marine Zooplankton (e.g., the Lanthanides and Actinides) would not accumulate in biological tissue, the oceanic food web, or the organic cycle in general. They would be efficiently "packaged" by the zooplankton into rapidly sinking materials, generally in fecal pellets or exoskeletons which are periodically released during molting, and the Zooplankton would therefore serve to depurate the surface waters of these elements (FOWLER and KNAUER, 1986; FISHER and FOWLER, 1987). The oceanic residence times for these elements is characteristically short (WHITFIELD and TURNER, 1987). In contrast, elements which show pronounced assimilation in the Zooplankton would enter into the organic cycle in surface waters and have much longer oceanic residence times than the unassimilated elements. These elements would therefore have lower concentrations in fecal pellets or exoskeletons than in body tissue or in the food upon which the animals had fed. Polonium has been well studied in this regard and has been shown to assimilate in the hepatopancreas of marine crustaceans (CHERRY *et al.*, 1983) and to associate in general with proteins in marine organisms (FISHER *et al.*, 1983b; HEYRAUD *et al.*, 1987). We have examined the assimilation of another group VIA element, Selenium, which may act as a Sulfur analog in aquatic organisms and which associates with seleno-amino acids in Algae and higher plants (BROWN and SHRIFT, 1982).

In a series of experiments, the small centric diatom Thalassiosira pseudonana was labeled with two gamma-emitting radiotracers, ^{75}Se, added as selenite (37-660 kBq l^{-1}, 0.136-2.42 nM)) and ^{241}Am (18.5-37.0 kBq l^{-1}, 0.6-1.2 nM), cells were harvested from their radioactive medium and resuspended into 200 ml unlabeled seawater to give cell densities of 1.3 to 2.1 x 10^5 ml^{-1}. These feeding suspensions then received 20 individuals of the adult copepod Acartia tonsa and the animals were allowed to feed for 6 hours. During the feeding, the radioactivity of the cells, the ambient water (ie., in the dissolved phase), and the fecal pellets and eggs produced by the animals was monitored using a gamma counter with a NaI (T1) crystal as described in FISHER *et al.* (1983a).

The assimilation efficiency of the Selenium was determined by relating the radioactivity in the food and fecal pellets as described by the equation :

$$\text{Assimilation efficiency} = \frac{{}^{75}\text{Se}/{}^{241}\text{Am (food)} - {}^{75}\text{Se}/{}^{241}\text{Am (feces)}}{{}^{75}\text{Se}/{}^{241}\text{Am (food)}}$$

The results indicated that the concentration of ^{75}Se in the fecal pellets was always reduced by over an order of magnitude in the fecal pellets relative to the levels in the food. The mean assimilation efficiency from four different experiments, conducted months apart from each other with different batches of phytoplankton and animals, was 97.1± 1.5% (Table 1). Mass balance assessments of Se assimilation efficiency gave comparable values. Further mass balance calculations indicated that only about 1% of the ingested ^{241}Am was assimilated.

The results suggest that Se should readily enter the organic cycle in the ocean, perhaps acting as a S analog in marine organisms. The high assimilation in animals and association with amino acids in Algae are consistent with the observation that most of the Selenium in surface waters is in organic form (CUTTER and BRULAND, 1984). Its biogeochemical behavior is therefore similar to that of Po.The organic cycling of Se is probably responsible for its relatively long residence time --2.6 x 10^4 years--in the oceans (BROECKER and PENG, 1982).

Table 1. Radioactivity of ingested and excreted material and assimilation efficiencies of Se calculated using the ratio method.

Experiment	Radioactivity (Bq μg^{-1} dry wt) Food Se	Food Am	Food Se/Am	Feces Se	Feces Am	Feces Se/Am	Assimilation efficiency
1	2.99	1.53	1.95	0.11	2.63	0.04	98%
2	2.74	1.19	2.30	0.05	0.55	0.09	96.1%
3	12.65	1.44	8.79	0.33	0.84	0.39	95.5%
4	6.14	0.65	9.45	0.26	2.12	0.12	98.7%
						mean :	97.1+1.5%

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