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Radioactive contamination of the Bulgarian Black Sea Coast due to Chernobyl accident

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INTRODUCTION The Chernobyl nuclear power plant accident released large quantities of vaporized radionuclides, and, to a lesser extent mechanically released small aerosol particles. Fallout radioactivity was likely to have been deposited to the Black Sea during the later stages of the accident (1-6 May)[1]. In order to obtain information on the degree of radioactive contamination of the bulgarian Black Sea coast, sampling and measurements of marine organisms, beach sands and sediments have been carried out. This work was performed under Contract 696/Bulgarian Ministery of Culture, Science and Education.

MATERIALS AND METHODS From the first days of May 1986 our Laboratory of Dosimetry and Radiation Protection was engaged in a routine control of food production. Field measurements and collection of marine samples started two months after the accident. All samples were treated by a dry ashing procedure at 110°C, mechanically homogenized and analyzed with low-background gamma-spectrometer.

RESULTS AND CONCLUSIONS From the results, shown in table 1, some preliminary conclusions could be drawn: 1) As a whole, the bulgarian Black Sea coast is contaminated to a lesser extent, compared with other regions of Bulgaria[2]. Only ^{106}Ru levels in plancton and microphytobentos are similar to observed in most plants from the land; 2) The absence of ^{144}Ce in plancton collected in June-July 1986 is likely to be due to the relatively higher rate of remouval from the surface water column of this more particle reactive radionuclide.

TABLE 1
CONCENTRATIONS OF FISSION RADIONUCLIDES AND ^{40}K IN SELECTED SAMPLES FROM BULGARIAN BLACK SEA COAST / Bq/kg / dry

SAMPLES	^{141}Ce	^{144}Ce	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{95}Nb	^{40}K
PHYTOPLANCTON			380	1400	160	260	340	14500
ZOOPLANCTON				1950	290	480		450
MICROPHYTOBENTOS	880	190-4700	20-760	480-1230	5-310	75-380	72-2500	4300-7100
CHLOROPHYTA	10	200	24-160	66-295	5-60	32-135	10-40	830-3800
PHAEOPHYTA	10-84	45-400	87-220	120-390	13-39	49-107	79-115	2300-2700
RHODOPHYTA	30-32	20-265	28-140	170-490	10-49	30-200	30-64	1000-2900
SEA GRASS *			80	285	37	54	35	2500
MOLLUSCA *			9-11	8-29	2-4	5-7		70-175
FISH *		LD		30	7	14		280
LICHENES		4000	80	1330	880	1950		570
BEACH SANDS	14-43	10-84	45-220	17-75	8-63	13-115	45-130	
SEDIMENTS		10-250		10-150	5-19	5-92	300	90-650

* Bq/kg wet weight

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The contribution of Fish consumption to the dose received by the Greek population due to the Chernobyl accident

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ABSTRACT The concentrations of artificial radionuclides in lake and marine fish samples have been determined after the Chernobyl accident. The related average and critical group doses have been evaluated.

INTRODUCTION The Chernobyl accident resulted in a considerable contamination of the Greek environment with fission and activation products. The major part of the radioactivity arrived in Greece early in the morning of May 2, 1986. Due to the strong differences in the precipitation conditions, the activity deposition vary by 1 to 2 orders of magnitude in different regions of the Country, with maxima clearly correlated with heavy local rainfalls. The average deposition of the radioactive cesium is estimated to be 9± 3 kBq/m2 and regional averages up to 40 kBq/m2 have been measured in certain parts of Central Greece (1,2). By use of the data from the island and coastal regions we estimate the average deposition of total cesium to be of the order of 4 kBq/m2 for the Aegean sea (including the Cretian sea) and 2 kBq/m2 for the coastal region of the Ionian sea.

EXPERIMENTAL Immediately after the accident and its early impact on Greece a sampling program was established in order to collect specific information concerning the contamination of the marine environment. The program included also sediments as well as different species of marine biota. The main sampling period was May 5 to July 25, 1986 while some additional samples were collected on October 1986. The sampling has been implemented by use of the oceanographic ship "Aegaio" as well as of a 400 HP fishing motorboat, while some samples have been provided by the Piraeus fish landing. The samples have been measured in the wet state with the addition of formaldehyde for preservation, due to the special circumstanses (large number of samples, urgent demand for early information). The analysis has been done by use of two high-resolution gamma spectrometry systems (HpGe detectors of 20% and 23% relative efficiency and 2.0 keV FWHM at 1.33 MeV, 4096 chan. analyzers and gamma spectrum analysis software support). Cylindrical and Marinelli geometries of 0.4 l and 0.9 l respectively have been used.

RESULTS and DISCUSSION The concentrations of Cs-137 in marine fish after the Chernobyl accident are of the order of 10 Bq/kg wet mass (mean value), higher typically one order of magnitude than those observed before May 1986 (3,4).
- The concentrations of Cs134+Cs137 in lake fish are typically one to two orders of magnitude higher than those in marine fish. Nevertheless, the 600 Bq/kg limit of the C.E.C is found to be exceeded in one sample only.
- The relatively high values of Ru103 (160 and 1050 Bq/kg w.m.) Zr/Nb95 (120 Bq/kg w.m.) and Ce141 (120 Bq/kg w.m.) observed in fish flesh from two sampling stations probably could be due to the ingestion of hot particle(s), which are characterized by enrichement in non-volatile elements (5). It must be noted that the ingestion is not considered as a critical pathway for exposure to hot particles.
- The fluctuations of the observed values in fish concentrations are supposed to be due mainly to different bioaccumulation of the various species as well as to the different ecological parameters of each region. The data available do not allow a sufficiently valuable correlation with the local activity deposition.
- The estimated doses due to fish consumption are given in Tab.1:

TABLE 1. ESTIMATIONS OF THE EFFECTIVE DOSE EQUIVALENTS COMMITTED DUE TO THE CONSUMPTION OF FISH DURING 1986.

Population group	Fish consumption (kg)	Total activity intake, Bq	Comm. eff. dose, μSv
Average adult	8.3	92 (total Cs)	1.2
Average child 10 yr	5.6	62 ..	0.8
Critical adult	17	3500 ..	47
Critical child 10 yr	11	2250 ..	30

The recently published IAEA conversion factors have been used in the above estimations. The members of the critical groups are supposed to consume purely lake fish with a rate 2 times higher than the average. Concerning the other radionuclides detected in the fish samples, we estimate that their contribution to the total dose is less than 30%. The values in Tab.1 should be considered as overestimations as long as they have been derived under the assumption that the measured concentrations during June 1986 were not changed till the end of this year. These values represent less than 1% and 2.5% of the total doses received by the average and the critical groups respectively. Therefore, we can conclude that the fish consumption has a minor contribution to the first year dose in a region located more than 1000 km away from an accidental radioactivity release to the atmosphere.

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