GENOTOXICITY ENVIRONMENT EVALUATION IN THE DOLJ DISTRICT (ROMANIA)

MIHAELA CORNEANU, GABRIEL CORNEANU, LUMINIȚA COJOCARU, CONSTANTIN NEȚOIU

Abstract. *The radionuclide amount from soil and two radiobiological indicator species (Salix alba and Taraxacum officinale), in seven stations situated under incidence of the NEP Kozlodui (Bulgaria), in the Mart month, 2007 year were analyzed. A high content in radionuclide in soil was recorded, the values decreased with the moving of the NEP Kozlodui. The values recorded in the Gighera station (situated near NEP Kozlodui), enhanced the average recorded in Romania for K-40, Ra-226 and Ac-228 radionuclide. The analysis of the radionuclide content from the leaves of the two vegetal species (Salix alba and Taraxacum officinale), pointed out their capacity to accumulate and stored in leaves radionuclide from soil, water and air, the both species can used as phytoremediatory species, having ability to phytoextraction and phytoaccumulation of the radionuclide from environment. The Allium test use, point out the cytogenetics effects induced by pollution environment with radionuclide. There were found very significantly correlations between the percent of aberrant cells in Allium cepa mitosis and the total content radionuclide, the highest values for correlation coefficient being recorded in U-235, Ra-226, and Th-234. Plant bioassays, which are most sensitive in detecting genotoxicity of environmental agents, can serve as the first alert for the presence of environmental hazards in water, air and soil.*

Keywords: *Genotoxicity, radionuclide content, Allium test, NEP Kozlodui activity effect.*

Rezumat. Evaluarea genotoxicității mediului în județul Dolj (România). *A fost analizată cantitatea de radionuclizi din sol și două specii indicator radiobiologic, în șapte stațiuni aflate sub incidența activității CEN Kozlodui (Bulgaria), în luna martie 2007. A fost înregistrat un conținut înalt de radionuclizi în sol, valorile înregistrate descrescând cu depărtarea față de NEP Kozlodui. Valorile înregistrate la stațiunea Gighera (situata în fața NEP Kozlodui), au depășit media pe țară pentru K-40, Ra-226 și Ac-228. Analiza conținutului în radionuclizi din frunzele celor două specii vegetale (Salix alba și Taraxacum officinale), a subliniat capcitatea lor de a extrage și stoca în frunze radionuclizii din sol, aer, sau apă, ambele specii putând fi utilizate ca specii phytoremediatoare, având capacitate de fitoextracție și fitoacumulare a radionucliziulor din mediu. Utilizarea testului Allium și a indicelui BR a evidențiat efectele citogenetice induse de mediul poluat cu radionuclizi. Au fost depistate corelații foarte semnificative între procentajul de celule aberante în mitoza de la Allium cepa și conținutul total în radionuclizi, cele mai înalte valori pentru coeficienții de corelație fiind înregistrați pentru U-235, Ra-226, Th-234. Utilizarea speciilor radiosensibile (plant bioassays), care sunt cele mai sensitive în detectarea genotoxicității agenților din mediul ambient, pot fi utilizate ca indicatori ai prezenței unor noxe în apă, aer sau sol.*

Cuvinte cheie: *Genotoxicitate, conținut în radionuclizi, Allium test, efectul activității CEN-Kozlodui.*

INTRODUCTION

The Dolj district, together with a part from the Olt, Gorj, Teleorman and Mehedinti districts constitute a region with nuclear risk, because of the Kozlodui NEP activity, situated in the South of the Danube River, in Bulgaria Republic. Under effect of NEP Kozlodui activity, the content of radionuclide in soil and vegetation present upper values. Inner an area of a hemisphere shape, with a ray of 20 km from NEP Kozlodui, the exposure dose can reach 0.3 – 0.5 Sv (CHIOSILA, 1998). In this area there are 15 villages with a population of almost 100,000 inhabitants (Fig. 1). The content in radionuclides in soil and plant near NEP Kozlodui present upper values (Fig. 1). Regarding the content in radionuclide in soil or vegetation in this region, were effected some investigations, establishing both the content in radionuclide (CORNEANU et al., 2003), as well as the cytogenetic effects on some genetic indicator species (CORNEANU et al., 2003).

Also the radioactivity in Romania and Bulgaria was enhanced after the NEP Chernobyl accident. Pertinent data regarding the NEP Chernobyl accident in Romania, are presented in some volumes and papers edited by Romanian Society for Radiological Protection (MILU et al., 1994; ONCESCU et al., 1995; ONCESCU, 1996, CORNEANU et al., 2000, a/o).

The investigations performed in Bulgaria, in the Franco-Bulgarian project OM2 (summer of 1993 year), for mountain environment monitoring and management (Rila National Park, Rila Mountains), indicate that the impact of the Chernobyl disaster is still dominant (STAMENOV et al., 2005). Several animals and plant species were found and recommended as radiobiological indicators. Recent research performe in Bulgaria, regarding the plutonium isotope fund in the area of NEP Kozlodui in comparison with the Rodope Mountains, reveal similar values (MISHEVA, 2005).

Artificial radionuclide appeared as a result of nuclear energy production (Cs-137, Cs-134, Sr-90, I-131, U-235 a.o.), as well as the natural ones from by-products or wastes (Ra-226, Ra-228, U-238, Th-232, Ac-228, Pb-214, Bi-214, Bi-212, Ac-228) having physicochemical properties similar to some constituent chemical elements of living organisms, are metabolized and arrive finally, through different natural trophy chains, into the human organism (CHIOSILA, 2004). Many of these radionuclide mentioned before were found in the samples collected from our considered area. Some features of this radionuclide are presented in Table 1.

In Romania, there are four areas of nuclear hazard (CHIOSILA, 1998), the main region being the region from this study, under incidence of the NEP Kozlobui. Over the radioactivity from this region, were published many studies in the recent period (CORNEANU et al., 2000, 2003, 2005, a/o).

Fig. 1. Villages from Romania, under activity incidence of NEP Kozlodui (after CHIOSILĂ, 1998).
Fig. 1. Localități din România aflate sub incidența activității CEN Kozlodui (după CHIOSILĂ, 1998).

Table 1. The features of some radionuclide.
Caracteristicile unor radionuclizi.

Radionuclide	Physical T1/2	Emitted radiations	Critical organ	Biological/ effective T1/2
Ac-228	21.773 years	β, γ	Whole body	≤ 10 days
Be-7	53.44 days	Neutrinos, γ	Whole body	280/44.84 days
Bi-210	5.01 days	α, β, γ, antineutrinos	Kidney	6.34/2.8 days
Cs-137	30.0 years	X, β, γ, antineutrinos	Muscle, conjunctive tissues	140/138 days
K-40	1.27 mid. Years	X, β, ν	Whole body	1.429 x 10 y. / 1.204 x 10 y.
Pb-212	10.64 hours	β, γ, X, antineutrinos	Kidney	531 / 10.43 days
Ra-226	1,600 years	α	Bone system	4.5 y (bone)
Th-234	24.10 days	α	Whole body	24.10 days
U-235	703.8 mil. Y.	α, γ	Whole body	300 d (bony)

PLANT BIOASSAY

Plant bioassays, which are most sensitive in detecting genotoxicity of environmental agents, can serve as the first alert for the presence of environmental hazards in water, air and soil (GOPALAN, 1999; cited by CORNEANU et al., 2007). Therefore meristematic and sporogenic tissues of plants generally show patterns of cytotoxic response similar to those of embryogenesis and spermatogenesis tissues of vertebrates (KRISTEN, 1997, cited by CORNEANU et al., 2007). The previously researches performed by our collective (CORNEANU, 2000, 2003, 2005), pointed out that some vegetal species can accumulate in their organism different radio-nuclides from soil, water or air (*Taraxacum officinale*, *Convolvulus persicum*, *Thlaspi* sp, a/o). Some genes of the plants synthesis chelating compounds (*methallo-thioneins* and *phytochelatins*) with role in the extraction of the heavy metals and/or radionuclide from environment (soil, water), being implicate in the *phytoremediation* process.

THE PHYTOREMEDIATION PROCESS

Some plants present property for the reduction of the amount of the heavy metals, radioactive elements or other pollution element from the environment. The phytoremediation consist in use of plant for the remediation of environment quality through moving of noxious organic substances, radionuclide and heavy metals from soil and water (RUSKIN et al., 1994). The researches performed in different countries, underlined some vegetal species with role in decontamination: *Thlaspi* sp., *Populus* sp., *Medicago sativa*, *Phaseolus vulgaris*, *Helianthus annuus*, *Taraxacum officinalis*, a/o. Were identified three enzymes classes (metalthionine, phytochelatine and nitrosoreductase), with capacity to chelate heavy metals and radionuclide from soil, water and probably from air in *T. officinale*). This process was used in the environment decontamination around the NEP Chernobyl (Ukraine). After the main action, exist many processes of decontamination.

* *Phytoextraction*–uptake of substances from the environment, with storage in the plant (*phytoaccumulation*).
* *Phytostabilisation*–reducing the movement or transfer of substances in the environment.
* *Phytostimulation*–enhancement of microbial activity for the degradation of contaminants, typical around plant roots.
Phytotransformation–uptake of substances from the environment, with degradation within the plant (*phytodegradation*).
* *Phytovolatilization*–removal of substances from the soil or water with release into the air, possibly after degradation.
* *Rhizofiltration*–the removal of toxic metals from ground water.

In Romania, studies on the phytoremediation process were performed by CORNEANU et al. (2007)

MATERIALS AND METHOD

Area of investigation

The investigations regarding the content in radionuclide in soil and vegetation as well as their effect on the genetic material of some tester genetic species were performed in an area around NEP-Kozlodui, only in Romania, near Danube vale. The soil and vegetation samples, in seven villages: Bechet, Zaval, Gighera, Macesu de Jos, Bistret, Ghidici, Piscu Tunari (Fig. 1), according to usual recommendations.

Biological materials

The amount of radionuclide in vegetation was established at some species, which absorbed the radionuclide from soil, air and water. Tester species were used in the phytoremmediation process. In this study were used: *Taraxacum officinale* and *Salix alba*, for the analysis of the amount of radionuclide accumulated in plant, as well as *Allium cepa* for the analysis the cytogenetics effects of the radionuclide from environment.

Fig. 2. The sites from which provenance samples of soil and plant, for the amount of radionuclide analysis.
Fig. 2. Locurile de provenienţă a mostrelor de sol şi plante pentru analiza cantităţii de radionuclizi.

The amount of radionuclide

The radionuclide amount from soil, vegetation and some food (honey), was establishes after Duggan method (gamma spectroscopy). The identification and quantification of radionuclide concentration in soil, plant or food (honey), was realized with a high resolution gamma spectrometric system with multichanel analyzer HPGe detector, GHP 34-TP 1106 9B model GEM 13180 P, preamplifier model 237 P, lead caste made FAN, analyzer SPECTRUM-MAESTRO A65-BI; WINMCA.EXE; MCBDLL 2.33 + ORTEC, power interval 40 – 2115 keV.

The work method was elaborated by the National laboratory of Reference for Environment Radioactivity in frame of National Agency for Environment Protection, being in conformity with the IAEA TECDOC 1092 directives. For the energy and efficiency calibration were used standard gamma punctiform and volume sources with energies of the gamma radiation in the range of interest (5 – 2,000 keV); Am^{241}, Cs^{137}, Co^{60}, Eu^{152}, Ba^{133}.

The soil sample where store dried at 105^0 C, ten sieven with sieve having the holes diameter of 0.2 mm. The vegetation samples were sore-dried at 105^0 C, afterward minced and pressed in the counting geometry. The counting geometry was identical with the one of the standard sources, and the density of the samples was close to the one of the standard sources. The counting time ranged from 40,000 s to 50,000 s. The collecting time of the natural background amounted to 200,000 s. The background was manually decreased from the samples spectrum. The confidencial level used in order to determine the Minim Detectable Activity was of 90%. The main characteristics of the radionuclide present in soil, plant and food, are shown in Table 2.

Table 2. The features of some radionuclide present in soil, vegetable and food.
Tabel 2. Caracteristicile unor radionuclizi din sol, vegetație şi miere.

Radionuclide	Physical time1/2	Emitted radiations	Critical organ	Biological time/ effective T1/2
Ac-228	21.773 years	β, γ	Whole body	≤ 10 days
Be-7	53.44 days	Neutrinos, γ	Whole body	280/44.84 days
Bi-210	5.01 days	α, β, γ, antineutrinos	Kidney	6.34/2.8 days
Cs-137	30.0 years	X, β, γ, antineutrinos	Muscle, conjunctive tissues	140/138 days
K-40	1.27 x 10^9 Years	X, β, ν	Whole body	1.429 x 10^9 years / 1.204 x 10^{10} years
Pb-212	10.64 hours	β, γ, X, antineutrinos	Kidney	531 / 10.43 days
Ra-226	$1{,}600^3$ years	α	Bone system	4.5 years (bone)
Th-234	24.10 days	α	Whole body	24.10 days
U-235	703.8 mil. y.	α, γ	Whole body	300 days (bony)

Genotoxicity evaluation.

The **genotoxicity evaluation** was established with the help of **the *Allium* test**, modified (FISKESJÖ, 1985, 1995). The 1-2 cm roots harvested from young onion bulbs were fixed in Carnoy II fixing solution and coloured with Carr reactive. Observations were performed on all cells in division in ten tips (belonging to different bulbs) and were recorded the number of cells in mitosis/tip, the percentage of chromosomal mutations in anaphase and telophase (dicentric, ring chromosomes, fragments), C-mitosis, micronuclei and metabolic alterations in prophase and metaphase.

Correlation analysis

A study regarding the correlations between the amount radionuclide accumulated in plants and different cytogenetics values recorded at chromosomal aberration in *Allium cepa* was performed, using the ANAVA-MANOVA test.

RESULTS AND DISCUSSIONS

The amount of radionuclide from soil.

The amount in different radionuclide in soil, in seven different villages, recorded different values depending on the radionuclide type and the distance of the considered sites toward to NEP Kozlodui (Table 3, Fig. 2).

Table 3. The radionuclide amount from soil (in Bq / kg soil) in some station in South of Romania (Dolj district).
Tabel 3. Cantitatea de radionuclizi din sol (Bq / kg sol) în unele stațiuni din sudul României (județul Dolj).

Place	K-40	Cs-134	Cs-137	Pb-210	Bi-212	Pb-212	Bi-214	Pb-214	Ra-226	Ac-228	Th-234	U-235
Bechet	125.7	1.90	8.48	10.40	27.0	47.3	26.2	32.6	29.4	29.2	14.00	5.18
Zaval	310.7	1.72	19.80	8.76	37.8	50.1	22.2	30.0	26.1	30.0	13.10	5.74
Gigera	968.9	2.00	123.9	22.50	50.7	50.7	40.3	37.6	39.0	51.8	14.60	5.54
Macesu	94.3	1.77	36.80	10.00	30.4	44.1	28.2	36.3	32.3	28.9	13.90	4.75
Bistret	151.0	1.42	12.40	8.78	23.8	43.6	26.8	31.8	29.3	27.8	10.70	4.53
Ghidici	170,9	1.60	9.24	6.78	31.3	38.4	22.2	29.8	26.0	28.3	11.90	4.63
Piscu Vechi	63.8	1.07	13.70	4.76	11.1	21.5	13.5	14.4	14.0	13.0	7.76	2.76

The Bechet, Zaval, Gighera, Macesu, Bistret are situated in the area of 20 km from NEP Kozlodui, in which was established an activity of 0.3 Sv (Fig. 2). Except the content in K-40, the radionuclides amount for the all element, recorded the high values in the Gighera village, situated toward NEP Kozlodui. The smallest values of radionuclide amount, were recorded at Piscu Vechi, situates at the West extremity of the analyzed area (Table 3, Fig. 2). In comparison with the average for Romania (Table 4), these values are upper towards the average values recorded in Romania at the 1994 year level.

Table 4. The radionuclides concentration in soil and in spontaneously vegetation in Romania (CHIOSILA et al., 1994).
Tabel 4. Concentraţia de radionuclizi din sol şi vegataţia spontană în România (CHIOSILA et al., 1994).

Radionuclide	**Radionuclides concentration in soil / vegetation (Bq/kg)**		
	Minimum	Maximum	Mean
Ra-226	10 / 1.8	90 / 3.7	38 / 2.5
Ac-228	13 / 1.6	65 / 3.5	39 / 2.2
K-40	330 / 350	800 / 640	540 / 505

The amount of radionuclides from radiobiological plants.

The radionuclide amount was established at two vegetal species, respectively *Taraxacum officinale* (in 5 stations) and *Salix alba* (in one station). The stations Ghidici (*Salix alba*) and Piscu Vechi (*Taraxacum officinale*) are situated in proximity (Fig. 2). The analysis of recorded values for the two species, reveal as *Salix alba* posses a greater capacity for absorbed the radionuclide, especially for K-40, Cs-134, Bi-212, Pb-212, Bi-214, Pb-214, Ra-226, Ac-228, Th-234 and U-235. As, in comparison with leaves of *Taraxacum officinale*, in leaves of *Salix alba*, was recorded a double amount of radionuclide for U-235, Ra-226, Bi-212 (7.4; 28.2 and 136 Bq/kg Salix alba leaves, in comparison with 3.7; 13.0 and 66.3 Bq/kg *Taraxacum officinale* leaves). A great amount of radionuclide in *Salix alba* leaves was recorded also for other radionuclide (Ac-228, Ra-226, Th-234, Cs-134, a/o (Table 3). Must be underlined that more of these radionuclide posses a great half time (U-235, K-40, Ra-226, Ac-228; Table 2). Regarding the radionuclide content in the *Taraxacum officinale* leaves from different stations, point out that in population originating from Bechet dam, near Danube River, was recorded the big amount for almost the all radionuclide (Table 5). In comparison with the average for vegetation recorded in Romania for Ra-226, Ac-228 and K-40 (Table 4), except K-40, in the all stations were recorded values more upper in comparison with average for vegetation in Romania (comparison between Table 4 and Table 5). Moreover, at the radionuclide with a great half time, were recorded upper values in the all stations, both for *Salix alba* and for *Taraxacum officinale*).

Table 5. The radionuclide amount (in Bq / kg plant) in two indicator radiobiological plant.
Tabel 5. Cantitatea de radionuclizi (Bg/kg planta) în două specii indicatoare radiobiologic.

Place	**Be-7**	**K-40**	**Cs-134**	**Cs-137**	**Pb-210**	**Bi-212**	**Pb-212**	**Bi-214**	**Pb-214**	**Ra-226**	**Ac-228**	**Th-234**	**U-235**
Taraxacum officinale													
Bechet	73.9	322	7.80	9.40	9.11	126	12.2	21.1	17.2	19.0	38.7	41.5	6.86
Zaval	38.8	236	5.87	4.07	6.17	95.6	9.00	15.4	13.4	14.0	28.1	32.3	5.19
Gighera	88.3	186	4.33	2.39	3.80	68.0	6.99	12.7	11.4	11.9	22.7	23.9	3.90
Macesu	92.5	227	6.00	4.80	6.35	97.0	9.24	15.3	13.5	14.4	27.6	31.7	3.48
Piscu Vechi	62.7	209	4.80	5.90	12.2	66.3	7.52	14.0	12.0	13.0	26.3	25.8	3.70
Salix alba													
Ghidici	30.9	340	8.3	3.98	9.0	136	11.8	21.9	28.2	28.2	40.0	43.4	7.4

The amount of radionuclide in a food (acacia honey)

The samples for acacia-honey were originating from four sites, between which two from the risk zone (situated in an area with a raze of 20 km around NEP Kozlodui; respectively Gighera, and Zaval), one from the evacuation zone (in an area with raze of 70 km, D=30 mSv, Ghidici) and one from the protective zone (in an area with raze of 140 km, D=3 mSvn out of this area; Vanju Mare). Between different places regarding the radionuclide amount, point out some small differences (Table 6). The analyzing the radionuclide amount with a great physical time ½ (U-235, K-40, Ra-226 and Ac-228) in honey-acacia (la six month from harvested), was established that the rich content are recorded at the Ghidici village, and the small content at Vanju Mare town. Probably the honey-acacia content in radionuclide was bigger at the harvested moment, but many radioactive elements present a physical time ½ small (Pb-210, P2-212, Bi-214) and thus in time the amount of radionuclide was reduced.

Table 6. The amount of radionuclide (in Bq/kg) in honey (after 9 month from harvested).
Tabel 6. Cantitatea de radionuclizi (Bq/kg) din miere (la 9 luni de la recoltare).

Place	Be-7	K-40	Cs-134	Cs-137	Pb-210	Bi-212	Pb-212	Bi-214	Pb-214	Ra-226	Ac-228	Th-234	U-235
Vanju Mare	<6.5	<34.0	<0.77	<0.64	<1.25	<11.0	<1.25	<2.34	<2.23	<2.30	<4.25	<5.13	<0.70
Gighera	<7.2	<36.4	<0.88	<1.06	<1.38	<14.6	<1.43	<2.46	<2.10	<2.23	<4.54	<5.79	<0.90
Bistret	<7.8	<38.2	<0.95	<1.12	<1.53	<12.4	<1.54	<2.88	<2.34	<2.55	<4.81	<6.24	<0.95
Ghidici	<8.6	<40.7	<0.99	<0.78	<1.56	<15.7	<1.60	<3.12	<2.66	<2.89	<5.21	<6.54	<1.00

Compared the radionuclide amount (Bq/kg) in Gighera station

In Gighera station, were made determined the amount of radionuclide in soil and in the same radiobiological indicator plant (*Taraxacum officinale*), in 2003 and in 2007 year. The analysis of the recorded values (Table 7), point out enhanced values in 2007 year both in soil and in plant. The main radionuclide accumulated in a normal soil was Cs-137 (17.80 Bq/kg soil in 2003 and 123.90 Bq/kg soil in 2007 as well as Ra-226 (20.36 Bq/kg soil in 2003 and 39.00 Bq/kg soil in 2007). In plant is noted the amount of Be-7 (0.10 Bq/kg in 2003 and 88.30 Bq/kg in 2007) and Pb-214 (2.88 Bq/kg in 2003 and 11.40 Bq/kg plant in 2007), as well as the presence of a notable amount of Ra-226, Ac-228 and U-223 in 2007 year, in comparison with trace amount in 2003 year. These results point out an accumulation in time or radionuclide in soil and in plant, as effect of the presence of a radioactive pollution source (NEP Kozlodui).

Table 7. The accumulation process in time of the radionuclide (Bq/kg) in soil and in plant (*T. officinale*) in Gighera station.
Tabel 7. Procesul de acumulare în timp al radionuclizilor (Bg/kg) în sol și planta (*T. officinale*) în stațiunea Gighera.

Place	Be-7	K-40	Cs-137	Pb-214	Ra-226	Ac-228	U-235
2003 - Gighera village							
Salted soil	-	389.52	11.57	13.26	72.92	20.13	trace
Normal soil	-	890.50	17.80	28.40	20.36	50.71	Trace
Taraxacum officinale	0.10	187.04	5.01	2.88	Trace	Trace	Trace
2007 – Gighera village							
Normal soil	-	968.90	123.90	37.60	39.00	51.80	5.54
Taraxacum officinale	88.30	186.00	2.36	11.40	11.90	22.70	3.90

The phytoremediation process

The analysis of the nucleotides content in soil and in the two species plant, point out the capacity of the two species, to accumulate of radionuclide from the environment (inclusive Be-7), the *Salix alba* and *Taraxacum officinale* being two species with certain properties of phytoremmediation species. The mainly radionuclide absorbed from environment and stored in these plant are presented in Table 8. *Salix alba* present in leaves a great amount of Be-7, Cs-134, Bi-212 and Th-234, accumulated from environment (together K-40, U-235, Ac-228 and Pb-210). In leaves of *Taraxacum officinale* are accumulated in a very great amount Be-7, together with Bi-212, Cs-134, Ra-226, K-40, Th-234, Ac-228, Pb-214 and U-235. These establishment, point out that the *Salix alba* and *Taraxacum officinalis*, present properties specific for the ***phytoextraction*** and ***phytoaccumulation*** of the radionuclide from the environment, and can use for these purposes.

Table 8. Radionuclide accumulation (n-x, %) in leaves of some plants with phytoremmediation activity.
Table 8. Acumularea de radionuclizi (de n-ori, %) în unele plante cu activitate de fitoremediere.

Organ	Be-7	K-40	Cs-134	Pb-210	Pb-214	Bi-212	Ra-226	Ac-228	Th-234	U-235
Salix alba										
Leaf	30.9	1.8	5.19	1.38	-	4.35	-	1.41	3.65	1.6
Taraxacum officinale										
Leaf	38.8 -92.5	2.7	3.51	-	1.80	3.54	3.4	2.02	2.53	1.3

Cytogenetics analysis

The cytogenetics analysis were effected using the ***Allium cepa* test** using different populations of this species, originating from Craiova (Control), Gighera and Bechet. The percentage of normal mitosis phases, the BR index in anaphase and telophase, as well as the micronuclei percentage in the next interphase were established (Table 9). The BR index (ratio between fragments/bridges) offer information on the reunion processes from the cell. The absence of the bridges, indicate absence of the reunion process of the broken end of chromosomes, respectively destructive effect of the environment factors (in this case of the radionuclide). Analysis of the data from table 9, indicate the sensibility of the Gighera population of *Allium cepa*, the village situated near Danube, in proximity of the NEP Kozlodui. The sensitive stage was anaphase, with the big values for of the abnormal cells, and with a big value for the BR index (Table 9). The metabolic modifications meet in prophase and metaphase were represented through different degrees of chromatin fibers compaction (Fig. 3) and nuclear spindle or centromere inactivation in metaphase (Fig. 4).

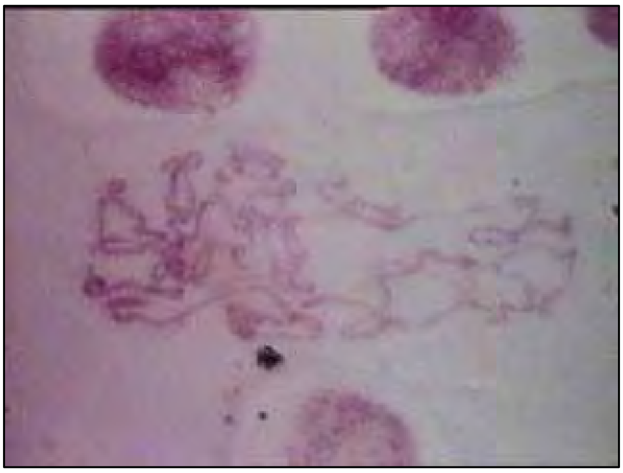

Fig. 3. Different compaction of chromatin fibers (prophase).
Fig. 3. Compactarea diferită a fibrelor de cromatină (profaza).

Fig. 4. Centromere inactivation in metafaze.
Fig. 4. Inactivarea centromerului în metafază.

The mainly types of chromosome aberrations were represented through acentric fragments in anaphase (Fig. 5) and telophase (Fig. 6) in Bechet population of *Allium cepa*. In Gighera population, the bridges are absent (Table 9). Also, the micronuclei percentage recorded in the next interphase, recorded big values in comparison with population from Bechet (1.17%) and from Control (0.38%). This indicates a strong effect of the radionuclide from environment.

Table 9. Environment radioactivity effect on the mitotic divisions in different *Allium cepa* populations.
Tabel 9. Efectul radioactivităţii mediului asupra diviziunii mitotice în diferite populaţii de *Allium cepa*.

***Allium cepa* Population**	**Percentage of the normal divisions phases**					**Anaphase**	**Telophase**	**Micronuclei (%)**
	Mitosis	**Prophase**	**Metaphase**	**Anaphase**	**Telophase**	**Fragm./Bridges**	**Fragm./Bridges**	
Control	98.36	99.79	97.27	98.30	97.70	5.27 / 0.0	1.74 / 0.0	0.38
Gighera	94.29	99.67	95,24	50.00	96.38	50.00 / 0.0	4.20 / 0.0	17.17
Bechet	96.40	99.14	96.34	81.82	97.69	33.33 / 9.09	3.08 / 4.62	1.17

Fig. 5. Bridge in anaphase (Bechet *Allium cepa* population).
Fig. 5. Punte în anafază (populaţia Bechet de *Allium cepa*).

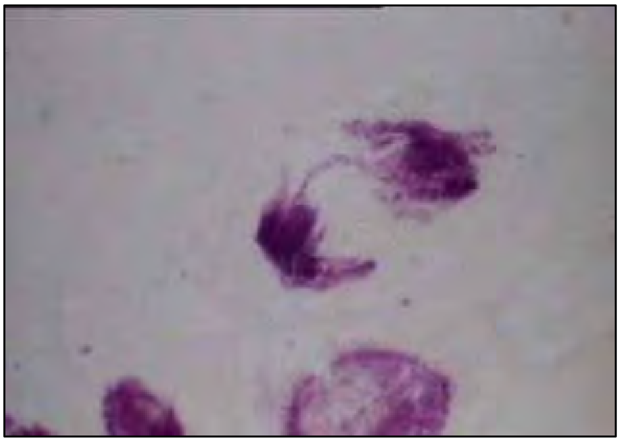

Fig. 6. Acentric fragments and bridges in telophase (Bechet *A. cepa* population).
Fig. 6. Fragmente acentrice şi punte în telofază (populaţia *A. cepa* de la Bechet).

Correlations

There were found very significantly correlations between the percent of aberrant cells in *Allium cepa* mitosis and the total content radionuclide, the highest values for correlation coefficient being recorded in U- 235, Ra- 226, Th-234 (r = 0.6674***, r = 0.6982***, r = 0. 7315***)

CONCLUSIONS

In South Romania, around the NEP Kozlodui, the soil radioactivity recorded enhanced values. The recorded values, decreased with the distance from NEP Kozlodui.

Some plants present capacity of absorbing radionuclide from soil, water or air (Be-7), having an important role in the *phytoremediation process*. In the leaves of *Taraxacum officinale* are accumulated Be-7, Cs-134, Bi-212, Ra-226, as well as K-40, Pb-210, Pb-214, Ac-228, Th-234, U-235. Also, in the *Salix alba* leaves are accumulated Be-7, Cs-134, Bi-212, Th-234, as well as K-40, Pb-210, Ac-228 and U-235.

Salix alba and *Taraxacum officinalis*, present specific properties for the ***phytoextraction*** and ***phytoaccumulation*** of the radionuclide from the environment, and can use for these purposes.

The environmental radioactivity induced chromosome aberrations in some radiosensitive species (*Allium cepa*), cultivated in area around NEP Kozlodui. The mainly chromosome aberrations were: acentric fragment, bridges, perturbations in the chromosome condensations, micronuclei, a/o.

Plant bioassays, which are most sensitive in detecting genotoxicity of environmental agents, can serve as the first alert for the presence of environmental hazards in water, air and soil.

REFERENCES

CHIOSILA I., DINCA G., MILU C., ONCESCU M., SONOC M., SANDRU P. 1994. *Natural radioactivity in Romania*. Romanian Society for Radiobiological Protection Bucuresti: 174 pp.

CHIOSILA I. 1998. *Radiațiile şi viata*. Societatea Română de Protecție Radiologică. Bucureşti: 1-100.

CORNEANU C. G., CORNEANU MIHAELA, HANESCU V., COJOCARU L., POPESCU G. G., GHEORGHE M. 1999. *Cytotaxonomical features in some Taraxacum officinale populations and environment radioactivity*. Acta Horti Botanici Bucurestiensis. Edit. Alo! Bucuresti. **28**: 121-128.

CORNEANU C. G., COJOCARU L., CORNEANU MIHAELA, LAZIN E. 2003. *The soil and vegetation radioactivity and some cytogenetic effects in the south of the Dolj district*. Environment and Progress Cluj-Napoca. **3**: 127-130.

CORNEANU C. G., COJOCARU L., CORNEANU MIHAELA. 2005. *Quick methods of the environment mutagen capacity with the possibility to use them in schools and in hospitals units*. J. Environmental Protection and Ecology. **6**(1): 31-34.

CORNEANU C. G., COJOCARU L., CORNEANU MIHAELA. 2006. *The radioactivity of the soil and of some vegetal species, radiobiological indicators, in different biotopes from Dobrudja*. Environment and Progress Cluj-Napoca. **6**: 77-82.

CORNEANU C. G., CORNEANU MIHAELA, COJOCARU L., NETOIU C. 2007. *The phytoremmediation process of the contamined environment with radionuclides in South Romania*. In “Ecological Complexity and Sustainability”, Abstracts of EcoSummitt 2007 Beijing: 92-93.

DUGGAN L. J. 1988. *Laboratory investigations in nuclear science*. Tennelec–The Nucleus. Oak Ridge, Tennessee: 208 pp.

FISKESJÖ G. 1985. *The Allium test as a standard in environmental monitoring*. Hereditas. **102**: 99-112.

FISKESJÖ G. 1995. *Allium test*. In: Methods in Molecular Biology. **43**. In vitro toxicity testing protocols (S. O’HARE, K.C. ATTERWILL). Eds. Humana Press Inc. Totava NY: 119-127.

MILU C., MAY C., CHIOSILA I., SONOC S., SIMA O., ONCESCU M. 1994. *Nuclear accident – management and impact on environment and public health*. Romanian Society for Radiological Protection Bucharest, Romania: 1-203.

MISHEVA L. 2005. *Regularities for distribution of plutonium isotopes around NPP Kozlodui and Rodopa Mountain*. XXXV ESNA Annual Meeting. Amiens, France.

ONCESCU M., CHIOSILA I., MILU C., SONOC S., SIMA O., DIACONESCU C., MAY C. 1995. *Artificial radioactivity in Romania*. Romanian Society for Radiological Protection Bucharest, Romania: 133-262.

ONCESCU M. 1996. *Conceptele radioprotecției*. Edit. Horia Hulubei Bucureşti: 1-80.

RUSKIN I. 1995. *Phytoremediation process*. Environ. Sci. Technol. **29**: 1239-1250.

STAMENOV J. N., CARBONNEL J. P., VACHEV B. I. 2005. *First results of the OM2 project for monitoring and management of Mountain environment*. w.w.w.om2.bas.bg/om2web/OM2.resl.htm: 1-13.

Corneanu Mihaela
USAMVB, Timisoara, Dept. Genetic Engineering,
Calea Aradului 119, Timisoara, Romania
e-mail: micorneanu@yahoo.com

Corneanu C. Gabriel
University Of Craiova, Biology-Genetics Dept.,
Str. A.I. Cuza 13, Craiuva Romania
e-mail: gabicorneanu@yahoo.com

Luminița Cojocaru
Environment Protection Agency
Calea Bucuresti 166, Craiova, Romania
e-mail: lumi_c2003@yahoo.co.uk

Constantin Nețoiu
Forest Research Institute, Craiova section
Str. G. Enescu 24, Craiova, Romania
e-mail: c_netoiu@yahoo.com