Bulgarian Journal of Agricultural Science, 21 (Supplement 1) 2015, 106–110
Agricultural Academy

BIOLOGICAL AND RADIOECOLOGICAL STUDIES OF SOME BENTHIC ORGANISMS AND SEDIMENTS IN THE COASTAL ZONE ALONG THE BULGARIAN BLACK SEA COAST

E. PETROVA[1], S. STOYKOV[1], D. STANEVA[2], L. MISHEVA[2] and I. YORDANOVA[2]
[1]*Institute of Fish Resources, BG – 9000 Varna, Bulgaria*
[2]*Institute of Soil Science, Agrotechnology and Plant Protection „Nikola Poushkarov", BG – 1080 Sofia, Bulgaria*

Abstract

PETROVA, E., S. STOYKOV, D. STANEVA, L. MISHEVA and I. YORDANOVA, 2015. Biological and radioecological studies of some benthic organisms and sediments in the coastal zone along the Bulgarian Black Sea coast. *Bulg. J. Agric. Sci.,* Supplement 1, 21: 106–110

The present paper includes the biological studies of the biodiversity of macrozoobenthos in the marine coastal area and radioecological studies for the presence of natural and anthropogenic radionuclides in some benthic organisms and sediments in the period 2010–2012. Macrozoobenthos samples were taken from the board of R/V „Prof. Al. Valkanov" by "Van-Veen" grab with opening mouth 1/10 m^2. The samples for radionuclides were analyzed by gamma-spectrometry with a multichannel analyzer DSA 1000 with Ge-detector. It was determinate the specific activity of the following radionuclides: the technogenic Cesium-137, the natural Thorium-134, Uranium-235, Radium-226, Actinium-228 and Potassium-40. It was made analysis and evaluation of the results. The biodiversity of benthic organisms is an indicator of the water pollution state and the radioecological cleanliness is utmost importance, due to the use of some zoobenthos organisms for food.

Key words: Black Sea, biological and radioecological studies, benthic organisms, sediments

Introduction

The pollution of the waters affected on biodiversity in Black Sea, particular on benthic organisms (especially attached forms) and they can be used as indicators of pollution. Due to its geographical location and limited water exchange with the World Ocean, the Black Sea is the most contaminated with artificial radioactivity. Anthropogenic radio nuclides originate mainly from two sources: major sources and atmospheric nuclear testing and weapons made before 1963 and the Chernobyl nuclear accident in April 1986 (Buesseler and Livingston, 1996). Besides of the environmental role of zoobenthos species, parts of them are subject to economic interest and used as food. Thus require investigation related to the radio ecological purity and increase the safety for human health. The main goal of the investigations, subject of the present paper was to establish the water pollution stage using biodiversity of benthic macroinvertebrates as indicator along the Bulgarian Black Sea coast, as well as availability of natural and artificial radio nuclides content in marine organisms (plant and animal origin) in their environment and sediments.

Materials and Methods

Studies for macrozoobenthos and radio nuclides were conducted in 2010–2012 with R/V „Prof. Al. Valkanov" in Varna Bay and Varna Lake system (Varna and Beloslav Lake) by determinate scheme of stations. In addition were collected samples for radio nuclides in sediments for comparison from coastal area in front cape Galata. It was collecting 70 benthic samples, taken by grab „Van-Veen", with opening mouth 1/10 sq.m. Primary processing of samples (washing through series of sieves) is performed on the vessel board. After that the materials were preserved in 4% formaldehyde.

In laboratory was done taxonomic identification of species composition (Morduhay-Boltovskoy, 1968, 1969, 1972;

Marinov, 1977), determining the quantitative characteristics (abundance and biomass) and statistical processing of the data.

The samples for radio nuclides are processed in the Laboratory on radioecology and radioisotope studies, Institute of Soil Science "Nikola Poushkarov". Quantification of the radio nuclides was done by validated methods applied routinely in the laboratory (Naydenov et al., 2001).

The activity of gamma-emitting radio nuclides are determined by multichannel analyzer CANBERRA with Ge/Li semiconductor detector with relative efficiency 12%, resolution 1.8 Kev (for 661.6 keV) and pure Ge detector with relative efficiency 20% and a resolution of 1.3 KeV. Error of the individual measurements was in the range 5-10%. The samples were homogenized and carried spectrometric analysis to determine the specific activities of Cesium-137, Thorium – 234, Uranium-235, Radium-226, Actinium-228 and Potassium-40.

Results and Discussion

Coastal area – Varna Bay and Varna Lake system (Varna and Beloslav Lake) – Macrozoobenthos

Varna Bay

The species composition during investigated period established 56 taxa, divided into four main groups: *Polychaeta, Mollusca, Crustacea* and *"Diversa"*. In comparison with previous periods (2000–2002), (Petrova, 2008), where the species composition was in limit 54 to 61 during different years shows similar values. Percentage proportion of benthic macroinvertebrate groups throughout the period of study is presented in Figure 1.

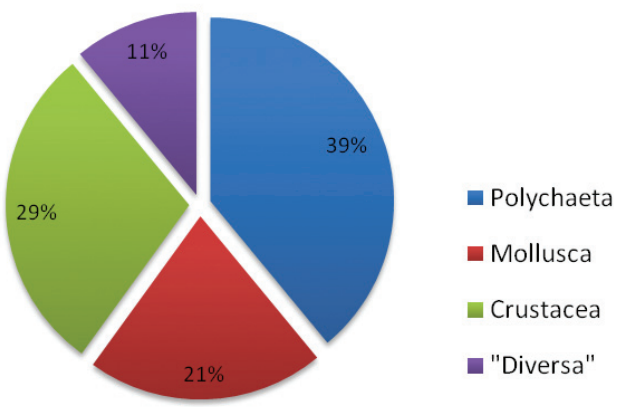

Fig. 1 Percentage distribution of benthic groups in Varna Bay in 2010–2012

The highest percentage during the period is for Polychaeta group – 39%, followed by crustaceans – 29% and molluscs – 21%. From the polychaetes meet typical species, as *Prionos piocirrifera,* from molluscs *Cerastoderma edule* and *Chamelea gallina,* observed with greater numbers of sand-muddy sediment. The common crustacean species were *Ampelisca diadema* and *Balanus improvisus.*

The average abundance of the macrozoobenthos in Varna Bay for the period 2010–2012 was estimated at 714 in d / m^2 and the average biomass – 108 $g.m^{-2}$. Graphic expression of the average quantitative values by groups for the entire period is given in Figure 2.

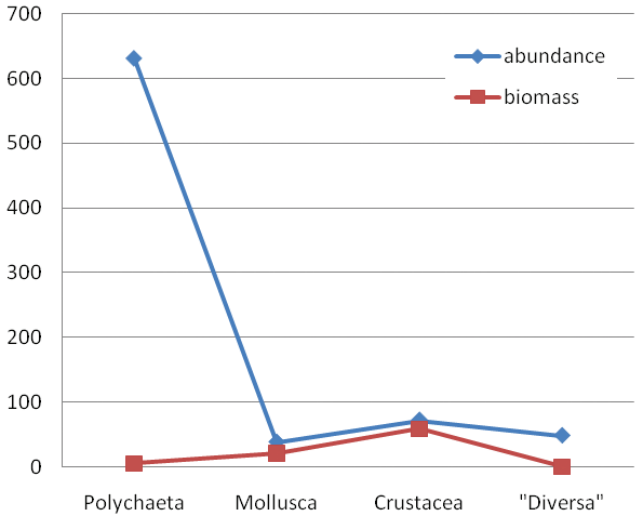

Fig. 2. Average abundance (ind/m^2) and biomass (gr/m^2) in Varna Bay by groups in 2010–2012

In comparison to 2000–2002, when the average value swere 992 ind/m^2 and 895 $g.m^{-2}$, the quantitative parameters show downward. Significantly lower amount of biomass due to the reduced presence of mollusc species which are with higher individual weights.

Varna Lake System (Varna and Beloslav)

For the observation period were identified 12 macro zoobenthos species vary from 7 to 10 species over the different years. Percentage correlation between the three groups is present in Figure 3.

The highest percentage is for polychaetes (42%), with typicals pecies *Nereis diversicolor, Prionospio cirrifera,* which are detritofag and resistant to increased pollution and molluscs *Cerastoderma edule* and *Mya arenaria,* which have a euryhaline nature. The last referred species *(Mya arenaria)* appears as a nadditional biofilter in the coast al-

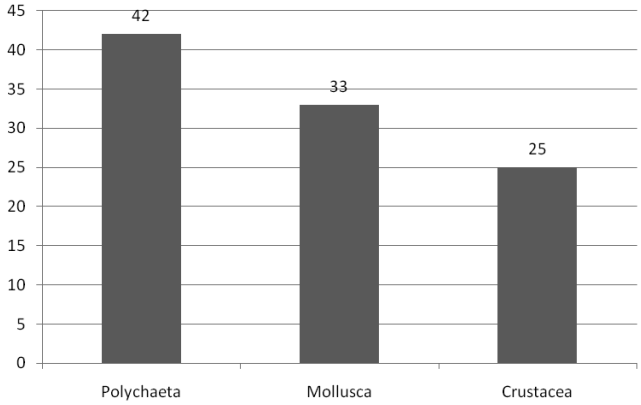

Fig. 3. Distribution of benthic groups in Varna Lake system in 2010–2012

zone, which is extremely important in areas of eutrophication (Zaitsev and Ozturk, 2001).

The total average abundance equal to 656 ind/m ^{2} and biomass 130 g.m^{-2} (Figure 4). The high values of abundance and biomass in Varna Lake system in comparison to previous periods of investigations is due to the falling of aggregation of polychaete *Mercierella enigmatica* and the mussel *Mytilus galloprovincialis.*

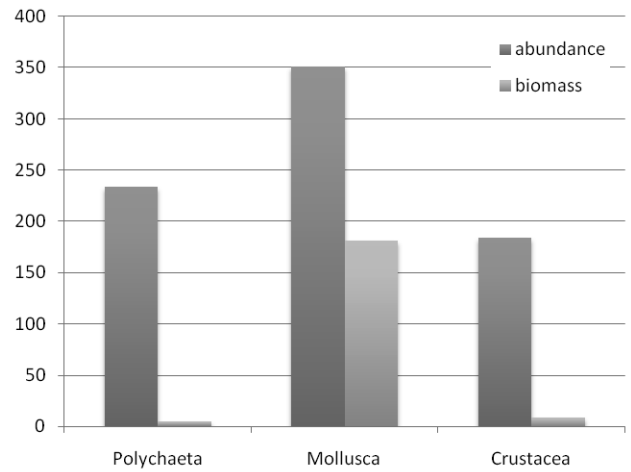

Fig. 4. Average abundance (ind/m^2) and biomass (gr/m^2) by groups in Varna Lake System in 2010-2012

The species *Mercierella enigmatica* is euryhaline species that inhabits coastal basins of meso-haline type and shallow bays (Marinov, 1977).

Data for the abundance and biomass during the period showed a difference in values over the three years studied. In the abundance for the entire period dominated polychaete sand mollusc sand the biomass is built from mollusc species

For characteristic of the biodiversity of benthic communities (based on data for the number of benthic species) were identified following indices: Number of species (S), total number (N), species richness (d), Uniformity (J′), Species diversity (H′). The average results of Varna Bay and Varna Lake System for the period 2010–2012 are shown in Table 1.

Table 1

Determinate indices for macro zoobenthos in Varna Bay and Varna Lake system in 2010–2012

Varna Bay	S	N	d	J′	H′
2010	3–14	180–1790	0.33–2.06	0.41–0.93	0.41–2.84
2011	5–14	280–1740	0.71–2.08	0.44–0.91	1.41–2.95
2012	8–12	410–760	1.16–1.67	0.73–0.84	2.19–2.74
Lake System					
2010	1–5	10–16 200	0.29–0.64	0.57–0.98	0.91–1.93
2011	1–3	10–220	0.22–0.44	0.77–0.81	0.38–0.51
2012	1–3	10–200	0.23–0.40	0.70–0.72	0.40–0.47

The number of species in Varna Bay is between 3–13 at the different stations and abundance from 180 to 1790 ind/m^2. The calculated indices displayed irregular distribution of the species in the Bay. In Varna Lake system, the number of species is small and varies 1–5 in different stations. There are large variations in the values of the number, which indicates the instability of the water ecosystem.

Studies of radionuclides in marine organisms and sediments from the Black Sea

During investigated period are collected samples for radionuclides content from marine organisms (rapana, black mussel, macrophytes, and fish) and sediments.

The results are calculated as the specific activity of the radionuclide per kilogram dry weight (Bq.kg^{-1}). Identified specific activities of the following radionuclides: Cesium-137, Thorium-234, Uranium-235, Radium-226, Actinium-228 and Potassium-40. The results of gamma-spectrometric analysis of the samples from marine organisms are presented in Table 2.

The majority of samples of studied radioactive elements were detected within the permissible error. Highest values of specific activity were recorded for K-40, which is expected, due to the fact that K-40 is actively involved in the physiological processes of living organisms.

In all samples the studied radionuclides are above the level of detectability. In the results of specific activity of the radionuclides are not detected outliers from the background areas cited in the literature.

The results for Cesium-137 in sediments from different depths is in the range of soil samples from the area, confirming sorbtsoinnite properties of sediments (Figure 5, Table 3)

Table 2

Results of gamma spectrometric analysis of samples of rapana, mussels, fish and macrophytes during the survey period

Samples	Cs-137	Th-234	U-235	Ra-226	Ac-228	K-40
Rapana (meat and shells)	0.2 ± 0.1 – 0.5 ± 0.2	–	< 2 – 2 ± 1	–	< 1	25 ± 2 – 74 ± 7
Macrophytes	≤ 0.5	4 ± 1	≤ 0.5	2 ± 1	2 ± 1	120 ± 10
Black mussel akvaferma	≤ 0.5	6 ± 2	≤ 0.5	1 ± 0.5	1 ± 0.5	4 6 ± 4
Black mussels	≤ 0.5	6 ± 2	≤ 0.5	8 ± 4	4 ± 2	70 ± 20
Fish	0.6 ± 0.2	1 ± 0.5	≤ 0.3	≤ 0.65	1 ± 0.5	86 ± 5

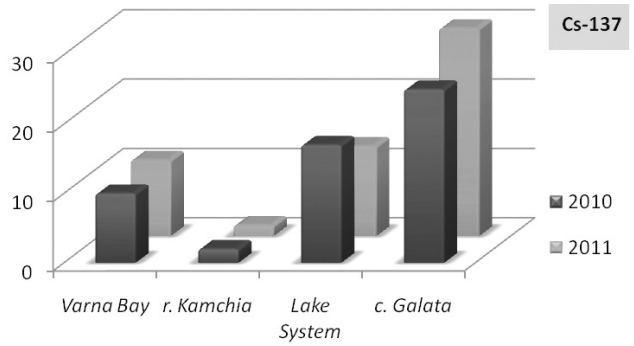

Fig. 5. Average values for Cs-137 in sediments of the studied areas

Table 3

Results of gamma spectrometric analysis for Cs-137 in sediment samples

Samples	Depth, (m)	2010	2011
Varna Bay (9 points)	14–17	11 ± 8 min 3.9 ± 0.2 max 26 ± 1	10 ± 7 min 2 ± 0.5 max 22 ± 1
In front mouth of River Kamchia (2 points)	10–12	1.6 ± 0.2 – 3 ± 0.5	2 ± 0.5 – 43 ± 2
Varna Lake System (9 points)	5–10	13 ± 6 min 9 ± 2 max 30 ± 3	17 ± 7 min 8 ± 2 max 30 ± 3
In front cape Galata (9 points)	20–23	30 ± 8 min 15 ± 1 max 40 ± 1	25 ± 9 min 12 ± 1 max 42 ± 3

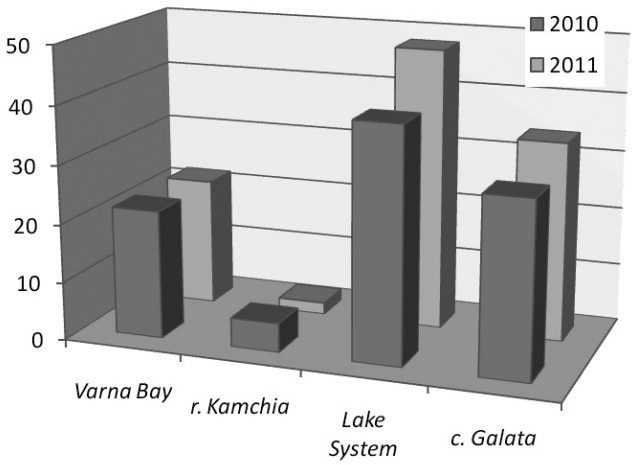

Fig. 6. Results of gamma spectrometric analysis for Th-234 in sediment samples

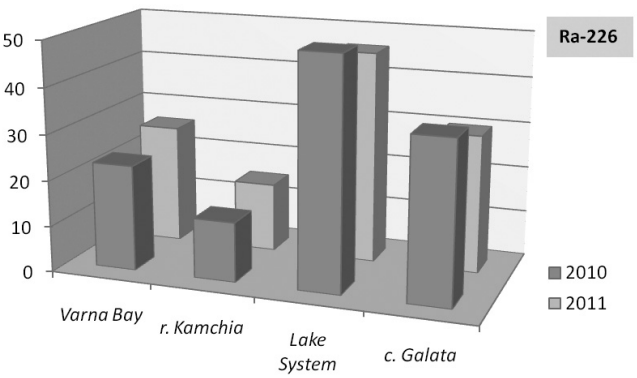

Fig. 7. Results of gamma spectrometric analysis for Ra-226 in sediment samples

The higher activity of Cs-137 in samples in front cape Galata, which is probably due to the greater depth of sampling and mud composition of the sediments.

Lower values found in sediments from River of Kamchia, probably due to the effect of washout by flowing water and the sand sediment. The content of Cs-137 in the studied sediments in both years didn't change significantly.

The activity of natural radioactive elements is within the normal for this area (Figures 6 and 7). The values are within the average for this region of Bulgaria and are the result of contamination after the accident at the Chernobyl nuclear power plant (1986). The results are within the levels established by previous studies in the area (Yordanova et al., 2008).

Conclusions

In the period 2010–2012 in Varna Bay during was observed reduced presence of the molluscs species, both in

species composition and the quantitative parameters and they are the main biofilter in seawater. Over the next two years of research period, there is a strong presence of small size molluscs species, as evidenced by the low value of biomass;

In studies of benthic macroinvertebrates according to the classification system of biological elements, which is based on the index of species diversity (H) the Varna Bay fall in status – good and moderate state during the three years of the period;

Both lakes Varna and Beloslav fall in status bad or very bad condition, except for station A-22 (H′ – 1.93), which falls in a moderate status in spring of 2010, because of closeness of this point to the sea;

In all sample the studied radionuclides are above the level of detectability. In the results of specific activity of the radionuclides are not detected outliers from the background areas cited in the literature.

The behavior of natural and artificial radionuclides not been well studied and there are no systematic data regarding both the content and their physico-chemical characteristics along the Bulgarian Black Sea coast. The results are within the levels established by previous studies in the area.

References

Buesseler, K. O. and H. D Livingston, 1996. Natural and man-made radionuclides in the Black Sea. In: Radionuclides in the Oceans: Inputs and Inventories, Editions de Physique, IPSN

Marinov, T., 1977. Fauna of Bulgaria. v.6, Polychaeta, S., *BAS,* 257 pp. (Bg).

Morduhay-Boltovskoy, M. D. (Ed.), 1968. A key to Black Sea and Azov Seafauna, vol. I, Kiev, *Naukova Dumka,* 437 pp. (Ru).

Morduhay-Boltovskoy, M. D. (Ed.), 1969. A key to Black SeaandAzovSeafauna, vol. III, Kiev, *Naukova Dumka,* 340 pp. (Ru).

Morduhay-Boltovskoy, M. D. (Ed.), 1972. A key to Black SeaandAzovSeafauna, vol. II, Kiev, *Naukova Dumka,* 536 pp. (Ru).

Naydenov, M., L. Misheva, I. Yordanova, D. Staneva and L. Dureva, 2001. Proceedings of methods for the determination of alpha, beta and gamma emitting radioisotopes in environmental objects, NCAN, Sofia, 40 pp. (Bg).

Petrova, E., 2008. Composition and Distribution of the Macrozoobenthos along the Bulgarian Black Sea Coast and Some Coastal Lakes. PhD thesis. (Bg).

Yordanova, I., D. Staneva, Ts. Bineva and E. Petrova, 2008. Preliminary results for content of natural and artificial radio nuclides in some marine objects from Black Sea coast. *Journal of Food Physics*, ISSN – 1416–2083, pp. 258–266.

Zaitsev, Yu. and B. Ozturk, 2001. Exotic Species in the Aegean, Marmara Black Azov and Caspian Sea. *Turkish Marine Research Foundation*, **8:** 266.