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**SOME RESULTS CONCERNING THE RADIOACTIVITY OF THE WATERS SEDIMENTS  
AND ORGANISMS OF THE BLACK SEA CONTINENTAL SHELF  
(ROMANIAN COASTLINE) IN 1973.**

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**ABSTRACT**

The authors submit the results of desmectric and spectrometric analysis performed in 1973 on sea water samples, sediments, vegetal organisms, animal organism from the Black Sea pointing out the importance of the Danube as a radionuclides carrier to the marine environment.

The radioactive pollution of the environment and implicit the radioactive pollution of the seas and oceans is a fact proved to a great extent taking into account that more than 50 mil. of Curie radioactive substance polluted the seas and oceans as a result of the nuclear tests made in the air, on the earth and underwater (8; 11).

The radioactive waste resulted because of the radionuclides production and use, though now are in large quantities, for the future it is expected a continuous growth.

The present stage of things and especially the future outlook give rise to national and international programmes for a

permanent checking of the evolution of the degree of radiocontamination.

At the same time the energy crisis will stimulate in addition the uses of the nuclear energy for different purposes, resulting a large series of radionuclides which will contaminate the ambient environment much more than at present.

As a matter of fact at the work with radioactive substances the waste can not be entirely captured and some of them sooner or later will reach directly or indirectly into the waters of the seas, the sea being the main collector of all these wastes.

Our interest in this problem comes from the fact that the Black Sea represents a semi-closed basin, with a different circulation and receives fresh water contribution of about 400 km<sup>3</sup>/year with a large series of radionuclides, whose quantities grow more and more.

After the Second World War, when the marine environment as well as the fresh waters become contaminated with artificial radionuclides the first studies in the field belonging to POLIKARPOV, for the Black Sea. In 1960 he proved with certain facts the contribution of Danube in the Black Sea radiocontamination(6).

Owing to his studies POLIKARPOV opened a large way to the researches in this area, to the dynamics and radionuclides effects in the marine environment and organisms (1; 6).

Intuiting the importance of this field, PORA (7) promoted the first experimental studies about the accumulation and elimination of <sup>32</sup>P in the marine organisms.

After this, the studies more were even more being carried out both in the laboratory and in the sea (2; 3; 4; 5; 9; 10).

This studies are connected both to the radioactive pollution on the sea surface by fall-out and by the establishing of the actual level of waters, sediments and organisms radiocontamination with the purpose to have a control level for the future.

#### THE SAMPLE GATHERING AND THE TECHNIQUE

For the analysis there were gathered a number of 36 samples from which 10 were sea water samples, 10 samples of sediments,

6 samples of vegetal organisms and 10 samples of animal organisms.

The points of the sample gathering were selected so that to make possible the comparison of activity values of the water and sediments brought by the Danube with those available in the zone of the romanian continental shelf.

The marine zone was extended between Sulina and Vama Veche, the water samples being gathered from the surface level of the isobaths of 10 meters and 20 meters.

The vegetal organisms were gathered from the shore zone, extended between Năvodari and Vama Veche, and the animal organisms were captured at the set nets with trap in the same zone.

The sea water samples were gathered in plastic vessels with a volume of 20 liters, then they were filtered with normal filter paper and infra-red dried.

The sediments were gathered from the surface level by means of the bodengreiffer, being gathered only the superficial layer bed with the help of a plastic spatula. The thickness of the superficial layer bed was of maximum 1 cm.

After that the silt was passed through some screens to retain the coarse substances, the silt was dried by the means of the infra-red method and then followed the homogenizing operation with the help of the mortar.

The samples of vegetal and animal organisms were dried by the means of the infra-red method and then followed the roasting operation at a temperature of 400°C.

The samples so prepared have been weighed and were subject to measurements of the activity.

For the global activity measurements we used an installation type "CUANTA" calibrated by means of  $^{90}\text{Sr}$  100 pCi source.

The results have been expressed in pCi/g ashes for organisms and p Ci/g dry sediment.

## THE OBTAINED RESULTS AND THEIR DISCUSSION

### THE SEA WATER ACTIVITY

Because the water has a low activity level we appreciated that the obtained salt from its evaporation constitutes the true reflection of the radiochemical content and from a

technical point of view this method presents also the advantage of more comfortableness so making possible the water activity estimation.

In table 1 are given the results of the global activity measurements of the samples.

From the behaviour of the above mentioned activity values results that the sample collected on the Dunărea Veche point Mila 23 presents the greatest activity, and the sample collected at Năvodari has a low activity lower than 3 standard deviations ( $R < 3 \sqrt{\quad}$ ). This low activity can not be taken into consideration significant.

Table 1

Sea water samples activity

The place of gathering and the isobath	$\Lambda \left[ p \text{ Ci/g} \cdot 10^{-3} \right]$
Mila 23 (surface)	6076
Sulina (surface)	461
Portița (20 m)	337
Sf.Gheorghe (10 m)	888
Chituc (20 m)	1283
Năvodari (20 m)	unsignificant
Est Constanța (20 m)	541
Tuzla (20 m)	90
Mangalia (20 m)	82
Vama Veche (20 m)	1240

A great activity can also be found in Chituc zone and Vama Veche zone while Tuzla and Mangalia zone proved that they are points with smallest activity.

The other samples prove activities from 337 p Ci/g·10<sup>-3</sup> to 888 p Ci/g·10<sup>-3</sup> and that indicates the presence of many active radionuclides.

#### THE ACTIVITY OF THE SEDIMENTS

The research made on the superficial sediments from the inferior Danube and the continental shelf (Sulina - Vama Veche) was intended: on the one hand to establish the radionuclides

composition of the Danube and the sea, and on the other hand to establish the general activity of the sediments.

Table 2 shows the global activity values.

From the comparative analysis of the figures presented in the above mentioned table results that the most active sediments are those situated in the zone of straight influence of the Danube (Sulina, Sf.Gheorghe, Portița) and those situate at Tuzla point.

Table 2

The activity of the sediment samples

The gathering place and the level	$\Lambda \left[ \text{p Ci/g} \cdot 10^{-3} \right]$
Canal Sulina	1021
Est Sulina (10 m)	1397
Est Sulina (20 m)	1055
Dunărea Veche (Mila 23)	936
Portița (10 m)	981
Portița (20 m)	975
Cap Midia (20 m)	919
Est Constanța (20 m)	699
Tuzla (20 m)	1367
Vama Veche (20 m)	920

This denotes that as the settling of the slurries is produced, as a result of sea water and fresh water mixing yields a decrease of the activity value; nevertheless the activity value is maintained at a high level (669 - 981 p Ci/g·10<sup>-3</sup>) owing to the naturally occurring isotopes activity.

The case of the point Sulina 10 m where the activity is the highest one (1397 p Ci/g·10<sup>-3</sup>) can be explained by dislocation velocity retardation of the Danube waters after their contact with the sea waters. This facilitates the quick settling of the particles in slurry which changed also their state of electric loading; at the some time a lot of radionuclides come out of the hydrochemical run.

## THE ACTIVITY OF THE VEGETAL ORGANISMS

The results of the global activity measurements for the vegetal organisms showed in table 3 indicates that the range of variation includes both insignificant values (with activities smaller than 3 standard variations) and bigger values of 17009 p Ci/g.10<sup>-3</sup> ashes.

Table 3  
The activity of the vegetal organisms samples

Species	$\Delta$ p Ci/g.10 <sup>-3</sup>
Enteromorpha intest.	unsignificant
Enteromorpha linza	8650
Cystoseira barbata	17009
Zostera sp.	4535
Phyllophora sp.	3536
Ceramium rubrum	7538

As can be noticed the alga Cystoseira barbata (17009 p Ci/g.10<sup>-3</sup>) has the highest activity, then follows the alga Enteromorpha linza (8650 p Ci/g.10<sup>-3</sup>), Ceramium rubrum (7538 p Ci/g.10<sup>-3</sup>) and the gramineous Zostera (4535 p Ci/g.10<sup>-3</sup>).

## THE ACTIVITY OF THE ANIMAL ORGANISMS

The results of the radiometric measurements made on animal organisms are given in Table 4.

From the comparative analysis of the figures presented in the above given table with those given in the table 3 relating to vegetal organisms results that the animal organisms activity is plainly inferior to that of the vegetal organisms.

This state can be explained only by the biological activity specific because the algae reflect more really the environment radiochemical composition; at the some time the degrees of concentration for different elements in algae are much more than in animals.

The most active specie is Belone belone euxinii (9406 p Ci/g.10<sup>-3</sup>) and then Trachurus mediterraneus ponticus (4602 p Ci/g.10<sup>-3</sup>); the other species show comparatively small activity

values about  $1100 \text{ p Ci/g.} \cdot 10^{-3}$ ) ash, the values are still significantly.

Table 4  
The activity of the animal organisms samples

Species	$\Delta \text{ p Ci/g.} \cdot 10^{-3}$
<i>Odontogadus merlangus euxinus</i>	632
<i>Trachurus mediterraneus ponticus</i>	4062
<i>Engraulis encrassicholus ponticus</i>	unsignificant
<i>Belone belone euxini</i>	9406
<i>Solea lascaris</i>	1776
<i>Trigla lucerna</i>	1820
<i>Gaidropsarus mediterraneus</i>	1563
<i>Sprattus sprattus</i>	1197
<i>Mya arenaria</i>	1282
<i>Carcinus mediterraneus</i>	1186

The gama spectrometric analysis made on the water, sediments and organisms samples made obvious the presence of the following radionuclides:  $^{40}\text{K}$ ,  $^{214}\text{Bi}$ ,  $^{137}\text{Cs}$ ,  $^{125}\text{Sb}$ ,  $^{144}\text{Pr}$ ,  $^{60}\text{Co}$ ,  $^{228}\text{Ac}$ ,  $^{214}\text{Pb}$ ,  $^{106}\text{Ru}$ ,  $^{208}\text{Tl}$ .

Since some of these radionuclides are also beta-emitters  $^{40}\text{K}$ ,  $^{137}\text{Cs}$ ,  $^{144}\text{Pr}$ ,  $^{106}\text{Ru}$ ,  $^{60}\text{Co}$ ,  $^{125}\text{Sb}$ , it is explainable the matter of fact that the activity of the gathered samples is significantly.

#### CONCLUSIONS

- The Danube represents a very important radionuclides carried to the Black Sea, the effects being felt in water, sediments and organisms.

- The activity of the vegetal organisms is higher than those found at the animal organisms.

- The most active species are the alga *Cystoseira barbata* and *Enteromorpha linza* as well as the gramineous *Zostera* sp. and among fishes, *Belone belone euxini* and *Trachurus mediterraneus ponticus*. These species can be taken into consideration at our sea coast for the estimation of the sea radiocontamination

level.

- Between the radiochemical composition of the salt obtained from the sea water, the radiochemical composition of sediments, vegetal and animal organisms on the one hand, and the Danube water and sediments on the other hand does not exist qualitative differences but only from the point of view of the entire activity.

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