

Stable elements of radioecological importance in certain Echinoderm species

by

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Abstract

Echinoderms may present variations in their elementary composition according to the surrounding medium and to their food source. The accumulation of certain trace elements by these organisms is connected with radioecological interest. The elements Co, Zn, Cr, Sc, Cs, Ag, Sb, Fe, Rb, and Se are determined in seven echinoderm species by instrumental neutron activation analysis. In this work the experimentally found values of the concentration factors of the elements investigated are reported and discussed from the point of view of their radioecological importance.

Résumé

La composition en « éléments traces » des Échinodermes peut varier, au point de vue chimique, conformément à la composition de l'ambiance et de la nourriture. L'accumulation de certains éléments traces par ces organismes présente un intérêt radioécologique. Les éléments Fe, Co, Zn, Cr, Cs, Sc, Ag, Sb, Rb, et Se sont déterminés dans sept espèces d'Échinodermes par radioactivation neutronique et analyse de l'échantillon par spectrométrie γ . Les teneurs de « coefficient de concentration » des éléments en question sont aussi déterminées. Ces teneurs sont discutées au point de vue radioécologique.

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Introduction

The "energy crisis" of recent years presents a great hazard to the marine environment associated with the continuous development of nuclear power industry. Most of the radioactive materials from the various sources are thrown into the oceans at the surface, the coasts, or the sea floor. This introduction of radioactive wastes into the sea entails great risks for the marine biosphere. Marine organisms modify the distribution of radioisotopes in the marine ecosystem. In order to explain the transport and the biological behaviour between stable elements and radionuclides we need to investigate the parameters, which influence these mechanisms. (1). One important parameter is the elementary composition of various marine organisms. Therefore further research is necessary to understand fully the accumulation patterns of certain elements in the marine ecosystem. Among the marine invertebrates the echinoderms seems to present variations in their elementary composition according to the surrounding medium and to their food source. The data on the chemical composition of echinoderm species are given by several authors [2, 3].

This work is dealing with the determination of Se, Cr, Ag, Cs, Rb, Sc, Fe, Zn, Co and Sb in the following echinoderm species: *Ophioderma longicauda*, *Echinaster sepositus*, *Marthasterias glacialis*, *Sphaerechinus granularis*, *Paracentrotus lividus*, *Arbacia lixula*, and *Holothurius tubulosa*. These animals

were collected from the North-east part of the Saronikos gulf on April 1974 (salinity 38 ‰ and temperature 14° C). The Saronikos gulf is considered as a defined biotope for pollution studies in order to provide us with preliminary information on the composition of the Greek marine ecosystem. The selection of the elements was done mainly on the basis of radioecological importance. Concentration factors of the determined elements are also given. Instrumental neutron activation analysis was applied for the determination of the elements.

Experimental

Ten animals for each species were selected. The whole bodies of each group were dried at 75° C for 20 hours. Samples for neutron irradiation were prepared by sealing 200-300 mgr of substance in quartz tubes. The standards were prepared in exactly the same way. Samples and standards were irradiated together in the N.R.C. "Demokritos" reactor at a flux of $2,2 \times 10^{13}$ n.cm⁻². sec⁻¹ for 30 hours. After 40 days cooling-time the γ -radiation spectra of the radioisotopes produced were measured by a 37 cm³ Ge(Li) detector connected with a 4000 channel pulse-height analyzer (Model Inter-technique-Didac 4000).

Results and discussion

The results obtained are listed in Table 1. The values of trace element content in the animals represent the mean value of duplicate analysis. The concentration factors K calculated on the fresh weight basis are given in Table 2. The elements (Ag, Sb, Zn, Co, Fe, Cs, Cr) selectively accumulated by the species: *Sphaerechinus gran.* (Sc, Fe, Co, Cs), *Marthasterias glas.* (Ag), *Echinaster sep.* (Zn), *Arbacia lix.* (Cr, Sb), are of special radioecological importance, because their artificial radionuclides enter into the oceans from: 1) Atmospheric fallout 2) discharges from nuclear plants and power reactors and 3) releases from nuclear-powered ships. In almost all the investigated animal species the concentration of Se was found to have high values. The biological importance of Se is known to be connected with some physiological functions of the organism, although its role in the biochemistry of marine animals is not yet well explained.

References

- [1] *Marine Radioecology*, 1971. — Proceedings of the second ENEA Seminar, Hamburg, 214 p.
- [2] GOLDBERG (E.), 1965. — *Review of trace element concentrations in marine organisms*. Puerto Rico Nuclear Center, Puerto Rico, 535 p.
- [3] RILEY (J.) & SEGAR (D.), 1970. — The distribution of the major and some minor elements in marine animals. *J. Mar. Biol. Ass. U.K.*, **50**, pp. 721-730.

TABLE 1.
Content of the elements determined in Echinoderm species
(Concentrations in ppm of dry matter)

| Species | Elements | | | | | | | | | |
|--------------------------|----------|------|------|---------|------|-------|------|------|------|------|
| | Se | Cr | Ag | Cs | Rb | Sc | Fe | Zn | Co | Sb |
| <i>Ophioderma long.</i> | 1,90 | 0,46 | 0,07 | 0,007 | 1,86 | 0,005 | 134 | 59,6 | 0,20 | 0,01 |
| <i>Echinaster sep.</i> | 4,37 | 0,83 | 0,25 | 0,003 | 0,93 | 0,013 | 174 | 119 | 0,38 | 0,02 |
| <i>Marthasterias gl.</i> | 3,07 | 1,64 | 7,29 | <0,0003 | 2,12 | 0,041 | 114 | 65,0 | 0,09 | 0,02 |
| <i>Sphaerechinus gr.</i> | 0,79 | 6,42 | 0,32 | 0,133 | 3,49 | 0,175 | 1140 | 100 | 0,66 | 0,13 |
| <i>Paracentrotus l.</i> | 1,15 | 4,78 | 0,32 | 0,041 | 4,77 | 0,044 | 598 | 54,0 | 0,28 | 0,07 |
| <i>Arbacia lix.</i> | 2,45 | 13,1 | 0,30 | 0,047 | 2,63 | 0,051 | 620 | 95,4 | 0,32 | 5,57 |
| <i>Holothurius tub.</i> | 3,39 | 0,80 | 0,05 | 0,017 | 1,97 | 0,005 | 74,5 | 36,2 | 0,11 | 0,05 |

TABLE 2.

Concentration factors estimated for the elements determined in Echinoderm species

| Species | Elements | | | | | | | | | |
|----------------------------|----------|------|------|-----|----|------|-----|-----|-----|------|
| | Se | Cr | Ag | Cs | Rb | Sc | Fe | Zn | Co | Sb |
| <i>Ophioderma long.</i> | 633 | 42 | 23 | 7 | 3 | 125 | 67 | 458 | 222 | 2 |
| <i>Echinaster sep.</i> | 1456 | 75 | 83 | 3 | 1 | 325 | 87 | 915 | 422 | 4 |
| <i>Marthasterias gl.</i> | 1023 | 149 | 2430 | — | 4 | 1025 | 57 | 500 | 100 | 4 |
| <i>Sphaerechinus gran.</i> | 263 | 583 | 106 | 133 | 6 | 4375 | 570 | 769 | 733 | 26 |
| <i>Paracentrotus liv.</i> | 383 | 434 | 106 | 41 | 8 | 1125 | 290 | 415 | 311 | 14 |
| <i>Arbacia lix.</i> | 823 | 1190 | 100 | 47 | 4 | 1275 | 310 | 734 | 355 | 1114 |
| <i>Holothurius tub.</i> | 1130 | 72 | 16 | 17 | 3 | 125 | 37 | 278 | 122 | 10 |

