Natural depuration rate of Chernobyl-derived ^{137}Cs in mussels (*Mytilus galloprovincialis*) from the Bosphorus

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During the days following the accident at the Chernobyl Nuclear Plant, increased levels of radioactivity were detected in fish and mussel samples from the Black Sea, Marmara Sea and the Bosphorus (TOPCUOGLU *et al.*, 1988). In this earlier study, ^{131}I, ^{103}Ru, ^{134}Cs and ^{137}Cs were determined and the results have been reported as total activity. Since then, the monitoring programme in our laboratory has especially focused on marine organisms from the Black Sea and Marmara Sea to follow contamination trends after the Chernobyl accident (GUVEN *et al.*, 1990; BULUT *et al.*, 1990).

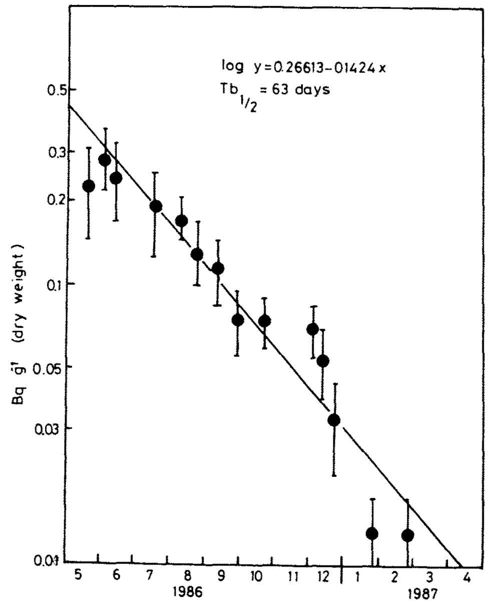
Several papers have been published concerning the biokinetics of ^{137}Cs in marine organisms under laboratory and field conditions. However, data on the biokinetics of ^{137}Cs in naturally-contaminated marine biota following the Chernobyl input are limited (WHITEHEAD *et al.*, 1988). We report here the results of our ^{137}Cs depuration rate measurements in mussels (*Mytilus galloprovincialis*) collected from the same Bosphorus station from May 1986 to February 1987.

Samples were collected at regular intervals and similar-sized mussels were dissected and soft parts were removed for analysis. The soft tissues were dried at 85°C, the dry weight was recorded and the samples were ground to powder and placed in a special cup. The cup was placed directly on a detector of high purity germanium with a resolution (FWHM) of 1.8 keV (at 1332.5 keV for ^{60}Co). All activities were corrected for decay to the date of the Chernobyl accident.

The decrease of ^{137}Cs activity in the mussel with time, or natural depuration rate, was estimated as the biological half-life which was observed under environmental conditions after Chernobyl. The depuration values have been fitted to a single component represented by the equation Log y = Log a+X Log b. From this equation, the depuration rate constant (k=log b*2.3) and biological half-life ($Tb_{1/2}$ = 0.693*k^{-1}) were calculated (Fig. 1).

If we could have obtained more measurements, especially during the first month following the accident, we would have observed an exponential decrease in radioactivity. The biological half-life of 63 days we found is not considerably greater than the 40 days obtained for ^{137}CS in mussels exposed to radioactivity in the Irish Sea (CLIFTON, 1983). Furthermore, a ^{137}Cs biological half-time of 75 days has been reported for a marine clam maintained under field conditions (HARRISON, 1973). On the other hand, WHITEHEAD *et al.* (1988) reported a biological half-life of 300 days in the slow component in mussels exposed to Chernobyl fallout in the northwestern Mediterranean. Clearly, ^{137}Cs depuration rates in Mediterranean mussels are variable and likely depend on several key parameters such as salinity, temperature, and growth, to mention a few.

Fig. 1. Depuration of Chernobyl-derived ^{137}Cs from mussels living in the natural environment.



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A study on the levels of natural gross beta radioactivity of some mollusc species and their sediments from Izmir and Aliaga Bays

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Marine ecosystems receive and accumulate natural and artificial radionuclides from many different sources and ways. Radionuclides when entering bays and estuaries precipitate and settle to the bottom where they are taken up by sediments and biota. Thus radioactive pollution in bay and estuarine waters is potentially hazardous to aquatic organisms, since the radioactive elements are absorbed by bottom dwelling and burrowing organisms not only from water, but also from contaminated sediments. Estuaries and bays serve as a nursery ground for most of the young aquatic organisms.Since the immature forms are most sensitive to many kinds of environmental changes, excessive radioactive pollution could reduce fishery resources (RICE *et al.*, 1970). However a large number of marine biologists who are interested in the subject agree that the present radioactive contamination of the marine environment is not at a dangerous level.

In recent years, fast development and the increase in the number of nuclear power reactors, recent accidents and the use of radionuclides in medicine, industry and in scientific research have led to the production of radioactive wastes in large amounts. Ultimately much of this waste reaches the marine environment. For example, the Chernobyl accident on April 26, 1986 has released large quantities of radionuclides into the atmosphere. This contamination was widely distributed over most parts of Europe. This has given the hydrobiologist the possibility of investigating the fate of radionuclides in the mentioned ecosystem. Due to some characteristics of the marine environment which may dilute or disperse radionuclides, the concentration and localization of radioactivity is very important and requires periodic monitoring to be carried out in different locals (SCHREIBER,1971).During recent years, several regional monitoring studies have been carried out concerning radioactivity levels in different representative species and their Mediterranean environments (GEORGESCU, 1985; AKCAY, 1988, UYSAL, TUNCER, 1986; OZKAYA, 1992).

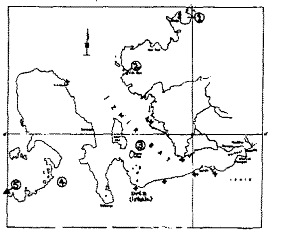

Fig. 1. Sampling stations (+)

In this investigation monitoring has been carried out for the determination of levels of natural gross beta radioactivity in the molluscs; *Mytilus galloprovincialis* Lam. *Tapes decessatus* L., *Cardium edule* L., *Patella* spp., *Venus verrucosa* L. *Natica millepunctata* Lam. and *Sepia officinalis* L. and their surrounding sediments from Izmir and Aliaga Bays. The specimens were collected from different polluted and unpolluted areas of Izmir and Aliaga Bays. The sampling stations are shown on the map in Fig. I. All samples were washed using clean sea water for the removal of sands and other contaminating materials.

Then sample preparation and measurement procedures were performed according to our previous methods (UYSAL and TUNCER, 1986). All the data were corrected for ^{40}K.

The levels of natural gross beta radioactivity in the above mentioned species, which represent different biotopes and environmental conditions, are given in Table 1. As it can be seen from the Table, there are some variations in natural gross beta radioactivitiy between the species and localities. The concentrations of natural gross beta radioactivity in the molluscs of Izmir Bay are higher than those from the other locality.

Table 1. The levels of natural gross beta radioactivity of some Mollusc species and their sediments in Izmir and Aliaga Bays (Bq/g Ash).

Locality		Species	Ash W./ Wet W.%	Ash W./ Dry W.%	Bq/g
Aliağa Bay (1)		-Mytilus galloprovincialis Lam.	4.10	22.12	0.91
		-Tapes decussatus L.	6.38	33.86	0.51
		-Patella spp.	10.39	36.00	1.14
		-Natica millepunctata Lam.	5.73	31.84	0.36
		-Sepia officinalis L.	10.13	37.08	1.39
		-Sediment	26.73	42.68	0.99
Foça Harbour (2)		-Patella spp.	15.94	37.63	0.66
		-Sediment	38.58	45.56	0.81
İzmir Bay (3)	+Homa Fishery	-Mytilus galloprovincialis Lam.	15.91	29.97	0.95
		-Cardium edule L.	4.80	32.89	1.26
		-Patella spp.	5.16	24.08	1.83
		-Sepia officinalis L.	8.68	37.08	3.30
		-Sediment	20.06	39.41	0.95
	+Çalıburnu Fishery	-Tapes decussatus L.	6.94	44.77	1.08
	+Bostanlı (Karşıyaka)	-Tapes decussatus L.	8.13	43.01	1.51
		-Sediment	28.50	47.00	1.12
	+Çakalburnu Fishery	-Tapes decussatus L.	4.51	23.85	1.08
		-Venus verrucosa L.	4.96	30.84	1.33
	+Liman reis	-Mytilus galloprovincialis Lam.	3.41	25.35	1.04
		-Patella spp.	11.40	45.93	0.83
	+Kalabak	-Patella spp.	5.88	29.94	0.84
	+Urla (iskele)	-Patella spp.	10.38	38.52	0.33
	+Karaburun	-Patella spp.	12.56	44.47	1.22
		-Sediment	21.62	46.52	0.36
Ildır (4)		-Mytilus galloprovincialis Lam.	2.89	26.23	1.66
Çeşme Harbour (5)		-Patella spp.	6.38	45.40	1.69
		-Sediment	27.45	44.39	0.37

According to our present data the natural gross beta radioactivity of samples varied between 0.33-3.31 Bq/g Ash. There is correlation between radioactivity and discharged volumes and pollution levels in the Izmir and Aliaga Bays. In general, radioactivity was found in low levels and is in good agreement with regional studies performed previously (GEORGESCU *et al.*, 1984; UYSAL, TUNCER, 1986; PARLAK, 1983; AKCAY, 1988).

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