# Gamma spectrometric analyses of some North Adriatic organisms

*by*

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The study of the contamination of the environment by fission products of heavy elements as a result of the nuclear weapon tests or by radionuclides resulting from the operations of the nuclear industry or nuclear power stations has been a matter of many investigations in the last two decades. Especially attention was paid to the radiocontamination processes which usually occur in the fresh water and the sea environment. Most of the radioecological problems of aquatic organisms have been summarized and presented by POLIKARPOV [1966].

This work presents a part of radioecological studies carried out in this laboratory and it is a continuation of our investigations on gamma spectrometric analysis of organisms from the North Adriatic. In our previous work [STROHAL *et al.*, 1968] we mentioned the presence of six radionuclides in the investigated samples, namely $Mn^{54}$, $Co^{60}$, $Zn^{65}$, $Zr^{95}$, $Ru^{106}$ and $Ce^{141}$.

Samples collected in the North Adriatic sea in the vicinity of Rovinj were dried, carefully ashed at moderate temperatures and powdered. Radioactivity of such prepared samples was checked using a Nuclear-Chicago anticoincident beta counter assembly with the actual background of about 1.5 cpm. Only those samples which showed a considerable beta activity which was not due to $K^{40}$ were selected for gamma spectrometric measurements. This method was described in more details in our previous paper [JELISAVČIĆ, *et al.*, 1968]. All gamma spectrometric measurements were performed using a $3 \times 3''$ NaI(Tl)scintillation crystal attached to the 256-channel analyser. Obtained gamma spectra were corrected for the background, while the calibration and the photopeak efficiency were made by standard methods [CROUTHAMEL, 1960]. Radioactivity of various radiocontaminants varied from 0-100 pCuries per gram of ash of biota.

Investigations in the past twenty years [POLIKARPOV, 1966] allowed us to chose so-called indicator organisms with the purpose to follow the radiocontamination of a certain area. As such indicators we chose phytoplankton, zooplankton, *Fucus virsoides*, *Cystoseira abrotanifolia*, *Mytilus galloprovincialis*, *Loligo vulgaris*, *Clupea pilchardus* and *Scomber scomber*. These organisms or group of organisms are well known to concentrate radionuclides.

From the results presented in Table 1. it can be seen that the best indicator for the presence of artificial radionuclides in a certain area are plankton samples. It can be also seen that plankton sample-accumulate fission produced radionuclides ($Zr^{95}$, $Ru^{106}$, $Ce^{141}$) to a greater extent than those produced by neutron activation ($Mn^{54}$, $Co^{60}$, $Zn^{65}$). Discussing our results one must mention that both, phytoplankton and zooplankton samples, were not free of inorganic and organic suspended matter. Therefore the possible radioecological conclusions based on plankton should be made with care, although there is no doubt that gamma spectrometric control of plankton samples is the most valuable for the radiocontamination control of a certain area.

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Table 1. — Maximum obtained levels of radiocontamination 1966-1968*

| | $Mn^{54}$ | $Co^{60}$ | $Zn^{65}$ | $Zr^{95}$ | $Ru^{106}$ | $Ce^{141}$ |
|---|---|---|---|---|---|---|
| Phytoplankton | T | 6,4 | 8 | 80,9 | 117,6 | 4,6 |
| Zooplankton | 4,7 | 18,4 | 3,4 | 41,4 | 54,7 | 2,4 |
| *Fucus virsoides* | 5,7 | 5 | 1,7 | T | 12 | 7,4 |
| *Cystoseira abrotanifolia* | 1,2 | 19 | 2,2 | 4,2 | 3,3 | 2,7 |
| *Mytilus galloprovincialis* | 2 | 4,1 | 3,3 | 5,2 | 21,4 | NS |
| *Loligo vulgaris* | 2,4 | T | T | T | 5,3 | T |
| *Clupea pilchardus* | 2,9 | 4,3 | T | NS | T | T |
| *Scomber scomber* | 2,6 | 3,8 | T | NS | T | T |

* Data are given in pC/g ash;
NS - not seen
T - traces (less than 1 pC/gram)

Neutron induced radionuclides, particularly $Mn^{54}$, $Co^{60}$ and $Zn^{65}$, can be highly accumulated by marine biota. As was shown by several Japanese authors [SAIKI *et al.*, 1955, YAMADA *et al.*, 1955, KAWABATA, 1955] and by LOWMAN *et al.*, [1957] these radionuclides are often present in fishes. Therefore fishes are good indicators for their presence in a certain area. Our results proved this statement and show contamination level of the North Adriatic with neutron induced radionuclides.

In the group of fission products $Ru^{106}$ is by far the most abundant radionuclide in the discharged radioactive wastes from nuclear installations. It is as well abundant in fallout, and therefore it is very interesting from the radioecological point of view. $Zr^{95}$ is another interesting radionuclide which is usually present in higher concentrations in fallout soon after nuclear explosions. Our results indicate the presence of both. It is believed that the presence of $Zr^{95}$ in analysed samples is due to the Chinese nuclear weapon tests carried out during the period of these investigations. Due to the low concentration of zirconium and cerium in sea water they behave as radiocolloids and become associated with any solid surface available. This may explain higher concentrations of $Zr^{95}$ and $Ce^{141}$ in plankton samples.

In conclusion one may mention that the investigated area was slightly contaminated by fission products as well as neutron induced radionuclides. The level of contamination is moderate, not higher than reported in our previous paper [STROHAL *et al.*, 1968].

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