

## Radionuclide concentrations in macroalgae and sediment samples from the Bosphorus

### Boğaziçi makroalg ve sedimentlerinde radyonüklid konsantrasyonları

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#### Abstract

The paper reports  $^{134}\text{Cs}$ ,  $^{137}\text{Cs}$  and  $^{40}\text{K}$  radionuclide concentrations in macroalgae and sediment samples collected from the Bosphorus of Turkey. They were determined during the period of 1989-1990. The highest accumulation of  $^{137}\text{Cs}$  radionuclide was found in *Enteromorpha linza* species. The  $^{134}\text{Cs}$  and  $^{137}\text{Cs}$  levels reached peak values in all sediment samples collected from Sariyer. The results showed that the Sariyer station was the most contaminated among all the stations of the Bosphorus.

**Keywords:** Bosphorus, radionuclide, macroalgae, sediment

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#### Introduction

Following the nuclear accident in Cheernobyl, the activity concentrations of fallout radionuclides were detected in macroalgae and sediment samples in the marine environment of Turkey (Güven, *et al.*, 1990; Güven,*et.al.*, 1993a; Topcuoğlu, *et al.*,1993; Topcuoğlu *et al.*, 1995; Topcuoğlu, *et al.*, 1996; Topcuoğlu *et al.*, 1998). However, no data on

radioactivity levels in macroalgae and sediment samples from the Bosphorus have not yet been published in scientific literature. On the other hand, several investigations have been carried out using Bosphorus algae species and sediment samples for determination of trace metal contents (Topcuoğlu, *et al.*, 1990., Güven, *et al.*, 1993b, Kut *et al.*, 1999).

This paper reports data for the radionuclide ( $^{134}\text{Cs}$ ,  $^{137}\text{Cs}$ ,  $^{40}\text{K}$ ) levels at macroalgae and sediment samples collected at different stations along the Bosphorus during the period of 1989-1990.

### Materials and Methods

The sampling stations of the Bosphorus are indicated on the map (Fig. 1). The macroalgae species were green algae (*Enteromorpha linza*, *Ulva lactuca*) and brown algae (*Cystoseira barbata*). The algal samples were firstly washed with clean sea water and then with distilled water. Afterwards they were dried at 85 °C for several days for constant weight.

The top 5 cm of sediment samples were collected near the shore (10-20m) of the stations by using of a Lenz Bottom sampler. The samples were dried at 85 °C for 48 h, crushed and homogenized prior to the analysis.

The samples (about 100 g) were pressed by hand into special cups for gamma isotopic analyses. Determination of the radioactivity level was made as previously described ( Topcuoğlu, *et al.*, 1997).

### Results and Discussion

The levels of activities in macroalgae samples are given in Table 1. The highest accumulations of the cesium radionuclides were found in *E. linza* species, specially at Sarıyer and Sarayburnu stations. On the other hand,  $^{134}\text{Cs}$  and  $^{137}\text{Cs}$  activities are not detected in *U. lactuca* species collected from Sarıyer. The macroalgae species collected in the Bosphorus can be ranked as *E. linza* > *U. lactuca* > *C. barbata* according to their  $^{137}\text{Cs}$  content.

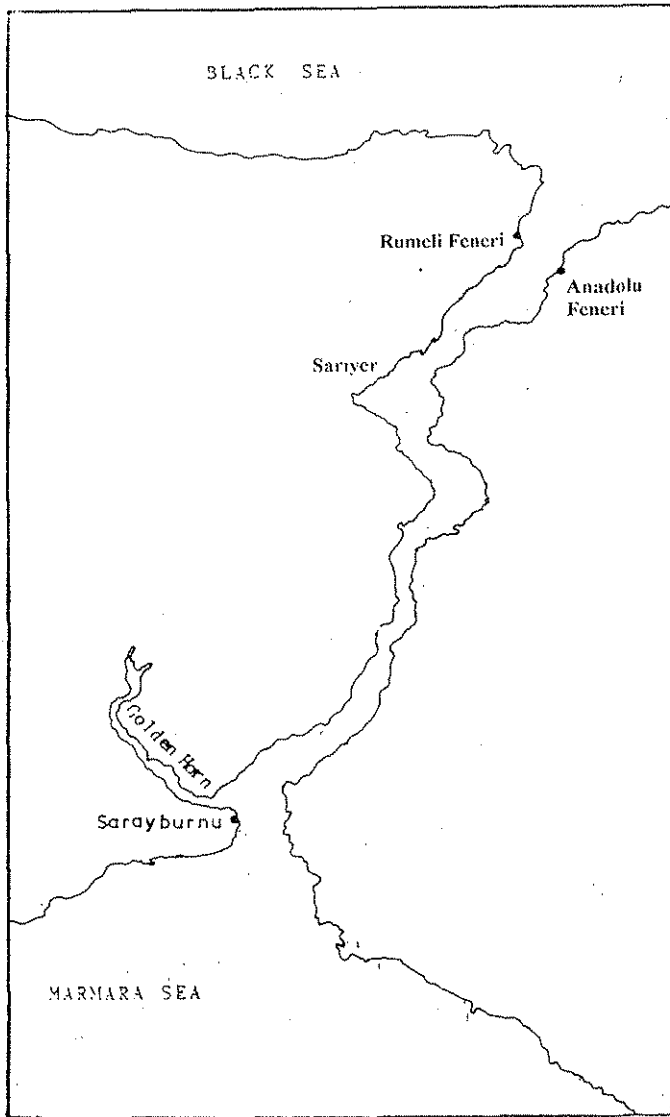


Fig. 1. Sampling stations

Table 1. Radionuclide concentrations in macroalgae species  
(Bq/kg dry weight)

Stations	Samples	Collection date	Counting Date	<sup>134</sup> Cs	<sup>137</sup> Cs	<sup>40</sup> K
Sarıyer	E. linza	06/1989	07/1989	<1	8.3±3.5	570±338
	E. linza	09/1989	03/1990	<1	9.1±2.6	-
	U. lactuca	06/1989	06/1989	<1	<2	404±144
	U. lactuca	09/1989	03/1990	nd	nd	-
	U. lactuca	02/1990	04/1990	nd	nd	-
Rumeli Kavağı	E. linza	05/1989	05/1989	nd	nd	-
	E. linza	09/1989	02/1990	nd	nd	-
	E. linza	02/1990	03/1990	<1	6.2±4.1	878±35
	C.barbata	06/1989	08/1989	nd	nd	-
Anadolu Kavağı	E. linza	09/1989	02/1990	nd	nd	-
	E. linza	02/1990	03/1990	<1	<2	780±390
	U. lactuca	09/1989	02/1990	<1	<2	-
Sarayburnu	E. linza	06/1989	06/1989	<1	6.4±1.2	-
	E. linza	06/1989	07/1989	<1	7.4±6.5	743±165
	E. linza	02/1990	03/1990	nd	4±4	539±84

nd: Not detected.

The radionuclide concentrations of the sediments are shown in Table 2. The highest levels of <sup>134</sup>Cs and <sup>137</sup>Cs were detected at the Sarıyer station. It is assumed that these differences depended on the sediment composition and underwater morphology of the Bosphorus. At the same time, it is well known that the pollutants are introduced through water way into the Bosphorus from the top and bottom currents in the reverse direction. In addition, precipitation rate of the Chernobyl radionuclides was high in the Sarıyer station, probably due to affinity of cesium radionuclides for particle suspended at Sarıyer water column. Discharges of the inorganic and organic chemicals at the Sarıyer station are higher than other stations. However, cesium radionuclides show relatively little affinity with sediments (a distribution coefficient,  $K_D$  of about  $10^3$ ) (Woodhead, 1997). On the other hand, the  $K_D$  at Sarıyer sediment was found to be significantly high level than the other sediment samples collected from the Rumelikavağı and Sarayburnu stations (unpublished data).

Table 2. Radionuclide concentrations in sediment samples  
(Bq/kg dry weight)

Stations	Collection date	Counting date	<sup>134</sup> Cs	<sup>137</sup> Cs	<sup>40</sup> K
Sarıyer	05/1989	05/1989	8.8±1.7	80±3	377±48
	09/1989	03/1990	12.4±1.8	72±2	376±39
	02/1990	03/1990	6.2±4.1	47±5	-
Rumeli Kavağı	05/1989	05/1989	nd	8.6±1.6	364±32
	02/1990	03/1990	<1	7.7±1.9	-
Anadolu Kavağı Sarayburnu	02/1990	03/1990	<1	6.5±2.5	227±50
	06/1989	06/1989	nd	4.5±1.9	181±55
	02/1990	03/1990	<1	6.1±4.0	229±30

nd: Not detected.

### Özet

Bu araştırmada, 1989-1990 yıllarında Boğaziçi makroalg ve sediment örneklerinde <sup>134</sup>Cs, <sup>137</sup>Cs and <sup>40</sup>K radyonüklid konsantrasyonları saptanmıştır. En yüksek <sup>137</sup>Cs radyonüklidini *Enteromorpha linza* türü birtirmiştir. Sarıyer istasyonundan alınan sediment örneklerinin tümünde, <sup>134</sup>Cs ve <sup>137</sup>Cs seviyeleri en yüksek düzeye erişmiştir. Bulgular, Sarıyer istasyonunun Boğaziçi'nin diğer istasyonlarına göre daha fazla kontamine olduğunu göstermiştir.

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