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Content and Season Dynamism of Aminoheterotrophes and Aminoautotrophes in some Soil Types of Kosovo and Metohia

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Abstract

This microbiological study included the three basic soil types of Kosovo and Metohia: Vertisol, Pseudogley, and Dystric Cambisol. The investigation involved microbiological profiles of so the cultivated soils as of the uncultivated (virgin) ones. Aminoautotrophes were better-

represented in all the investigated soil types than amino heterotrophes. The highest content of this microflora was observed in Vertisol, then in Pseudogley, and the lowest one was observed in Dystric Cambisol.

Key words: Microorganism, soil, Vertisol, Pseudogley, Dystric Cambisol.

INTRODUCTION

Microorganisms represent a significant factor of soil biogeneity, so their number in soil can reach a few milliards per a gram of absolute dry soil, and that number is greater if microorganisms are smaller (*Giljarov, 1950*). The zone of plant roots is a centre in which microbial processes and activities take place more intensively, and, in favourable ecological conditions, their effect on soil is largely expressed (*Vergnes, 1953*). Aminoheterotrophes are one of the most important microorganism groups in soil, where they actively take part in transformation of nitrogen containing organic compounds. When transform these compounds, microorganisms release to soil an amount of amoniac. The released amount of amoniac depends upon ecological factors, organic matter content, carbon vs. nitrogen ratio, and microflora composition. Nitrogen is very significant for plant nutrition, but it is also necessary for microorganisms, so they, in some cases, can be in a competitive relation with plants regarding nitrogen compounds. Aminoautotrophes, as mineral nitrogen users, mostly are more numerous than aminoheterotrophes, and their prevalence can be explained by their ability of using so mineral nitrogen, as the one of microbial origin - made by ammonification, nitrification, and nitrogen fixation. Microorganisms number, based on a row of data from home and foreign papers, is changed not only by the season changes of ecological factors (moisture, temperature, organic matter content, etc.), but also by internal rules of micro-population development. These changes have a pulsation character and are carried out in short intervals, even within a single day (*Aristovskaya, 1965; Milošević, 1967; Hudjakov, 1972*). This case can be observed not only in ammonifiers, but also in all the other microorganism groups.

MATERIAL AND METHODS

The investigation presented in this paper has been carried out on different soil types as follows: the Vertisol location Laplje Selo (Priština), the Pseudogley location Vitomirica (Peć), and the Dystric Cambisol location Tankosić (Uroševac). The investigation involved so the cultivated soils as the uncultivated (virgin) ones. Soil sampling for the mentioned study was done in autumn 1994, winter 1994/95, as well as in spring and summer 1995. For every season sampling we opened new profiles. Samples were taken in the open profile, from different depths as follows: 0-25 cm, 25-50 cm, 50-75 cm, and 75-100 cm. In the laboratory, from the collected samples, were made dilutions, and the dilution of 10⁻⁴ was used for inoculation. Inoculation of culture media was carried out by 0.5 ml of inoculum, and all of that was done in three repetitions. We analysed in the studied samples the following microorganisms: -Aminoheterotrophes on meat-peptone agar (MPA); -Aminoautotrophes on starch-amoniac-nitrate agar. Number of the investigated microorganism groups has been expressed per a gram of absolute dry soil. Results and Discussion

Aminoheterotrophes were well-represented in the investigated Vertisol, which was expected because this soil had favourable physical and chemical properties, and ammonifiers are one of the most numerous physiological microorganism groups in the total microflora. Cultivated Vertisol had by 16% higher content of this microflora in regard to the uncultivated one.

Regarding vertical arrangement of aminoheterotrophes, their content decreased by depth, which followed arrangement of soil organic matter (Mišustin, 1947). The investigated Pseudogley had a lower content of humus maters and unfavourable physical and chemical properties comparing with the investigated

Tab. 1. Season dynamism of aminoheterotrophes (in millions per a gram of absolute dry soil)

UNCULTIVATED SOIL					CULTIVATED SOIL			
depth	autumn	winter	spring	summer	autumn	winter	spring	summer
Vertisol Laplje Selo								
0-25	0.270	1.583	3.146	3.967	0.695	0.864	3.076	6.628
25-50	0.571	0.853	1.910	0.346	0.674	0.567	2.384	2.000
50-75	0.244	0.549	1.727	0.506	0.690	0.391	1.658	0.320
75-100	0.256	0.302	0.354	1.802	0.320	0.342	0.948	0.610
Pseudogley Vitomirica								
0-25	1.826	2.429	3.117	3.102	1.583	8.345	2.719	3.336
25-50	0.315	1.852	0.574	0.704	0.466	3.204	11.146	4.021
50-75	0.208	1.098	0.340	0.462	0.134	1.707	1.101	4.611
75-100	0.178	0.884	0.058	0.210	0.029	1.402	0.839	0.090
Dystric Cambisol Tankosić								
0-25	0.325	0.494	1.172	2.358	0.151	0.274	0.483	0.549
25-50	0.022	0.059	1.190	0.113	0.180	0.145	0.190	0.045
50-75	0.090	0.059	0.045	0.256	0.101	0.082	0.093	0.159
75-100	0.022	0.079	0.035	0.100	0.045	0.011	0.176	0.102

Vertisol. In uncultivated Pseudogley aminoheterotrophes content was slightly lower in regard to uncultivated Vertisol.

However, in cultivated Pseudogley was observed the highest number of ammonification microflora among all the investigated soil types. Reason for that certainly was growing of alfalfa for the past three years and larger income of nitrogen-containing organic matter. Uncultivated pseudogley had significantly lower amount of aminoheterotrophes than the cultivated one. The lowest content of aminoheterotrophes was found out in Dystric Cambisol, where the lowest content of humus matters and the worst soil physical and chemical properties were also observed. Uncultivated Dystric Cambisol was significantly richer with aminoheterotrophes than the cultivated one. Aminoautotrophes were better-represented than aminoheterotrophes in all the investigated soil types, which was expected because they used mineral nitrogen as well as the one of the microbial origin got by ammonification,

nitrification, and nitrogen fixation. The greatest content of aminoautotrophes (tab. 2) among the investigated soil types was observed in Vertisol, and their number was higher in cultivated Vertisol where mineral fertilizers were used for nutrition of the grown plants.

The investigated Pseudogley had a high content of this microflora but, different from Vertisol, a little higher content of aminoautotrophes was observed in uncultivated Pseudogley. Cultivated Pseudogley had approximately the same content of aminoheterotrophes and aminoautotrophes. The lowest content of aminoautotrophes was in the investigated Dystric Cambisol. Cultivated Dystric Cambisol was richer with this microflora than the uncultivated. However, one ought to point out that in cultivated Dystric Cambisol percental part of aminoautotrophes in total microflora was significantly greater with respect to aminoheterotrophes.

Tab. 2. Season dynamism of aminoautotrophes (in millions per a gram of absolute dry soil)

UNCULTIVATED SOIL					CULTIVATED SOIL			
depth	autumn	winter	spring	summer	autumn	winter	spring	summer
Vertisol Laplje Selo								
0-25	2.800	6.037	8.910	2.913	4.024	4.945	10.705	4.282
25-50	5.059	2.946	8.314	3.011	4.267	3.121	9.345	0.820
50-75	1.976	1.904	4.188	1.185	3.178	1.808	4.532	0.842
75-100	0.451	0.644	3.443	0.666	3.111	1.351	3.051	0.688
Pseudogley Vitomirica								
0-25	6.000	5.576	12.917	3.125	2.630	2.876	6.011	6.456
25-50	2.032	2.068	4.045	1.352	0.755	1.506	11.797	0.758
50-75	0.703	0.518	0.818	1.919	0.348	1.230	2.033	0.688
75-100	0.619	0.210	0.294	1.471	0.216	1.045	1.590	0.067
Dystric Cambisol Tankosić								
0-25	0.674	0.494	2.387	1.442	1.023	1.238	3.805	0.132
25-50	0.415	0.143	1.298	0.159	0.123	0.373	1.262	0.091
50-75	0.090	0.155	0.382	0.089	0.146	0.163	0.767	0.182
75-100	0.067	0.157	0.081	0.033	0.214	0.129	0.776	0.159

CONCLUSION

On the basis of the obtained results concerning seasonal content of amino-heterotrophes and aminoautotrophes in Vertisol, Pseudogley, and Dystric Cambisol the following can be pointed out: -Content of aminoautotrophes was higher in all the investigated soil types comparing with aminoheterotrophes. -The highest content of the investigated physiological microorganism groups was observed in Vertisol, and the lowest one in Dystric Cambisol.

REFERENCES

- Aristovskaja, T. V. (1965): Mikrobiologija podzolastih počvi. "Nauka", Moskva -Lenjingrad.
- Hudjakov, I. (1972): Pitanie rastenij iz rizosferi. Trud. Konfer. Počvi. Uspehi sovremenij biolog., 37. Moskva.
- Kiković, D. (1989): Ispitivanje mikroflore nekih prirodnih i antropogenih tipova zemljišta Kosova. Magistarski rad, Beograd, 154.
- Mišustin, E. N. (1975): Asociaciji počvenih mikroorganizmov. Izdатеlj "Nauka" Moskva.
- Milošević, R. (1967): Mikroflora i njena dinamika na raznim staništima Deliblatske peščare, II. Mikrobiologija, 4, 175-197.
- Tešić, Ž. (1957): Načela savremene metode mikrobioloških ispitivanja zemljišta. Zemljište, mikroorganizmi i biljka, 7, 65-79.
- Todorović, M., Tešić, Ž. i Bogdanović, V. (1976): Uticaj meliorativne obrade lesiviranog pseudogleja na njegovu mikrofloru. V. kongres JDPZ, Sarajevo, 249-255.
- Vergnes, N. (1953): Etude microbiologique de cshunes sols saharines relation avec la présence d'Anaasis. Coss. et Moq. Desrt. Res. Jerusalem, 318-324.
- Vukmirović, M., Todorović, M. i Bogdanović, V. (1985): Uticaj različitih tipova vegetacije na sezonsku zastupljenost nekih grupa mikroorganizama u pseudoglejnim zemljištima. Mikrobiologija, Vol. 22, No 1. Beograd.
- ZASTUPLJENOST I SEZONSKA DINAMIKA AMINOHETEROTROFA I AMONIOAUTOTROFA U NEKIM ZEMLJIŠTIMA KOSOVA I METOHIJE
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- Mikrobiološkim proučavanjima su obuhvaćena tri osnovna tipa zemljišta Kosova i Metohije, smonica, pseudoglej i crvenica. Ispitivani su mikrobiološki profili navedenih tipova zemljišta koja se obrađuju i koja nisu obrađivana (devičansko zemljište). Aminoautotrofi su kod svih ispitivanih zemljišnih tipova zastupljeniji od aminoheterotrofa. Najveću zastupljenost ove mikroflore srećemo kod smonice zatim pseudogleja a najmanju kod crvenice.

REZIME

ZASTUPLJENOST I SEZONSKA DINAMIKA AMINOHETEROTROFA I AMONIOAUTOTROFA U NEKIM ZEMLJIŠTIMA KOSOVA I METOHIJE
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Content of Amonifiers, Cellulose Decomposers, Nitrogen-fixing Bacteria, and Nitrifiers in some Soil Types of Kosovo and Metohia

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ABSTRACT

This microbiological study included the three basic soil types of Kosovo and Metohia: Vertisol, Pseudogley, and Dystric Cambisol. The investigation involved microbiological profiles of so the cultivated soils as of the uncultivated (virgin) ones. Content of cellulose decomposers and ammonifiers in the investigated soil types

of Kosovo and Metohia was high, but content of nitrogen-fixing bacteria and nitrifiers was significantly lower. The highest content of the investigated physiological microorganism groups was observed in Vertisol, then in Pseudogley, and the lowest one was observed in Dystric Cambisol.

Key words: Microorganism, soil, Vertisol, Pseudogley, Dystric Cambisol.

INTRODUCTION

A large number of microorganism species lives in soil, which represents a source of nutritive matters and energy for them, and, at the same time, they change soil chemical properties by their metabolism products. Certainly, in such biocenosis with the interaction relations, they also become changed by the action of environmental factors. Content of particular physiological or systematic species cannot satisfy an investigation aim without analyse of these species season dynamism. One should point out that no physiological species disappears completely from soil micro-population, even when status of a soil is significantly changed. In such cases, changes of some species relation to the others can be observed (Mishustin, 1960). Season changes of microorganism number, as well as the other parameters, depend upon income of fresh organic matter, aeration, humidity, and temperature (Zvjagincev et al., 1981). When humidity is unfavourable, number of bacteria is proportional to the water content (Jones, 1977; Nelson, 1978).

MATERIAL AND METHODS

The investigation presented in this paper has been carried out on different soil types as follows: the Vertisol location Laplje Selo (Priština), the Pseudogley location Vitomirica (Peć), and the Dystric Cambisol location Tankosić (Uroševac). The investigation involved so the cultivated soils as the uncultivated (virgin) ones. Soil sampling for the mentioned study was done in autumn 1994, winter 1994/95, as well as in spring and summer 1995. For every season sampling we opened new profiles. Samples were taken in the open profile, from different depths as follows: 0-25 cm,

25-50 cm, 50-75 cm, and 75-100 cm. In the laboratory, from the collected samples, were made dilutions, and the dilution of 10⁻⁴ was used for inoculation. Inoculation of culture media was carried out by 0.5 ml of inoculum, and all of that was done in three repetitions. We analysed in the studied samples the following microorganisms: -Amonifiers on meat-peptonic agar (MPA); -Cellulose decomposers on silica gel with the standard solution for cellulose decomposers and filter paper as the only carbon source; -Azotobacterium sp. on silica gel with the proper standard solution without nitrogen, and with manit as the only carbon source; -Nitrifiers (nitrite and nitrate bacteria) with the proper standard solution for nitrite or nitrate bacteria, and with calcium carbonate. Number of microorganisms has been expressed per a gram of absolute dry soil for ammonifiers, and as a percent of fertile soil granules for cellulose decomposers, nitrogen-fixing bacteria, and nitrifiers.

RESULTS AND DISCUSSION

Amonifiers, as one of the most numerous physiological groups of micro-organisms, were relatively low-represented in Vertisol during the autumn and winter periods. Amonification microflora increase in spring and summer was, among others, a result of increased activity of the other microorganism groups, especially cellulose decomposers, as well as of increased protein mass produced by these microorganisms and higher plants root system secretions.

Table 1. Season dynamism of ammonifiers in Vertisol (Laplje Selo) (in millions per a gram of absolute dry soil)

depth	UNCULTIVATED SOIL				CULTIVATED SOIL			
	autumn	winter	spring	summer	autumn	winter	spring	summer
total ammonifiers								
0-25	0.270	1.583	3.146	3.967	0.695	0.864	3.076	6.628
25-50	0.571	0.853	1.910	0.346	0.674	0.567	2.384	2.000
50-75	0.244	0.549	1.727	0.506	0.690	0.391	1.658	0.320
75-100	0.256	0.302	0.354	1.802	0.320	0.342	0.948	0.610
spores of ammonifiers								
0-25	0.117	0.262	0.921	0.225	0.232	0.297	1.012	0.089
25-50	0.309	0.333	0.977	0.139	0.279	0.301	1.166	0.076
50-75	0.104	0.033	0.246	0.111	0.202	0.243	0.454	0.066
75-100	0.146	0.039	0.202	0.037	0.197	0.135	0.149	0.065

Amonification microflora on MPA is always represented by a smaller number than the total microflora on soil agar and, therefore, it is reasonable to separate this microorganism group from the total microflora, because impressive differences concerning quantitative and qualitative composition of these groups can be observed (Todorović et al., 1972). We can observe, comparing amonification microflora of uncultivated and cultivated Vertisol, that it was better represented in cultivated soil. Spores of ammonifiers followed the observed season dynamism, but always with a lower number. The higher ammonifiers number of the investigated soil types was observed in cultivated Pseudogley, where alfalfa had been grown for the last three years. Root secretions of legume plants certainly influenced the increased number of ammonification microflora in the total microflora, which was better represented in Vertisol. Uncultivated pseudogley had significantly lower ammonifiers content in regard to the cultivated one.

Table 2. Season dynamism of ammonifiers in Pseudogley (Vitomirica) (in millions per a gram of absolute dry soil)

depth	UNCULTIVATED SOIL				CULTIVATED SOIL			
	autumn	winter	spring	summer	autumn	winter	spring	summer
total ammonifiers								
0-25	1.826	2.429	3.117	3.102	1.583	8.345	2.719	3.336
25-50	0.315	1.852	0.574	0.704	0.466	3.204	11.146	4.021
50-75	0.208	1.098	0.340	0.462	0.134	1.707	1.101	4.611
75-100	0.178	0.884	0.058	0.210	0.029	1.402	0.839	0.090
spores of ammonifiers								
0-25	0.478	0.283	0.741	0.307	0.119	0.197	0.292	0.176
25-50	0.206	0.170	0.287	0.136	0.022	0.060	0.561	0.022
50-75	0.076	0.086	0.022	0.045	0.022	0.085	0.056	0.033
75-100	0.059	0.026	0.012	0.045	0.010	0.183	0.066	0.011

Table 3. Season dynamism of ammonifiers in Dystric Cambisol (Tankosić) (in millions per a gram of absolute dry soil)

depth	UNCULTIVATED SOIL				CULTIVATED SOIL			
	autumn	winter	spring	summer	autumn	winter	spring	summer
total ammonifiers								
0-25	0.325	0.494	1.172	2.358	0.151	0.274	0.483	0.549
25-50	0.022	0.059	1.190	0.113	0.180	0.145	0.190	0.045
50-75	0.090	0.059	0.045	0.256	0.101	0.082	0.093	0.159
75-100	0.022	0.079	0.035	0.100	0.045	0.011	0.176	0.102
spores of ammonifiers								
0-25	0.034	0.094	0.247	0.610	0.046	0.048	0.035	0.176
25-50	0.067	0.071	0.012	0.034	0.034	0.047	0.035	0.023
50-75	0.011	0.042	0.022	0.044	0.022	0.047	0.035	0.045
75-100	0.011	0.046	0.035	0.022	0.022	0.000	0.035	0.000

The investigated Dystric Cambisol had significantly lower content of ammonification microflora than Vertisol and Pseudogley (tab. 3). In this location we observed significantly higher content of ammonification microflora in uncultivated soil.

Table 4. Season dynamism of cellulose decomposers (in percent of fertile soil granules)

depth	UNCULTIVATED SOIL				CULTIVATED SOIL			
	autumn	winter	spring	summer	autumn	winter	spring	summer
Vertisol Laplje Selo								
0-25	88	28	84	94	100	20	90	84
25-50	52	12	62	82	100	20	96	32
50-75	24	12	24	2	58	6	36	24
75-100	8	0	24	2	12	4	10	10
Pseudogley Vitomirica								
0-25	84	100	66	98	80	86	92	86
25-50	52	50	62	58	44	78	40	28
50-75	12	2	14	20	24	2	8	6
75-100	2	2	8	14	4	12	2	6
Dystric Cambisol Tankosić								
0-25	64	6	66	72	88	74	72	46
25-50	46	34	48	10	36	32	26	6
50-75	2	2	2	2	8	6	2	14
75-100	2	2	2	2	2	2	2	12

Cellulose decomposers were well-represented in all the investigated soil types, and their highest number was observed in surface layers, but that number decreased by depth, which followed the arrangement of organic matter and oxygen also decreasing by depth (Todorović, 1968).

Table 5. Season dynamism of Azotobacter sp. (in percent of fertile soil granules)

depth	UNCULTIVATED SOIL				CULTIVATED SOIL			
	autumn	winter	spring	summer	autumn	winter	spring	summer
Vertisol Laplje Selo								
0-25	12	0	8	6	2	0	8	18
25-50	0	0	0	4	0	0	14	4
50-75	0	0	0	0	0	0	4	2
75-100	0	0	0	0	0	0	0	0
Pseudogley Vitomirica								
0-25	0	2	6	2	2	6	4	2
25-50	0	14	4	0	0	0	6	0
50-75	0	0	0	0	0	0	0	0
75-100	0	0	0	0	0	0	0	0
Dystric Cambisol Tankosić								
0-25	0	6	4	0	0	4	0	0
25-50	0	2	8	0	0	6	2	2
50-75	0	0	16	0	0	4	0	4
75-100	0	0	2	0	0	0	0	0

The main cellulose decomposers in Vertisol, which had a neutral pH value, were bacteria, in Pseudogley with an acid pH fungi were significantly greater involved in cellulose transformation, and in Dystric Cambisol with a very acid pH the main cellulose transformers were fungi. In all the three investigated soils we met a higher content of cellulose decomposers in cultivated soil comparing with the uncultivated one. Mishustin (1974) stated that mineral fertilizers carried in cultivated soil influenced significantly on microorganisms content and composition.

Free aerobic nitrogen-fixing bacteria (Azotobacter sp.) were represented by a low number in the all investigated soil types (tab. 5). In the Vertisol location content of Azotobacter sp. was higher in cultivated soil, but in the Pseudogley and Dystric Cambisol locations was observed a little higher number of this microflora in uncultivated soil which was not expected, because this type of nitrogen fixation was characteristic for cultivated and aerated soils. Nitrificators, as a very significant physiological group for transformation of ammoniac to nitrates and, for that reason, for nitrogen retaining in soil, were relatively well-represented. We analysed both nitrate and nitrite bacteria and, on the basis of the obtained results, we can say that content

of nitrite bacteria was a little higher. The greatest nitrifiers content was observed in Vertisol, where the total microbial activity was also the greatest. Cultivated Vertisol had a higher content of nitrification microflora. The investigated Pseudogley and Dystric Cambisol had a lower nitrifiers content in comparison with Vertisol.

Table 6. Season dynamism of nitrifiers. (in percent of fertile soil granules)

depth	UNCULTIVATED SOIL			CULTIVATED SOIL		
	autumn	winter	spring	autumn	winter	spring
Vertisol Lapje Selo						
nitrate bacteria						
0-25	0	18	24	60	0	18
25-50	0	4	32	52	0	24
50-75	0	0	2	32	0	0
75-100	0	0	0	32	0	0
nitrite bacteria						
0-25	0	46	14	38	0	6
25-50	0	10	0	0	0	0
50-75	0	16	0	0	0	0
75-100	0	0	0	0	0	0
Pseudogley Vitomirica						
nitrate bacteria						
0-25	0	2	56	36	0	2
25-50	0	4	16	28	0	32
50-75	0	0	0	24	0	2
75-100	0	0	0	2	0	0
nitrite bacteria						
0-25	0	0	4	8	0	0
25-50	0	0	0	6	0	0
50-75	0	0	0	4	0	0
75-100	0	0	0	0	0	0
Dystric Cambisol Tankosić						
nitrate bacteria						
0-25	0	0	10	66	0	6
25-50	0	0	0	10	0	0
50-75	0	0	0	14	0	0
75-100	0	0	0	0	0	0
nitrite bacteria						
0-25	0	0	12	18	0	0
25-50	0	0	10	20	0	4
50-75	0	4	8	0	0	0
75-100	0	0	0	0	0	0

CONCLUSION

On the basis of the obtained results concerning seasonal content of ammonifiers, cellulose decomposers, free aerobic nitrogen-fixing bacteria (*Azotobacterium sp.*), and nitrifiers in Vertisol, Pseudogley and Dystric Cambisol, the following might be pointed out: -The highest content of the investigated physiological groups in uncultivated soil was observed in Vertisol. -In cultivated soil the highest ammonifiers content was observed in Pseudogley, where had been grown alfalfa for the last three years and where incom of fresh nitrogen-containing organic matter had been greater. That means a grown crop and applied agro-

technique measures have the effect on microorganism content and activity.

REFERENCES

Kiković, D. (1989): Ispitivanje mikroflore nekih prirodnih i antropogenih tipova zemljišta Kosova. Magistarski rad, Beograd, 154.

Mišustin, E. N. (1960): Obrabotka počvi i ego efektivnost plodorođia. Trudi Inst. Mikrob. AN SSSR, 7, 7-17, Moskva.

Mišustin, E. N. i Emcev, V. T. (1974): Mikrobiologija, Sarajevo.

Mišustin, E. N. (1975): Associjacija počvenih mikroorganizmov. Izdatelj "Nauka" Moskva.

Todorović, M., Kalinović, D. i Tešić, Ž. (1972): Ispitivanje zemljишne i rizoslerne mikroflore kukuruza u monokulturi i plodoredu. Mikrobiologija, 9, 2; 213-229.

Zvjagincev, D. G., Golombet, B. E. (1981): O kratkovremenih izmenenijah čislenosti mikroorganizmov v počvi. Mikrobiologija, T. 50, No.3.

REZIME

ZASTUPLJENOST, AMONIFIKATORA, CELULOLIZATORA, AZOTOFIKSATORA I NITRIFIKATORA U NEKIM ZEMLJIŠNIM TIPOVIMA KOSOVA I METOHIJE

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Mikrobiološkim proučavanjima su obuhvaćena tri osnovna tipa zemljišta Kosova i Metohije, smonice, pseudoglej i crvenica. Ispitivani su mikrobiološki profili navedenih tipova zemljišta koja se obrađuju i koja nisu obrađivana (devičansko zemljište). Celulolizeri i amonifikatori su dobro zastupljeni kod ispitivanih zemljишnih tipova Kosova i Metohije dok su azotofiksatori i nitrifikatori znatno manje zastupljeni. Najveću zastupljenost proučavanih fizioloških grupa mikroorganizama srećemo kod smonice, zatim pseudogleja, a najmanje ih je kod crvenice.

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Peryphyton Algae in the System of Djeravica Lakes on the Spring Branch of Erenik

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ABSTRACT

During 1996 the presence of peryphyton in three lakes and two arms of the lakes, and in 6 localities of Djeravica lakes, was explored. Total of 239 peryphyton taxon were established: *Cyanophyta* - 15, *Pyrrophyta* - 1, *Bacillariophyta* - 102, *Euglenophyta* - 10 and *Chlorophyta* - 111. Each locality is characterized by various structures of Peryphyton (53 - 115 taxons), and by feature of taxons linking with some localities. Qualitative and quantitative dominant *Bacillario-* phyta was the only one present with 5 common

taxons: *Cymbella gracilis*, *Frustulia rhomboides* var. *saxonica* f. *undulata*, *Neidium affine* var. *amphyrhinchus*, *Pinnularia borealis* and *Tabelaria flocculosa*, present in each locality. Total 48 indicator species were established by saprobiological analysis: (xenosaprobic 12, oligosaprobic 15 and betamesosaprobic 21) which are the indicators for water purity. This is confirmed by calculated saprobity index (1,18 - 1,40) and water bonity (I and I-II class).

Key words: Algae, Peryphyton, Djeravica glacial lakes, Saprobity

INTRODUCTION

In the geographic and geologic system Dinaridi spread from Mt. Triglav to the Zeta plain with Skadar lake and to the Metohija valley. Kossmat (1924) included in the Dinaridi a wide Vardar area toward the north-east, which is, according to Cvijić (1924), a transitional area. The south-east border of Dinaridi toward the Rodope massif spread through Thessaloniki bay - South Morava. Dinaridi faces Rodope massif on the line of Medovski bay - Zeta and Skadar plain - Metohija valley (Cvijić, 1899). The main feature of this area, in morphological sense, is limestone as the base that makes the characteristically landscape of karst. This karst consists of carbonate rocks: limestone and dolomites, which crack easily and dissolve equally in the water. In these waters, as the main feature of its mineralisation, is the presence of bicarbonate - calcium - magnesium hardness of water. According to Petrik (1975) among 180 observed waters of this area, only the one consisted of firmness bellow 100 mg/l of CaCO₃, and 23 waters consisted of firmness from 220 - 880 mg/l, and with alkalinity from 135 - 230 mg/l, giving great sulfate hardness.

The Prokletije Mt. takes a special place in the Dinaridi massive. Marković (1955) explored the area of the Prokletije and marked a group of massive as a separate entirety. It spread from the south and southwest of Dečanska Bistrica toward the west and northwest. It includes Dečanska Mt., Junička Mt. with Rosa Zogo, Vokša Mt., Djeravica Mt., Bogičevica Mt., Maja Rops, Pasji Vrh and Marjaš Mt. Because of intensive glaciation which took place in recent geological past, on these mountains, many mountain lakes used to exist. The proof for this are the traces of old lake beds

and plateau of lake bottoms in the places where they do not exist today. But some of them are still present: Djeravica lakes, Nedžinatsko, Ridsko and 20 others which are smaller. They are all of glacial origin. They were formed through glacial erosion of soft paleolithic rocks. The surfaces where the waters collect are small and their variations in level depend on precipitation and melting of snow.

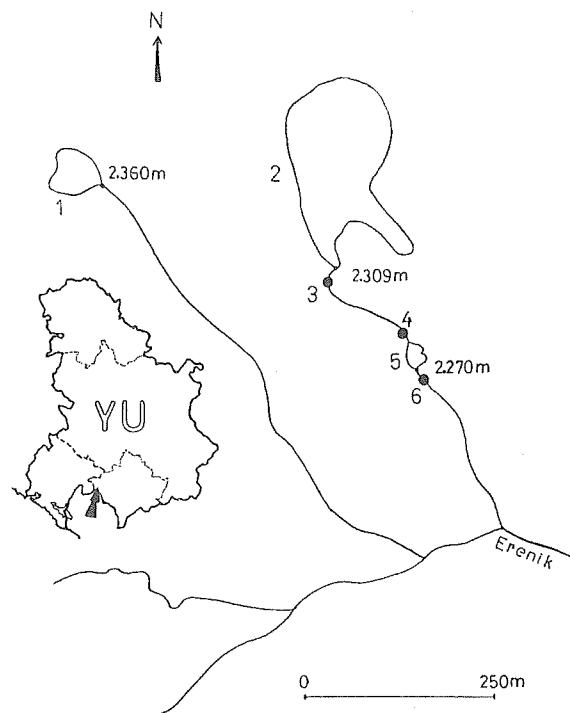


Fig. 1. Geographical position of Djeravica Lake
Sl. 1. Geografski položaj jezera na Đeravici

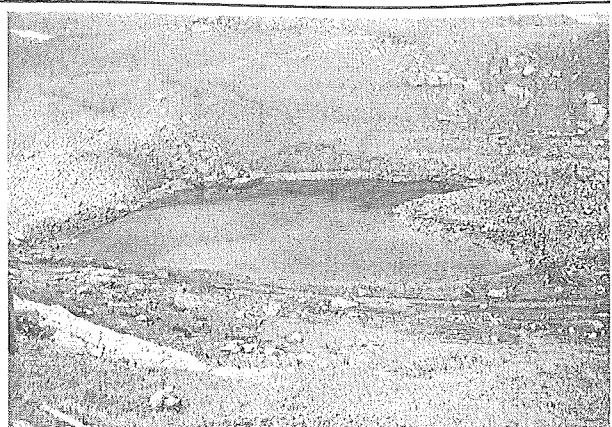
The object of our exploring were lakes in Djeravica Mt. complex (2656 m). These lakes are divided into two river basins. One line of lakes consists of spring branch of Kožnjarska Bistrica. The other line consists of spring branch of Erenik. Both rivers flow into the Beli Drim which then flow into the Adriatic sea.

In this paper peryphyton algae which are present in spring branch of Erenik were treated. That complex consists of three lakes: Malo Đeravičko jezero (2360 m), Veliko Đeravičko jezero (2309 m) and Lokva (2270 m). We have also treated the algae from the arms of those lakes.

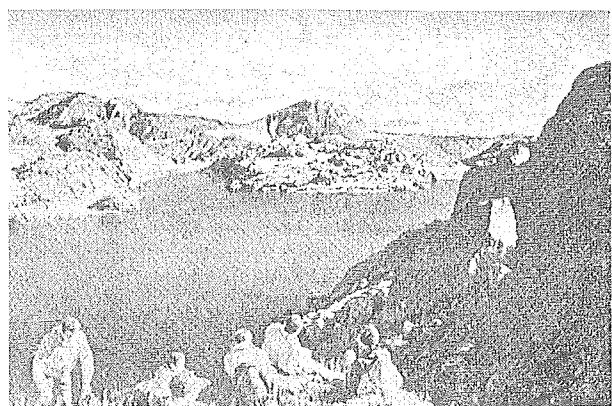
On geological-tectonic map of Kosovo and Metohija (Industropprojekt, Zagreb, 1974) we can see that Djeravica massive, where these lakes are located, mostly consist of gabbro and diabases and its south slopes consist of rocks mixed out of schists, limestone and dolomites. In pedological sense Djeravica massif consist of bare rock while the lakes bellow lie on typical rendzina on compact limestone (Pavićević et all., 1974). Because of highly interesting problems some biological researches on high mountain lakes in this part of the Dinaridi were carried out. Petković Smiljka and Petković Stevan (1971) did some researching of plankton communities present in Visitor lake. Petković Sm. (1981) also researched phytoplankton present in Ridsko lake and Bukumirske lake (Petković S., 1984). The living world of Djeravica lake hasn't been explored yet, so we decided to do research on peryphyton algae present in these lakes.

MATERIAL AND METHODS

The fauna Section of the Faculty of natural Sciences in Priština (Serbia) have organised one week field trip for biologists which were joined experts for environmental protection from Beograd and Novi Sad. Parallel to this, collecting of material used for analysis of algae was carried out. Collecting of peryphyton took place from 30th of July to 4th of August in 1996.



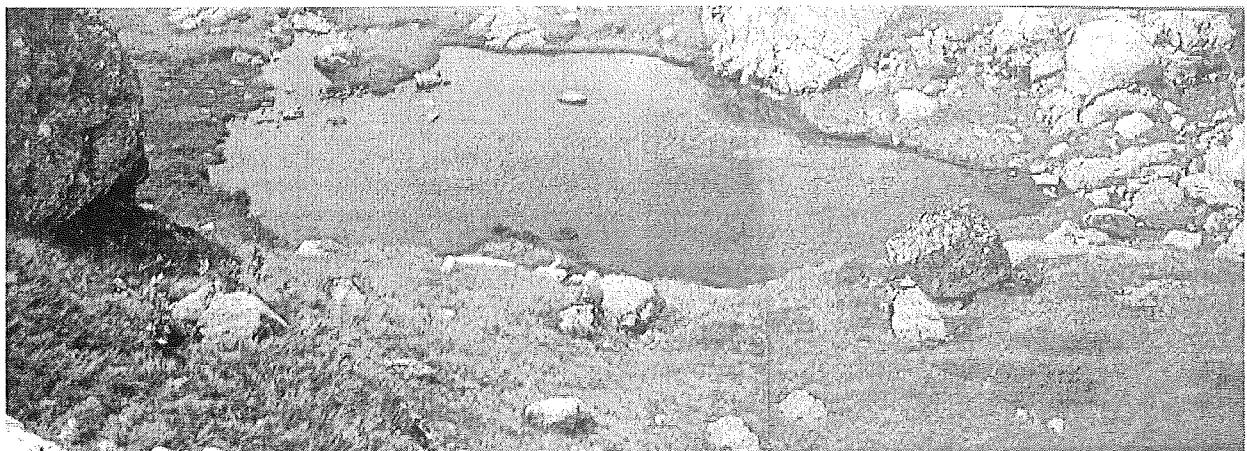
**Fig. 2. Small Djeraica lake
Sl. 2. Malo Đeravičko jezero**



**Fig. 3. Big Djeraica lake
Sl. 3. Veliko Đeravičko jezero**

I am using the opportunity to thanks my colleague Gordana Ristić, biology student, for her help.

Six localities were explored: 1. Malo Đeravičko lake (2360 m), which is heart-shaped, 50 m in its length, 40 m wide and 20 - 50 cm deep (Fig. 2); Veliko Đeravičko lake (2309 m), 260 m long, 130 m wide and about 8 m deep (Fig. 3); 3. An arm of Veliko Đeravičko lake, located 4 m further; 4. An arm of Veliko Đeravičko lake located toward the Lokva lake; 5. Lokva lake (2270 m), 30 m long, 16 m wide and 60 cm deep (Fig. 4); 6. An arm of Lokva lake which is 3



**Fig. 4. Lake Lokva
Sl. 4. Jezero Lokva**

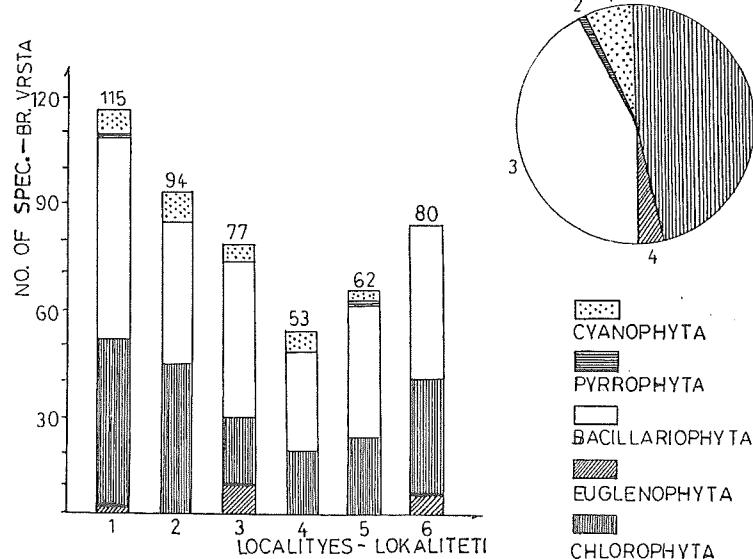


Fig . 5. Number of peryphyton taxa in Djeravica Lake
Sl. 5. Broj vrsta pefitonskih u Đeravičkim jezerima

m far from the flow out (Fig. 4, left). This arm is also the left spring branch of Erenik. Temperature measurements and extermination of water pH (with pH digital device) were done. Peryphyton was obtained through grating of stones and straining of moss. The specimens were fixed in 4% Phormaldechide on the field. For *Bacillariophyta* Hustedt's modified method (1930) was used. The rest of peryphyton was analysed while being in fixed condition. Microscopic analysis was carried out by using the "Ergeval" microscope (Zeiss, Jena) in the Biology Department lab, PMF in Priština. Determination of material was done according to following works: Dedusenko et all., (1959), Gollerbach et all. (1953), Hustedt (1930), Hustedt (1961 - 1965), Hindak et all. (1975), Komarenko et all. (1975), Lazar (1969), Patrick - Reimer (1966), Pascher (1925), Vodenicharow et all. (1971), Zabelina et all. (1951), Popova (1966), Palmar - Mondviceva (1982). Indicators of water saprobity were established according to Sladeček (1973). Saprobity index was determined according to Pantle and Buck (1955).

RESULTS AND DISSCUSION

During our research on peryphyton, which took place during 1996 on 6 localities of Djeravica lakes and their arms, we have established a total of 239 taxons (Tab. 2). We have classified them in the following sections: Cyanophyta - 15 taxons (6,3%), Pyrrophyta - 1 taxon (0,4%), Bacillariophyta - 102 taxons (42,6%), Euglenophyta - 10 taxons (4,2%) and Chlorophyta - 111 taxons (65,5%). The *Bacillariophyta* representatives were dominant in each sample, except the Veliko Djeravica lakes where the community of *Bacillariophyta* - *Chlorophyta* was equally present with 46 taxons (Fig. 5). Wealth and variety in flora of algae separately reflected through each locality (53 - 115

taxons). But, they were also reflected through the feature of taxons connection in individual locality. Related to this, Malo Djeravičko lake, located on the highest height above sea level (2360 m), have the lowest pH value (7,3), high water temperature (16,00C) and the biggest number of established taxons (46) tied only with this locality. Veliko Djeravičko lakes is the biggest (260 x 130 m) and the deepest ((8 m) one of all in the complex. It is on the second place in number of taxons (94) and taxons characteristically only for this locality (23). It is the reaches locality in flora of Cyanophyta representatives with 9 established taxons. As locality number 3 we marked an arm located 4 m further from Veliko Djeravičko lake. Proximity and connection of localities number 2 and 3 (Tab. 1) is confirmed by small differences in water temperature (1,00C) and by their pH reaction (0,1 pH units). The differences in structure (77 taxons), decreasing number of taxon (17) and connection of new taxon related to this locality were quite clear. *Euglenophyta* present in this locality with its 9 taxons takes a special place. *Trachelomonas intermedia* species together with 7 individually represented taxons of this section which are typical only for this point, were highly present.

Tab. 1. Physical features of water in Djeravica lakes system:
Tab. 1. Fizičke odlike voda Đeravičkih jezera:

LOCALITIES	t°C	pH
1. Malo Djeravičko lake	16,0	7,3
2. Veliko Djeravičko lake	10,0	7,7
3. Arm of the V. Dj. lake	11,0	7,8
4. Arm of the V. Dj. lake	15,0	8,2
5. Lokva lake	17,0	8,1
6. Arm of the Lokva lake	15,0	7,9

Tab. 2. The systematic inventori of established taxons of periphyton and frequency (skale 1-5) of some species that are the indicators of water saprobity in the complex of Deravica lakes, August 1996.

CYANOPHYTA	1	2	3	4	5	6	7
<i>Calothrix parietina</i> (NÄG.) THURET.		1	1				0
<i>Chroococcus cohaerens</i> (BRČB) (NÄG)	1	1	1	1	1		
<i>Chroococcus limenticus</i> LEMM.			1				
<i>Chroococcus turgidus</i> (KÜTZ) NÄG.	1						
<i>Cyanotheca aeruginosa</i> (NÄG.) KOM.	1	1	1	1			
<i>Dichotrix gypsophila</i> (KÜTZ.) BORN et FLAH	1	1		1			X
<i>Merismopedia tenuissima</i> LEMM.			1				b
<i>Microcystis elatens</i> (MENEGH.) KÜTZ.				1			
<i>Oscillatoria anguina</i> (BORY) GOM.		1					
<i>Oscillatoria bornetii</i> ZUKAL				1			
<i>Phormidium autumnale</i> (AG.) GOM.		1					b
<i>Synechococcus aeruginosus</i> NÄG.	1				1		
<i>Stigonema informe</i> KÜTZ.	1						
<i>Tolyphothrix distorta</i> KÜTZ.		1		1			
<i>Tolyphothrix lanta</i> WART.	1						
PYRROPHYTA							
<i>Peridinium willsei</i> HUITF. & KAAS.	1				1		
BACILLARIOPHYTA							
<i>Amphora ovalis</i> KÜTZ.					1		0
<i>Amphora ovalis</i> var. <i>pediculus</i> EHR.			1		1		
<i>Anomoeoneis serians</i> var. <i>brachysira</i> (BRÉB.) HUS	1	1			1	1	X
<i>Caloneis alpestris</i> CL.	1	1			1		X
<i>Caloneis bacillum</i> (GRUN.) MER.	3					1	X
<i>Ceratoneis arcus</i> (EHR.) KÜTZ.					1		X
<i>Cyclotella bodanica</i> EULENST.	1	1	3	1		3	0
<i>Cymbella cistula</i> (HEMP.) GRUN.		3	1			1	b
<i>Cymbella cymbiformis</i> (AG?KÜTZ) V.H.		1	1				
<i>Cymbella gracilis</i> (RABENH.) CL.	1	1	1	1	3	1	x
<i>Cymbella hebridica</i> (GREG.) GRUN.	1				1	1	
<i>Cymbella microcephala</i> GRUN.					1		
<i>Cymbella naviculiformis</i> AUERSW.	1				1	1	b
<i>Cymbella perpusilla</i> A. CL.		1					
<i>Cymbella ventricosa</i> KÜTZ.			1			1	b
<i>Diatoma aniceps</i> (EHR.) KIRCHEN.						1	0
<i>Epithemita turgida</i> (EHR.) KÜTZ.	1						
<i>Eunotia arcus</i> var. <i>bidentata</i> GRUN.	1						b
<i>Eunotia bidentata</i> W. SM.						1	
<i>Eunotia bigibba</i> KÜTZ.		1					
<i>Eunotia bigibba</i> var. <i>pumila</i> GRUN.		1					
<i>Eunotia diodon</i> EIIR.	1						
<i>Eunotia exigua</i> (BRÉB.) RABENH.		1	1				

<i>Eunotia flexuosa</i> (BRÉB.) KÜTZ.	1	1					
<i>Eunotia gracilis</i> (EHR.) RABENH.	1					1	
<i>Eunotia monodon</i> var. <i>major</i> (W.SM.) HUST.	1	1	1		1	1	
<i>Eunotia nagellii</i> A.G.C.				1			
<i>Eunotia lunaris</i> (EHR.) GRUN.					1		
<i>Eunotia paralella</i> EHR.			1	1		1	
<i>Eunotia pectinalis</i> (DILLW?KÜTZ.) RABENH.				1			x
<i>Eunotia pectinalis</i> var. <i>minor</i> (KÜTZ.) RABENH.		1		1		1	x
<i>Eunotia praerupta</i> var. <i>muscicola</i> BOYEP.	1						
<i>Eunotia robusta</i> var. <i>tetraodon</i> (EHR.) RALFS.	1	1	1		1	1	
<i>Eunotia sudetica</i> var. <i>bidens</i> HUST.	1					1	
<i>Eunotia tenella</i> (BRUN.) HUST.	1					1	
<i>Eunotia valida</i> HUST.	1	1	1		1	1	
<i>Eunotia</i> sp.			1				
<i>Eunotia</i> sp.				1			
<i>Eunotia</i> sp.						1	
<i>Fragilaria bicapitata</i> A. MAYER	1						0
<i>Fragilaria crenatula</i> var. <i>lanceolata</i> GRUN.			1	3	1	1	
<i>Frustulia rhomboides</i> var. <i>amphibleuroides</i> GRUN.	1						
<i>Frustulia rhomboides</i> var. <i>saxonica</i> (RABENH.) DT.	1	1	1		1	1	
<i>Frustulia rhomboides</i> var. <i>saxonica</i> f. <i>undulata</i> HUST.	1	1	1	1	1	1	
<i>Gomphonema angustatum</i> (KÜTZ.) RABENH.	1	1		1	1		0
<i>Gomphonema constrictum</i> EHR.		1	1				b
<i>Gomphonema gracile</i> EHR.	1	1			1	1	
<i>Gomphonema longiceps</i> var. <i>montanum</i> (SCHUM.) CL.	1	1		1		1	x
<i>Gomphonema longiceps</i> var. <i>montanum</i> f. <i>succiculum</i> GRUN.		1	1	1			
<i>Gomphonema pravulum</i> (KÜTZ.) GRUN.			1	1			b
<i>Gomphonema pravulum</i> var. <i>micropus</i> (KÜTZ.) CL.				1			
<i>Gyrosigma acuminatum</i> (KÜTZ.) RABENH.				1			b
<i>Melosira italica</i> ssp. <i>subarctica</i> O. MÜLL.	1	1	1		1	3	
<i>Melosira roeseana</i> RABENH.				1		1	x
<i>Navicula minima</i> GRUN.				1			
<i>Navicula rotaena</i> (RABENH.) GRUN.	1		1		3	1	x
<i>Neidium affine</i> (EHR.) CL.	1	1					
<i>Neidium affine</i> var. <i>amphibryncus</i> (EHR.) CL.	1	1	1	1	1	1	
<i>Nedium bisculatum</i> (LAGERST.) CL.	1	1	1				
<i>Neidium bisculatum</i> f. <i>undulatum</i> O. MÜLL.	1	1	1				
<i>Neidium dubium</i> (EHR.) CL.	1	1					b
<i>Neidium iridis</i> var. <i>amphigomphus</i> (EHR.) V.H.						1	
<i>Neidium viridis</i> var. <i>ampliatum</i> (EHR.) CL.	1						
<i>Neidium productum</i> (W. SM.) CL..	1		1		1	1	
<i>Nitzschia gracilis</i> HANTZSCH.							
<i>Nitzschia thermalis</i> var. <i>minor</i> HILSE.	1						

<i>Pinnularia borealis</i> EHR.	1	1	1	1	1	1	x
<i>Pinnularia distiguenda</i> CL.	1						1
<i>Pinnularia divergens</i> W. SM.		1			1		
<i>Pinnularia sivergens</i> var. <i>undulata</i> HERIB. et PERAG.	1						
<i>Pinnularia giba</i> EHR.	1	1	1		1	1	x
<i>Pinnularia giba</i> var. <i>mesogongula</i> f. <i>interrupta</i> CL.				1			
<i>Pinnularia gibba</i> f. <i>subundulata</i> A.MAYER		1					
<i>Pinnularia interrupta</i> W. SM.	1			1	1		
<i>Pinnularia interrupta</i> var. <i>minor</i> BOYEP.	1	1	1		1		
<i>Pinnularia lata</i> (BRÉB.) W. SM.	1						
<i>Pinnularia lata</i> var. <i>minor</i> GRUN.	1			1	1		
<i>Pinnularia lata</i> var. <i>tueringiaca</i> (RABENH.) A. MAYER	1			1	1		
<i>Pinnularia legumen</i> EHR.	1	1			1		
<i>Pinnularia major</i> var. <i>lacustris</i> MEIST.	1	1			1		b
<i>Pinnularia mesolepta</i> (EHR.) W. SM.	1						
<i>Pinnularia mesolepta</i> var. <i>angustata</i> CL.			1				0
<i>Pinnularia microstauron</i> (EHR.) CL.	1						
<i>Pinnularia molaris</i> GRUN.	1						0
<i>Pinnularia parva</i> (EHR.) GREG.				1			
<i>Pinnularia stomatophora</i> GRUN.				1			
<i>Pinnularia subcapitata</i> var. <i>bilseana</i> (JANISCH.) O. MÜLL.				1			
<i>Pinnularia subsolaris</i> (GRUN.) CL.		1					1
<i>Pinnularia viridis</i> (NITZSCH.) EHR.	1	1			1	1	b
<i>Pinnularia viridis</i> var. <i>elliptica</i> MEIST.			1		1		
<i>Pinnularia viridis</i> var. <i>fallax</i> CL.		1					1
<i>Stauroneis anceps</i> EHR.	1	1	1		1	1	b
<i>Stauroncis anceps</i> f. <i>gracilis</i> (EHR.) CL.	1	1			1	1	
<i>Stauroneis phoenicenteron</i> EHR.	1	1	1		1	1	b
<i>Stauroncis phoenicenteron</i> f. <i>gracilis</i> A. V.H.	1						
<i>Surirella linearis</i> W. SM.	1						b
<i>Surirella tenera</i> GREG.	1	1	1		1	1	b
<i>Synedra acus</i> KÜTZ.			1				b
<i>Synedra acus</i> var. <i>angustissima</i> GRUN.			1				0
<i>Synedra ulna</i> (NITZSCH.) EHR.			1			1	b
<i>Tabellaria flocculosa</i> (ROTH.) KÜTZ.	3	3	3	3	1	1	0
CHLOROPHYTA							
<i>Artbrodesmus triangulairis</i> LAGERH.	3						
<i>Bulbochaeta</i> sp.		3					
<i>Bulbochaeta</i> sp.			1				
<i>Bulbochaeta</i> sp.					1		
<i>Bulbochaeta</i> sp.						1	
<i>Chlamydomonas</i> sp.	1						
<i>Closterium abruptum</i> W. WEST.	1						

<i>Closterium cynthia</i> De NOT			1			
<i>Closterium dianae</i> EHRENB.		1				0
<i>Closterium lineatum</i> EHRENB.		1				
<i>Closterium lunula</i> (MÜLL.) NITZSCH.	1			1	1	0
<i>Closterium striolatum</i> ENRENB.	1				1	
<i>Cosmarium amoenum</i> BRÉB.		1				
<i>Cosmarium anceps</i> LUND		1				
<i>Cosmarium boeckei</i> WILLE					1	
<i>Cosmarium caelatum</i> RALFS.			1	1		1
<i>Cosmarium calcareum</i> WITTR.		1	1			
<i>Cosmarium crenatum</i> RALFS.			1	1		1
<i>Cosmarium crenatum</i> var. <i>bicrenatum</i> NORDS.		1				
<i>Cosmarium crenatum</i> var. <i>bicrenatum</i> f. <i>bodtianum</i> (GUTW.) et G. S. WEST.				1		
<i>Cosmarium cucumis</i> (CORDA) RALFS.				1		
<i>Cosmarium cyclicum</i> var. <i>arcticum</i> NORDS.		1				
<i>Cosmarium etchachanense</i> ROY et BISS.	1					
<i>Cosmarium formosulum</i> HOFF.				1		b
<i>Cosmarium garrolense</i> ROY et BISS.	1	1	1	1		
<i>Cosmarium impressulum</i> ELFV.		1	1			
<i>Cosmarium margaritiferum</i> MENEGH.		1		1		1
<i>Cosmarium nitridulum</i> De NOT.		1				
<i>Cosmarium orthostichum</i> LUND.	1					
<i>Cosmarium palangula</i> BRÉB.	1					
<i>Cosmarium pseudamoenum</i> WILLE.					1	
<i>Cosmarium pseudamoenum</i> var. <i>pseudamoenum</i> WILLE.				1		
<i>Cosmarium punctulatum</i> BRÉB.	1					
<i>Cosmarium pygmaeum</i> ARCI.			1			1
<i>Cosmarium quadratum</i> RALFS.	1	1		1		
<i>Cosmarium quadratum</i> f. <i>quadratum</i> RALFS.			1			
<i>Cosmarium quadratum</i> f. <i>willei</i> W. et G. S. WEST.		1				
<i>Cosmarium regnelli</i> WILLE.	1				1	1
<i>Cosmarium subalatum</i> W. et G.S. WEST.			1			
<i>Cosmarium subcostatum</i> NORDST.	1					
<i>Cosmarium subcrenatum</i> HANTZSCH.	1		1	1		
<i>Cosmarium subprotumidum</i> var. <i>subprotumidum</i> NORDS.			1			1
<i>Cosmarium umbilicatum</i> LÜTKEM.	1					
<i>Cylindrocystis brebissonii</i> (MENEGH. et RALFS.) De BARY	1				1	
<i>Cylindrocystis brebissonii</i> var. <i>minor</i> W. et G. S. WEST.	1					
<i>Euastrum affine</i> RALFS.	1				1	1
<i>Euastrum ampullaceum</i> RALFS.		1			1	1
<i>Euastrum ansatum</i> EHRENB.	1	1			1	1
<i>Euastrum bidentatum</i> NÄG.		1		1		
<i>Euastrum binale</i> (TURP.) EHRENB.	1					

<i>Euastrum denticulatum</i> (KIRCHN.) GAY.	1		1		1	1	
<i>Euastrum elegans</i> (BRÉB.) KTZ.	1	1	1			1	0
<i>Euastrum gemmatum</i> BRÉB.	1						
<i>Euastrum humerosum</i> RALFS.			1				
<i>Euastrum insulare</i> (WITTR.) ROY	1						
<i>Euastrum oblongum</i> (GREV.) RALFS.	1	1			1	1	0
<i>Euastrum spinulosum</i> LENORM.	1						
<i>Euastrum verrucosum</i> EHRENB.				1		1	
<i>Gonatozygon monotaenium</i> De BARY				1			
<i>Haylotheca dissiliens</i> (SM.) BRÉB.	1	1	1				0
<i>Micrasterias denticulata</i> BRÉB.				1			
<i>Micrasterias fimbriata</i> RALFS.	1	1					
<i>Micrasterias papillifera</i> BRÉB.	1	1				1	
<i>Micrasterias thomasiana</i> ARCH.	1	1			1	1	
<i>Mougeotia</i> sp.			1				0
<i>Netrium digitus</i> (EHRENB.) JTZGS. et ROTHE	1	1	1		1	1	
<i>Netrium oblongum</i> (De BARY) LÜTKEM	1	1					
<i>Oedogonium</i> sp.	1						
<i>Oedogonium</i> sp.			1				
<i>Oedogonium</i> sp.					1		
<i>Oedogonium</i> sp.						1	
<i>Oedogonium</i> sp.							1
<i>Pediastrum braunii</i> WARTM.					1		
<i>Penium phymatosporum</i> NORDS.	1						
<i>Penium polymorphum</i> PERTU	1						
<i>Penium spinospermum</i> JOCH.	1					1	
<i>Penium spirostrialatum</i> BARKER	1						1
<i>Pleurotaenium minutum</i> (RALFS.) DELP.	1						
<i>Roya obtusa</i> (BRÉB.) W. et G. WEST	1	1					
<i>Scenedesmus</i> sp.						1	
<i>Staurastrum aculeatum</i> (EHR.) MENEGH.			1				3
<i>Staurastrum alternans</i> BRÉB			1		1		1
<i>Staurastrum basidentatum</i> BORGE	1	1	1				
<i>Staurastrum brevicostatum</i> G. M. SMITH	1						
<i>Staurastrum capitulum</i> BRÉB.			1				
<i>Staurastrum coarctatum</i> BRÉB					1		
<i>Staurastrum dilatatum</i> EHR.			1				
<i>Staurastrum diplacanthum</i> De NOT	1						
<i>Staurastrum furcatum</i> (EHR.) BRÉB.			1				
<i>Staurastrum grenbaldii</i> SKUJA			1				
<i>Staurastrum mamillatum</i> NORDS.						1	
<i>Staurastrum margaritaceum</i> (EHR.) MENEGH.	1						

<i>Staurastrum muticum</i> BRÉB	1					
<i>Staurastrum orbiculare</i> RALFS	1	1	1		1	1
<i>Staurastrum polymorphum</i> BRÉB.					1	
<i>Staurastrum polytrichum</i> (PERTY.) RABENH.	1					
<i>Staurastrum punctatum</i> BRÉB.	1	1	1			
<i>Staurastrum punctatum</i> var. <i>pygmaeum</i> BRÉB.			1			
<i>Spbaerocystis schöeterii</i> CHOD.	1	1	1	1		1
<i>Spirogyra</i> sp.		1				
<i>Spirogyra</i> sp.			1			
<i>Spirogyra</i> sp.				1		
<i>Spirogyra</i> sp.					1	
<i>Spirogyra</i> sp.						1
<i>Teingia granulata</i> var. <i>granulata</i> (ROY et BISS.) BURR.		1	1	1	1	1
<i>Tetmemorus laevis</i> (KTZ.) RALFS	1	1	1		1	1
<i>Zygnea</i> sp.			1			
<i>Zygnea</i> sp.					1	
<i>Zygnea</i> sp.						1
EUGLENOPHYTA						
<i>Euglena granulata</i> (KLEBS.) LEMN.	1					b
<i>Trachelomonas bacilifera</i> var. <i>bacilifera</i> PLAUF.			1			1
<i>Trachelomonas hispida</i> var. <i>granulata</i> PLAUF.			1			1
<i>Trachelomonas intermedia</i> DANG.			3			1
<i>Trachelomonas planctonica</i> f. <i>planctonica</i> SWIR.			1	1	1	b
<i>Trachelomonas planctonica</i> f. <i>oblonga</i> DRÉZ.			1			
<i>Trachelomonas ornata</i> (SWIR.) SKV.			1			1
<i>Trachelomonas volvocina</i> var. <i>volvocina</i> EHR.			1			
<i>Trachelomonas volvocina</i> var. <i>subglubosa</i> LEMM.			1			
<i>Trachelomonas woycicki</i> f. <i>woycicki</i> KOCZW.			1			1

Cca. 180 m long arm of Veliko Djeravičko lake, located only few meters beneath Lokva lake, is marked as locality number 4. Its water has fast flow because of altitude drop about 30 m and bottom overgrown with mose. Water temperature was high (15,00C) for mountain conditions, but it had the highest pH value (8,2) which points out on mild alkaline milieu. It is highly possible than this type of ecological conditions restrict the survival of larger types of algae, but also causes species adaptation to this specific conditions. In addition to this conclusion we added fact that its waters were very poor in flora, 53 taxons of individually represented algae and 18 taxons related to this locality only. Comparing with other two lakes the altitude of Lokva lake is the lowest (2270 m). The lake is well insolated and the highest temperature of water (170 C) is caused by dark muddy bottom. Sixty two separately present taxons and two frequently

present xenosaprobic species: *Cymbella gracilis* and *Navicula rotaeana*, were found in calm waters of the Lokva lake. From the total number of found species, only 8 taxons were typical for this locality. Locality number 6 is situated few meters from the flow out of Lokva lake. Comparing with the arms number 3 and 4 where the number of taxons drastically decreases in comparison with previous locality, the number of taxons in this locality is increasing (80 taxons) for 18 taxons in comparison with Lokva lake. In communities of *Bacillariophyta* (4 taxons), *Chlorophyta* (7 taxons) and *Euglenophyta* (1 taxon) 12 new taxons which are characteristic only for the conditions of this domicile were established. Clear, clean and by appearance lifeless waters of Djeravica lakes, are very rich in separately present taxons, but on the other hand only 5 taxons (2%) of total structure were common for all localities: *Cymbella gracilis*, *Frustulia rhombooides* var.

saxonica f. undulata, *Neidium affine var. amphyrinchus*, *Pinnularia borealis* and *Tabellaria floccosa* (all Bacillariophyta). Environmental factors like hydrochemical, hydrogeological, edifice etc., are of the great significance for rich and various community of periphyton. High temperatures of water measured on these altitudes (Tab. 1), by which even the average temperature of these waters during the year equals +20 C (Labus, 1977), are caused by intensive insulation of each locality and darkly colored geological base of gabbro.

These two factors have effect on mineralization of water and development of *Chlorophyta*, the largest community which was established (111 taxons) in the system of Djeravica lakes.

Even after going through a lot of literature we could not carry out the phytogeographic analysis of periphyton in Djeravica lakes with neighbouring lakes (Rikavačko, Bukumirsko, Visitorsko, Plavsko etc.), since only plankton flora analysis was carried out in these lakes. In the system of Djeravica lakes, 239 taxons of periphyton algae were established by quantitative and qualitative analysis. The number of 48 species or 20,0% belong to the indicators for water saprobity: xenosaprobic 12 (31,2%), oligosaprobic 15 (25,0%) and betamesosaprobic 21 (43,8%). In qualitative structure of community there were no alfamesosaprobic indicators - indicators for water impurity. The value of water saprobity index, which depends on locality, was ranging from 1,18 to 1,40 and belonged only to I and I - II bonity class. Locality index was: 1 - 1,32, 2 - 1,36, 3 - 1,40, 4 - 1,18, 5 - 1,27 and 6 - 1,36. Based on these presented results we can conclude that Djeravica lake complex is very rich in periphyton algae. For this reason it should be further explored. Waters of this system are of high quality so, they should be protected and preserved.

REFERENCES

- Anonymous, 1974. Geološko-tektonska karta SAP Kosova, 1: 100 000. Industropunkt, Zagreb.
- Božinović M., 1951. Deravica i njena jezera. Kroz planine, 1: 11-15, 2: 45-50, Beograd.
- Cvijić J., 1899. Glacijalne i morfološke studije o planinama Bosne, Hercegovine i Crne Gore. Glas Srpske Kraljevske akademije, LVII: 1-196, Beograd.
- Cvijić J., 1924. Geomorfologija, Knj. 1, Beograd.
- Dedusenko-Šćegoleva A.M., Matvivenko L.A Škorbatov, 1959. Chlorophyta. Opredel. Presnovod. Vodorosli SSSR, 8: 1-230., Moskva - Leningrad.
- Golerbah M.M., E.K. Kosinkaja, V.I. Poljanskij, 1953. Sinzelenije vodorosli. Opredel. Presnovod. Vodorosli SSSR, 2: 1-652., Moskva-Leningrad.
- Hindak F., J. Komarek, P. Marva, J. Ružička, 1975. Kluč na určovanie vytrsných rastlin. I. Del. Riasu. Slovenske pedagogicke nakladatelstvo. Bratislava.
- Hustedt F., 1930. Bacillariophyta. Subwasserflora Deutschlands, Helf 10, 2. Aufl., 23.
- Hustedt F., 1961 - 1965. Rabenhorsst Krypt., Fl. Die Kisalgen., 3. Teil.
- Jakšić P. i Belij S., 1995. Bibliografija o prirodi kosova i Metohije. Univerzitet u Prištini, Str. 1-335, Priština.
- Komarenko L.E., I.I. Vasiljeva, 1975. Presnovodne diatomovie i sinzelenie vodorosli vodemov Jakuti. Izdateljstvo Nauka, Moskva.
- Kossmat F., 1924. Geologie der zentralen Balkanhalbinsel. Verlag von gebr(der Borntrger. Berlin.
- Labus D., 1977. Hidrološke odlike sliva Belog Drima sa iskorišćavanjem njegovih resursa. Doktorska disertacija, PMF Beograd, str. 1-208., Beograd.
- Lazar J., 1969. Alge Slovenije. Slovenska akademija znanosti in umetnosti. Ljubljana.
- Marković M., 1958. Kraći geološko-tektonski pregled osobina jugoslovenskog dela Prokletija. Almanah Prokletije, Str. 49-61, Peć.
- Palmar G.M.-Mondviceva, 1982. Opredel. Presnov. Vodorosli. Zelenie vodorosli. Vjip. 11(2). Conjugatophyceae, Desmidiales. Nauka, Leningrad.
- Pantle R. Buck H., 1955. Die Biologische Übervachung der gev(sser und die darstellung der Ergebnisse. Besondere Mitteilung Z. deut. gev(sserkunde 12: 135-143.
- Pascher A., 1925. S(sswasser-flora deutschlands, (sterreich und der Schweiz. Cyanophyceae. Helf 12. Prag.
- Patrik R.W.C. reimer, 1966. The Diatoms of the United States. Acad. Nat. Scien of Philadelphia. Monograph, no. 13, Philadelphia.
- Pavićević N., grujić Lj., Milošević Lj., Katalina P. i Vasić G., 1974. Pedološka karta SAP Kosova, razmerna 1: 50 000., Jaroslav Černi, Beograd.
- Petković Smiljka i Petković S., 1971. Sastav i karakter planktonskih zajednica dva mala visokoplanska glacijalna jezera na planini Visitoru i Bogičevici u Crnoj Gori. Poljoprivreda i Šumarstvo, XVII(3): 3-30, Titograd.
- Petković Smiljka, 1981. Novi prilog poznavanju algi Ridskog jezera. Poljoprivreda i šumarstvo, XXII(1): 51-77., Titograd.
- Petković Smiljka, 1984. Limnofloristički i trofički status Bukumirskog jezera., Poljoprivreda i šumarstvo, XXX(1): 33-56, Titograd.
- Petrić M., karakteristike voda na Dinarskom kršu. Jugoslovensko-Američki simpozijum "Hidrologija i vodno bogatstvo krša", str. 1-10, Dubrovnik.
- Popova T.G., 1966. Evglenovie vodorosli. Vjip. 1. Euglenophyta. Izdateljstvo Nauka, Moskva.
- Sladecák V., 1973. System of Water Quality from Biological Point of View. Archiv f. Hydrobiologie. Beih. 7, Ergebnisse der limnologie, E. Schweizerart'sche verlagbuchhandlung (Nagel und Obermiller), Stuttgart.

Urošević Violeta, 1994. Alge visokoplaninskih jezera Siriničke strane Šar-planine, Univerzitet u Prištini, str. 1-95, Priština.

Vodeničarov D.S.T. Draganov, D. Timniskikova, 1971. Flora na Bulgaria. Narodna Prosveta, Sofia.

Zabelina M.M., Kiselev I.A., Proškina-Lovrenko A.I., V.C. Šešukova., 1951. Opredel. Presnov. Vodorosl. SSSR., Vjip. 4. Diatomovie vodorosli., Akademija nauka SSSR, Leningrad.

REZIME

OBRAŠTAJNE ALGE U SISTEMU ĐERAVIČKIH JEZERA NA IZVORIŠNOM KRAKU ERENKA

UROŠEVIĆ Violeta

U letnjem periodu 1996. godine istraživane su obraštajne alge glacijalnih jezera (Malo Đeravičko, Veliko Đeravičko i Jezero Lokva) i otoke (dve otoke na tri lokaliteta) u kompleksu Đeravičkih jezera (Fig. 1 - 4). Istraživani lokaliteti razlikovali su se međusobno u kvalitativnom i kvantitativnom sastavu obraštajnih algi i neznatno u fizičkim faktorima sredine (Tab. 1 i Tab. 2). Flora algi bila je bogata a brojem taksona dominirali su predstavnici razdela *Chlorophyta* (111 taksona) i *Bacillariophyta* (102 taksona). Razdeli *Cyanophyta*, *Euglenophyta* i *Pyrrophyta* bili su slabije zastupljeni. Od jezera najbogatiju floru i vegetaciju obraštajnih algi imalo je (Fig. 5) Malo Đeravičko (115 taksona), koje je najvisočije locirano (2360 m n.m.), ima najnižu pH vrednost vode (7,3) i najveći broj taksona (46), vezanih samo za ovaj lokalitet. Florno najsiromašnija u taksonima (53) je otoka velikog

Đeravičkog jezera, pre uliva u Jezero Lokva (lokalitet 4). Voda do ovog lokaliteta ima visinski pad od oko 30 m, brzi protok i najveću vrednost aktivne reakcije (pH 8,2). To pokazuje da dejstvo faktora sredine omogućava i reakciju zajednice algi na specifične uslove života, ali, istovremeno, deluje ograničavajuće na brojniju zastupljenost taksona u obraštaju. Istraživana glacijalna jezera i njihove otoke u kompleksu planine Đeravice (2656 m n.m.) imaju visinski položaj (2360 - 2270 m n.m.) koji ih svrstava u najviša jezera Jugoslavije. Za klimatske prilike koje karakterišu takva područja na istraživanim lokalitetima Đeravice utvrdili smo relativno visoke temperature vode (10,0 - 17,00 C). Njihove visoke vrednosti možemo dovesti u vezu sa jugoistočnom ekspozicijom jezera, dobroj osunčanosti, ali je verovatno da najsnažniji uticaj ima tamna podloga koju čine stene vulkanskog porekla izgradjene pretežno od gabra. Na dobar kvalitet vode ovih jezera i njihovih otoka (I i I - II klase) ukazuju alge indikatori saprobnosti vode (kseno 12, oligo 15, beta 21), njihova učestalost po lokalitetima i izračunata saprobnost koja ne prelazi vrednost indeksa od 1,40. Na osnovu iznetih rezultata možemo zaključiti da kompleks Đeravičkih jezera i njihovih otoka predstavlja izuzetno bogatu životnu sredinu obraštajnih algi. Ova jezera treba i dalje istraživati sa više aspekata, a kao retka prirodna blaga sačuvati i zaštiti.

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Contribution to the Flora of Djeravica Mountain (I)

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ABSTRACT

The authors started studying the flora of Mt. Djeravica in 1978 on mapping the vegetation of

the Mt. Prokletije. On this occasion they are presenting a part of results from that research.

Key words: Vascular plants, Djeravica Mt.

INTRODUCTION

Mt. Djeravica belongs to the volcanic massif of the central Prokletije. It stretches between 42 and 43° of the northern geographical latitude and between 20 and 21° of the eastern geographical longitude. From the Metohia plain (500 m above sea level) to the peak of Mt. Djeravica (2656 m) there is a height difference of 2156 metres. The geological substratum of Mt. Djeravica is made of the silicates (diabase, gabbro, granite), while from the southern side one of the smaller ridges is made of the limestones (dolomites). From foot to peak the soil, too, is zonally developed. Among the most wide-spread types are the brown podsol, sour humus, and the humus silicates. With the difference in height there are encountered the various types of climate, from foot to peak: the changed Mediterranean climate, moderate continental climate, mountain climate, and Arctic and Alpine climate.

As a result of the interaction of the various geological features, pedological composition and climatic conditions there has developed the diversified vegetation (Tab. 1) and also the very interesting diversity of the flora with numerous endemic and relict species.

MATERIAL AND METHODS

The specimens were identified utilizing Josifović (1970-1977), Sarić (1986, 1992), Jordanov (1963-1982), Velčev (1982-1989), Kožuharov (1995) and Stojanov, Stefanov and Kitanov (1966/67). The collected plants are kept in "Herbarium moesiacum" in Doljevac (HMD).

RESULTS AND DISCUSSION

During floristical investigations of Mt. Djeravica following species was found (species have been listed in the alphabetical order):

- Acer campestre* L.
A. heldreichii Orph.
A. pseudoplatanus L.
A. tataricum L.
Achillea tanacetifolia All.
Aconitum lamarckii Rchb.
Agrostis rupestris All.
Ajuga genevensis L.
Alopecurus gerardii Vill.
Alyssum montanum L. ssp. *scardicum*
(Wettst.) Hay.

Table 1. The vegetation belts of Mt. Djeravica (Lakušić et al. 1974)

Silicates	Limestones
<i>Ranunculion crenati</i> Lakušić 1966	
<i>Seslerion comosae</i> Ht. 1935	
<i>Jasinion orbiculatae</i> Lakušić 1966	
<i>Bruckenthalion spiculifoliae</i> Ht. 1949	
<i>Pinetum peucis berticum</i> Lakušić 1974	<i>Pinetum heldreichii bertiscum</i> Blečić 1959
<i>Piceo-Pinetum peucis</i> Lakušić 1965	<i>Seslerio autumnalis-Fagetum</i> (Ht 1950) M. Wraber 1957
<i>Abieti-Fagetum moesiacum</i> B. Jov. 1953	<i>Seslerio-Ostryetum</i> Ht. et H-ić 1950
<i>Fagetum moesiaceae montanum</i> Blečić et Lakušić 1970	<i>Dioscoreo-Carpinetum orientalis</i> Blečić et Lakušić 1966
<i>Querco-Aceretum bircani</i> Lakušić 1974	<i>Querco-Castanetum submediterraneum</i> Wraber 1954
<i>Querco-Castanetum metobiensae</i> Glišić	<i>Orno-Quercetum illýsis</i> H-ić (1956) 1958
	<i>Salicetum albo-fragilis</i> s.1

- Androsace bedreantha* Gris.
Anemone narcissiflora L.
A. nemorosa L.
Angelica pancicii Vandas
Antennaria dioica (L.) Gäertn.
Anthemis carpatica Willd.
Anthyllis montana L.
Arabis alpina L. ssp. *flavescens* (Gris.) Hay.
Artemisia petrosa (Baumg.) Fritsch
Iasarnum europaeum L.
Asperula longiflora W.K. var. *condensata* Heldr.
A. cynanchica L.
Aster bellidiastrum (L.) Scop.
Atamantha turbith (L.) Brot. ssp. *haynaldii*
 (Borb. et Uchtr.) Tutin
Avena versicolor Vill.
Barbarea balcana Panč.
Bruckenthalia spiculifolia (Salisb.) Rchb.
Calamintha alpina (L.) Lam.
C. grandiflora (L.) Mch.
C. vulgaris (L.) Druce
Campanula scheuchzeri Vill.
Carex atrata L.
C. laevis Kit.
Cardamine glauca Spreng. f. *pumila*
 (O.F.Schult.) Dunjić
Carduus scardicus (Gris.) Wettst.
Carpinus orientalis Mill.
Carum rupstre Boiss. et Heldr.
Centaurea nervosa Willd.
C. splendens L.
C. triumfetti All.
Cerastium cerastoides Britton
C. lanatum Lam.
Colutea arborescens L.
Corydalis solida (L.) Sw. ssp. *densiflora*
 (Persl.) Hay.
Corallorrhiza trifida Chtel.
Coronilla emerus L.
Corylus avellana L.
C. colurna L.
Crataegus monogyna Jacq.
Crocus vernus Herb.
Daphne mesereum L.
Deschampsia flexuosa Trin.
Dianthus deltoides L.
D. pancicii Vel.
D. sylvestris Ewulf.
Draba korabensis Küm. et Deg.
D. scardica (Gris.) Deg. et Dörfel.
Dryas octopetala L.
Edraianthus graminifolius (L.) DC. subvar.
 baldacii (L.) DC.
E. montenegrinus Horak
Erigeron polymorphus Scop.
E. uniflorus L.
Euphrasia minima Jacq.
Festuca amethystina L.
F. duriuscula L.
F. balleri All.
F. paniculata (L.) Sch. et Thell.
F. violacea Gaud.
Fraxinus excelsior L.
F. ornus L.
Genista ovata W.K.
Gentiana asclepiadea L.
G. kochiana Perr. et Song.
G. nivalis L.
G. punctata L.
G. utriculosa L.
G. verna L.
Geranium coeruleatum Schur.
G. sylvaticum L.
Geum coccineum S.S.
G. montanum L. f. *minor* (pers.) Bmg.
Globularia cordifolia L. ssp. *bellidifolia*
 (Ten.) Wettst.
Jasione orbiculata Gris.
Juniperus nana Willd.
Juglans regia L.
Juncus trifidus L.
J. monanthos Jacq.
Knautia midzorensis Form.
Leontodon montanus Lam. var. *rilaensis*
 (Hay.) Gajić
Leucorchis friwaldii (Hampe) Schlechter
Lilium albanicum Gris.
L. martagon L.
Linum elegans Spr. ex Boiss.
Melampyrum scardicum Wettst.
Melittis melissophyllum L.
Minuartia recurva (All.) Schinz. et Thell.
Moneses uniflora (L.) A. Gray
Monotropa hypopitidis L.
Mycelis muralis Rchb.
Nardus stricta L.
Onobrychis montana DC. ssp. *scardica*
 (Gris.) Ball.
Oxyria digyna (L.) Hill.
Pedicularis petiolaris Ten.
Phyteuma confusum A. Kern.
Plantago atrata Hoppe
Poa nemoralis L.
P. pumila Host.
P. violacea Bell.
Pinguicula leptoceras Rchb.
Polystichum lonchitis (L.) Roth.
Potentilla ternata K. Koch
Pulsatilla montana (Hoppe) Rchb.
P. vernalis L.
Polygonum alpinum All.
P. viviparum L.
Prenanthes purpurea L.
Primula minima L.
Ramischia secunda (L.) Opiz
Ranunculus crenatus W.K.

- Rumex arifolius* All.
R. balcanicus Rchb.
R. scutatus L.
Salix retusa L.
Saxifraga carpatica Rchb.
S. exarata Vill.
S. glabella Bertol.
S. grisebachii Degen et Dörfler
S. marginata Stern.
S. oppositifolia L.
S. paniculata Mill.
S. pedemontana All. ssp. *cymosa* (W.K.) Engl.
S. sempervivum C. Koch
S. taygetea Boiss. et Heldr.
Sempervivum macedonicum Praeger
Senecio carpaticus Herb.
Sesleria coerulans Friv.
S. comosa Vel.
Sedum alpestre Vill.
Silene asterias Griseb.
Soldanella dimorpha Vierh.
Stachys alpina L.
Thymus albanus H. Braun
T. balcanus Borb.
T. kernerii Borb.
Tilia argentea Desf.
Trifolium noricum Wulf.
Trinia delechampii (Ten.) Janch.
Ulmus montana Stockes
Vaccinium myrtillus L.
V. uliginosum L.
Valeriana pannicaria Hal. et Bold.
Veronica alpina L.
V. bellidoides L.
V. officinalis L.
Verbascum baldacii Deg.
Viola elegantula Schott.
V. zoysii Wulf.
Viscaria viscosa Roch.
Wulfenia blecici Lakušić ssp. *robusta* Lakušić

CONCLUSION

On the basis of the many years' (and still insufficient) research, the authors are of the following opinion: - floristically, Mt. Djeravica is one of the most interesting mountains within the Prokletije complex; - by partial literary and field (in 1978, 1987 and 1996) research work there has been collected the ample material, on the basis of which 159 species have been identified in this paper; - it is necessary to continue this work, because Mt. Djeravica area is very rich in the above species.

REFERENCES

- Jordanov, D. (Ed.) 1963-1982: Flora na NR Blgaria, I-VII. BAN. Sofia.
Josifović, M. (ed.) 1970-1977: Flora SR Srbije, I-IX. SANU. Beograd.
Kožuharov, S. (ed.) 1995: Flora na NR Blgaria, X. BAN. Sofia.
Lakušić, R., Grgić, P., Medjedović, S., 1974: Zakanitosti vertikalnog rasporeda vegetacije na vulkanskim masivima centralnih Prokletija. Tokovi 9. Ivangrad.
Sarić, M. (ed.) 1986: Flora SR Srbije, X. SANU. Beograd.
Sarić, M. (ed.) 1992: Flora Srbije, I (2nd ed.). SANU. Beograd.
Stojanov, N., Stefanov, B., Kitanov, B., 1966/67: Flora na Blgaria. Nauka i iskustvo. Sofia.
Velčev, V. (ed.) 1982-1989: Flora na NR Blgaria, VII-IX. BAN. Sofia.

REZIME

PRILOG FLORI PLANINE ĐERAVICE (I)

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Vulkanski masiv Đeravice pripada centralnim Prokletijama. Proteže se između 42°-43° severne geografske širine i 20°-21° istočne geografske dužine. Od metohijske ravnice (500 m n.v.) do vrha Đeravice (2656 m n.v.) postoji visinska razlika od 2156 m. Geološku podlogu Đeravice čine silikati (dijabaz, gablo, granit), dok sa južne strane jedan manji greben je građen od krečnjaka (dolomiti). Od podnožja prema vrhu i zemljište je zonalno razvijeno. Među najrasprostranjenijim tipovima su smeđa podzolasta zemljišta, pa kisela humusna zemljišta i humusna silikatna zemljišta. Na visinskoj razlici susrećemo različite tipove klime. Od podnožja ka vrhu: izmenjenomediteranska klima, umereno kontinentalna klima, planinska klima, arktoalpska klima. Kao rezultat interakcije raznovrsnih abi-

By this paper we have identified 159 species of the vascular flora, the majority of it belonging to the high-mountain species often designated as the Arctic and Alpine flora of the mountain massif of Mt. Prokletije, some of which are encountered on Mt. Djeravica only. Of special interest is the wealth of the following genera: *Acer*, *Dianthus*, *Festuca*, *Gentiana*, *Poa*, *Rumex*, *Saxifraga*, *Thymus* and *Veronica* - considered by the authors to be insufficiently studied on this massif. The special place in the flora (and in the vegetation itself) is occupied by the endemic and relict species the *Pinus heldreichii* (on the limestone) and the *Pinus peuce* (on the silicate). In the previous work little attention has been paid to the hygrophilic vegetation and to the flora - what is sure to be corrected by the authors.

otičkih ekoloških faktora razvila se raznovrsna vegetacija (Šema 1), a takođe i veoma interesantan diverzitet flore, sa brojnim endemičnim i reliktnim vrstama. Tokom 1978. godine i tokom 1996. godine vršena su floristička istraživanja masiva Đeravice. Tom prilikom smo identifikovali 159 vrsta vaskularne flore, od kojih većina pripada visokoplaninskim vrstama koje se često označavaju kao arkto-alpijska flora. Mnoge među utvrđenim vrstama susreću se jedino na Prokletijama, tj. na Đeravici. Ovom prilikom je prezentiran deo utvrđenih vrsta, a preostali deo će biti prezentiran u nastavku. Analizom priloženog spiska možemo zak-

ljučiti da su floristički posebno interesantni rodovi: *Acer*, *Dianthus*, *Festuca*, *Gentiana*, *Poa*, *Rumex*, *Saxifraga*, *Thymus* i *Veronica*, za koje verujemo da su na ovom masivu još nedovoljno proučeni. Posebno mesto u flori i vegetaciji Đeravice zauzimaju endemoreliktnе vrste: *Pinus heldreichii* Chirst. (na krečnjaku) i *Pinus peuce* Gris. (na silikatu). U dosadašnjem radu je malo pažnje posvećivano hidrofilnoj flori i vegetaciji, čemu će autori posvetiti ubuduće veću pažnju.

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August Aspect of the High-mountain Vascular Flora of the Djeravica Volcanic Massif

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ABSTRACT

Amidzic Lidija, Krivosej Zoran (1997): august Aspect of the High-mountain Vascular Flora of the Djeravica Volcanic Massif. The University Thought - Natural Sciences (Special Edition).

Djeravica occupies large part of the central Prokletije territory, representing the highest

mountain massif of Yugoslavia and the largest silicate massif of southeastern Dinarides too. Due to its inaccessibility, high-mountain flora of the highest volcanic parts of Djeravica has been fragmentarily studied only. Thus, the paper represents an attempt of its overall presentation.

Key words: Djeravica, volcanic massif, flora

INTRODUCTIONS

Prokletije represents the huge mountain system in the Balkan peninsula, located between the Dinarides continuing toward northwest, the Sar - Pindus mountain system at southeast and Rhodopes at east and northeast. These ""South-European Alps"" consists of some 40 marking wholeness divided by deep valleys and gorges. Yugoslav, the southwestern Prokletije respectively, are divided into the northern, Mid and southern mountain group. Djeravica belongs to the southern group, representing the highest massif of Yugoslav Prokletije, but, at the same time, the largest massif of the southeastern Dinarides too. This massif, with its eastern and northeastern sides, inclines pyramid-like above the Metohian flat reaching the height of 2,656 m/a/s/l.

The toothed peaks, sloppy cliffs, spacious circues, moraines and numerous glacial lakes of the highest parts of Djeravica are the characteristics of its glacial morphology that gives a specific severe appearance. From the geologic point, the largest part of the massif's high-mountain zone is made of diabase and gabbro. The northern part of the slope is made of granite only, while, toward south, it continues with zone of schist, marble limestone and dolomites. Although rocky ground and bare rock masses predominate, shallow pedologic substrate, represented by humus silicate soil on diabase and gabbro, acid humus silicate soil on granite and hydrogen humus soil around the high-mountain tresava, appear in the zone from place to place.

High-mountain area of Djeravica is characterized by the domination of Prokletije variant of Arctic - Alpine climate, within which, a climate of firm snow and ice in northern exposed circues and snow packs conditioned locally - morphologically, expresses its full severeness.

Specific flora presenting the results of, not only, severe environment, but the historical factor, specific geographic position and anthropo-genic influence too, appears in such frames of the surrounding area. Unfortunately, the flora of Djeravica, at present, has been researched partially only. This, precisely, induced our interest to implement some more detailed research of its most attractive part that covers the massif of Velika (Great) Djeravica and its west circue with Veliko and Malo (Great and Small) Djeravica lakes in.

MATERIAL AND METHODS

Herbal material from Djeravica was collected and herbariumed by the beginning of August 1996. The check-up of the herbariumed material was done with the assistance of voluminous literature for the determination of vascular flora. Determination of floral elements affiliation was done according to M. Gajic (1980).

RESULTS AND DISCUSSION

The area, from which the herbal material was collected, covers a spacious west circue of Djeravica with the Veliko (2,309 m/a/s/l) and Malo (2,360 m/a/s/l) Djeravica lakes, as well as, from the ridge of surrounding crests. Velika (Great) Djeravica (2,656 m/a/s/l) with its marking inclination above the Great lake, Veliki Krs (Great Rocks 2,502 m/a/s/l) with its vertical rocks above the spring part of Erenik river and the saddles, so called, Zeleni Krs (Green Rocks 2,505 m/a/s/l) of the northwestern direction connecting Crni Krs (Black Rocks) with Velika (Great) Djeravica, Dominate within the bordering crest.



Figure 1. A part of Djeravica with florist research made.
Slika 1. Deo Đeravice na kojem su obavljena floristička istraživanja R 1:25000

According to the latest field research (Mijatovic, 1997), the bottom of the circue with the Veliko (Great) and Malo (Small) Djeravica lakes in, as well as, the system of high-mountain meadow bogs with Lokva as the largest, are made of gabbro spreading toward west in the bottom of Velika (Great) Djeravica up to the bottom of Crni Krs (Black Rocks). The diabase gradually developed from gabbro, are significantly more dispersed, primarily making up Velika (Great) Djeravica massif and surrounding crests. On the circue borders, especially toward the Zeleni Krs (Green Rocks) saddle, diabase and gabbro gradually transfer into green schist belonging to eastern part of Paleozoic series.



Figure 2. Peak of Velika Djeravica
Slika 2. Vrh Velike Đeravice

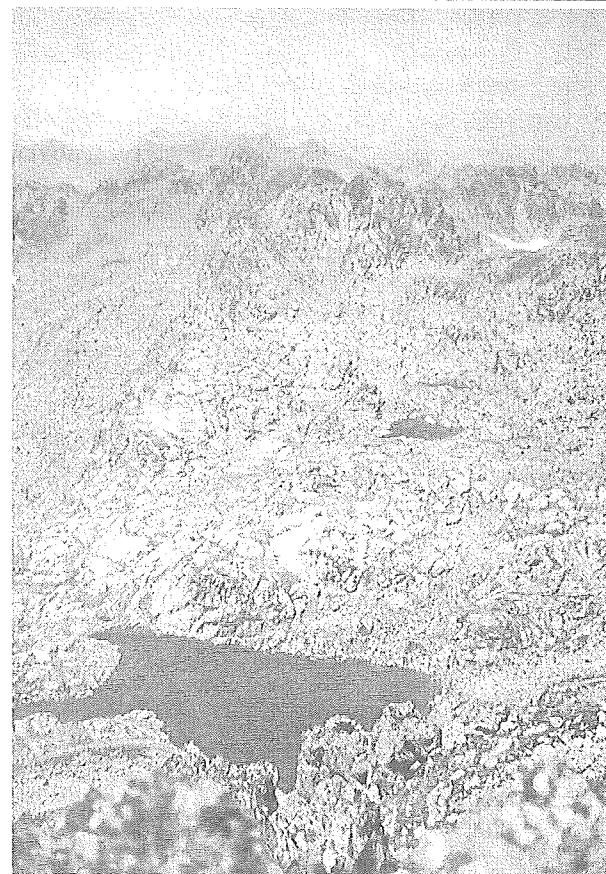


Figure 3. Veliko and Malo Djeravica lake
Slika 3. Veliko i Malo Đeravičko jezero

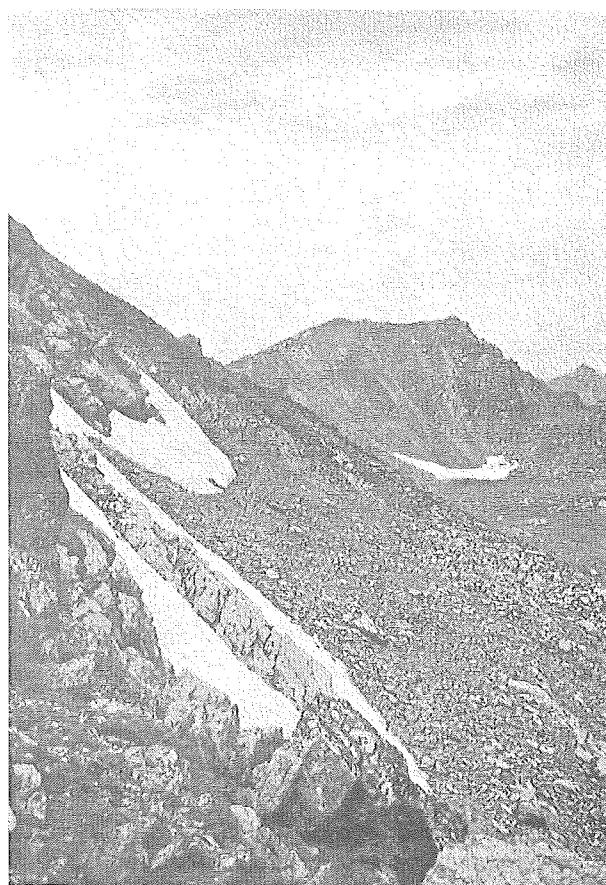


Figure 4. One of the recent Snow-packs of Djeravica
Slika 4. Jedan od recentnih snežnika Đeravice

From the biogeographic point, the area belongs to Dinaride province that is connected with the highest regions of Dinaride mountains of Durmitor, Bjelasica, Komovi, Prokletije. Also, the area covers eco-systems of mountain turfs, snow-packs and rocks, especially in the circues (Stevanovic, 1995). The province belongs to Mid-European mountain sub-region of Mid-South-European mountain biogeographic region that is analogue to high-mountain and Nordic tundra biome, i.e., to Alpine - High-Nordic rocks grounds, pastures, snow-packs and rocky meadows (Matvejev, Puncer, 1989).

Within the area mentioned, the vegetation of high-mountain turfs and meadow bogs, rocky grounds, snow-packs and in the rock-cracks is developed and has the structure of eco-tone due to mosaic schedule, providing the registration, by the beginning of August, of 107 species of vascular flora, affiliated into 36 families:

Fam . Ophioglossaceae	Fam . Plumbaginaceae
<i>Botrychium lunaria</i> (L.) Sch .	<i>Armeria alpina</i> (DC) Willd .
Fam . Hypolepidiaceae	Fam . Hypericaceae
<i>Pteridium aquilinum</i> (L.) Kihn .	<i>Hypericum alpinum</i> W.K
Fam . Aspleniaceae	Fam . Brassicaceae
<i>Asplenium trichomanes</i> L .	<i>Cardamine glauca</i> Spreng .
Fam . Athyriaceae	<i>Draba korabensis</i> Kum . et Deg .
<i>Cystopteris fragilis</i> (L .) Bernh .	<i>Barbarea balcanica</i> Panč .
Fam . Aspidiaceae	<i>Arabis alpina</i> L . var . <i>flavescens</i> Gris .
<i>Polystichum lonchitis</i> (L .) Roth .	Fam . Vacciniaceae
Fam . Cupresaceae	<i>Vaccinium uliginosum</i> L .
<i>Juniperus sibirica</i> Burgs .	<i>Vaccinium myrtillus</i> L .
Fam . Ranunculaceae	Fam . Empetraceae
<i>Ranunculus montanus</i> Willd .	<i>Empetrum nigrum</i> L .
<i>Ranunculus nemorosus</i> DC .	Fam . Primulaceae
<i>Ranunculus crenatus</i> W.K .	<i>Androsace hedraentha</i> Gris .
Fam . Caryophyllaceae	<i>Primula minima</i> L .
<i>Paronychia kapela</i> (Hacq.)Kern .	Fam . Rosaceae
<i>Cerastium alpinum</i> L .	<i>Geum montanum</i> L .
<i>Cerastium lanatum</i> Lam .	<i>Potentilla ternata</i> K .Koch .
<i>Cerastium cerastoides</i> (L .) Brilt .	Fam . Malaceae
<i>Minuartia recurva</i> (All .) Sch . et Thell .	<i>Cotoneaster integerrimus</i> Med .
<i>Dianthus cruentus</i> Gris .	Fam . Crassulaceae
<i>Dianthus deltoides</i> L .	<i>Jovibarba heuffelii</i> A . et D . Love
<i>Silene vulgaris</i> (Moench)Garcke	<i>Sempervivum kosaninii</i> Praeg .
<i>Silene sendtneri</i> (Boiss) Jord . et Pan .	<i>Sedum hispanicum</i> L .
<i>Silene doerfleri</i> Nik., Lak., Stev. et Bul .	<i>Sedum acre</i> L .
<i>Silene pusilla</i> WK . subsp . <i>monachorum</i> (Vis .)Neum .	Fam . Saxifragaceae
<i>Scleranthus annus</i> L .	<i>Saxifraga pedemontana</i> All . subsp . <i>cymosa</i> (W.K.)Engl.
Fam . Polygonaceae	<i>Saxifraga moschata</i> Wulf.
<i>Rumex acetosella</i> L .	<i>Saxifraga aizzon</i> Jacq .
	<i>Saxifraga adscendens</i> L . ssp . <i>adscendens</i> Hay .
	<i>Saxifraga carpatica</i> Rchb .
	<i>Saxifraga rotundifolia</i> L .
	Fam . Fabaceae
	<i>Trifolium repens</i> L .
	<i>Lotus corniculatus</i> L .
	Fam . Oenotheraceae
	<i>Epilobium anagallidifolium</i> Lam .
	Fam . Geraniaceae
	<i>Geranium coruleatum</i> Shur .
	Fam . Apiaceae
	<i>Ligusticum mutellina</i> (L .)Crantz .
	<i>Pimpinella alpina</i> Host .

Fam . Gentianaceae	<i>Allium sibiricum</i> L .
<i>Gentiana kochiana</i> Perr . et Song	Fam . Juncaceae
<i>Gentiana punctata</i> L .	<i>Juncus trifidus</i> L .
<i>Gentianella crispata</i> (Vis .) Holub . f . <i>crispata</i>	<i>Luzula sudetica</i> (Willd.) DC .
Fam . Rubiaceae	<i>Luzula spicata</i> (L .) Lam .
<i>Galium anisophyllum</i> Vill .	Fam . Cyperaceae
<i>Galium elongatum</i> Vill .	<i>Carex sempervirens</i> Vill .
<i>Asperula cynanchica</i> L .	<i>Carex curvula</i> All .
Fam . Boraginaceae	<i>Carex atrata</i> L .
<i>Myosotis alpestris</i> Schm .	Fam . Poaceae
Fam . Scrophulariaceae	<i>Nardus stricta</i> L .
<i>Veronica bellidioides</i> L .	<i>Poa bulbosa</i> L . f . <i>vivipara</i>
<i>Veronica teucrium</i> L .	<i>Poa ursina</i> Vel .
<i>Wulfenia blecicii</i> R . Lak .	<i>Poa pumila</i> Host .
<i>Pedicularis verticillata</i> L .	<i>Agrostis rupestris</i> All .
<i>Scrophularia vernalis</i> L .	<i>Alopecurus gerardi</i> Vill .
<i>Euphrasia minima</i> Jacq .	<i>Avena versicolor</i> Vill .
Fam . Lentibulariaceae	<i>Deschampsia caespitosa</i> (L .) P .B .
<i>Pinguicula vulgaris</i> L .	<i>Festuca scardica</i> Gris .
Fam . Lamiaceae	<i>Festuca varia</i> Haenke
<i>Lamium garganicum</i> L .	<i>Festuca alpestris</i> Simk .
<i>Ajuga pyramidalis</i> L .	<i>Sesleria comosa</i> Vel .
<i>Calamintha alpina</i> (L .) Lam . subsp . <i>alpina</i>	
<i>Thymus cherlerioides</i> Vis .	
Fam . Campanulaceae A . L . Juss .	
<i>Phyteuma confusum</i> A . Kern .	The list enclosed indicates that the largest number of species are presented in the family of Asteraceae (13 species), Poaceae (12 species) and Caryophyllaceae (12 species).
<i>Phyteuma pseudorbiculare</i> Pant .	
<i>Edraianthus montenegrinus</i> Horak .	
<i>Campanula rotundifolia</i> L .	
Fam . Asteraceae	
<i>Homogyne alpina</i> Cass .	The analysis of this part of the Djeravica high-mountain flora indicates the greatest presence of the Mid-European mountain elements (MEM) with 37 species, 34.58% respectively. The South-European mountain (SEM) elements further dominate with 26 registered species making up 24.30% (Figure 1). The Euro-Asian (EUA - 14.02%), the Arctic - Alpine (Arct.-Alp. - 6.54%), the Circum-Polar (CIRP - 6.54%), the Circum-Boreal (CIRBOR - 5.61%), Hol-Arctic (HOL - 3.74%), the Boreal-Sub-Boreal (0.93%) flora elements, as well as, the cosmopolites (3.74%), follow up. The domination of the Mid-European mountain plants, that migrated to the Balkan, through the Alps, during the last glaciation, together with the Circum-Boreal and the Arctic-Alpine species, indicates the glacial, refugee character of this part of Prokletije. However, ancient Tertiary oro-phytes also implemented their continued development on Djeravica, proved by a significant participation of the South-European mountain species, mostly of an endemic character. Especially significant are, as follows: Prokletije (Silene doerfleri, Wulfenia blecicii), Dinarides (Edrianthus montenegrinus, Silene pusilla ssp. Monachorum), Dinarides - Balkan endemic (Phyteuma pseudorbiculare, Hippocratea masculata ssp. Pelivanovicii, Poa ursina, Festuca scardica, Sempervivum kosaninii, Silene sendtneri), but, also, Carpathian - Balkan sub-endemic (Jovibarba heuffelii, Anthemis carpatica, Saxifraga pedemontana ssp. Cy-
<i>Anthemis carpatica</i> Willd .	
<i>Achillea lingulata</i> W.K .	
<i>Antennaria dioica</i> (L .) Goertn .	
<i>Erigeron uniflorus</i> L .	
<i>Centaurea nervosa</i> Willd .	
<i>Artemisia petrosa</i> (Bauerng .) Frits .	
<i>Adenostyles alliaria</i> (Gouan) Kern .	
<i>Hypochaeris maculata</i> L . subsp . <i>pelivanovicii</i>	
Petrov . var . <i>koritnicensis</i> Hay .	
<i>Hieracium guttnickianum</i> Heg . et Heer .	
<i>Leontodon montanus</i> Lam . var . <i>rilaensis</i> (Hay .)	
Gajić	
<i>Taraxacum officinale</i> Web . , Wigg .	
<i>Senecio carpaticus</i> Herb .	
Fam . Liliaceae	
<i>Veratrum album</i> L .	
Fam . Alliaceae	

mosa, *Lamium garanicum*). A significant inflow of the Euro-Asian, Hol-Arctic and cosmopolite elements simultaneously confirms the openness of the area toward wider influences, contributing to their florist resource.

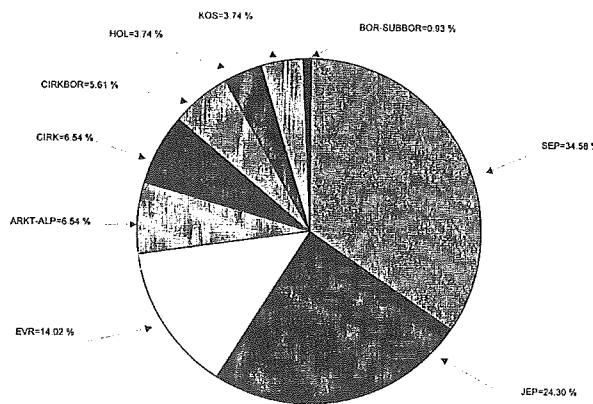


Figure 6. A spectrum of floral elements of the Djeravica highest silicate massif

Slika 6. Spektar flornih elemenata najviših silikatnih masiva Deravice

CONCLUSION

Djeravica represents the highest massif of Yugoslav part of Prokletije and of Yugoslavia as a whole too, but, also is the largest silicate massif of the southeastern Dinarides too.

In the highest parts of the massif, mostly built of diabase and gabbro, glacial morphology dominates and Prokletije type of Arctic - Alpine climate prevails. Within significantly severe high-mountain conditions, by the beginning of August, the presence of 107 species of vascular flora, grouped in 36 families, were registered. The largest number of the species belongs to the Mid-European mountain, the South-European mountain, the Euro-Asian and the Arctic - Alpine elements.

REFERENCES

Amidžić Lidija (1997) : Visokoplaninska flora i vegetacija prokletijskih masiva Žqeba , Nedžinata i Deravice (elaborat) . Zavod za zaštitu prirode Srbije . Priština - Beograd .

Belij , S . et Amidžić Lidija (1996) : Geodiversity of Prokletije as a precondition of Highmountain Flora Diversity. National Parks and their Role in Biodiversity Protection on Balkan Peninsula . Ohrid .

Božinović , M. (1951) : Deravica i wena jezea . Kroz planine , Br . 1 : 11 -15 . Beograd .

Božinović , M. (1952) : Deravica i wena jezera (nastavak) . Kroz planine , Br . 2 : 45 -50 . Beograd .

Gajić , M. (1980) : Pregled vrsta flore SR Srbije sa biquogeografskim oznakama . Glasnik Šumarskog

fakulteta , Serija A "Šumarstvo" , Br . 54 : 111 - 140 . Beograd .

Hayek , A . (1927 - 1933) : Prodromus Florae Peninsulae Balcanicae . Berlin - Dahlem .

Javorka , S . et Ksapody , V. (1934) : Magyar Flora Kepegeben (Iconographia) Flora Hungaricae . Budapest .

Josifović , M . (ed .) (1970 - 1977) : Flora SR Srbije , I - IX. SANU. Odeqeve prirodno - matematičkih nauka. Beograd .

Lakušić , R. Grgić , P . et Međedović , S . (1974): Zakonitosti vertikalnog rasporeda vegetacije na vulkanskim masivima centralnih Prokletija . Tokovi , Br . 9 : 235 247 . Ivangrad .

Matvejev ,D . S . , Puncer , Q. (1989) : Karta bioma , Predeli Jugoslavije i vihova zaštita . Prirodwečki muzej, Posebna izdanja, Knj . 36 . Beograd .

Mijović , D . (1997) : Hidrogeološka istraživanja izvornog dela Erenika (elaborat) . Zavod za zaštitu prirode Srbije . Beograd .

Sarić , M . (ed .) (1986) : Flora SR Srbije , X. SANU, Odeljenje prirodno - matematičkih nauka . Beograd .

Sarić , M . (ed .) (1992) : Flora Srbije , 1 . SANU, Odeljenje prirodno - matematičkih nauka . Beograd .

Stevanović , V . (1995) : Biogeografska podela teritorije Jugoslavije . Biodiverzitet Jugoslavije sa pregledom vrsta od međunarodnog značaja (ed .) : 117 - 127 . Ekolibri , Biološki fakultet Univerziteta u Beogradu .

REZIME

AVGUSTOVSKI ASPEKT VISOKOPLANINSKE VASKULARNE FLORE VULKANSKIH MASIVA ĐERAVICE

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Prokletije predstavljaju najgorostasniji planinski sistem na Balkanskom poluostrvu smešten između Dinarida koje se na njih nastavljaju prema severozapadu , Šarsko - pindskog planinskog sistema na jugoistoku i Rodopa na istoku i severoistoku. Ovi "južnoevropski Alpi" sastoje se od oko 40 markantnih celina rasčlanjenih dubokim dolinama i klisurama. Jugoslovenske, odnosno, severozapadne Prokletije, dele se na Severnu, Srednju i Južnu planinsku grupu. Deravica pripada Južnoj grupi predstavljajući najviši masiv jugoslovenskih Prokletija i Jugoslavie, ali i najveći silikatni masiv jugoistočnih Dinarida. Ovaj masiv se svojim istočnim i severoistočnim stranama piramidalno izdiže iznad metohijske ravnicе dosežući visinu od 2656 m .

Nazubljeni vrhovi , strme litice , prostrani cirkovi, morene i mnogobrojna glacijalna jezera najviših de-

lova Đeravice, odraz su njene glacijalne morfologije koja joj daje specifičan surov izgled. U geološkom pogledu najveći deo visokoplaninske zone masiva je izgrađen od dijabaza i gabra. Jedino deo severnih padina izgrađuje granit na koji se prema jugu nastavlja zona škriljaca, mermerastih krečnjaka i dolomita. Mada preovlađuju kamenjari i površine golih stenskih masa, u ovoj se zoni mozaično javlja i plitak pedološki supstrat predstavljen humusnim silikatnim zemljишima na dijabazu i gabru, kiselim humusnim silikatnim zemljishima na granitu i hidrogenim humusnim zemljishima oko visokoplaninskih tresava (Lakušić, R. et al., 1974).

Visokoplaninski pojas Đeravice se karakteriše dominacijom prokletijske varijante arkto-alpske klime u okviru koje svoju punu surovost pokazuje lokalno morfološki uslovljena klima većnog snega i leda u severno eksponiranim cirkovima sa recentnim snežanicima.

Prostor sa kojeg je sakupljan bijni materijal obuhvata prostrani zapadni cirk Đeravice u kojem je smešteno Veliko (2309 m n.v.) i Malo (2360 m n.v.) Đeravičko jezero kao i venac okolnih grebena. U okviru ovog obodnog grebena dominira masiv Velike Đeravice (2656 m n.v.) koji se markantno izdiže iznad Velikog jezera, Crni krš (2502 m n.v.) sa svojim vertikalnim liticama iznad izvorišnog dela Erenika i presedlina, takozvani, Zeleni krš (2505 m n.v.) severozapadnog pravca pružanja koja povezuje Crni krš sa Velikom Deravicom.

Prema najnovijim terenskim istraživawima (Mijović, 1997), dno cırka u kojem se nalaze Veliko i Malo Đeravičko jezero, kao i sistem visokoplaninskih livadskih tresava sa Lokvom kao najvećom, izgrađeno je od gabrova koji se od podnožja Velike Đeravice pružaju prema zapadu, do podnožja Crnog krša. Dijabazi, koji su se postepeno razvili od gabrova, imaju znatno veće rasprostranjenje gradeći pre svega, Masiv Velike Đeravice i okolne grebene. Po obodu cırka, posebno u pravcu presedline Zeleni krš, dijabazi i gabrovi postepeno prelaze u zelene škriljce koji pripadaju istočnom delu paleozojske serije.

U biogeografskom pogleu, ovaj prostor pripada Dinarskoj provinciji koja je vezana za najviše regije dinarskih planina kao što su Durmitor, Bjelasica, Komovi, Prokletije. Obuhvata ekosisteme planinskih rudina, snežanika i stena, posebno u cirkovima (Stevanović, 1995). Ova provincija pripada Srednjeevropskom

planinskom podregionu Srednje - južnoevropsko planinskog biogeografskog regiona koji je analog biomu visokoplaninske i nordijske tundre, odnosno, biomu alpsko - visokonordijskih kamenjara, pašnjaka, snežanika i osulina (Matvejev, Puncer, 1989).

U okviru navedenog prostora razvijena je vegetacija visokoplaninskih rudina, livadskih tresava, kamenjara, snežanika i u pukotinama stena koja usled mozaičnog rasporeda ima strukturu ektona u kojem je početkom avgusta registrovano 107 vrsta vaskularne flore svrstanih u 36 familija. Sa najvećim brojen vrsta su zastupljene familije Asteraceae (13 vrsta), Caryophyllaceae (12 vrsta) i Poaceae (12 vrsta).

Analiza visokoplaninske flore ovog dela Đeravice pokazuje da su najzastupljeniji srednjeevropski planinski elementi (SEP) prisutni sa 37 vrsta, odnosno, 34,58 %. Iza njih dominiraju južnoevropski planinski elementi (JEP) koji sa 26 registrovanih vrsta čine 24,30 % (sl. 1). Sledi evroazijski (EVR - 14,02 %), arktičko - alpski (Arkt - Alp - 6,54 %), cirkumpolarni (CIRK - 6,54 %), cirkumborealni (CIRKBOR - 5,61 %), holarktički (HOL - 3,74 %), borealno - subborealni (0,93 %) elementi flore kao i kosmopoliti (3,74 %). Dominacija srednjeevropskih planinskih biljaka koje su na Balkan migrirale preko Alpa tokom zadnje glacijacije, zajedno sa cirkumborealnim i arktičko - alpskim vrstama, ukazuje na glacijalno refugijalni karakter ovog dela Prokletija. Međutim, na Đeravici su svoj kontinuirani razvoj ostvarile i drevne tercijarne orofite o čemu svedoči značajno učešće vrsta južnoevropskih planina koje uglavnom imaju endemično obeležje. Posebno su značajni prokletijski (*Silene dioecia*, *Wulfenia biecicii*), dinarski (*Edraianthus montenegrinus*, *Silene pusilla* ssp. *monachorum*), dinarsko - balkanski endemiti (*Phyteuma pseudoboriculare*, *Hippocratea maculata* ssp. *pelivanovicii*, *Poa ursina*, *Festuca scardica*, *Sempervivum kosaninii*, *Silene sendtneri*), ali i karpato - balkanski subendemiti (*Jovibarba heuffelii*, *Anthemis carpatica*, *Saxifraga pedemontana* ssp. *cymosa*, *Lamium garganicum*). Značajan upliv evroazijskih, holarktičkih i kosmopolitskih elemenata istovremeno govori o otvorenosti ovog prostora prema mnogo širim uticajima što doprinosi njihovom florističkom bogatstvu.

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Saxifragetum cymosae - a New Chasm-phyte Community on the Metohian Prokletije

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ABSTRACT

**Amidzic Lidija, Stevanovic Vladimir (1997):
Saxifragetum cymosae - a New Chasm-phyte Community on the Metohian Prokletije. The University Thought - Natural Sciences (Special Edition).**

Very interesting and specific communities can be found in the high-mountain region of Djeravica, the largest volcanic massif of Prokletije. The chasm-phyte community of *Saxifragetum cymosae ass. nova* occupies the most extreme positions and is located in the cracks of the volcanic rocks.

Key words: new association, Djeravica, Prokletije

INTRODUCTIOT

The grandiose massif of Prokletije, properly named by Cvijic as The Balkan Alps, has always attracted the botanists. During the expeditions, dating the end of the past and the beginning of this century, over 20 new species were described by scientists, of which, the major percentage were the local endemic dispersed on this mountain massif only. Also, great number of new communities of endemic character were described within the vegetation research.

Present analyses of the Balkan high-mountain flora indicated that the great massif of Prokletije, on Yugoslavia and Albania border, is the richest on the Peninsula. The flora recorded at the heights over 1500 m only, accounts for over 700 species of vascular plants (Stevanovic, V., 1996). However, although thanks to numerous papers (Bladacci, A., 1900, Hayek, A., 1917, Kosanin, N., 1922, Grebenscikov, O., 1943, Diklic, et Nikolic, 1961, Rudski, I., 1949, Stevanovic, V., 1996, Jankovic M. M., 1958, Kusan, F., 1953, Blec i c, V., 1961, Lakusic, R., 1968, Cernjavski, P., 1974) on the plant world of the massif most of the facts are relatively known, the fact is that, Prokletije is still one of the least researched mountains on the Balkan Peninsula from the florist and vegetation point. The reason for is not because of less visits to the mountain, but, first of all, in its size and area, as well as, in its inaccessibleness and severe relief of dramatic plastics.

One of the least researched parts of Prokletije is the grandiose massif of Djeravica, whose high-mountain flora and vegetation, except in one paper (Lakusic, R., Grgic, P. et Medjedovic, S., 1974), was at present only partially presented, within the frame of general presentations of the overall area of Prokletije, the Dinarides, respectively. This paper presents the contribution to more concrete and precise introduction to a

very complex and diverse high-mountain vegetation of this hardly accessible part of Prokletije.

MATERIAL AND METHODS

The phyto-cenologic research of the Djeravica high-mountain vegetation were done by a standard method of Zurich - Montpelier School (Brown-Blanquet, 1932). The floral element analysis was done on the basis of Walter & Struck (1970) division, amended by Landault & Hess et Hirzel (1967-1972) and Stevanovic (1992). The plant living forms were given according to Ellenberg & Mueller - Dambois (1967).

RESULTS AND DISCUSSION

Representing a part of South-eastern Dinarides, Prokletije, as "the most giant mountain group on the Balkan Peninsula" (Cvijic, 1913), belongs to a wider area of the Mediterranean zone of younger range mountains.

These are the mountains located at the border of the Adriatic Sea in the central part of the Balkan Peninsula. Yugoslav, northwestern Prokletije respectively, are divided into the Northern, the Mid, and the Southern mountain group.

The volcanic massif of Djeravica with Bjelic, Karanfili, Trojon, Popadija and Bogicevica as general oro-morphological zones, makes up the Southern mountain group, building up the range 70 km long, along the border of Albania. Rising above the Metohian flat up to the height of 2,656 m, the mountain range represents the tallest silicate massif of the Southeastern Dinarides, but, the tallest massif of Yugoslavia too. The

Tab.1

Asocijacija
SAXIFRAGETUM CYMOSAE Ass.nova

FLORISTIC ELEMENT (FLORNI ELEMENT)												
CONSTANCY CLASS (PRISETNOST)												
LIFE FORM (ZIVOTNA FORMA)												
NUMBER OF SAMPLE												
REDNI BROJ SNIMKA	1	2	3	4	5	6	7	8	9	10	11	12
LOCALITY	LOKALITET											13
SIZE OF SAMPLE (m ²)	25	25	25	25	25	25	25	25	25	25	25	25
VELIČINA SNIMKA (m ²)	25	25	25	25	25	25	25	25	25	25	25	25
LOCALITY	LOKALITET											
ALTITUDE (m)	2350	2420	2460	2500	2656	2320	2390	2420	2500	2400	2350	2320
NADMORSKA VISINA(m)	2350	2420	2460	2500	2656	2320	2390	2420	2500	2400	2350	2320
SLOPE (n°)												
NAGIB TERENA (n°)	45	75	30	65	5	45	60	10	80	20	20	45
EXPOSURE	SW	W	SW	W	W	E	N	N	E	W	W	W
EKSPOZICIJA	SW	W	SW	W	W	E	N	N	E	W	W	W
ROCK OF SUBSTRATUM												
GEOLOŠKA PODLOGA												
SILICATE (SILIKAT)												
GENERAL COVERAGE (%)	40	30	40	60	40	20	30	60	20	60	20	10
OPSTA POKROVNOST (%)	40	30	40	60	40	20	30	60	20	60	20	10
CHARACTERISTIC COMBINATION OF SPECIES												
KARAKTERISTIČNA KOMBINACIJA VRSTA												
Saxifraga pedemontana All. ssp.cymosa	1.2	1.2	1.2	3.3	1.2	1.2	+2	1.2	+2	2.2	+1	+1
Saxifraga moschata Wulf.	+1.2	+1.1	+1.1	2.2	+2	+1	+1	+	+1	+1	+	+
Juncus trifidus L.	+1	+1	+1	1.2	+2	1.2	+2	1.2	+2	1.2	+1.2	+1.2
Cardamine glauca Spreng	+	+	+		1.2	+	1.2	1.2	+	1.2	+	+
OTHER SPECIES												
OSTALE VRSTE												
Jovibarba heuffelii A. et D. Love	+	+	+1	1.2			+		+	1.1	1.1	1.1
Veronica bellidioides L.	+	+				+		+		H ros succ	H ros	H ros
Anthemis carpathica Willd.	+		+	+		+				III	III	III
Festuca alpestris Simk	+1	+	+1		+					Ch suffr	Ch suffr	Ch suffr
Minuartia recurva (All.) Sch. et Thell	+1	+	+2	+2						H caesp	H caesp	H caesp
Saxifraga aizoon Jacq.		1.2	+2	+2						Ch suffr pulv	Ch suffr pulv	Ch suffr pulv
Saxifraga rotundifolia L.										H pulv.	H pulv.	H pulv.
Cerastium alpinum L.	+									H ros	H ros	H ros
Sempervivum kosaninii Praeg.	2.2	+1	1.2		+					Ch herb caesp	Ch herb caesp	Ch herb caesp
					+					H ros.succ	H ros.succ	H ros.succ

Species occurring in one stand only (vrste zabeležene samo u jednom snimku): *Ligusticum mutellina* (L.) Crantz 1 (+), *Centaurea nervosa* Willd. 2 (+), *Paronychia kapela* (Hacq.) Kern. 5 (+.), *Scleranthus annuus* L. 6 (+.), *Geum montanum* L. 7 (+), *Silene sendtneri* (Boiss.) Jord. et Pan. 8 (+.), *Silene dioica* Nik., Lak., Stev. et Bul. 9 (+.), *Hypericum alpinum* W.K. 9 (+), *Luzula sudetica* (Willd.) DC 10 (+), *Thymus cherleroides* Vis. 12 (+).

community of *Saxifragetum cymosae* ass. nova refers to these tallest parts of Djeravica precisely.

Natural frames, the chasm-phyte community mentioned develops in, are made of the silicate rock cracks and of the rock mass cracks in the spacious Western Djeravica circue with the Veliko /The Great/ (2,309 m/a/s/l) and Malo /The Small/ (2,360 m/a/s/l) Djeravicko lakes settled in. The whole surrounding is characterized by severe glacial morphology, whose characteristic is not only the glacial lakes, but also the toothed peaks, sloppy cliffs, circues and moraines. The circue bottom, with the lakes and the high-mountain meadow bogs settled in, is made of gabbro, spreading from the bottom of Velika Djeravica westward, to the bottom of Crni Krs. The diabase, developed from the gabbro gradually, is significantly more dispersed, first of all, making up the massif of Velika Djeravica (2,656 m/a/s/l) and surrounding mountain ranges. Along the circue borders, especially in the direction of the Zeleni Krs saddle, the diabase and gabbro are gradually transferred into green schist (Mijatovic, 1997). However, the area of silicate rock mass is partially incorporated by the dolomitic limestone, contributing to its more complex geologic foundation. Although, rocky ground and bare rocky mass parts predominate the area, a mosaic-like distributed, shallow pedologic substrate, presented with humus silicate soil on the diabase and gabbro in hydrogen humus soils around the high-mountain bogs is also present (Lakusic, 1974).

The tallest parts of Djeravica, from the point of climate, are characterized by the domination of the Arctic - Alpine climate, within which, a locally and morphologically conditioned climate of firm snow and ice expresses its full-scale severeness in the northern exposed circues with recent neves.

The association of *Saxifragetum cymosae* occupies the western, southwestern, northern and eastern expositions with an inclination of 5 to 80, on the heights ranging from 2,320 to 2,656 m. It is mainly located in rock cracks and dispersed stone blocks of Velika Djeravica, covering its peak. However, it is fragmentarily incorporated in the rock cracks of the bottom of Crni and Zeleni Krs, mosaic-like mixing with the communities of turfs, neves and meadow bogs.

Based on 13 phyto-cenologic surveys, some 43 species were registered in the community (Table 1). The *Saxifraga pedemontana* All. ssp. *Cymosa* (Waldst. Et Kit.) Engl., *Saxifraga moschata* Wulf., *Juncus trifidus* L. and *Cardamine glauca* Spreng make a characteristic group. The *Jovibarba heuffelii* A. et D. Love, *Veronica bellidioides* L., *Anthemis carpatica* Willd., *Festuca alpestris* Simk., *Minuartia recurva* (All.) Sch. Et Thell., *Saxifraga aizoon* Jacq. And *Saxifraga ratundifolia* L. are joining the above as the most present.

The living form spectrum indicated the domination of chame-phyte - chemi-crypto-phyte character of the *Saxifragetum cymosae* community. Namely, the two living forms were presented in the overall spec-

trum with 93.6%, while the share of nano-phanerophytes, tero-phytes and geo-phytes were insignificantly low (Figure 1). Such a living form spectrum is characteristic for the vegetation of the high-mountain cold regions and, somewhat, corresponds to the living form spectrum of the Arctic and Alpine regions. The predominance of the chame-phyte - chemi-crypto-phyte composition of the community is derived from the fact that, here we deal with the chasm-phyte vegetation of the Alpine zone's silicate rocks. The living form specifics of the chasm-phyte community is reflected in the great presence of the clod-like and pillow-like chame-phytes (*Ch herb caesp*, *Ch herb pulv*) and the clod-like chemi-crypto-phytes (*H ceasp*) taking part with some 55% in the overall living form spectrum. A negligible small number of tero-phytes (T) and geo-phytes (G) is brought in connection with, not only the absence of adequate micro-residence for the development of the living forms, but, also, with extreme climatic conditions predominating over the residence of the community.

The species of cold Arctic - Boreal and Alpine (Mid-European mountain) region play a dominant role in the horologe spectrum of the community. The species share in the overall floral element spectrum amounts to over 75% (Figure 2). Relatively high presence of the Arctic - Alpine elements (14.3%) is especially interesting and indicative, indicating the glacial character of the community. If a significant percentage of the Mid-European mountain plants (42.8%), that dispersed from the Alps toward the Balkan Peninsula during the glaciation, is added, as well as, a certain number (10, 2%) of the species of Circum-Boreal dispersion, that, in most cases, used to have similar history as the Arctic - Alpine species had, then, a real picture of the community horologe spectrum is obtained. However, having in mind, the mountains of Western and Central Balkan, with Prokletije belonging to, represent the encounter place of various genetic and migration elements, it is natural to expect other floral elements too. The ones, regarding their dispersion, gravitating to the South-Europe mountains, and, generally speaking, considered to be within the group of Oro-Mediterranean species, are especially considered. As a rule, these species are presented with the endemic taxonomies, created from the ancient Tertiary orophytes. There 20% of such species in the community of *Saxifragetum cymosae*, and the ones being mostly emphasized among, are the Dinarides (*Edrianthus montenegrinus*, *Silene pusilla* ssp. *Monachorum*), the Dinaride - Balkan's (*Festuca scardica*, *Sempervivum kosaninii*, *Silene sendtneri*) and the Prokletije species (*Silene doerfleri*), as well as, the sub-endemic Carpathian - Balkan elements (*Jovibarba heufelii*, *Anthemis carpatica*). The ratio of Mid-European mountain (MEM), the Arctic - Alpine (Arct. - Alp.) and Circum - Boreal (Circ - Bor.) on one side and, the South-European mountain (SEM), including the species of en-

demic dispersion, on the other, amounts to almost 4 : 1. The above is an additional indicator of the Mid-European community character and its glacial-refugee character, too.

The determination of the *Saxifragetum cymosae* association's syntaxo-nomic position is somewhat difficult due to the presence of the surrounding communities around the neves (*Ranunculus crenatus*, *Cardamine glauca*), the turfs (*Festuca alpestris*, *Festuca scardica*, *Festuca varia*, *Veronica bellidoides*, *Dianthus deltoides*, *Armeria alpina*, *Euphrasia carpatica*, *Minuartia recurva*, *Senecio carpaticus*, *Antennaria dioica*, *Saxifraga carpatica*, *Artemisia petrosa*, *Juncus trifidus*, *Avena versicolor*) and juniper bush soil (*Juniperus sibirica*, *Vaccinium myrtillus*) whose syntaxo-nomic affiliation should be precisely determined. However, if the *Saxifraga pedemontana* and *Saxifraga moschata* species domination, as well as, the characteristic species combination together with the complex of all the ecological conditions, the community develops in, are considered, it can be stated that the respective belong to the group of *Saxifragion cymosae* Lakusic, 1968, of the order of *Androsacetalia vandellii* Br. - Bl. 1926, of the class of *Asplenietea trichomanis* Br. - Bl. 1934, that are present in the high-mountain zone of the Balkan Peninsula silicate massifs.

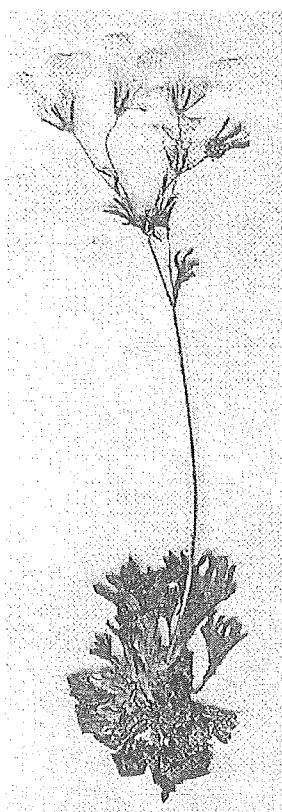


Fig. 1. *Saxifraga pedemontana* All. subsp. *cymosa*. (W. et K.) Engl.

Fig. 2. *Saxifraga carpatica* Rchb.

CONCLUSION

Saxifragetum cymosae ass. nova chasm-phyte community occupies the Alpine zone highest parts of the Prokletije silicate massif of Djeravica. The living form spectrum indicates its chame-phyte - chemi-crypto-phyte character. Such a spectrum is characteristic for the cold region vegetation and, more or less, corresponds to the Arctic and Alpine region living form spectra. The Mid-European mountainous, the Arctic-Alpine, the South-European mountainous and Circum-Boreal flora elements dominate in the community horologe spectrum. Their relation indicates the community Mid-European and glacial-refugee character. From the syntaxo-nomic point, *Saxifragetum cymosae* ass. nova community belongs to the group of *Saxifragion cymosae* Lakusic, 1968, of the order of *Androsacetalia vandellii* Br. - Bl. 1926, of the class of *Asplenietea trichomanis* Br. - Bl. 1934, that are present in the high-mountain zone of the Central Balkan.

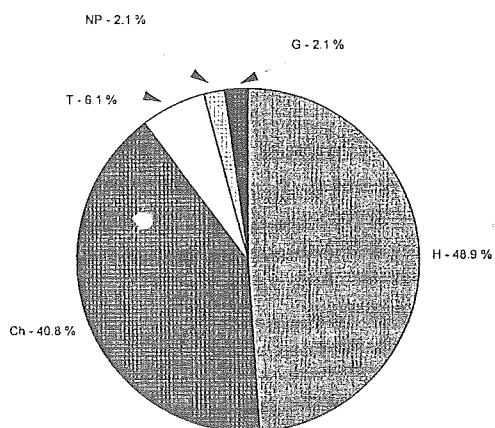


Fig. 3. Life-forms spectrum of the community *Saxifragetum cymosae*

Sl. 3. Spektar životnih formi zajednice *Saxifragetum cymosae*

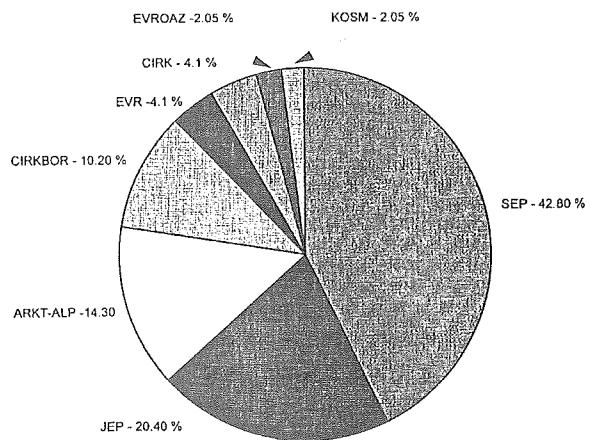


Fig. 4. Chorological spectrum of the community *Saxifragetum cymosae*

Sl. 4. Spektar flornih elemenata zajednice *Saxifragetum cymosae*

REFERENCES

- Amidžić Lidija (1997) : Visokoplaninska flora i vegetacija prokletijskih masiva Žljeb , Nedžinat i Đeravica (elaborat) . Zavod za zaštitu prirode Srbije . Priština.
- Belij , S . , Amidžić Lidija (1996) : Geodiversity of Prokletije as a precondition of Highmountain Flora Diversity . Balkan Conference "National Parks and their Role in Biodiversity protection on Balkan Peninsula " . Ohrid.
- Blečić , V . , Lakušić , R . (1966) : Prodromus biljnih zajednica Crne gore . Glasnik Republ . zavoda za zaštitu prirode , 9 : 57 - 98 . Titograd.
- Braun - Blanquet , J . (1932) : Pflanzensoziologie . Wien.
- Diklić , N . , Nikoloć , V . (1961) : Novi podaci o nalazištu biljnih vrsta u Srbiji . Glas. Prirod. muzeja, Ser. B, 17 : 215 - 234, Beograd.
- Ellenberg , H . , Mueller - Dambois , D . (1967) : A key to Raunkier Plant Life Forms with revised Subdivisions . Ber . Geobot. Inst.. ETH , 37 : 56 - 73. Zurich.
- Grebenshikov , O . (1943) : Prilog poznavawu vegetacije planine Koprivnik kod Peći . - Ohridski zbornik , posebno izdawe Srp . Kraq . Akad . 35.
- Hayek , A . (1927 - 1933) : Prodromus florae Peninsulae Balcanicae . Berlin - Dahlem.
- Javorka , S. et Ksapody , V. (1934) : Magyar Flora Kepegben (Iconographia) Florae Hungaricae. Budapest.
- Josifović , M . (ed.) (1970 - 1977) : Flora SR Srbije., I - IX . SANU , Odeljenje prirodno - matematičkih nauka . Beograd . Lakušić . R . (1968) : Planinska vegetacija jugoistočnih Dinarida . Glasnik Republ . zavoda za zaštitu prirode , 1 : 9 - 75 . Titograd.
- Lakušić , R. , Grgić , R. et Međedović , S . (1974) : Zakonitosti vertikalnog rasporeda vegetacije na vulkanskim masivima centralnih Prokletija . Tokovi , Br . 9 : 235 - 247 . Ivangrad.
- Landolt , E. & Hes , H. & Hirzel , R. (1967 - 1972) : Flora der Schweiz . Band 1, 2, 3. Birkhauser Verlag, Basel und Stuttgart.
- Mijović , D .(1997) : Hidrogeološka istraživanja izvornog dela Erenika (elaborat). Zavod za zaštitu prirode Srbije . Beograd.
- Rudski , I. (1949) : Ekskurzija na Žljeb i Mokru planinu. Prirod. muzej u Beogradu. Posebna izdanja, 25.
- Sarić , M. (ed.) (1986) : Flora SR Srbije , X . SANU, Odeqewe prirodno - matematičkih nauka . Beograd. Sarić , M. (ed.) (1992) : Flora Srbije , 1 . SAU , Odeljenje prirodno - matematičkih nauka . Beograd.
- Stevanović , V . (1992) : Floristička podela teritorije Srbije sa pregledom viših horiona i odgovarajućih flornih elemenata . Flora Srbije , 1 (ed .) : 50 - 65 . SANU, Odeljenje prirodno - matematičkih nauka .
- Stevanović , V . (1996) : Analysis of the Central European and Mediterranean orophytic element on the mountains of the W . and Central Balkan Peninsula , with special reference to endemics . Boccone 5 : 77 - 97 .
- REZIME**
- SAXIFRAGETUM CYMOSAE - NOVA
HAZMOFITSKA ZAJEDNICA NA METOHIJSKIM
PROKLETIJAMA
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- Dosadašnje analize balkanske visokoplaninske flore su pokazale da je veliki masiv Prokletije , najbogatiji na poluostrvu . Međutim , iako se zahtvaljujući brojnim radovima o biljnem svetu ovog masiva relativno dosta zna, ostaje činjenica da su Prokletije jedan od najslabije floristički i vegetacijski proučenih planinskih sistema na Balkanskom poluostrvu. Razlog tome ne leži samo u njihovoj relativno slaboj posećenosti, već, pre svega, u njihovoj veličini i nepristupačnom i surovom reljefu deamatične plastike .
- Jedan od najslabije proučenih delova Prokletrija je grandiozni masiv Đeravice čija je visokoplaninska flora i vegetacija osim u jednom radu (Lakušić, Grgić et Međedović , 1974), do sada prikazana samo parcialno, u okviru opšteg prikaza Prokletija, odnosno, Dinarida.
- Upravo na ovom grandioznom masivu registrovali smo prisustvo hazmofitske zajednice *Saxifragetum cymosae* - ass. nova koja koja zauzima jugozapadne, severne i istočne ekspozicije nagiba 5 do 80 u visinskom dijapazonu od 2320 do 2656 m. Uglavnom se javlja u pukotinama stena i razbacanim blokovima Velike Đeravice izgrađene od dijabaza , prekrivajući i njen vrh. Međutim, fragmentarno se umeće i u pukotine stena u podnožju Crnog i Zelenog krša mozaično se smenjujući sa zajednicama rudina, snežanika i livadskih tresava.
- Na osnovu 13 fitocenoloških snimaka u zajednici su registrovane 43 vrste. Karakterističan skup čine *Saxifraga pedemontana* ssp. *cymosa* , *Saxifraga moschata*, *Juncustrifidus* i *Cardamine glauca*. Njima se kao najzastupljenije pridružuju *Jovibarba heuffeltii* , *Veronica bellidioides*, *Anthemis carpatica*, *Festuca alpestris*, *Minuartia recurva*, *Saxifraga aizoon* i *Saxifraga rotundifolia*.
- Spektar životnih formi je pokazao dominaciju hanefitsko - hemikriptofitskog karaktera zajednice . Naime, u ukupnom spektru ove dve životne forme zastupljene su sa 93,6%, dok je zanemarljivo mali ideo nanofanerofita, terofita i geofita. Ovakav spektar životnih formi karakterističan je za vegetaciju visokoplaninskih hladnih predela i u izvesnom smislu korespondira

sa spektrom životnih formi arktičkih i alpskih predela. Pretežno hamefitsko - hemikriptofitski sastav zajednice proizilazi i iz činjenice da se radi o hazmofitskoj vegetaciji alpijske zone silikatnih stena. Specifičnost životnih formi ogleda se u velikoj zastupljenosti busenastih i jastučastih hamefita i busenastih hemikriptofita koje učestvuju sa oko 55 % u ukupnom spektru životnih formi zajednice *Saxifragetum cymosae*. Zanemarljivo mali broj terofita i geofita dovodi se u vezu ne samo sa odsustvom adekvatnih mikrostaništa, već i ekstremnim klimatskim uslovima koji vladaju na staništima ove zajednice.

U horološkom spektru zajednice dominantnu ulogu imaju vrste hladnih i arktičko - borealnih i alpskih (srednjeevropskih planinskih) regionala. Ove vrste učestvuju sa preko 75% u ukupnom spektru flornih elemenata. Posebno je interesantno i indikativno relativno veliko prisustvo arktičko - alpijskih elemenata (14,3 %) koji ukazuju na glacijalni karakter ove zajednice. Ako dodamo i značajan procenat srednjeevropskih planinskih biljaka (42,8 %) koje su svoje širenje s Alpa prema Balkanu ostvarile tokom glacijacije, kao i određen broj (10,2 %) vrsta cirkumborealnog rasprostranjenja koje su, u većini slučajeva, imale sličnu istoriju kao i arktičko - alpijske vrste, dobija se prava slika o horološkom spektru ove zajednice. Međutim, imajući u vidu činjenicu da su planine

Zapadnog i Centralnog Balkana kojima pripadaju i Prokletije mesto susreta različitih geno - i migro-elemenata, prirodno je očekivati i druge florne elemente, posebno one koji svojim rasprostranjenjem gravitiraju planinama južne Evrope i koje se svrstavaju u grupu oromediteranskih vrsta u širem smislu. Po pravilu ove vrste predstavljene su endemičnim taksonima nastalim od drevnih tercijarnih orofita. Takvih vrsta u zajednici *Saxifragetum cymosae* ima 20,4% a među njima se naročito ističu dinarske, dinarsko - balkanske i proletijske vrste, kao i subendemični karpatsko - balkanski elementi. Odnos srednjeevropskih planinskih (SEP), arkto - alpijskih (ARKT-ALP) i cirkumborealnih (CIRKBOR) s jedne, i južnoevropskih planinskih (JEP) s druge strane, iznosi gotovo 4 : 1. To je još jedan pokazatelj srednjeevropskog karaktera zajednice i njenog glacijalnog refugijalnog karaktera.

U sintaksonomskom pogledu zajednica *Saxifragetum cymosae ass. nova*, pripada svezi *Saxifragion cymosae* Lakušić 1968, reda Androsacetalia vandellii Br.-Bl. 1926, klase Asplenietea trichomanis Br.-Bl. 1934 prisutne u visokoplaninskoj zoni silikatnih masiva Centralnog Balkana.

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Peroxide and Katalase Enzymes Activities in Corn and Wheat Seedlings in the Conditions of Experimental Intoxication with Pb-Acetate

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ABSTRACT

Measurements of peroxide and katalase enzymes activities in corn (*Zea mays L.* var. domestic white) and wheat (*Triticum vulgare L.* var. grain) plantlets in the conditions of experimental intoxication with different concentrations of Pb-acetate (10^{-5} , 10^{-4} , 10^{-3} , 10^{-2} and 2×10^{-2} M) for different periods of time (0, 24, 48 and 72 hrs. after treatment) were taken. Gasometric method was used for determination of katalase activity,

and for peroxides activity we have used reaction of benzedine oxidation with enzyme effect. The highest activity of peroxides and katalase was measured in corn at concentration of 10^{-2} M of Pb-acetate, 24 hrs. after the treatment (200% more than in control), and 48 hrs. after the treatment in wheat (130% more than in control). Peroxide and katalase activity was decreased 72 hrs after the treatment.

Key words: plants, Pb-acetate, enzymes, catalase, peroxidase

INTRODUCTION

Changes which occur in metabolism under the influence of pollutants are actually the inhibitions or modifications of enzyme activity and can be detected very early, before visible damages of plant tissue occur (Pierre Michele, 1985). It is known that under the influence of polluter, enzyme activity goes into two directions: as an inhibition of some enzymes or increased activity of other enzymes. It is concluded that enzyme inhibition is a consequence of blocking of different functional enzyme groups by antropogenic xenobiotics. However, Stiborova et al. (1986; 1988) have found that heavy metals (Pb, Cd, Cu) irretrievably inhibit the activity of enzyme ribulosic - 1,5-diphosphocarboxilase which is isolated from barley leaves (*Hordeum vulgare L.*) through the formation of mercaptides with tyol groups of enzymes. In these same plants they found destruction of fourfold enzyme structure as well as enzyme disassociation on subunits of different size, which resulted in decrease intensity of photosynthesis.

Also other research workers (Stiborova and Zeblova, 1985) have noticed that plants which are intoxicated with Pb, have some decreased enzyme activity, in this case in alcohol dehydrogenase, in which the degree of decreased activity depends on the pH values. The same authors showed that in the presence of NAD and of NAD-ethanol complex enzyme (which probably complex with metals), the inhibiting effects of heavy metals are decreasing, thus increasing the activity of alcohol dehydrogenase.

On the other hand, heavy metals which are present in plants lead to increased activity of some enzymes (peroxide and katalase), which is probably

some form of plant protection from the influence of polluters.

Related to control, Keller (1974) found that in the conditions of air pollution peroxides enzyme activity in fir (*Abies alba*) increases up to 70%.

Besides these plants, linden (*Tilia sap.*) and black poplar (*Populus nigra L.*), under the influence of higher concentration of polluters (SO₂ and Pb), and on short exposition, also react through the increase of peroxides and oxidodismutaze activity (Jager et al., 1985). According to these authors, tolerant plants develop different capacities including the most efficient defense mechanisms on the influence of pollutants.

On the contrary, low Pb concentrations in peas leaves substantially increase the activity of nitrate reductase, while the activity of this same enzyme at high Pb concentrations is decreasing. This points out that the reaction of this enzyme is of a differential character (Singha et al., 1978).

It is confirmed through various experiments that peroxide activity degree is characteristic for each species (for example, it is higher in pine tree than in arish), and it is higher in younger plants than in old ones (Zavialova, 1992).

Based on available literature and on our preliminary results of the research on enzyme activity (katalase and peroxide), under the influence of different Pb-acetate concentrations, we have decided to examine activity of these enzymes in corn and wheat seedlings at different concentrations (10^{-5} , 10^{-4} , 10^{-3} , 10^{-2} and 2×10^{-2} M) of toxicants, without the influence of other polluters.

According to our opinion, the obtained results can be used for the benefit of early detection of pollution - the biochemical monitoring.

MATERIAL AND METHODS

We have analyzed wheat (*Triticum vulgare L.*, var. "žitnica") and corn (*Zea mays L.* var. domestic white) seeds.

The seeds were planted in lab conditions. Young plants were treated with 20ml. Pb-acetate solution of different concentration (10^{-5} , 10^{-4} , 10^{-3} , 10^{-2} and 2×10^{-2} M).

Measurements of peroxide and katalase activity were made in different periods of time: in the moment of treatment (zero time) and after 24, 48 and 72hrs. from the treatment. Enzyme activity in control plants was measured at the same time.

Gasometric method was used to measure peroxide and catalase activity (Moseva, 1982). This method is based on determination of oxygen amounts after the addition of plant extract which contains hydrogen peroxide catalysis.

Bajarkina method (Pleskov, 1985) was used to estimate peroxide activity. This method is based on the speed rate of benzidine oxidation under the influence of plant enzyme, until the product of oxidation reaches blue color of specific concentration which is determined by colorimeter.

RESULTS AND DISCUSSION

Peroxides and katalase activity in corn and wheat plantlets was measured in the conditions of experimental intoxication with different Pb-acetate concentrations (10^{-5} , 10^{-4} , 10^{-3} , 10^{-2} and 2×10^{-2} M) and in different periods of time (0h, 24h, 48h and 72h) after treatment. The obtained results show a tempestuous increase in activity of these enzymes, especially at high Pb-acetate concentrations.

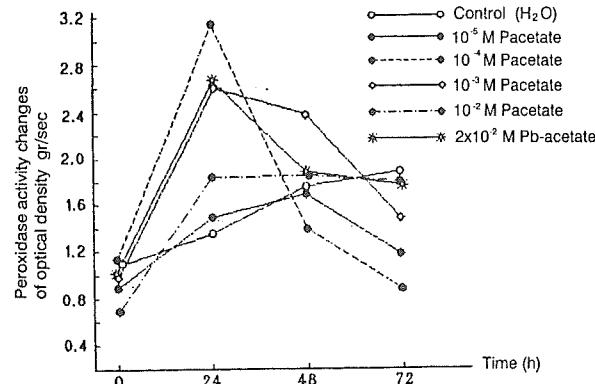


Fig. 1. Peroxidase activity in seedlings of corn (*Zea mays L.*, var. domestic white) treated by Pb-acetate under experimental conditions.

Sl. 1. Aktivnost enzima peroksidaze kod mladih biljaka kukuruza (*Zea mays L.*, var. domaći beli), tretiranih Pb-acetatom u laboratorijskim uslovima.

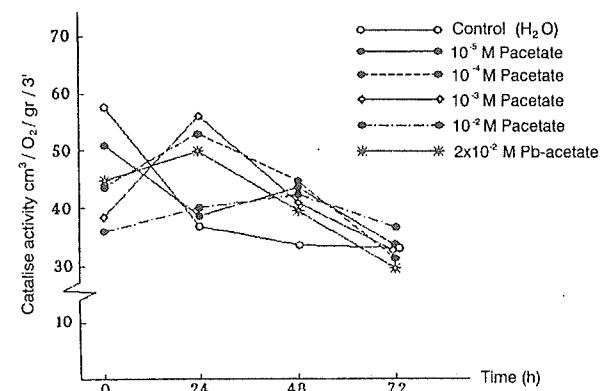


Fig. 2. Catalase activity in seedlings of corn (*Zea mays L.*, var. domestic white) treated by Pb-acetate under experimental conditions.

Sl. 2. Aktivnost enzima katalaze kod mladih biljaka kukuruza (*Zea mays L.*, var domaći beli), tretiranih Pb-acetatom u laboratorijskim uslovima.

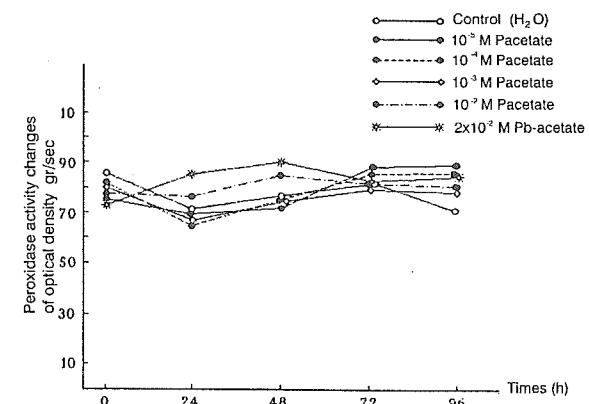


Fig. 3. Peroxidase activity in seedlings of wheat (*Triticum vulgare L.*) treated by Pb-acetate under experimental conditions

Sl. 3. Aktivnost enzima peroksidaze u uzircima mladih biljaka pšenice (*Triticum vulgare L.* var. žitnica), tretiranih Pb-acetatom u laboratorijskim uslovima

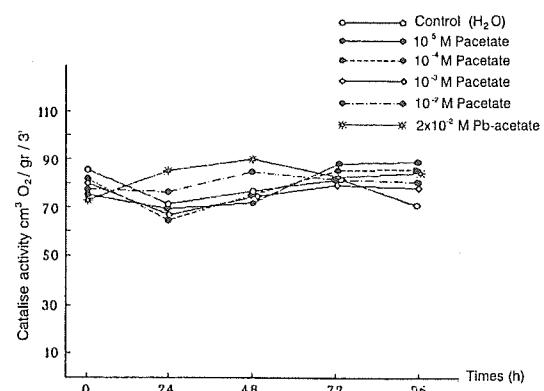


Fig. 4. Catalase activity in seedlings of wheat (*Triticum vulgare L.*) treated by Pb-acetate under experimental conditions

Sl. 4. Aktivnost enzima katalaze kod mladih biljaka pšenice (*Triticum vulgare L.* var. žitnica), tretiranih u laboratorijskim uslovima

Maximum values for peroxides and catalase activity was measured in young corn plants after 24hrs. of treatment (Figures 1,2). But in young wheat plants, maximum value of peroxides and katalase activity was measured after 48hrs. after the treatment (Figures 3, 4).

Measurement results clearly show that peroxides activity in corn and wheat, at concentration of 10^{-2} M of Pb-acetate, is increased for 200% compared to the control. Catalase activity in the same plants at the same Pb-acetate concentration is increased for 130% compared to the control (Figures 2 and 4).

According to the obtained results, peroxide activity is higher in both groups of examined plants than catalase activity.

This research also showed that peroxide and catalase activity decreases after 72hrs. from treatment in both types of plants (corn and wheat). Probably, it is because of the decrease of Pb-acetate concentration due to the watering of plants.

Similar results on the increased activity of these enzymes under the influence of the pollutants can be found in literature as well.

Sarsenbajev et al (1983) point to increased peroxide activity in young plants of different types of grains treated with SO₂. These authors have found that peroxide activity is increased especially on the spots where SO₂ caused injury of plant tissue.

Romanova and Kemerov (1986) proved that peroxide activity is increasing several times more in grains which are watered with contaminated water.

According to Munir et al. (1990), different Pb-acetate concentrations provoke increased peroxide activity in seedlings of winter crop (wheat) in controlled conditions. But in the seedlings of that same wheat which were grown in field condition near to the industrial zones, peroxide activity was not detected.

In the conditions of experimental intoxication of bean seedlings with chrome sulfate, the catalase activity increased several times more comparing to the control (Mukherji and Kumar, 1981).

Jablanovic et al. (1985) pointed out on the increased catalase activity in corn plantlets which were treated with different Pb-acetate concentrations. According to the authors, higher Pb-acetate concentrations provoke increased catalase activity but in the plants which were permanently exposed to the Pb and other heavy metals the catalase activity had not been changed.

Based on some published data and on the results obtained during our research, the increased catalase and peroxide activity represents the process of detoxification through the adaptation of metabolism, which belongs to the qualitative mechanisms of seedlings to acquire the resistance toward the pollution. We assume that the peroxide and the catalase are involved in defense mechanisms for toxic effects of active forms of oxygen and hydrogen peroxide, which are formed due to the mutual activity of toxicant with cell mem-

brane and cell organelles membrane. We think that the increased activity of these enzymes is actually a biochemical indication for higher contamination of the environment.

CONCLUSION

The measurements of peroxide and catalase activity in young wheat and corn plants in the conditions of experimental intoxication show an increased activity of these enzymes representing a biochemical indication for higher pollution of the environment. The results of the research show that the activity reactions of these enzymes are very tumultuous, and the response on the presence of pollutants is best in corn, after 24hrs., and in wheat, 48hrs. after the treatment.. This is happening because the mechanism of detoxification, which disassembles harmful substances to the products which are not harmful for plants, is activated.

The increased peroxide and catalase activity is the response of plants to pollution before the visible damages occur. That is why we can use these results as biochemical monitoring for the purpose of early diagnosis of the pollution.

REFERENCES

- Jablanović M., Hoxha Y., Filipović R., (1985); Catalase activity in the plants exposed to contamination with heavy metals. *Acta Biologica Med. Exp.* 10, 21-24, Priština, Yugoslavia.
- Jager H. J., Bender J., Grunhage L., (1985); Metabolic responses of plants differing in SO₂ sensitivity to words SO₂. *Fumigation Environ. Pollut.* A 39, N0 4, 317-335.
- KellerT. (1974): The use of peroxidase activity for monitoring and mapping air pollution areas. *European Journal of forest Pathology* 4; 11-19
- Moševa L.V. (1982): Opredelenie aktivnosti katalazi v rastitel'nykh objektaх Praktikum po fiziologii rastenij. (Red. Tretjakova, N.N.) Kolos, Moskva 134.
- Mukherji S., Roy Kumar, (1981): Changes in the enzyme levels of mungbean (*Phaseolus aureus* seedlings caused by the toxicity of chromium., "Sciand Cult", 47, No 10, 354-355.
- Munir Aq Habib, Aq Arid, Jacjuk, T. (1990); Isofermenti spektri oksidoreduktaz pri fitoksičeskom vozdejstvii svinca. Prom. Botan. Sostojanie i perspektivie razvitiya. Kiev. S.132-133.
- Pierre Mishele, (1985); Efects de la pollution atmosphérique sur le fonctionnement des enzymes foliaires. *Bull. Soc. ecophysiologe.* 10, No2, 75-80.
- Pleškov B. P. (1985); Praktikum po biokhimii rastenij. Izdatelstvo Kolos Moskva.
- Romanova O.A.,Kemerov, (1986); Vlijanie fenosideržačih stocnih vod na aktivnost peroksidazi u

pšenici. Kemerovo, 96. Il. Bibliogra. Lonazv. (Rukopis dep. V Viniti), No 5 778-8

Sarsenbaev K.N., Mezeiceva N.I., Kosaev M.N., (1983); Vlianije dvojokisi serii na aktivnost i komponenti sostav peroksidazi v listiev introduciruemii rastenii. Vses. Kon. Poteor.osnovii introdukci rast. Tez. Dokl, M.242.

Suingh A. (1988); Hevy metal influences chlorophyll content in "indian pasture legume Photosinthetica", 22, No 1, 125-127.

Stiborova M., Leblova S., (1985): The effects of environmental pollutants on plant alcohol dehydrogenase., " Rast in kislorod stres. Tes. Medzunar. Silep. Po anaerobiozu rast." Moskva. 9-13 sent., B.M. v. d., 32/33.

Stiborova Marie, Dubravova Marta, Brežinova Alena, Friedrich A., (1986): Effect of heavy metal ions on growth and biochemical characteristics of photosynthesis of barley (*Hordeum vulgare L.*) Photosinthetica, 20, No 4, 418-425.

Stiborova Marie (1988); Cd jons effect the quaternary structure of ribulose -1,5-biphosphate carboxylase from barley leaves. Biochem and Physiol. Phlanz. 183. No 5, C. 371-378

Zavalova N.S, (1992); Aktivnost peroksidazi u soski i listvenici v zone promišlenova zagrijaznenija. Tehnogen, vozdejstvia na les coobšćestva i problemi, ih voctolov i sohranenija (RAN. Ur. Int. lesa) - Ekaterinburg, -S. 47-52.

REZIME

AKTIVNOST ENZIMA PEROKSIDAZE I KATALAZE KOD MLADIH BILJAKA KUKURUZA I PŠENICE U USLOVIMA EKSPERIMENTALNE INTOKSIKACIJE Pb-ACETATOM

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Teški metali a, i drugi zagađivači kod biljaka izazivaju promene enzimskog sistema u metabolizmu, koje se manifestuju kao inhibicije jednih enzima ili aktivacije drugih enzima.

Inhibicije enzima nastaju kao posledice blokiranja funkcionalnih grupa enzima od strane zagađivača. Sa druge strane aktivacije enzima pod uticajem zagađivača predstavljaju zaštitne reakcije biljaka na delovanje polutanata, koje se mogu upotrebiti u korisne svrhe biohemiskog monitoringa. U vezi sa tim vršili smo ispitivanja aktivnosti enzima katalaze i peroksidaze kod mlađih biljaka kukuruza (*Zea mays L.* var domaći beli), i pšenice (*Triticum vulgare L* var žitnica), u uslovima eksperimentalne intoksikacije različitim koncentracijama Pb-acetata (10-5, 10-4, 10-3, 10-2 i 2 x 10-2M), u funkciji vremena (0h, 24h, 48h i 72h od tretmana). Aktivnost katalaze određivana je gasometrijskom metodom a peroksidaze reakcijom oksidacije benzidina pod dejstvom enzima. Dobijeni rezultati pokazuju da se aktivnost ovih enzima burno povećava u prisustvu Pb-acetata kod obe grupe biljaka (kukuruza i pšenice), to naročito pri većim koncentracijama, što verovatno predstavlja pokretanje odbrambenog mehanizma reakcije na prisustvo pb-acetata. Najveća aktivnost peroksidaze (200% više u odnosu na kontrolu) zabeležena je pri koncentraciji od 10-2 M Pb-acetata a katalaze pri istoj koncentraciji (130% više u odnosu na kontrolu.) Prepostavljamo da je ovo povećanje aktivnosti peroksidaze i katalaze jedan vid detoksifikacije na nivou ćelije. Kako se ove promene aktivnosti enzima javljaju pre pojave vidljivih oštećenja mišljenja smo da se ovi rezultati mogu koristiti za raznu detekciju zagađenja.

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Faunistic-ecological Investigationes of the Oligochaetes (*Annelida: Oligochaeta*) on the Mouth of the Left Tributary Lepenac at the Upper Part of River Vardar, Macedonia

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ABSTRACT

This paper represents the data obtained from faunistic-ecological investigations of the mouth waters of the river Lepenac. A list of determined species is given. It comprises 8 naidids, 5 tubificids, 2 lumbricids and enchytraeid species undetermined. Two communi-

ties from stony and muddy habitats were ecologically studied. Also it was made some observations for pollution influence on the structure of oligochaete's community from the mouth of this left tributary at river Vardar.

Key words: Oligochaeta, Lepenac river, Ecological analysis

INTRODUCTION

The former aquatic oligochaete's researches on running water ecosystems in Macedonia are very obscure. Just in the last time begin the faunistic and ecologic investigations (Šapkarev and vagner, 1990; Šapkarev, 1991, 1992). This work represents the data obtained from faunistic-ecologic investigations on aquatic oligochaetes of the mouth of Lepenac. This river, as a north tributary of river Vardar, there is the greatest part of its basin in Serbia and only small part in Macedonia. Its spring is located on the east side of the mountain Šar-planina at 1860 m above sea level and its mouth is at 253 m.a.s. near the village Zlokucani. Its length amounts 75 km with a relative fall of 210/00 (Gaševski, 1978, 1979). In regard to the pollution, the river Lepenac is recipient of communal waste waters from tourist settlement Brezovica, and from the settlements of the village Štrpcce and town Kačanik, this river receives large quantities of agricultural, communal and industrial waste waters. Nevertheless, River Lepenac flowing through the settlement of Deneral Janković where a large cement factory is settled, it is polluted by suspended soluble anorganic matters, which are brought at the river mouth near Zlokucani.

MATERIAL AND METHODS

The qualitative and quantitative material from the mouth of River Lepenac seasonal was collected during 1989. The first one from various habitats (stones, bottom overgrown with algae, sand, mud, on the vegetation or amongst the roots of water plants) was obtained using an usual hydrobiological net. The second one was collected using an Ekman dredge (15 x 15 cm) for

softly (mostly muddy) and Surber's stream-bottom sampler (33 x 33 cm) for hard (mostly stony) habitats.

RESULTS OF INVESTIGATIONS

The following list presents the composition of the fauna of oligochaetes on the mouth of the examined river:

Fam. NAIDIDAE

- Chaetogaster diaphanus* (Gruit.) 1828
Ophidonaia serpentina (Müller) 1773
Dero digitata (Müller) 1773
Nais pardalis Piguet, 1906
Nais communis Piguet, 1906
Nais bretschieri Michaelsen, 1899
Nais sp.
Pristina rosea (Piguet) 1906

Fam. TUBIFICIDAE

- Tubifex tubifex* (Müller) 1774
Limnodrilus hoffmeisteri Clapareda, 1862
Limnodrilus udekemianus Clapareda, 1862
Psammoryctides albicola (Michaelsen) 1901
Tubificidae gen. sp. (juv.)

Fam. ENCHYTRAEIDAE

ssp. undet.

Fam. LUMBRICIDAE

- Eiseniella tetraedra* (Savigny) 1826
Aporrectodea rosea (Savigny) 1826

From this list it can be seen that 14 species of oligochaetes were determined, and some species of *Tubificidae* and *Enchytraeidae* were not determined. Determined species can be classified into 9 genera and 3 families. Total 7 species from 5 genera belong to fam. Naididae, 4 species from 3 genera to fam. *Tubificidae* and 2 species from 2 genera belong to fam. *Lumbricidae*. The most dominant genera in examined mouth of river Lepenac were *Nais* represented with 4 species and *Limnodrilus* with 2 species and one species to *Chaetogaster*, *Ophidonaia*, *Pristina*, *Dero*, *Tubifex*, *Psammoryctides*, *Eiseniella* and *Aporrectodea* each.

The analysis of the numerical representation of the oligochaete species populated on stony shows 3 dominant species (*Nais pardalis* - 23.9%, *N. bretschieri* - 21.2% and *Ophidonaia serpentina* - 8.6%, which everyone together represent 53.7% of the total average number of the sampled oligochaetes during 1989. Far behind were *Limnodrilus hoffmeisteri*, *Tubifex tubifex*, *Nais communis* and *Pristina rosea* took a part altogether with 26.0%. The remaining oligochaetes represent all together cca 20.0%. In the muddy habitats dominant species were tubificid species, on the contrary of stony habitat, were the tubificids *Tubifex tubifex*, *Limnodrilus hoffmeisteri* and *L. udekemianus*, which participate all together more than 80.0% of the total numbers of the sampled oligochaetes.

ECOLOGICAL ANALYSIS

The bottom of the river mouth was stony, sandy, muddy and a few habitats were overgrown with plants. Naidids of Oligochaeta prefer stony habitat or a bottom overgrown with plants while tubificids - a muddy habitat. Qualitative samples were taken of all kind habitats but quantitative ones were taken only from stony and muddy habitats. The communities of oligochaetes of those two last habitats can be seen on tables I and II.

Table I. Seasonal changes of the population density of oligochaetes inhabited on a stony habitat at the mouth of Lepenac during one-year period.

Table I. Sezonske promene gustine populacije oligobeta naseljenih na kamenitom staništu ušća reke Lepenac u jednogodišnjem periodu.

Species - Vrste	Spring 15.III 1989. Proleće	Summer 20. VI 1989. Leto	Autumn 2.IX 1989. Jesen	Winter 18.IX 1989. Zima	Average
<i>Nais communis</i>	103.8*	69.2	103.8	0	69.2
<i>Nais bretschieri</i>	242.2	173.0	0	692.0	276.8
<i>Nais pardalis</i>	276.8	207.6	138.4	622.8	311.4
<i>Nais</i> sp.	69.2	0	0	0	17.3
<i>Pristina rosea</i>	34.6	69.2	0	0	25.9
<i>Ophidonaia serpentina</i>	138.4	103.8	69.2	138.4	112.4
<i>Dero digitata</i>	0	0	69.2	0	17.3
<i>Chaetogaster diaphanus</i>	0	0	0	276.8	69.2
<i>Limnodrilus hoffmeisteri</i>	69.2	138.4	34.6	103.8	86.5
<i>Limnodrilus</i> sp.	0	0	69.2	0	17.3
<i>Tubifex tubifex</i>	69.2	103.8	69.2	69.2	75.6
<i>Tubificidae</i> juv.	69.2	0	0	0	17.3
<i>Enchytraeidae</i> undet.	0	519.0	0	311.4	207.6
• individuals per square meter	1072.0	1384.0	545.6	2214.4	1303.8

Table II. Season changes of the population density of oligochaetes inhabited in a muddy habitat at the mouth of Lepenac during one-year period.

Table II. Sezonske promene gustine populacije oligobeta naseljenih u muljevitom staništu ušća reke Lepenac u jednogodišnjem periodu.

Species - Vrste	Spring 15.III 89. Proleće	Summer 20.VI 89. Leto	Autumn 2.IX 89. Jesen	Winter 18.XI 89. Zima	Average Proslek
<i>Nais bretschieri</i>	0	133.2*	0	0	33.3
<i>Nais pardalis</i>	0	177.6	0	0	44.4
<i>Naididae</i> spp.	0	399.6	0	0	99.9
<i>Tubifex tubifex</i>	1420.8	444.0	976.8	799.2	910.2
<i>Limnodrilus hoffmeisteri</i>	222.0	310.8	1243.2	355.2	532.8
<i>Limnodrilus udekemianus</i>	44.4	88.8	710.4	444.0	321.5
<i>Psammoryctides albicola</i>	0	0	133.2	44.4	44.4
<i>Tubificidae</i> juv.	0	310.8	0	0	77.7

Euconstant species in the oligochaete's community of the stony habitat were *Nais pardalis*, *Ophidonaia serpentina*, *Limnodrilus hoffmeisteri* and *Tubifex tubifex*, while in the community of the muddy habitat euconstant species were only tubificids, namely *Tubifex tubifex*, *Limnodrilus hoffmeisteri* and *L. udekemianus*. Sporadic species at the community of the stony habitat were *Dero digitata* and *Nais* sp. And for the muddy community were naidids (*Nais bretschieri*, *N. pardalis* and other naidids) only.

The dominant species in the community of stony habitat were *Nais pardalis* with 311.4 ind/m² in annual average, respectively 23.9% of the total number of individuals from all species, *N. bretschieri* (276.8 ind/m² or 21.2%) and *Ophidonaia serpentina* (112.4 ind/m² or 8.6%). That means, these three naidid species represent more than 50% of the whole number of the sampled oligochaetes. On the contrary, the dominant species of the muddy habitat were tubificid species *Tubifex tubifex* (910.2 ind/m² in annual average, resp. 44.1% of the total number of individuals from all species), *Limnodrilus hoffmeisteri* (532.8 ind/m², resp. 25.7%) and *L. udekemianus* (321.5 ind/m², resp. 15.6%) or these three tubificid species represent 85.4% from the total number of the populated oligochaetes in that site.

It was obviously that the structure of the community and the density of oligochaete's populations were conditioned by the character and the facies of the bottom from the explored river's mouth. So, in the stony habitat was greater number of species and smaller population density, while in the muddy habitat on the contrary - the number of representatives was smaller but the density of populations was greater. As result of that annual average in the stony habitat was 1303.8 ind/m² and 2064.6 ind/m² of the whole fauna of oligochaetes in the muddy habitat of river Lepenac mouth.

Analysing frequency, that is the degree of finding of the species according to Parele (1975), they can classify to four groups:

- massive found species (pF<20%): *Tubifex tubifex*, *Limnodrilus hoffmeisteri* *Nais pardalis* and *N. bretschieri*;

- species found usually ($pF = 5-20\%$): *Limnodrilus udekemianus*, *Ophidona serpentina*, *Nais communis*, *Chaetogaster diaphanus*;

- rare found species ($pF = 1-5\%$): *Psammoryctides albicola*, *Pristina rosea*, *Nais sp.*, *Limnodrilus sp.*, *Dero digitata*;

- very rare species ($pF < 15$): *Eiseniella tetraedra*, *Aporrectodea rosea*.

The quantitative analysis of the population density of various oligochaetes inhabited on the hard basis-stony and in soft basis-muddy habitats from the mouth of Lepenac river in various seasons during 1989 are given on the tables I and II. The two dominant naidid species, *Nais pardalis* and *N. bretschieri*, on the stony habitat show the same dynamics of the population density, namely from spring (March) to autumn (September) their density of populations make smaller but in winter (November) it suddenly increase. The most numerous tubificid *Tubifex tubifex* in the muddy habitat there was the densest populated in spring and in autumn, and the smallest population density in summer. The other two dominant tubificid species in this habitat, *Limnodrilus hoffmeisteri* and *L. udekemianus*, were with the greatest population density in autumn, while it was at least in spring. Dynamics of the whole fauna of fresh-water oligochaetes from the stony habitat illustrate the most numerous density in November (2214.4 ind/m⁻²) and at least - in September (553.6 ind/m⁻²) during the examined year. In the muddy habitat the dynamics of the population density shows increasing from spring (in March 1687.2 ind/m⁻²) to autumn (in September) when it reaches a maximum of 3063.6 ind/m⁻² and a minimum in winter (November only 1642.8 ind/m⁻²).

POLLUTION AND SAPROBITY LEVEL OF THE MOUTH WATERS

River Lepenac, as many other tributaries of river Vardar, is recipient of waste waters. At first, it recipient of communal waste waters from tourist settlement Brezovica. In addition, downstream, flowing near village Štrpce and local town Kačanik, river Lepenac receives great quantity of agricultural, communal and industrial waste waters. However, flowing through the settlement of Deneral Janković there is a big cement factory, the river is polluted by suspended hardly soluble anorganic materials which are the basic mark to the mouth of the river, which polluted waters empty into the River Vardar. As a conclusion may be said that river Lepenac is intensively polluted and belongs to group of very polluted tributaries in Vardar River system. Dominant species of oligochaetes on the stony habitat of the mouth waters of river Lepenac were the naidids *Nais pardalis*, *N. bretschieri* and *Ophidona serpentina*, whilst in the muddy habitat were the tubificids *Tubifex tubifex*, *Limnodrilus hoffmeisteri* and *L. udekemianus*. It was said that these structures of oli-

gochaete's communities were conditioned by the nature of the bottom of the mouth in the explored tributary. Meanwhile, it is necessary in connection with the pollution and saprobity level of the mouth waters, which are that oligochaetes and do they can serve as bioindicators for the saprobity level of the waters from this part of the river Lepenac. The most dominant species on the explored site was *Tubifex tubifex*, which in the muddy habitat was populated with 910 ind/m⁻² in annual average or 44 per cent of the total number of individuals from all species. According to Kolkwitz and Marsson (1909), Liebmann (1962), Sladaček (1973) and Uzunov (1977) this species represents polysaprobic indicator. It is characteristical for an extremely polluted waters (Stephenson, 1930) and it shows a great resistance to a shortage of oxygen (Aston, 1971). *Limnodrilus hoffmeisteri* is typical species for hypertrophic biotopes and it resistant to an influence of waste waters (Brinkhurst and Kenedy, 1965). It is classified by Sladaček (1973) in group of alphamesosaprobic to polysaprobic indicators. Finally, the third dominant tubificid species, *L. udekemianus*, is frequently found, together with *L. hoffmeisteri* and *T. Tubifex* (Wachs, 1963; Howmiller and Scott, 1977) in mouths of rivers. Uzunov (1977) is of the opinion this species for alphamesosaprobic indicator. The presence of tubificid species, together with dominant naidids of the stony habitats as bioindicators, it makes possible to classify the mouth's waters of the river Lepenac in beta-mesosaprobic range of pollution. That is confirm with floristic and saprobiologic investigations on the same river by Krstić et al., 1990 as well as pollution influence on microflora of Lepenac mouth waters by Kungulovski et al., 1992.

CONCLUSIONS

The Fauna of oligochaetes was investigated at the mouth of the river Lepenac from point of view species composition, ecological analysis, pollution and saprobity level of the mouth waters. These investigations seasonaly were carried out during 1989. The obtained results can be summarized as follows:

- in the whole material collected with qualitative and quantitative samples 15 species (without enchytraeids) were established, belonging to 3 families: *Naididae* (8), *Tubificidae* (5) and *Lumbricidae* (2 species);
- the kind of substrate as an abiotic factor was of primary importance for the species composition in the community of oligochaetes;
- in the stony habitat were populated 12 species and in muddy habitat - 8 species only;
- the naidids prevail in the community of a stony habitat but in muddy habitat prevail tubificids;
- euconstant species in the community of the stony habitat were *Nais pardalis*, *Ophidona serpentina*, *Limnodrilus hoffmeisteri* and *Tu-*

- bifex tubifex*, while in muddy habitat - *T. tubifex*, *L. boffmeisteri* and *L. udekemianus*. Sporadic species in the stony habitat were *Dero digitata* and *Nais* sp. and in muddy habitat were naidids only;
- dominant species on the stony habitat were *Nais pardalis*, *N. bretschieri* and *Ophidona serpentina* and these 3 naidid species represent more than 50% of the whole number of oligochaetes. In the muddy habitat were tubificid species *Tubifex tubifex*, *Limnodrilus boffmeisteri* and *L. udekemianus* which altogether represent more than 80%;
 - analysing frequency, oligochaetes from the mouth of the river are classify into 4 groups:
 - a) massive found species (*T. tubifex*, *L. boffmeisteri*, *N. pardalis* and *N. bretschieri*)
 - b) species found usually (*L. udekemianus*, *O. serpentina*, *N. communis* and *Cb. diaphanus*)
 - c) rare found species (*P. albicola*, *P. rosea*, *Nais* sp., *Limnodrilus* sp. and *D. digitata*)
 - d) very rare species (*E. tetraedra* and *A. rosea*).
 - the dominant species from the stony habitat, *Nais pardalis* and *N. bretschieri*, show the same dynamics of the population density, namely from spring to autumn it make smaller population and in winter it suddenly increase. The most numerous *Tubifex tubifex* from the muddy habitat there was the densest population in spring and autumn and the smallest in summer;
 - dynamics of the whole fauna from the stony habitat illustrates a maximum of the density in November and minimum in September, but in the muddy habitat shows opposite direction;
 - river Lepenac is intensively polluted and belongs to group of very polluted tributaries in Vardar River system;
 - the tubificids *Tubifex tubifex* and *Limnodrilus boffmeisteri* are polysaprobic indicators. These two polysaprobic indicators are followed by *L. udekemianus* and all together are very resistant to waste waters.

LITERATURE CITED

- Aston, R.J., 1973. Tubificids and Water Quality. Environ. Pollut., 5(1): 1-10.
- Brinkhurst, R.O., 1965. The Biology of the Tubificidae with special reference to pollution. Biological problems in water pollution. Proc. Third Semin. 1962: 57-65.
- Brinkhurst, R.O. and Kennedy, C.R., 1965. Studies on the biology of the Tubificidae (Annelida, Oligochaeta) in a polluted stream. J. Animal. Ecol., 34: 429-443.
- Gaševski, M., 1978. Osnovni hidrografske osobenosti na rečnata mreža vo SR Makedonija. Geografski razgledi, 15-16: 33-53.
- Gaševski, M., 1979. Osnovni hidrografske osobenosti na glavnite pritoki na Vardar vo SR Makedonija. Geografski razgledi, 17: 29-42.
- Howmiller, R.P. and Scoot, M.A., 1977. An environmental index based on relative abundance of Oligochaeta species. J.W.P.C.F., 49(5): 809-815.
- Kolkwitz, R. And Marsson, M., 1909. (kologie des tierischen Saprobiens. Beiträge zur Lehre von den biologischen Gewässerbeurteilung. Int. Revue ges. Hydrobiol. Hydrogr., 2: 126-152.
- Krstić, S., Stojanovski, P. And Kungulovski, D., 1990. Floristic and saprobiologic investigations of the mouth waters of river Lepenac at River Vardar. God. Zb. Biol., 41-42: 251-261.
- Kungulovski, D., Krstić, S. I Stojanovski, P., 1991. Vlijanie na zagaduvanjeto vrz mikroflorata na vlivnite vodi na rekata Lepenac vo rekata Vardar. God. Zb. Biol., 43-44: 155-163.
- Liebmamn, H., 1962. Handbuch der Frischwasser und Abwasserbiologie. I. Olgenbourg, M(nchen, 2. Aufl.
- Parele, E., 1975. Malošetinkovje červi ustevih rajonov r. Daugavi i r. Lielupne, ih značenie v sanitarno-biološkoj ocenke. Avtoref. Kand. Diss., Tartu, 24. C.
- Šapkarev, J., 1991. Uporedna analiza sastava i gustina naselja Oligochaeta ušća dva susednih pritoka reke Vardara sa različitim stepenom kontaminacije. Jug. Društ., zašt. voda., 328-332.
- Šapkarev, J., 1993. Qualitative and quantitative composition of the oligochaetes (Annelida: Oligochaeta) from the mouth waters of two tributaries on the upper part of the River Vardar, Macedonia. God. Zb. Biol., 46: 19-27.
- Šapkarev, J. And Vagner, D., 1990. Comparative analysis of the structure and the density of populations of the oligochaetes (Annelida: Oligochaeta) from two tributaries of the river Vardar, Macedonia. God. Zb. Biol., 41-42: 93-102.
- Sladeček, V., 1973. System of Water Quality from the Biological Point of View. Ergebn. Limnol., 7: 1-218.
- Stephenson, J., 1930. The Oligochaeta., Oxford, Clarendon Press.
- Uzunov, J., 1977. Influence of the pollution on the oligochaete fauna of the rivers Mesta and Struma. Hydrobiology, Sofia, 6: 23-35.
- Wachs, B., 1963. Zur Kenntnis der Oligochaeten der Werra. Arch. Hydrob., 59(4): 508-514.

REZIME

FAUNISTIČKO-EKOLOŠKA ISTRAŽIVANJA OLIGOHETA (*Annelida: Oligochaeta*) UŠĆA REKE LEPENAC - LEVA PRITOKA GORNJEG DELA VARDARA

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Istraživana je fauna oligoheta sa ušća reke Lepenac u pogledu sastava vrsta, populacione strukture, ekoloških odnosa i indeksa saprobnosti. Sezon-ska istraživanja su vršena u toku 1989. godine. Utvrđeni rezultati se mogu predstaviti u sažetoj formi na sledeći način: priroda rečnog dna, kao abiotički faktor, predstavlja primarnu važnost za sastav vrsta u zajednici oligoheta; u kamenitim staništima bilo je nadjeno 12 vrsta, dok je u muljevitim staništima nadjeno svega 8 vrsta; Naididae preovladavaju u zajednicama kamenitih staništa, dok su Tubificidae dominantne u zajednicama muljevitog staništa: Nais pardalis, Ophidonaïs serpentina, Limnodrilus hoffmeisteri i Tubifex tubifex su u zajednici kamenitog staništa bile eukonstantne vrste, dok su u muljevitim staništima takve vrste bile: T. tubifex, L. hoffmeisteri i L. udekemianus. Sporadične u kamenitom staništu su Dero digitata i Nais sp., a u muljevitom staništu su samo Naididae.; dominantne vrste u zajednici kamenitog staništa su Nais pardalis, N. bretscheri i Ophidonaïs serpentina i ove tri

vrste Naididae predstavljaju više od 50% od ukupnog broja oligoheta. U muljevitom staništu to su bile vrste *Tubifex tubifex*, *Limnodrilus hoffmeisteri* i *L. udekemianus* (Tubificidae), koje sve zajedno čine iznad 80%; ispitujući frekventnost oligoheta sa ušća reka možemo ih klasifikovati u četiri grupe: masovno nalažene vrste (*T. tubifex*, *L. hoffmeisteri*, *N. pardalis* i *N. bretscheri*) obično nalažene vrste (*L. udekemianus*, *O. serpentina*, *N. communis* i *Ch. diaphanus*) retko nalažene vrste (*P. albicola*, *P. rosea*, *Nais* sp., *Limnodrilus* sp. i *D. digitata*) vrlo retke vrste (*E. tetraedra* i *A. rosea*). dominantne vrste sa kamenitog staništa, *Nais pardalis* i *N. bretscheri* pokazuju istu dinamiku gustine populacije, naime, od proleća ka jeseni gustina postaje manja i iznenadno se povećava zimi. Najbrojnija vrsta *Tubifex tubifex* sa muljevitog staništa pokazuje najveću brojnost populacije uprleoće i u jesen, a najredja je leti; dinamika ukupne faune kamenitog staništa ilustruje maksimum gustine u novemburu i minimum u septembru, ali u muljevitom staništu dinamika pokazuje obrnuti smjer; reka Lepenac se intenzivno zagadjuje i kao takva pripada grupi zagađenih pritoka Vardarskog rečnog sistema; vrste *Tubifex tubifex* i *Limnodrilus hoffmeisteri* (Tubificidae) su izrazito polisaprobeni indikatori. U pratnji ova dva bioindikatora je i vrsta *Limnodrilus udekemianus* a sve zajedno su vrlo otporne na zagadjenja vode.

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Composition of Zooplankton and Macrozoobenthos in Big and Small Djeravica Lake

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ABSTRACT

Investigating the composition of zooplankton and macrozoobenthos in two glacial Djeravica lakes (Big and Small Djeravica lakes) and Lokva in the summer 1996., it is established the few but diverse fauna. Fauna mostly occupies littoral parts of the lake, where the eutrophication process has began by creation of thin layer of sand and soil with dense clods of swagnum moss. Zooplankton is poor and represented with three kinds of Copepoda and one kind of Cladocera. Beside the *Acanthodiaptomus denticornis* species, the rest of the species are faunistic rarity for the high mountain lakes of this geographical area. The best qualitative and quantitative composition of macrozoobenthos is represented in the Big Djeravica lake with 18 taxons and 88 individuals, where the representatives of Trichoptera group predominate. Twelve taxons and 37 individuals were established in Small Djeravica lake and the representatives of Chironomidae and Trichoptera groups predominates.

Nine taxons and 21 individuals in total were established in Lokva and Oligochaeta and Chironomidae predominates. Besides the eurytopic species, the occurrence of stenotopic species *I. subaneus* is characteristic, adjoined by the species that belong to *Sericostoma* sp., *Limnesphilus* sp., *Dina* sp. and *Peloscolex* sp. groups, for which it was shown that coincide with certain endemic species, so that their detailed taxonomic treatment and confirmation are necessary. Although these lakes are of the similar genesis and conditions their faunistic similarity is very small so that this diversity, as a consequence of ecological variety, may lead to the development of their fauna in two different evolution directions. Both investigated Djeravica lakes belong to oligotrophic type in which indicator species for oligo and O-b mesosaprobity prevail, while in Lokva the process of eutrophication is obvious.

Key words: Djeravica glacial lakes, Zooplankton, Macrozoobenthos.

INTRODUCTION

Prokletije represents the south-east, final part of Dinarids. They are characteristic for their numerous high mountain lakes, mostly of glacial origin. Basins of these lakes are represented by circular and wave-shaped relief, where the glacial-erosive, and in thermal basins the glacial-accumulative lakes are formed. Most of these lakes are concentrated at the highest top of the mountain, not far away from Djeravica, the highest top of Prokletije, which is one of the center of Pleistocene glaciation. The lakes mostly represents the isolated aquatic biotops with the specific ecological conditions. Such biotops, besides the generally spread palearctic types and types with the regionally spread are characterized by endemic species and subspecies. The establishing of these species contributes to the knowledge and connecting the periods in the historic settlement of fresh waters of certain areas. Investigating the mountain massifs of the western part of Balkan, an Dinarids among them, Apflbeck (1896) had observed the typicalness ad richness of endemic species and subspecies of invertebrate fauna, and aquatic forms among them. It is believed that fauna of Dinarids, that fauna of

Prokletije belongs to, is one of the most interesting in Europe (Komarek, 1953, Mučibabić, 1979). Faunistic investigations of the fresh waters in SR Jugoslavija areas date back to the end of the last century and the beginning of this century (Apflbeck, 1896, Mrazek, 1903, 1904) and mostly have comprised the depression flow and still waters. The investigations of the high mountain waters, because of the inaccessibility, started much later. It specially refers to investigation of fauna of Prokletije glacial lakes. The first contribution to better knowledge about fauna of Prokletije high mountain lakes can be found in the works of Radovanović (1957), who established the characteristic species from the Trichoptera group in Ridsko lake. In 1968, Ivanović and associates gave short preliminary data for the fauna of several high mountain lakes on Durmitor, Bjelasica and Prokletije (Visitorsko lake). Žunjić (1970) has also treated benthos of some Durmitor lakes. The more detailed studies with the ecological analysis of the lake bottom fauna can be found in the work of Nedić (1975), who comprised Biogradsko and Plavsko lake. In his faunistic researches of certain groups of

plankton organisms, Petković (1970) has treated two lakes on Prokletije, Ridsko and Visitorsko lakes. Biological investigations of the high mountain lakes of Kosovo and Metohija has started much later. The first complex and systematic investigations had started by Urošević, V. (1979), who worked on algalogical study of numerous lakes of Šar mountain, but the fauna investigations had not been performed. Since the already mentioned specific ecological conditions that give the basis for development of the special biocenosis, we started to investigate the composition of fauna of Kosovo and Metohija high mountain lakes. For the beginning, we determined ourselves for two glacial Djeravica lakes, Small and Big lakes and Lokva, which outflow rivers represents one of the source branches of Ereniku river, that belongs to the river basin of Beli Drim.

MATERIAL AND METHOD

The collection of the faunistic material in Djeravica lake, had been announced in the summer season (30.7 - 04.8), 1996. Zooplankton has been collected by standard plankton net, fixed and later on treated with the standard methods. The relative number of the established species has been determined on the basis of the estimation five stage scale according to Pantle-Buck (1955). Because of the non-homogeneousness and hardness of the substrate, fauna of the lake bottom has been collected in different ways, according to the abilities and needs, but mostly using the Schworbel's net, passing the sand through the sieve, hand sorting by turning the underwater stones and rocks etc. That is the reason why the number of the lake bottom fauna is not expressed on the unit surface, but it is presented by the total number of the selected individuals. During the sampling procedure we tried to take the samples from the different places in each lake in the littoral zone, and also from the pelagic and deep parts of the lakes. Simultaneously with the faunistic tests, the water temperature on the surface, i.e. in small depths was measured, as well as the pH-reaction of the water. We are especially grateful to Prof. Dr Vlasta Pujin, who determined and treated the zooplankton material.

FEATURES OF INVESTIGATED BIOTOPS

The investigated lakes are characterized by high altitude and they are difficult to access. They are situated in the vicinity of Djeravica (south-west), the highest peak of Prokletije (2.656 m above the sea level), Fig.1. As the result of glacier activity they represent the glacial lakes created by the water accumulation in circular areas. They are fed by rain water and melted snow, as well as by waters of poor and periodical wells. The lakes loose water by vaporizing and small outflows, that downstream build the source branch of

Ereniku. The surrounding of Djeravica lakes is bare, without trees and bushes, markedly rocky, with mosaic areas of thin layer of grass land. Small Deravica lake - is situated on 2.360 m above the sea level and represents the highest lake in Balkan. The lake is of circular shape with the surface and depth that vary depending on the rapid melting of snow and frequency of rainfall. In the time of our investigation the lake was 50 m long, 40 m wide and up to 90 cm deep. The bank zones are stony, accessible and with the mild slopes towards the shallow trough. The lake bottom is leveled with gray-brownish stone blocks, and only on separated parts of the littoral zone is covered with the thin soil slime layers, eroded stone parts and sand, as well as with dense moss vegetation. The lake water is olive green and transparent to the bottom. Big Djeravica lake - is situated on a little bit lower altitude (2.309 m) and on the distance of about 500 m from the Small Deravica lake. These two lakes are separated by the long, high reef. The surface of this lake is much bigger from the Small lake, 260 m long, 130 m wide and 6-8 m deep. The lake has deep trough, with the steep banks. The littoral zones are also steep, so that the accessibility of the lake is limited only on some parts. The water is transparent, of the blue to brown color, that comes from the black stone blocks dispersed on the bottom. On certain shallow parts of the littoral there is a thin layer of sandy and slimy substrate. The outflow stream and bottom of the lake around it are covered with moss. Downwards on 2.270 m altitude this outflow stream enters the enlarged part, so called Lokva, that can be the product of the glacier activity. On the basis of morphometric parameters and structure of the bottom, Lokva differs a lot from the investigated Djeravica lakes. It is 30 m long, 16 m wide and 20 -30 cm deep. The bottom of shallow Lokva on its bigger portion is markedly slimy, covered with the dense moss bushes. By its appearance, such and similar puddles represents the transitional form between lake and swamp (Petković, Sm., Petković, S., 1981).

INVESTIGATION RESULTS

The high mountain lakes are characterized by very low water temperature during the whole year. In the warmest month of August the highest water temperature of 17°C is measured in Lokva, that is, most probably, the consequence of small depth, slimy substrate and intense biological activity. The water of Lokva is characterized by a mild alkaline reaction, pH-8.1. The water of Small Djeravica lake was one degree colder, 16°C, while its pH value was 7.3, i.e. in the range of neutral reaction. The water of Big Djeravica lake was also in these limits, but with significantly lower temperature of only 10°C. The huge water mass of this lake slowly heats up, that enables the creation of thermal stratification with the differentiated thermal layers and significant thermal differences be-

Table 1. Qualitative and quantitative composition of fauna of Small (I) and Big (II) Djeravica lakes and Lokva (III)

	I	II	III	Saprobic level
ZOOPLANKTON	RELATIVE FREQUENCY			
GLADOCERA				
<i>Eury cercus lamellatus</i> O.F.M.	3	2	/	O
COPEPODA				
<i>Acanthocyclops vernalis</i> FISCHER	1	1	/	O
<i>Acanthodiaptomus denticornis</i> WIERZ.	1	1	/	O
<i>Diaptomus castor</i> JURINE	1	1	/	O
MACROZOOBENTHOS	TOTAL NUMBER			
CHIRINOMIDAE				
<i>Chironomus</i> sp.	/	/	1	a
<i>Procladius</i> sp.	3	6	1	
<i>Tanytarsus</i> sp.	4	/	2	
<i>Ablabesmyia</i> sp.	2	3	/	b
<i>Orthocladiinae</i>	3	1	1	
MEGALOPTERA				
<i>Sialis lutaria</i> LINNAEUS	4	/	/	b
COLEOPTERA				
<i>Coelambus impressopunctatus</i> SCHALER	8	2	/	
<i>Ilybius subaneus</i> ERICHON	/	4	/	
TRICHOPTERA				
<i>Limnephilus</i> sp.	3	2	1	O - b
<i>Limnephilus</i> ssp.	1	2	/	O - b
<i>Limnephilus lunatus</i> CURTIS	1	2	/	O
<i>Gorea pilosus</i> FABRICIUS	/	1	/	O
<i>Sericostoma</i> sp.	4	/	/	O
<i>Anabolia c.f. nervosa</i> CURTIS	/	18	/	O - b
<i>Polycentropus flavomaculatus</i> PICTET	/	4	/	O
Trichoptera	/	2	/	
HIRUDINEA				
<i>Erpobdella octoculata</i> LINNAEUS	/	5	/	b
<i>Dina</i> sp.	/	2	/	
OLIGOCHAETA				
<i>Enchitrus</i> sp.	1	2	/	
<i>Peloscolex</i> sp.	/	17	/	O - b
<i>Peloscolex swirencowi</i> JAROSCHENKO	/	5	/	O - b
<i>Potamothrix hammoniensis</i> MICHAELSON	2	/	/	a
<i>Tubifex ignotus</i> STOLC	/	/	3	b
<i>Nais christina</i> KASP.	/	/	2	
<i>Lumbriculus</i> sp.	/	/	5	b
BIVALVIA				
<i>Pisidium</i> sp.	2	10	5	O
NUMBER OF TACSONS	12	18	9	
TOTAL NUMBER OF INDIVIDUALS	37	88	21	

tween surface and deeper layers. This explains the fact that fauna of zooplankton and zoobenthos was mostly found in the warmer littoral portion, where the thin layer of slime and sand is and where probably exist the increased mineralization.

The community of Djeravica lakes zooplankton is very poor. There were established only four species, one from Cladocera group, and three species are representatives of the Copepoda group (Tab.1). The impression of uniformity is increased by the mass development of *E.lamellatus* population in both Deravica lakes in the small littoral bays, while the population of the Copepoda group is minimal. The established species are good indicators for oligosaprobity. The *Acanthodiaptomus denticornis* species is euritropic and well known widely spread in the fauna of mountain lakes of this geographical area (Ivanović and ass., 1968; Petković, 1970; Petković, Sm., Petković,

S., 1971, 1981). Other species represents a significant faunistic occurrence with stenotopic features. In Lokva the complex of zooplankton was not established, probably as a consequence of inadequate conserving and separation. Faunistic poverty of the investigated lakes is reflected in the qualitative and quantitative composition of microfauna of the bottom. Macrozoobenthos of Small Djeravica lakes is presented with 12 taxons (Tab.1). Because of low water level, fauna of the bottom is spatially uniformly distributed. The most significant components of this fauna were Insecta groups, Chironomidae with 4 and Trichoptera with 3 taxons. For the Trichoptera group this site is the highest altitude in Balkan where it can be found. The most numerous were larva of Coleoptera species, *C.impressopunctatus* - 8 individuals, while the number of other taxons was minimal. The most of the established taxons involves eurytopic species, indicators of

oligosaprobit and oligo-beta mezosaprobit waters. BigDjeravica lake is inhabited by qualitatively and quantitatively more numerous fauna of the bottom than the previous one and it is represented with 18 taxons and 88 individuals in total. Spatially, fauna has been found mostly in the littoral portion of the lake, where the convenient ecological conditions exist. The Trichoptera group is represented with 7 taxons and its representatives were also the most numerous. Then the Oligochaeta, Chironomidae and Coleoptera groups follow (Tab.1). The most numerous was population of *A. nervosa* with 18, then *Peloscolex* sp. with 17 and *Pisidium* with 10 individuals. Most of the taxons involves the species, indicators for the oligosaprobit of waters. Diversity of the macrozoobenthos groups is conditioned by existence of different ecological conditions in this lake. The species *I. Subaneus*, *P. flavomaculatis* are characterized by stenotopic character, so that their populations were found in deeper, cold zones on stony substrate. The representatives of *Sericostoma* sp., *Dina* sp., *Peloscolex* sp., taxons are characterized by the series of specific characteristics, so that it can be shown, by the detailed analysis and taxonomic check, that this is a case of endemic forms or at least their varieties which express the deviations in certain elements of typical morphological structure. Comparing the qualitative composition of the macrofauna of the lake bottom it may be stated that a small number of taxons, only 6, is common for both investigated lakes. Macrozoobenthos of Lokva is presented with 9 taxons and 21 individuals. Because of the slimy bottom in Lokva Chironomidae and Oligochaeta groups prevails. The most numerous are taxons of *Lumbriculus* sp. and *Pisidium* sp. groups with five individuals each. Faunistic similarity of Lokva and Djeravica lakes is minimal. Only four common taxons with Big and five with Small Djeravica lakes. Most of the established taxons of Djeravica lakes are characteristic for smaller stagnant waters that are widely spread, ecologically very diverse and smaller number is selective according to the altitude.

DISCUSSION AND CONCLUSIONS

Investigations of many glacier lakes of Balkan, Alps, Pirineas and so on (Borner, 1921; Rylov, 1931, 1935; Pljakić, 1966; Ivanović et al., 1968; Žunjić, 1970; Petković, 1970; Stanković, 1975; Nedić, 1975; Petković, Sm., Petković, 1981.) showed that they posses a series of similarities created under the influence of historical and geological factors. However, in the longer period of time they underwent the changes and development of specific ecological conditions that influenced the diversity in composition and structure of their biocenosis. Although the investigated Djeravica lakes are glacial lakes of the same origin, geological age and substrates, and they exist in similar climatic conditions and are relatively close to each other, they show sig-

nificant faunistic diversity. It is, first of all, related to the qualitative and quantitative composition of macrozoobenthos. The qualitative and quantitative differences in algae flora of these lakes is also established (Urošević, 1997). The established differences, spatially close biotops are reflection of different ecological conditions that exist in them. Undoubtedly, the long and high reef that separates these two lakes had a contribution to the divergent development of the mentioned conditions. It may be said that fauna of Djeravica lakes is not numerous, but it is diverse in regard to their dimensions and ecological conditions that exist in them. These conditions are obviously most appropriate in the summer when the best qualitative and quantitative composition occur in them. Besides the eurotopic organisms, that are widely spread in different types of freshwater biotops, taxons which species are selective toward the elevation spread are established in fauna of Djeravica lakes. They can be found mostly on higher elevation in pure well or stagnant waters. It is specially valid for the representatives from the Trichoptera group (Radovanović, 1957; Kumanski, 1971; Gospodnetić-Marinković, 1978, 1979.). According our investigations, and on the basis of other data (Ivanović et al., 1968; Petković, Sm., Petković, 1971, 1981) it may be stated that the investigated Djeravica lakes belong to oligotrophic lakes and contain little nutritional materials and this is reflected on relatively small population of fauna. However, washing out of the banks and decaying of the plant materials in littoral portions create a small slime and sand layers covered with the dense moss that represents the beginning of eutrophication. The convenient conditions for the development of fauna are created in those parts, where fauna is also the most abundant. It is especially evident on some parts of Small Djeravica lake and in Lokva where Oligochaeta and Chironomidae prevail. On the basis of our investigation of qualitative and quantitative composition of fauna in high mountain Prokletije lakes, Small (2.360 m a.s.l.) and Big (2.309 m a.s.l.) Djeravica lakes, as well as Lokva (2.270 m a.s.l.) during the summer in 1996. We may conclude: Small Djeravica lake and Lokva are characterized by relatively increased water temperature of 16°C and 17°C, respectively, as the consequence of low water level. Water temperature of Big Djeravica lake is low (10°C), typical for the mountain lakes as wells. Water pH reaction in Big and Small Djeravica lakes is in the limits of neutral reaction (pH 7.3-7.7), while the water in Lokva is mildly basic (pH 8.1). Zooplankton in both lakes are made of population of four species, where *E. lamellatus* has a mass occurrence. Besides *A. denticornis*, other species are not established in high mountain lakes of Prokletije and neighboring mountains. Qualitative and quantitative compositions of macrozoobenthos in the investigated lakes are small. The biggest diversity of macrofauna of the lake bottom and the biggest number of the individuals was established

in Big Djeravica lake, 18 taxons and 88 individuals in total, with the marked prevalence of Trichoptera group. The populations of *A. nervosa* with 18, and *Peloscolex* sp. with 17 individuals are the most numerous. Twelve taxons were determined in Small Djeravica lake, mostly from the Chironomidae and Oligochaeta groups, and the most numerous is population of the *C. impressopunctatus* species from the Coleoptera group. Fauna of the Lokva bottom is represented with 9 taxons, with the prevalence of Cironomidae and Oligochaeta. Four macrozoobenthos taxons are common for all three investigated biotops. Big Djeravica lake has 6 common taxons with Small Djeravica lake, and 4 with Lokva. Only 5 taxons are common for Small Djeravica lake and Lokva. It can be generally concluded that Small and Big Djeravica lakes represent oligotrophic lakes with increased mineralization on certain portions of the littoral. The process of eutrophication, which takes place over a transient mezotrophic state, is intense in Lokva. The species indicators for oligo and 0-b saprobity prevail in Djeravica lakes, while in Lokva indicators for 0-b mesozaprobity prevail. On the basis of the presented results of one season aspect we may state that the investigated biotops of Small and Big Djeravica lakes, as well as of Lokva, even with the common genesis, by their ecological features influence the fauna composition to develop in various evolution directions.

REFERENCE

- Apfelbeck, V., 1896. Karakteristike faune invertebrata (beskičmenjaka) u Bosni i Hercegovini. ANU BiH, 17, 8: 11-20, Sarajevo.
- Božinović, M., 1951. Đeravica i njena jezera. Kroz planine, 1 : 11-15, 2: 45-50, Beograd.
- Borner, L., 1911. Die Bodensauna des St. Mordzen-See-Ein Monografphische Studie. Arch. fur Hydrobiologie, Band 13, Helf 1/2 : 1-91, 209-281, Stuttgart.
- Hrabe, S., 1980. Vodni malostetinatci (Oligochaeta) Československa. Acta Universitatis Carolinae - Biologica 1-2, Československa Academie Ved.: 1-521, Praha.
- Ivanović, B. I sar., 1968. Hidrobiološka istraživanja nekih visokoplaničkih jezera Crne Gore. Polj. i šumarstvo, 24 (2): 31-51, Titograd.
- Ivanović, B., 1970. Istorijiski pregled limnoloških istraživanja u Crnoj Gori. Glas. Rep. zav. zaštite prirode - Prirodnački muzej, 3: 99-107, Titograd.
- Komarek, J., 1953. Hekunft der Süsswasser - Endemiten der dinarischen Gebirge, Revision der Arten, Artenentstehung bei Hohlfentieren. Arch. f. Hydrobiol., 48 (3): 269-349, Stuttgart.
- Kumanski, K., 1971. Prinos kom izučavaneto na rečenjnicite (Trichoptera) v Blgaria - III - Isv. Zool. inst. BAN, 33: 99-109, Sofia.
- Marinković - Gospodnetić, M., 1978. Same characteristics of the Yugoslav faune of Trichoptera. Proc. of the Int. Symp. on Trichoptera, 1977, Junk, The Hague: 35-40.
- Marinković - Gospodnetić, M., 1979. The species of the genus *Hidropsyche* of group *Pellicidula* (Trichoptera) in the Dinarides. Glas. Zemalj. muz., Prirod. nauke, 18: 165-171, Sarajevo.
- Petković, S., 1970. Prilog fauni Crne Gore I. Crustacea, Phyllopoda, Cladocera. Polj. i šumarstvo, XVI (4): 77-86, Titograd.
- Mučibabić, Smilja, 1980. Specifičnost faune Bosne i Hercegovine. ANU BiH, 17 (8): 11-20., Sarajevo.
- Nedlić, M., 1975. Neki aspekti faune dna Biogradskog i plavskog jezera u Crnoj Gori. Polj. i šumarstvo, 21 (2): 57-73, Titograd.
- Petković, Smiljka i Petković, S., 1971. Sastav i karakter planktonskih zajednica dva mala visokoplanička jezera na planini Visitoru i Bogičevici u Crnoj Gori. Polj. i šumarstvo XXII (1): 3-30, Titograd.
- Petković, Smiljka i Petković, S., 1981. Florističko-faunistički i ekološko-biološki aspekt plankto-bentoskih elemenata Limnoflore i Limnofaune Šiškog jezera i ševarne lokve na Bjelasici. Polj. I šumarstvo, 27 (4): 11-26, Titograd.
- Pljakić, M., 1961. Varijabilitet dafnija - *Daphnia longispina* u populacijama izolovanih stajačih voda. Glas. Prir. muz., B, 17: 3-57, Beograd.
- Radovanović, M., 1957. Životinjski stanovnici planinskih jezera. Zaštita prirode, 11: 10-16, Beograd.
- Rilov, W., 1931. Einge resultate der Limnologischen Untersuchungen am Kardywatsch-see (Nordwestlicher Kaukasus) Aqrch. fur Hydrobiol., XXII, 3: 389-409, Stuttgart.
- Rozkosny, R., 1980. Klic larev vodnoho h myzu. Československa Akademie Ved : 1-521, Praha.
- Stanković, M., S., 1967. Visitorsko jezero. Gl. Srpskog geograf. društva, XLVII, 1, Beograd.
- Stanković, M., S., 1989. Jezera Jugoslavije. Stručna knjiga, 97-107, Beograd.
- Tuhtar, D., 1990. Zagađenje zraka i vode. Svijetlost, 180-185, Sarajevo.
- Urošević, V., 1994. Alge visokoplaničkih jezera Siriničke strane Šar-planine. Univerzitet u Prištini, 1-95, Priština.
- Urošević, V., 1997. Obraštajne alge u sistemu Đeravičkih jezera na izvoršnom kraku Erenika. Univerzitetska misao, Priština (u štampi).
- Fizičko-hemijske i biološke karakteristike durmitorskih jezera i njihove mogućnosti za ribarstvo. Polj. i šumarstvo, XVI, 3, Titograd.

REZIME

SASTAV ZOOPLANKTONA I MAKROZOOBE- NTOSA VELIKOG I MALOG ĐERAVIČKOG JEZERA

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Visokoplaninska glacijalna jezera predstavljaju
biotope sa specifičnim ekološkim uslovima i karakterističnom faunom. Od brojnih glacijalnih jezera Deravičkog kompleksa za faunistička istraživanja izdvojena su Malo (2360m n. v.) i Veliko (2309m n. v.). Uzorci su sakupljeni avgusta meseca 1996. godine. Karakteristični mali otoci ovih jezera predstavljaju izvođenu granu reke Ereniku, koja pripada slivu Belog Drima. Istraživanja su preduzeta u letnjoj sezoni u periodu niskog vodostaja, kada je pristup jezerima bio bezbedniji, obzirom da se radi o najvišim jezerima Balkana. Temperatura vode Malog Deravičkog jezera (160C) i Lokve (170C) relativno je visoka zbog male površine dubine, dok je voda Velikog Deravičkog jezera znatno hladnija (100C). U Velikom Deravičkom jezeru fauna je uglavnom bila locirana u litoralnom delu, dok u Malom Deravičkom jezeru i Lokvi zbog male dubine, prostorno fauna je nalazišta u svim delovima. Zajednicu zooplanktona u oba jezera grade tri vrste Copepoda i jedna vrsta Cladocera, koja se javlja u masovnim populacijama. Osim euritropne vrste *A. denticornis*, poznata u fauni visokoplaninskih jezera ovog područja, ostale vrste (*E. lamelatus*, *A. vernalis*, *D. castor*), predstavljaju značajnu i retku faunističku pojavu. Sve utvrđene vrste zooplanktona su indikatori za oligosaprobnost. Najbolji kvalitativno-kvantitativni sastav utvrđen je u Velikom Deravičkom jezeru, 18

taksona sa ukupno 88 jedinki. Najviše taksona je iz grupe Trichoptera (7), koji su ujedno i najbrijiniji od čega je posebno brojna populacija vrsta *A. nervosa* - 18 jedinki. Sledi grupa Oligochaeta gde je najbrojniji takson *Peloscolex* sp. sa 17 jedinki. Vrsta Coleoptera *I. subaeneus* je stenotopnog karaktera. Takođe i taksoni *Sericostoma* sp., *Peloscolex* sp. i *Dina* sp. poseduju morfološke odlike koje se poklapaju sa nekim stenotopnim endemičnim vrstama i podvrstama. Zbog toga je potrebna njihova detaljna taksonomska analiza. U Malom Deravičkom jezeru utvrđeno je 12 taksona gde dominiraju Trichoptera sa 3 i Chironomidae sa 4 taksona, a ukupna brojnost je jako mala svega 37 jedinki. U Lokvi je utvrđeno samo 9 taksona sa ukupno 21 jedinkom. Iako se radi o jezerima slične geneze, očigledno se ova jezera ekološki razlikuju što pokazuje mali broj zajedničkih vrsta. Na osnovu toga se može prepostaviti da se sastav faune u njima razvija različitim evolutivnim pravcima. Istraživana Deravička jezera po nizu karakteristika pripadaju tipu oligotrofnih jezera, u kojima dominiraju indikatorske vrste za oligosaprobnost, dok su u Lokvi prisutni indikatori za oligo-beta mezosaprobnost. Na pojedinim delovima Malog Deravičkog jezera, a posebno u Lokvi, otkrio je proces eutrofifikacije spiranjem okolnog zemljišta i stena i raspadanjem busenaste vegetacije mahovina. Pored toga što je utvrđena fauna istraživanih biotopa, kvalitativno-kvantitativno veoma mala, ipak možemo konstatovati da se radi o veoma zanimljivoj fauni, na čijem proučavanju treba raditi posebno sa ekološko-taksonomskog i zoogeografskog aspekta.

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New discovery of the species *Salamandra atra* (Laurenti 1768; Salamandridae: Caudata) in the area of Prokletije

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ABSTRACT

Alpine-Dinaride glacial relict species *Salamandra atra* has been found so far in two locations in the area of Prokletije: Raski do (UTM DN 22), (RADOVANOVIC 1964) and Bogicevic (UTM DN 21), (PASULJEVIC 1968; DZUKIC 1993). This new discovery in the area of Lumbards mountains (UTM DN 32) pushed farther the eastern border of the habitat area of this species. This particular specimen was registered at altitude of 1980 meters, above the zone of upper forest limit, in the area of mountain pine (*Pinus mugo*). Captured specimen is a female with two incom-

pletely metamorphosed larvae. The form and position of the vomero-palatine teeth have been analyzed and compared to published data on other specimens found in other parts of the area and other specimens of Prokletije population. The specimen from the newly discovered location is obviously different from the specimens in proximal area which have been described so far. Variations of this type are known within the isolated population of Prokletije, to which belongs the specimen from Lumbards mountains.

Key words: *Salamandra atra*, Prokletije

INTRODUCTION

Glacial relict species, *Salamandra atra*, as Alpine-Dinaride species is inhabiting disjunct, island-type area. The area of habitation stretches from northern parts of the French Alps and Jurassic, through most parts of Switzerland, Bavarian Alps and Wurtenberg in Germany, Austrian Alps, Koruska to Italian Alps. In the south-western part of the area are Dinarides, namely, from the western parts of the Balkan Peninsula, through certain sections of the Dinaride system, to Prokletije massif in the far south-east (Dzukic 1993).

This species inhabits high mountain areas above the forest zone, mostly above the altitude of 1000 meters, although it has been registered at the altitude level of 900 meters in the zone of beech forest (Kletecki 1990). Alpine salamander, as one of the most rare examples of amphibious fauna in Serbia, was discovered in 1964 in Prokletije, at the location Raski Do (UTM DN 22) (Radovanovic 1964). Known habitats in our country are limited to the area of Prokletije massif (Raski Do) and Bogicevica mountains, namely between Maja Rops and Pasji vrh at altitude between 2100 and 2200 meters (UTM DN 21), (Pasuljević 1968; DZUKIC 1993). According to Džukić (1993) there are indications that this species is present in Sar planina, at the location Piribeg (UTM EM 06 and DM 96).

RESULTS

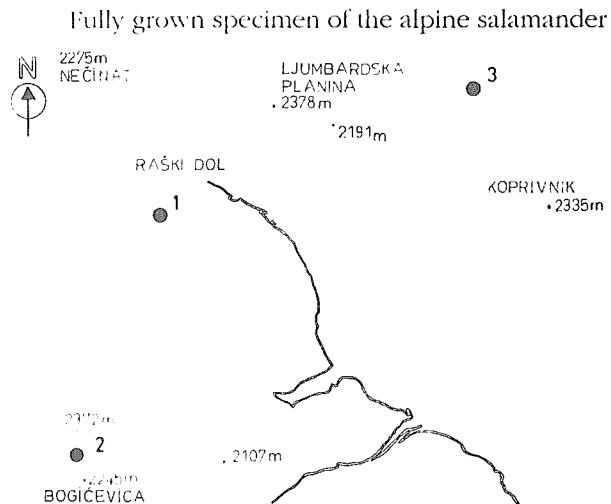


Fig.1 Distribution map of *S.atra* in the area of Prokletije.
(1 Raski do; 2. Bogicevica; 3. Lumbards mountains - an arrow indicates position of the newly discovered location)

was registered on 07.07.1995 in the area of eastern part of Lumbards (Ljumbardska) mountains, (UTM DN 32) at altitude of 1980 meters, above the forest area, in the zone of mountain pine (*Pinus mugo*).

Weather conditions at the time when the specimen was caught (low clouds with maximal temperature of 12 °C and drizzling rain) characterize good accommodation of this animal to the conditions of high humidity and relatively low temperature. Thanks to these meteorological conditions the specimen was caught on ground surface at 1:00 p.m., in spite of the

presence of larvae which could be discerned laterally on both sides; color is monochrome black with no dorsal or ventral blurs or spots. Tail is characteristically shorter than the length of the body and tail taken together, oval at the cross-section with no groove on ventral side.

MORPHOMETRIC CHARACTERISTICS (Add)

L	115.05	Ac	8.5	Spp	4.8
Lsd	71.05	D	38.7	Lpr	9.1
Lsv	73.25	Lpa	18.9d/19.81	A	9.15d/81
L-Lsd	44.35	Lpp	21.35d/22.11	P	11d/10.71
Lc	16.30	Dn	4.9	Lm	11.4
Ltc	12.50	Do	5.05		

L - total length	Ac - maximal head height	Spp - minimal orbit distance
Lsd - standard length	D - limb distance P	Lpr - parotids gland length
Lsv - Snout-vent lenght	Lpa - forelimb length	A - palm length
L-Lsd - tail length	Lpp - hindlimb length	P - foot length
Lc - head length	Dn - nostril width	Lm - jaw length
Ltc - head width	Do - eyeball length	

(measures given in mm)

The form and position of vomero-palatine teeth have been used as determinative characteristic in differentiation of intraspecific relations so far, because of lack of other proofs. This characteristic was used in determination of the sub-species *Salamandra atra* prenjensis (Miksic 1969). Known forms of vomero-palatine teeth (according to Bolkay 1928, Miksic 1969, Dzukic 1993) are shown in Figure 2 (taken from Dzukic 1993), and the form of vomero-palatine teeth in newly discovered specimen is shown in Figure 3. Fig.2 Shape and position of vomero-palatine teeth of the alpine salamander (taken from Dzukic 1993) (A.-S.*atra* *atra* (according to Bolkay 1928); *S.atra* *prenjensis* (according to MIKSIC 1969) C. - a specimen from Prokletije) Fig.3 Shape and position of vomero-palatine teeth of the alpine salamander from Lumbards mountain The specimen from the newly discovered location (Figure 3) shows evident difference from the known shape (Figure 2) both in distal and proximal section. In the distal section outside curve of the arches, as well as the central narrowing, are closer to the shape found in specimens from Prenj (A) and other, previously described specimens from Prokletije (C), where as the proximal end shows more resemblance to the shape of vomero-palatal teeth described by (Bolkay 1928) for

nominative sub-species. Relation between the appearance of the proximal part of the vomero-palatal teeth in our specimen (Figure 3) and the specimen from Prokletije (Figure 2 C), which is characteristic for extreme joining of the ends of both arches, indicates that there are variations of this character present among the specimens of isolated population of Prokletije. Both juvenile specimens that have been analyzed were in the final phases of metamorphosis with significantly reduced outer gills and open hones.

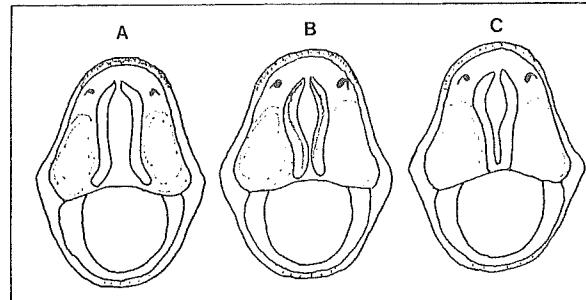


Figure 2.

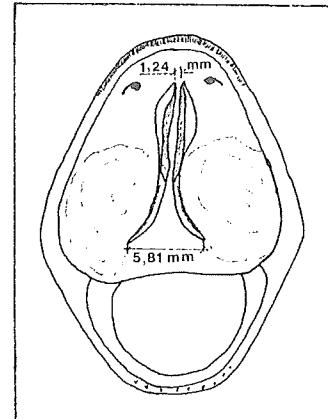


Figure 3.

MORPHOMETRIC CHARACTERISTICS (Juv.I)

L	44.95	Ac	4.45	Spp	2.65
Lsd	24.55	D	11.35	Lpr	4.45
Lsv	27.85	Lpa	8.45d/7.661	A	3.55d/3.351
L-Lsd	20.40	Lpp	8.05d/9.051	P	4.75d/4.251
Lc	7.95	Dn	2.55	Lm	5.45
Ltc	6.55	Do	2.55		

MORPHOMETRIC CHARACTERISTICS (Juv.II)

L	47.65	Ac	5.05	Spp	2.55
Lsd	28.55	D	15.75d/15.651	Lpr	4.15
Lsv	31.45	Lpa	9.15d/8.151	A	3.70d/3.751
L-Lsd	19.10	Lpp	8.60d/8.201	P	5.05d/4.551
Lc	7.55	Dn	2.15	Lm	6.55
Ltc	6.35	Do	1.55		

This newly discovered habitat in the area of Lumbards mountains is in congruence with the assumption of Dzukic (1993) that new findings pertaining to distribution of the species *S.atra* in Prokletije could be expected.

REFERENCES

1. Bolkay, J.S.(1928): Die Schadel der Salamandren, mit besonderer Rucksicht auf ihre Systematische Bedeutung. - Zeitschrift fur Anatomie und Entwicklungsgeschichte, 86 (3/4): 259-319. Bergman & Julius Springer, Munchen und Berlin.
2. Dzukic, G. (1993): Fauna, zoogeografija i zastita repatih vodozemaca (Caudata) Srbije. Doktorska disertacija PMF, Fakultet za bioloske nauke, Beograd
3. Karaman, S. (1921): Beitrage zur Herpetologie von Jugoslavien. Glasnik Hrvatskog prirodoslovnog drustva, 33(2), Zagreb
4. Kletecki, E. (1990): New finding of the alpine salamander (*Salamandra atra* Laurenti 1768; Salamandridae: Caudata) in Croatia. - Arhiv bioloskih nauka, vol.42, br.1-2, 5p, Beograd
5. Miksic, S. (1969): Nova podvrsta alpskog dadevnjaka (*Salamandra atra prenjensis* nov.). Glasnik zemaljskog muzeja. BiH, N.S.8, Sarajevo
6. Pasuljevic, G. (1968): Prilog poznavanju herpetofaune Kosova i Metohije. Zb.Fil.fak., 5, Pristina

REZIME

NOVI NALAZ VRSTE SALAMANDRA ATRA
(Laurenti 1768; Salamandridae: Caudata) NA PROSTORU PROKLETIJA

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Zavod za zaštitu prirode Srbije, odelenje u Novom Sadu

Alpsko-Dinarska glacijalna i reliktna vrsta *Salamandra atra* je do sada bila poznata na dva lokaliteta na Prokletijama: Raški do (UTM DN 22) (Radovanović 1994) i Bogićević (UTM DN 21), (Pasuljević; 1968 Džukić 1993).

Novi nalaz na području Ljumbardskih planina (UTM DN 32) dalje je pomerio istočnu granicu areala ove vrste. Ova specifična vrsta registrovana je na nadmorskoj visini od 1980 metara, iznad zone gornje granice šuma na prostoru gde vegetira bor krivulj (*Pinus mugo*).

Nađeni primerak je ženka sa dve nekompletno metamorfozirane larve u abdomenu. Oblik i položaj vomeropalatinskih zuba je analiziran i upoređen sa objavljenim podacima za druge primerke nađenih na ovim prostorima. Primerak sa novo otkrivene lokacije se očigledno razlikuje od primeraka sa drugih lokacija koje su do sada opisane. Varijante ove vrste poznate su u okviru izolovanih populacija na Prokletijama kojima pripada primerak sa Ljumbardskih planina.

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The Mosor Lizard Occurs also in the Prokletije Mountain Massif

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ABSTRACT

It is discussed the question of distribution the Mosor lizard. Field investigations proved its presence on Prokletije Mountain.

Key words: The Mosor lizard, Prokletije Mts.

INTRODUCTION

As early as at the time of the initial dilemma on taxonomic relations of then newly described species of *Lacerta mosorensis* Kolombatović, 1886 and *Lacerta koritana* Tomasini, 1889, the idea has been perceived on the possibility for Mosor Mt. which is terra typica for this lizard, to be situated at the northwest edge of this species range of distribution. However, the anticipation on the southeast boundary of the distribution range is quite different. For almost a century, it has been believed that the range of distribution of the Mosor Rock lizard in this direction is limited approximately by a line connecting Crvaj Mt. in Herzegovina with a part of Orjen Mt. in Montenegro. The finds that have followed (Radovanović 1948, Bischoff 1984, Džukić 1987, 1989, De Luca unpublished, Capula & Lapini 1991, Crnobrnja-Isailović & Džukić in press) led to the shift of the range of distribution boundary to the Southeast with a simultaneous argument-supported denial on the existence of the Neretva disjunction of the range of distribution.

It has been demonstrated that the last successes in discovery of the new *Lacerta mosorensis* habitats are primarily related to a progress in identification of their specificities. A sign-post in this direction was indicated by Karaman (1939) who connected this species with the mountains of the Adriatic Mediterranean. After that, Matvejev (1961, 1973) determined the Mosor Rock lizard as a characteristic inhabitant of Mediterranean mountain forest zone on rocky grounds of the "ancient Mediterranean mountains". Later on, based on phytocoenological and florogenetic data, botanists have included this zone in oromediterranean region (Trinajstić 1985) what was accepted by biogeographers (Matvejev & Puncer 1989), as well. Heldreich's pine (*Pinus heldreichii*) represents an easily identified tree species on mountains exposed to the influence of Mediterranean climate.

Investigations of plant communities formed by Heldreich's pine, which is an endemic and a tertiary relict of the Balkan Peninsula, were performed with the hope that due to a syngenetic link, *Lacerta mosorensis*,

also an endemic and a tertiary relict of the Balkan Peninsula could be found here. After successful finds of this lizard at Lovćen, Maganik and Prenj Mts. (Bischoff 1984, Džukić 1987, 1989, Capula & Lapini 1991) our studies were focused on the community *Pinetum heldreichii bertiscum Bleč.* 1959 at the complex Prokletije massif. The second stimulus to search for *Lacerta mosorensis* at this massif was a rather old and courageous hypothesis of the distinguished European herpetologist Schreiber (1912) suggesting that Mosor Rock lizard could inhabit the Albanian mountains, as well. This possibility has been rejected neither by Bischoff (1984) nor by Džukić (1987, 1989, 1991).

During long lasting investigations of the neoteny phenomenon in the Kuč region related to mountain lakes occurring there, we attempted several times to find *L. mosorensis* species in the immediate surrounding of Bukumir and Rikavac Lakes. Finally on May 31, 1995, at debris fans of the Bukumir circle at 1600 m a.s.l. under southwest cliffs of the Djebaza Mt., a subadult Mosor Rock lizard female was found. So, our multidecade expectations on the possibility of this lizard occurrence at the Prokletije massif were confirmed. During the next two expeditions (June 1, 1996 and August 24, 1996) the northeast slopes of Djebaza Mt. towards the Mokrog circle were investigated. It has been found that the cliffs and blocks of rocks above 1550 m a.s.l. were inhabited by a dense population of the *L. mosorensis* species. Djebaza Mt. itself represents a terminal mountain with a sharp intercircle reef beginning with Torač at Širokar and dividing from that point a simple circle into two parts (Cvijić 1913). At the same time, this reef represents a watershed of the Danubian and Black Sea confluences. The Djebaza, a 1755 m high mountain, consists of heterogeneous geological substrate with Triassic limestones and Cretaceous period sandstones as dominant rocks. At altitudes over 1600 m a forest of Heldreich's pine is developed. Prof. V. Stevanović and D. Lakušić, M. Sci. of The Institute for Botany and Botanical Garden "Jevremovac", Belgrade, found that in the plant community *Pinetum*

heldreichii bertiscum, the plants belonging to the Mediterranean floristic or florogenetic element (e.g. *Campanula pyramidalis*, *Stachys recta*, *Anthyllis aurea*, *Thymus acicularis*, *Potentilla appenina*, *P. spaciosa*, *Satureja montana*, *Minuartia clandenstina*, *Saxifraga marginata*, *Scabiosa fumaroides*, *Bupleurum kargli*, etc.) represent dominant species.

It is important to underline that up to the altitude of about 1600 m, the Mosor Rock lizard shares the habitat with the wall lizard *Podarcis muralis*. It is also worth mentioning that some females were gravid as early as on June 1, indicating that the mating could start already in May, i.e. earlier than reported in the available literature (Langerwerf 1983).

Taking into consideration the fact that Helderich's pine forests are fragmentarily scattered throughout the Prokletije and neighbouring mountains (Komovi Mt.), and even throughout somewhat more remote mountains (Paštrik, Koritnik, Ošljak Mts.) it is quite to be expected that new finds of *L. mosorensis* will be discovered what woul lead to shifting of its range of distribution both in the South and East directions.

REFERENCES

- Bischoff, W., 1984. *Lacerta mosorensis* Kolombatović, 1886, Mosor-Eidechse. In: Blume, W. (ed.) Handbuch der Reptilien und Amphibien Europas. Aula Verlag, Bd.2-I, Echsen II (*Lacerta*), 290-300., Wiesbaden.
- Capula, M. & Lapini, L., 1991. The karyotype of *Lacerta mosorensis* (Reptilia: Lacertidae): evidence for a new case of female heterogamety in a lacertid lizard. Atti della Accademia Nazionale Dei Lincei, Scienze fisiche e naturali, Ser. IX, 2 (1): 51-57, Roma.
- Crnobrnja-Isailović, Jelka & Džukić, G. in press. *Lacerta mosorensis*. In: Atlas of European Reptiles and Amphibians. S.E.H., Mus.Nat.Hist.Naturelle, Paris.
- Cvijić, J. 1913. Ledeno doba u Prokletijama i okolnim planinama. Glas Srpske Kraljevske akademije, 91, Prvi razred 38: 188-267, 13 slika, 21 skica, Beograd.
- Džukić, G. 1987. Remarks on distribution and protection problems of the mosor rock lizard, *Lacerta mosorensis* Kolombatović, 1886 (Reptilia, Lacertidae). 4th International Congress on zoogeography and ecology of Greece and adjacent regions, Kammena Vourla 20-25.iv 1987, Book of Abstracts, p.74, Kammena Vourla.
- Džukić, G. 1989. Remarks on distribution and protection problems of the mosor rock lizard, *Lacerta mosorensis* Kolombatović, 1886 (Reptilia, Lacertidae). Biologia Gallo-hellenica, 15: 185-190, Athenes.
- Džukić, G. 1991. Vodozemci i gmizavci. Građa za faunu vodozemaca i gmizavaca Durmitora. In: Nonveiller, G. (ed.) Fauna Durmitora. CANU Posebna izdanja 24, Odeljenje prir.nauka 15, Sveska 4: 9-78, 12 slika, Titograd.
- Karaman, S. 1939. ber die Verbreitung der Reptilien in Jugoslawien. Annales Musei Serbie Meridionalis, 1 (1): 1-20, Skoplje.
- Langernjerf, B. 1983. Notes on the mosor rock lizard, *Lacerta mosorensis* Kolombatović, 1886 and its reproduction in captivity. British herpetological Society Bulletin, 6: 20-22 (1983), London.
- Matvejev, S. 1961. Biogeografija Jugoslavije. Biol. inst. N. R. Srbije, Posebna izdanja 9, Naučna knjiga, Beograd.
- Matvejev, S. 1973. Predeli Jugoslavije i njihov živi svet. Naučna knjiga, Beograd.
- Matvejev, S. & Puncer, I. 1989. Karta bioma. Predeli Jugoslavije i njihova zaštita. Prirodnački muzej u Beogradu, Posebna izdanja 36, Beograd.
- Schreiber, E. 1912. Herpetologia Europaea. Gustav Fischer, Jena.
- Trinajstić, I. 1985. Oromediterska fitogeografska regija. Biosistematička, 11 (2): 83-89, Beograd.

REZIME

MOSORSKI GUŠTER PREBIVA I U MASIVU PROKLETIJA
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Prvobitna nadanja (Schreiber 1912) i docnija očekivanja (Bischoff 1984, Džukić 1987, 1989, 1991) da bi mosorski gušter mogao da prebiva i u složenom masivu Prokletija, ostvarena su otkrićem vrste na planini Debezi (31.maj 1995.). Kako je većina novih nalazišta, uključujući i gore pomenuto, vezana za biljne zajenice koje izgrađuje munika, a koje su fragmentarno rasprostranjene širom Prokletija i susednih, pa čak i nešto udaljenijih planina, realno je na ovim prostorima očekivati nove nalaze *Lacerta mosorensis*, uz pomeranje granice areala u južnom i istočnom pravcu.

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The Presence of Homozygotic Recessive Traits in Deaf-mute Children and in Controloled Sample

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ABSTRACT

Population - genetic research on 25 chosen , genetic controlled morphophysiological traits was performed in the sample of 103 deaf-mute school children, as well as in the sample of 103 healthy children of the same ege. The results of this research (HRCs-test) indicated significant difference between the average presence of these traits in sample of deaf -mute children and in control sample. Significant differ- nce in the type

of frequency distribution for 1/5 analyzed traits was also observed. This indicates that differences in the phenotype level may have genetic base. Increased genetic loads present in deaf children, together with other environmental negative factors, disturbs genetic and physiologic homeostasis and has influence on expressiveness of specific genes.

Key words: genetic load, homozygotously -recessive traits, deaf-mutism

INTRODUCTION

As a result of significant efforts in the area of human population genetics, performed by certain authors and teams in last 30 years , there are many papers which deal with the analysis of genetic structure of local and special samples of human population (Berberovic et al. 1972; Blagojevic et al. 1987; Bozic et al. 1973; Bozic -Krstic, 1990; Hadziselimovic, 1971; Hadziselimovic et al 1982; Hadziselimovic et al. 1984; Hadziselimovic et al 1987; Knezevic, 1984; Marinkovic, 1989; Marinkovic et al. 1990; Cukuranovic et al. 1989; Novosel, 1985; Ristic, 1990; Balog, 1992; Savic, 1993; Tomic et al. 1994; Cvjeticanin, 1994; Jovanovic et al. 1995). Phenotype (morphophisiological) approachis used frequently in the population-genetic research, because the series of morphophysiologal traits appear as qualitative mono or oligogenical determined traits (Winchester, 1968; 1973; McQuisic, 1968; Fristom and Cleg, 1987; 1991).

When the presence and distribution frequency of these traits in homozygotic recessive form is established, it can be used as a base to estimate the size and the type of genetic predisposition for the appearance of certain diseases, medical and biological phenomena, and homozygotic degree of different chromosomes.

Based on the results of these investigations we have assumed the presence of certain differences with regard to homozygotic recessive features in deaf-mute children and in the sample of control group. The aim of our work was to establish the degree of genetic homozygosity in deaf-mute children and in the control sample of school children in Belgrade.

MATERIAL AND METHODS

Research was performed in Belgrade and it included 206 school children. That is 103 children with damaged hearing and in 103 children used and the control group

Alternative morphophysiological characters were used as genetic markers, since they are clearly distinct as dominant or homozygotously recessive. We have examined the presence of 25 homozygotic recessive traits (HRC - test, Marinkovic et al. 1990). Obtained data were used to establish the difference in degree of genetic homozygosity between analyzed groups. Relative frequency of recessive alel (q) was calculated according to formula $q = \sqrt{a/n}$; n = the size of sample. Statistically significant difference in frequency of recessive phenotype between analyzed groups was tested by using t - test. Importance of differences in the obtained degree of homozygosity between deaf - mute children and the control group was found through χ^2 test for each trait and through total cumulative χ^2 test for 25 examined homozygotic morphophysiological traits. Variability in the control group and in the sample of deaf - mute children was found by the variance analysis and using the F- test.

RESULTS AND DISCUSSION

Numerical presence and relative frequency of recessive alel (q) for 25 analyzed traits is shown in Table 1.

Average homozygosity in A sample is $7,44 \pm 0,19$, and in B sample $\pm 0,21$. This is the significant difference in average presence in 25 observed HRC-s between these two analyzed samples.

Table 1. The presence of 25 homozygotously recessive traits in two samples of school children in Belgrade**Tabela 1.** Prisustvo 25 homozigotno recessivnih osobina kod dva uzorka školske dece u Beogradu

A - sample of children from a special school – uzorak dece iz specijalne škole

B - sample of children from regular elementary school – uzorak dece iz regularne osnovne škole

Home-recessive traits Homozigotno recessivne osobine	----- A -----		----- B -----		χ^2
	a%	q	a%	q	
Straight hair	72,81	0,85	66,99	0,81	0,52
Prava kosa					
Flat scalp	77,66	0,88	63,1	0,79	35,76***
Ravan skalp					
Blue eyes	22,33	0,47	20,38	0,45	0,19
Svetlo plave oči					
Soft hair	23,3	0,48	16,5	0,40	2,88
Meka kosa					
Linked ear lobe	31,06	0,55	31,06	0,55	0,0
Vezan ušni režanj					
Ear without Darwinian knot	66,99	0,81	37,86	0,61	18,28***
Odsustvo Darvinove krvžice					
Narrow nostrils	29,12	0,53	13,59	0,36	36,10***
Uzane nozdrve					
Thin lips	28,15	0,53	9,7	0,31	0,0
Tanke usne					
Small and ingrate chin	0,97	0,09	0,0	0,0	0,0
Mala i uvučena brada					
Face asymmetry	0,0	0,0	0,0	0,0	0,0
Asimetrično lice					
Inability to roll tongue	9,7	0,31	16,5	0,40	2,88
Nemoguć, uzdužn. savijanja jezika					
Inability to tongue curving	66,01	0,80	42,71	0,65	13,09***
Nemogućnost popr. savijanja jezika					
Right thumb over lapin	33,98	0,58	27,18	0,52	1,75
Desni palac preko levog					
Right hand over left muscle	80,58	0,89	67,96	0,82	2,42
Desna šaka preko levog mišića					
Three streaks in hand base	3,88	0,19	3,88	0,19	0,0
Tri žilic u korenju šake					
Absence of tiny hair on the 2 nd segment of hand fingers	23,3	0,48	26,21	0,51	0,33
Odsustvo maljia na II članaku prstiju					
Nail abnormalities	0,97	0,31	0,0	0,0	0,0
Nenormalni nokti					
Thumb proximal hyperextensibility	13,59	0,36	17,47	0,41	0,88
Poveć. pokretlj. proksim. zgl. palca					
Thumb distal hyperextensibility	23,3	0,48	27,18	0,52	0,57
Poveć. pokretlj. distal. zglobo palca					
Double top of the hair	8,73	0,29	2,91	0,17	12,00***
Dvostruko teme					
Reverse top of the hair	16,5	0,40	15,53	0,39	0,06
Obrotnut cvet u kosi					
Campo-streptomicrodactilia	50,48	0,71	46,6	0,68	0,33
Nepravilnost malog prsta					
Digital index 4th Vs. 2nd > 1	17,47	0,41	17,47	0,41	0,0
Digitalni indeks					
Dimple in the chin	62,13	0,78	60,19	0,77	0,06
Rupica u bradi					
Light hair	9,7	0,31	10,67	0,32	0,09
Svetlo plave kosa					

p>0,05* p > 0,01** p > 0,001***

 $\Sigma \chi^2 = 128,98$

a% - Percentual frequency of the recessive phenotype - Procentualna učestalost recessivnog fenotipa

q - Relative frequency of the recessive allele - Relativna frekvencija recessivnog alela

The total cumulative chi-square difference for 25 observed HRCs amount $\chi^2 = 128,98$ (d.f. = 23; p 0,001). This indicates that the frequency distribution of HRCs in the sample of children with damaged hearing (deaf-mute) and in the sample of healthy children (control sample) are statistically significantly different. The results of individual variability in the presence for each of 25 analyzed homozygotic recessive traits are shown in Fig. 1.

Curves of distribution differ which point to the presence of important distinctions in the type and scope of variability. Between the sample of children

with damaged hearing and control sample there was a difference in the type and distribution for one fifth of analyzed traits. The obtained results are the indicators for the differences on the phenotype level; between the control sample and the sample of children with damaged hearing. The presence of differences between examined children is the results of the genotype level, although we cannot exclude the effects of some negative factors such as infective diseases, drugs, (antibiotics), physical and chemical factors, high temperature, mechanical injuries, noise, vibrations, incompatibility of parents Rh factors, etc., which can

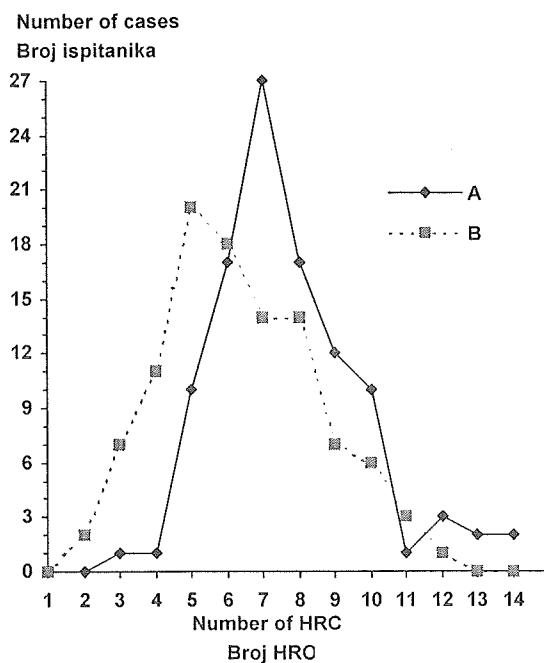


Fig. 1. - Distribution of HRCs in two samples of school children in Belgrade

A - from a special school

B - from a regular elementary school

Slika 1. - Distribucija HRO kod dva uzorka školske dece u Beogradu

A - iz specijalne škole

B - iz regularne osnovne škole

also affect the appropriate genes. Differences established in regard with the average presence and distribution of HRCs indicate the different degree of genetic homozygosity of analyzed groups. Proportional increase in homozygotic locus disturbs genetic-physiological homeostasis and altogether with pleiotropic action of present genes, decreases the resistance to their action of specific environmental factors and increases predisposition for disease genesis. The analysis of obtained results indicates the following: There exists a population-genetic difference between observed groups, as well as large individual variability. Increased genetic loads is not a direct cause for diseases genesis. But, together with the effect of inheritance factors and specific environmental factors, it can increase the predisposition for genesis of damaged hearing.

REFERENCES

- Balog E. (1992): M. Sc. thesis. Facult.Biol., Univ. of Belgrade
- Blagojevic J., D. Marinkovic and Z. Radovanovic (1989): Population-genetic studies of endemic nephropathy in the surrounding of Loznica.
- Chattopadhyay, P. K. (1968): A note on the ear lobe attachment among the Jats and Ahirs.
- Cerny , M. (1967): Lekarska genetika. Statni zdravotnickie nakladatelstvi Praha.

Cukuranovic R., D. Marinkovic S. Strahinic and V. Stefanovic (1989): Population-genetic analyses of Balkan endemic nephropathy. Genetika 21 (2), 171.

Knezevic D. (1984): M. Sc. thesis. Facul. Biol. University of Belgrade.

Marinkovic D. (1989): Population-genetic approaches to the studies of Yugoslavian inhabitants. Genetika 21 (3), 179

Marinkovic D., B. Spremo and M. Ilic (1990): Studies of human population-genetic variation. I. Comparisons of homozygously recessive traits in attendants of special and regular schools in SR Srbija. Arch. Biol. Sci. 42 (3-4), 11.

Ristic S., R. Hadziselimovic and D. Marinkovic (1992): Population-genetic analysis of some phenotypic systems of qualitative variation in the population of Rijeka. - Vol 24, No. 2. 101 - 107

Savic M. (1993): M. Sc. thesis. Facul. Biol. University of Belgrade.

Tomic V., S. Jankovic and D. Marinkovic (1994): Genetic homozygosity and the occurrence of allergic bronchial asthma . - Genetika, Vol. 26. No. 1. 51-56

Winchester, A. M. (1958): Genetics. H. Mifflin Co., Boston

Winchester, A. M. (1973): Modern Biological Principles, Matica Hrvatska, Zagreb

REZIME

ZASTUPLJENOST HOMOZIGOTNO RECESIVNIH OSOBINA KOD GLUVONEME DECE I KONTROLNOG UZORKA

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Populaciona genetička analiza odabranih 25 genetički kontrolisanih morfofizioloških osobina obavljena je u uzorku od 103 učenika specijalne škole za decu sa oštećenim slušom , kao i u kontrolnom uzorku 103 učenika redovne osnovne škole. Utvrđivanjem zastupljenosti homozigotno recesivnih osobina (HRO test) ustanovaljena je značajna razlika u prosečnom prisustvu ovakvih odlika između uzorka dece sa oštećenim slušom i kontrolnog uzorka. Utvrđena je i značajna razlika u tipu distribucije učestalosti za jednu petinu analiziranih karakteristika. Ovo nam, sugerise da razlike na fenotipskom nivou mogu imati genetičku osnovu. Uvećana genetička opterećenja uočena kod dece sa oštećenim slušom , zajedno sa drugim faktorima spoljašnje sredine remete gensko - fiziološku homeostazu i utiču na izražajnost odgovarajućih gena.

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Water-bearing Capacity of Cracked Rocks and Hydrogeological Characteristics of Fracture Aquifers in the Spring Area of Erenik-Djeravica

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ABSTRACT

As a part of the project of evaluation of natural resources in the spring area of Erenik-Djeravica hydrogeological characteristics and water-bearing capacity of fracture aquifer of gabbros and diabases have been examined by means of hydrogeological methods and laboratory analyses. Slightly mineralized waters of this aquifer are mostly formed through inflow of waters

from deep cracks stretching along NNW - SSE axis, which direction is generally assumed to be the direction of movement of underground waters in the area. Average value of the fracture porosity coefficient is 2%, and complexity of the rupture block resulted in utter anisotropy of water-bearing capacity of metamorphites.

Key Words: Hydrogeology, fracture aquifer, water-bearing, water permeability, Djeravica.

INTRODUCTION

The objective of quantitative determination of water bearing capacity of the spring area of Erenik Djeravica is regarded as the most important part of the hydrogeological research program carried out as a part of the field research project aiming at evaluation and protection of this particular area, mostly because of its highly specific geologic structure and required interdisciplinary approach.

However, the general objective of the research project is determination of hydrogeological characteristics of isolated lithologic environments, namely, determination of quantitative and qualitative characteristics of underground waters, as well as assessment of the level of danger for the water-bearing structure. Besides, as a part of this project, protective measures for underground waters and the spring area in general have been defined and future potentials of this area have been determined.

Research of the area under examination has not been very detailed and the results that have been procured are generalized and mostly inferred by interpolation and comparison with the areas at lower altitude. Earlier petrological research was carried out by S.Mojsilovic, V.Avramovic (1962) and D.Rajcevic (1968), and the basic geologic mapping was done by R.Antonijevic and his associates (1978). There were no available hydrogeological data pertaining to this area, and some hydrological research was done by R.Ilic (1989).

abases, resulted in development of fracture hydrogeological system the structure of which is continually changing, mostly because of development of rupture, as well as other factors. Hydrogeological research project designed on the basis of the general concept of the research project in the spring area of Erenik Djeravica comprised both cabinet and field work, carried out in accordance with the following dynamics scheme...

- collection and analysis of geological and hydrogeological results of previous research work in broader region of the spring area of Erenik. This analytical approach facilitated determination of lithologic areas, spatial disposition of geologic structures and most interesting points within the research area;

- realization of the hydrogeological mapping of the area under research, with special emphasis on fracture systems developed over outcrops of metamorphites for the purpose of collecting data necessary for definition of water-bearing capacity. Structural elements have been determined (measured) by means of geological compass;

- mapping of hydrogeological phenomena was carried out by means of electronic thermometer and pH-meter, and determination of carbon-dioxide was carried out by means of titration of sampled water by Na_2CO_3 . Water samples were prepared for laboratory analysis for oxygen by means of fixing by NaOH and MnCl_2 . Waters also have been sampled for laboratory determination of biochemical consumption of oxygen. Waters found in representative hydrogeological phenomena also have been sampled for the basic chemical analysis;

- statistical processing of collected elements of the structure and application of empirical-graphical

RESEARCH METHODOLOGY

High level of fracture porosity inside the solid rock masses found in this area, i.e. gabbros and di-

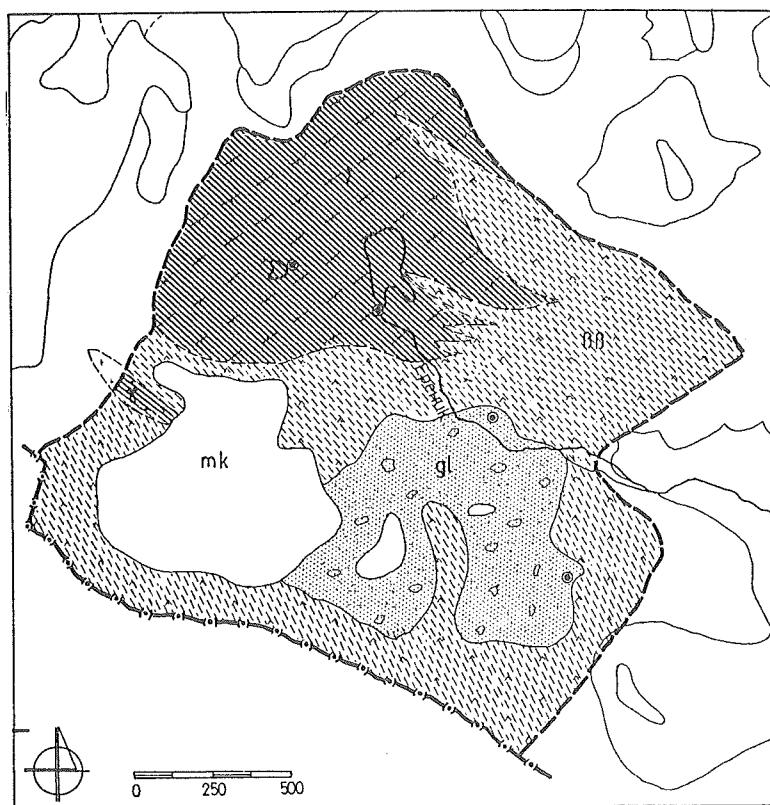


Figure 1. Hydrogeological map of the spring area of Erenik-Djeravica 1:12.500

Legend

mk	Surfaces under the sea of stones
gl	Glacial material
+	Granitoid
^	Diabase
/	Gabbro
●	Permanent spring of fresh water with yield of $Q=0,1-1 \text{ l/s}$
IB-42	Water-bearing material of the fourth group, class II
IB-50	Water-bearing material of the fifth group
IB-60	Water-bearing material of the sixth group

analysis methods resulted in determination of water-bearing capacity and coefficient of water permeability of the aquifers under examination;

- interpretation of results of chemical analyses of sampled waters relative to the effective drinking water regulations for the purpose of establishing qualitative characteristics of examined aquifer;

- synthesis of the obtained research results.

RESULTS

The spring area of Erenik consists of gabbros, whereas the western-summit parts of Djeravica slopes, as well as those in the north and east, consist of diabases. Gabbros and diabases generally belong to the group of basic magmatic rocks, however, due to in situ granitization of rocks of Junika, in this particular case they belong to the group of metamorphic rocks. The following rock types have been observed as dominant in the broader area of the research zone: epidot-actinolite shale and rocks. There are also wide spread glacial material and coarse alluvial sediments, as well as large blocks which form so called sea of stone.

Research area belongs to outside Dinarides, i.e. eastern-Bosnian-Durmitor block which is a part of the geotectonic system of Dinarides (M.Dimitrijević, 1995).

Highly developed hydrogeological relations inside the gabbros and diabases, as well as in the surrounding terrain, conditioned by hydrodynamic conditions within widely spread lithologic elements, resulted in formation of fracture type aquifers as the dominant type. Although it has been formed in midst of glacial material, alluvial deposits and the compact

type aquifer is practically insignificant for the underground waters of the fracture hydrogeological system.

Spreading of isolated lithologic environments with corresponding type of aquifers within the research area is shown in Figure 1.

Analysis of the developed fracture type aquifer revealed difference between that part of the aquifer which is situated within the fracture system in the zone of regional fracturing, and that part which is situated in the fault zone, i.e. above the local erosion basis and below the local erosion basis. Formation of the local erosion basis occurred after impression of magmatite. Due to impact of endogenic and exogenous forces it is still descending.

Geostructural analysis and hydrogeological interpretation of the data obtained revealed that complexity of rupture structure of the block resulted in utter anisotropy of water-bearing capacity of metamorphites.

Maximal effective porosity of metamorphites (n_{\max}) composed of the dominant family of hydrogeologically active fractures (Fig.2) is about 2%.

Completed research work has not determined the character of changes in effective porosity of metamorphites which vary depending on depth. Isolated fracture families are distinguished by variety of filtration characteristics.

Minimal coefficient of water porosity for certain families of fractures is around $K_{\min} = 4.5 \times 10^{-6} \text{ cm/s}$, and maximal coefficient of water porosity does not exceed $K_{\max} = 1.26 \times 10^{-5} \text{ cm/s}$. On the basis of these values this water-bearing structure is placed in the category of structures with low water-bearing capacity. Coefficients of water porosity are shown in the polar diagram (Fig.2).

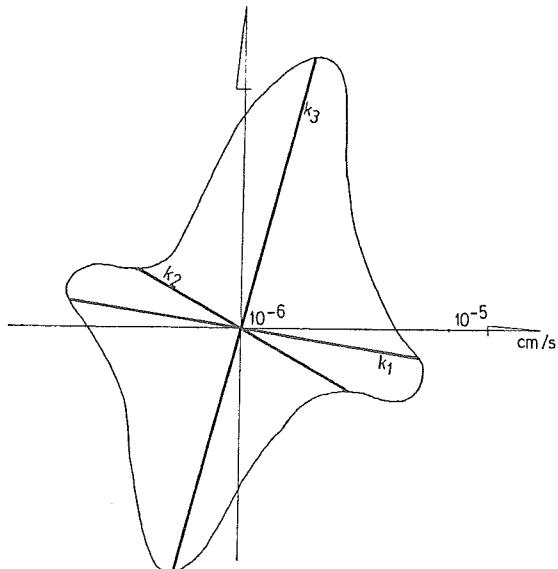


Figure 2. Polar diagram of water permeability in the spring area of Erenik-Djeravica

As regards filtration quality - in spite of the fact that the diagram of water porosity indicates that the whole area has relatively poor filtration quality - the most distinguished direction is the one with approximate orientation NNW - SSE.

This family of fractures significantly influences the conditions of formation, movement and flow of water through fracture aquifers developed in metamorphites of the spring area of Erenik. On the basis of completed analysis, it has been established that its dip elements (DE) are 110/80, and average value of the coefficient of water porosity of this system for fractures is $K_1 = 1.26 \times 10^{-5}$ cm/s. Other families of fractures have far less impact on filtration quality of gabbros and diabases.

According to physical properties, analyzed waters are mostly clean and pure, with no color, smell or taste. Temperature of aquifer waters is usually between 2.3 and 7.3 °C. Concentration of hydrogen ions (pH) of analyzed waters varied between 5.3 and 5.5, which means that these waters may be described as slightly acidic.

Overall hardness of water of the fracture aquifer is between 0.5 and 0.8 dH, which means that according to Klut classification this water is categorized as soft.

Electrochemical conductivity varies between 10 and 18 $\mu\text{S}/\text{cm}$, which fact indicates formation under reduction conditions.

According to O. A. Alekin classification, all examined waters from fracture type aquifer belong to the hydrocarbonate water class, calcium group of the first type.

Representative elements of the chemical composition of underground waters, from the point of view of usability for water supply purposes, are presented in Figure 3.

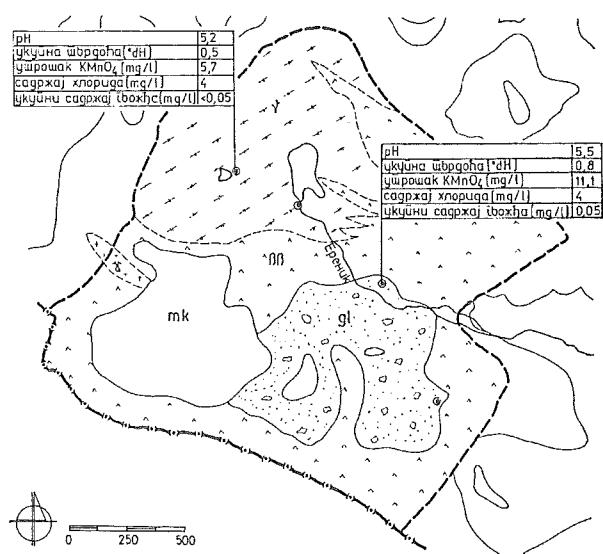


Figure 3. Map of representative components in chemical composition of underground waters, 1:12500

DISCUSSION AND CONCLUSION

On the basis of the results of completed hydrogeologic and other research work and complex analysis and synthesis thereof, the following facts have been established:

- formation of the fracture hydrogeological system has been conditioned by mechanical and other characteristics of the rock mass of gabbros and diabases, which, regardless of their genetic origin, display clearly defined elements, structure and borderline conditions;

- according to the hydrogeological structure, rock masses of the area under examination belong to the semi-closed type;

- formation of aquifer waters takes place in the fracture hydrogeological system of metamorphic gabbros and diabases, where the main additive source is inflow from other aquifers (peripheral epidot-actinolite shale, limestone and dolomite in south-east) especially along the deep cracks. Paths of the deep cracks on which the structures with divergent movement are located (B. Marković, 1980) are parallel with spreading of lithologic units in the researched area, namely NNW - SSE, and, taking into consideration that terrain in this area is rising at rate of 6 to 8 mm a year, we should expect that circulation of underground waters in the future shall be most intensive along these privileged paths;

- drainage of aquifer waters is taking place through "exurgence" Erenik and other, less abundant springs which belong to the ascending type;

- fracture porosity coefficient values for isolated families of fractures are between 1.5 and 2.5 % and they fit well into statistical data published by foreign authors;

- on the basis of completed research work and obtained results, it is clear that the spring basin of Erenik has exceptional natural potentials which need to be protected and presented for the purpose of preservation and protection from any technogenic factors. In order to achieve this, it is necessary to determine the basin surface of Erenik through further research projects, establish directions and routes of movement of underground waters, carry out hydrodynamic research and produce mathematical models.

REFERENCES

- Antonijević R. Et all., 1978. Tumač za listove OGK Peć (K 34-53) i Kukes (K 34-65) Zavod za geološka i geofizička istraživanja, Beograd
- Dimitrijević M.D., 1995. Geologija Jugoslavije, Geoinstitut Barex, Beograd.
- Ilić R., 1989. Reka Erenik - veliko vodno bogatstvo. Geografska istraživanja, br. 10, Univerzitet u Prištini, Priština
- Marković B., 1980. Tektonski položaj ultramafitskih masa Dinarida. Geološki anali Balkanskog poluotrva; Geološki zavod Univerziteta u Beogradu., Beograd.

REZIME

VODONOSNOST ISPUCALIH STENA I HIDROGEOLOŠKA SVOJSTVA PUKOTINSKIH IZDANI U IZVORIŠNOM DELU ERENIKA-ĐERAVICA

Mijović Dušan

Kao deo Projekta ocene prirodnih resursa u izvorišnom delu Erenika-Đeravica hidrogeološke karakteristike i vodonosnost pukotinskih izdani gabra i dijabaza, ispitivane su uz pomoć hidrogeoloških metoda i laboratorijskih analiza na uzorcima. Blago mineralizovane vode ovih izdani se uglavnom formiraju kroz dotok vode iz dubokih pukotina koje se pružaju po pravcu sever, severozapad-jug, jugoistok, za koji se smatra da je pravac kretanja podzemnih voda na tom prostoru. Prosečna vrednost koeficijenata poroznosti naprslina je dva procenta, a kompleksnost pukotina se odražava u potpunoj anizotropiji vodonosnog kapaciteta metamorfita.

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The Grlja Canyon Natural and Tourist Resource

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ABSTRACT

The paper, from the tourist-geographic aspect, dealt with the tourist (geomorphologic and hydrographic) resource of the Grlja Canyon within the Ropojansko-Vrujski glacial valley in the Gusinje part of Prokletije. The canyon is significantly interesting with its numerous water falls and gigantic water basins, meanders, natu-

ral bridges and lakes. It attracts numerous visitors as a unique geomorphologic-hydrographic natural monument. However, due to its peripheral position, incomplete tourism material base and organizations needed for tourist visits, its tourist value is small and inadequate compared to its natural resource.

Key words: Grlja canyon, Ropojansko-Vrujski glacial valley, water falls, springs, natural resource, tourist value.

INTRODUCTION

Glacial erosion and accumulation forms dominate in the geomorphologic structure of the Plav-Gusinje part of Prokletije due to an intensive Pleistocene glaciation. Valleys are the most interesting among them. Ropojansko-Vrujska, Grncarsko-Ljucka and Babinopoljska glacial valleys are the most significant according to their area, recreation, esthetic and curiosity characteristics. The Ropojansko-Vrujski glacial valley is of the highest tourist value with the most favorable conditions for tourist activities. Interesting geomorphologic and hydrographic objects, as well as, rare plant and animal species are listed and combined in the valley, 10 km in length. The Grlja canyon with waterfalls and gigantic basins, tall and sharp peaks of Maja Scokista and Karanfili, moraine blocks in Ropojana, the hole Suplja Vrata in one of the Karanfili rocks, Vrulja and Savino karst springs with Vruja river and Jezerce lake created around, attract a special attention with its natural tourist characteristics. The paper analyses the most important natural elements of the canyon and the valley tourist value (geomorphologic, hydrographic and floral), indicating the need for tourist organization and making the canyon an active one.

The Grlja Canyon Position and its Discovery

From the point of local, regional and wider contractive zone, the Ropojansko-Vrujski glacial valley with the Grlja Canyon is characterized by a peripheral and nonfunctional tourist-geographic position. There are no larger town settlements, within the local and regional zone, that could be the emissive centers for the excursion and stationary tourism in the valley within the frame of Prokletije. An unfavorable position of the valley, Gusinje settlement, respectively, toward the main tourist places, as the sources of tourist demand, and bad traffic connections indicate an undeveloped tourism. The Ropojansko-Vrujski glacial

valley extends south of Gusinje, up to the state border toward Albania, between the mountains of Karanfili and Vezirova Brada, in the west, and Maja Scokista, Bjelica and Bor, in the east. The Ropojansko-Vrujski glacier, as one of the largest Plavski glacier spring branches, moved down the valley. It started from the circues, located among the Bjelic (Maja Rosit, 2,523 m), Maja Jezercesa (2,694 m) and Maja Snikuta (2,554 m). Pec-Gusinje-Skadar (Pecki road) caravan road used to pass along the valley bottom, up to the moment of the border division with Albania in 1912. It climbed down into the Valbona valley in Albania through the Cafa Pejs (1,690 m). The custom-office building ruins can be found in the spring part of Ropojana, indicating the significance of the road. Nowadays, a village cart road, connecting Vusanje and Gusinje, leads along the valley bottom and by the Grlja Canyon. It reaches the Savino Oko spring and Jezerce in Ropojana.

The attempts of invading, discovering and researching the canyon are recent, and are connected to the Savino Oko spring and Skakavica river dry period, when there is the smallest water quantity, making the only possible passage of the canyon. In October 1982, the Plav "Visitor", mountain club, team members (H. Sahmanovic and A. Bakovic) succeeded in intruding the canyon interior by boat, from the downstream direction, some 100 meters upstream. Then, they discovered a new water fall in the canyon, some 25 m high. The same team, October 10, 1983, succeeded in climbing down the canyon, starting from the entrance, and reaching some 200 m downstream. Three more waterfalls were discovered then. A very strong karst spring was found just below the Skakavica entering waterfall gigantic water basin. Thanks to the spring, Grlja, as a difference to Skakavica, does not get dry even in the driest period. But, the Belgrade Mountain Association - Rescue Service - Kopaonik Station team

was awarded the honor of the first invaders of the whole canyon, headed by the engineer M. Rudakovic (1987). The team was joined by the Plav Mountain Club member H. Sahmanovic. From October 18-19, 1987, the team was the first to pass the whole canyon using the alpine and speleological equipment. According to the team member impressions, narrow cuts (1-2 m) are exchanged with vertical water fall cuts and gigantic water basins. There are two natural bridges in the canyon, one of which represents built-in natural bridge, while the other one was created by the accumulation of falling rocky blocks. According to the opinion of mentioned team members, the Grlja Canyon with its meanders, water falls, gigantic water basins, filled with water, and the lakes, is no less impressive than the Komarnica Canyon, named "Nevidio".

RESULTS

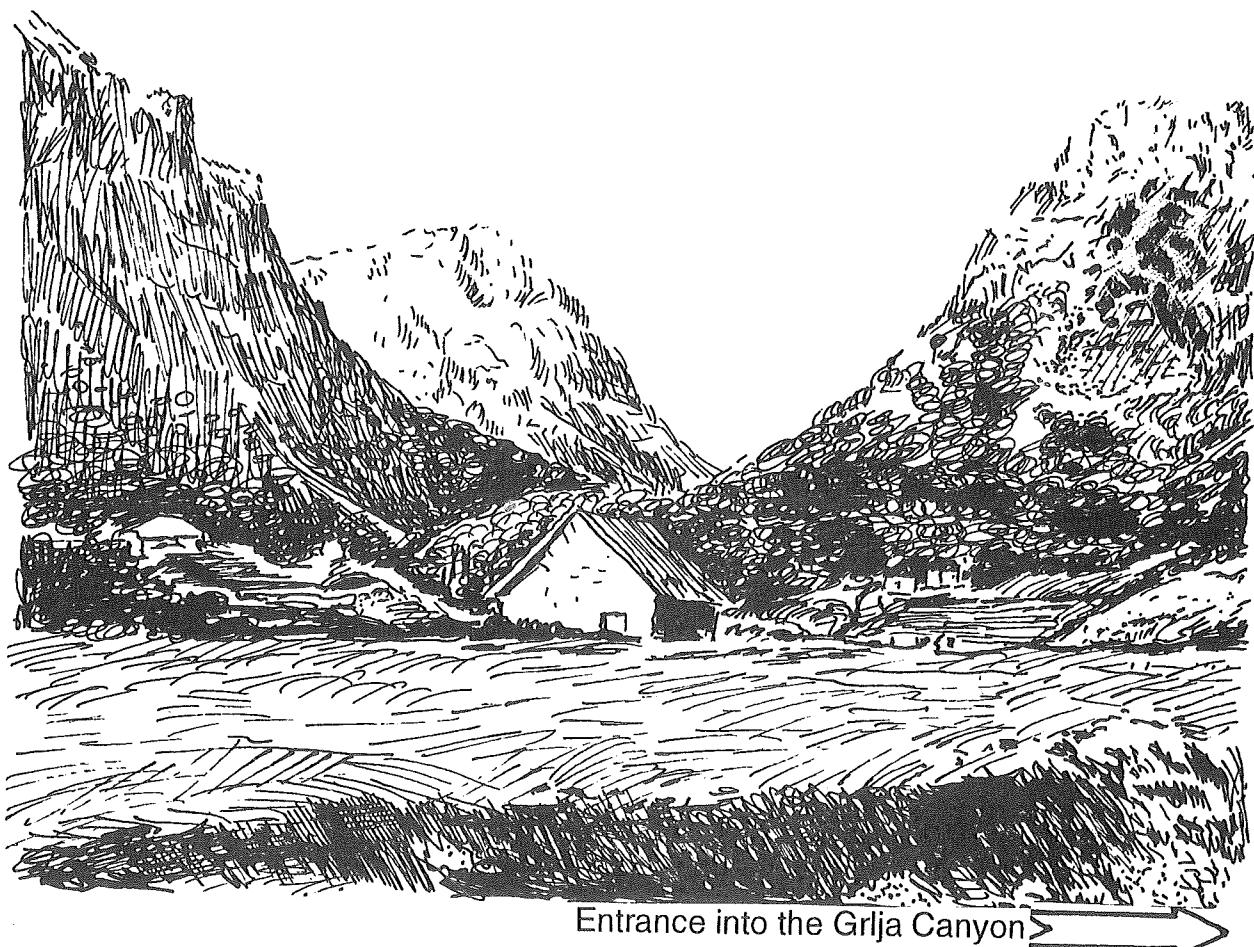
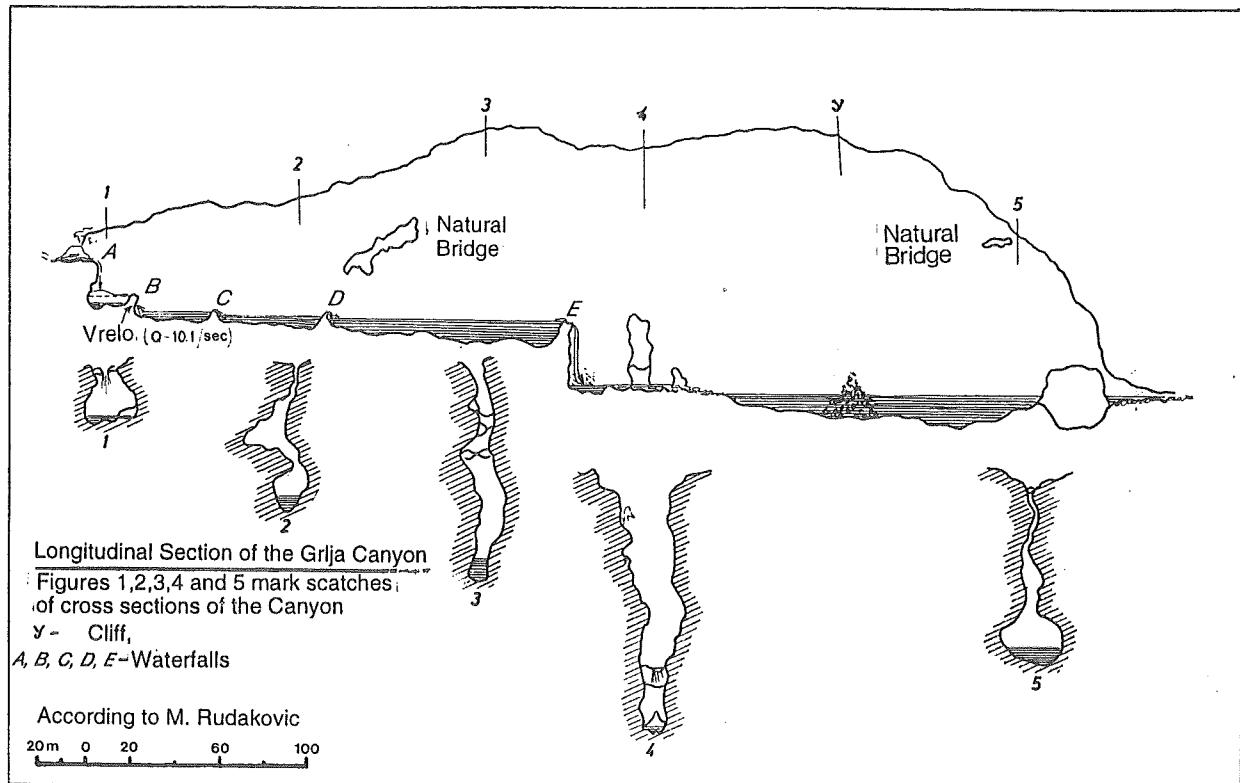
The Canyon Natural Characteristics

The Ropojansko-Vrujski glacier, in its longitudinal profile, has continually deepened its valley, along a significant length, and has created five dams, made of limestone, by a selective erosion, due to various surface resistance (limestone, schist, erosive limestone). Continual depths and dams are alternately replaced one by another. When the valley was inherited by the Vruja river after the ice melted, it cut and destroyed two lowest dams with its erosion. The fragments of the dams mentioned are the Cekica Krs near Gusinje and Cosovica Krs in the lower part of the Vusanje village. The three other dams are complete, still damming the valley. The first of them upstream, named Suka, is located in Vusanje. The dam absolute height accounts to 1,063 m, relative one to 65 m, respectively. The dam is 1,000 m in length, and 500 m in width. It is made of the upper-Cretaceous soft limestone that, in the upper part of the Djombalici settlement, join with the upper Cretaceous erosive lime stone of the southwestern slopes of Bor mountain (Zivaljevic, 1959). "Suka" is karstified on the surface. It consists of moraine blocks, looking like the tombstone monuments from the distance (Cvijic, 1933). Surmounting the "Suka", the Vrulja river, that, in its spring flow, from the Savino Oko spring to the dam, some 1.5 km in length, is called Skakavica, and downstream of the dam Vruja, has cut through an unusual canyon named Grlja, some 40-50 m deep, with an average width some 2-5 m, in the upper part, and 500 m long. Although being of small dimensions, the canyon represents a unique geomorphologic natural monument, its attraction being filled with waterfalls, gigantic water basins and lakes.

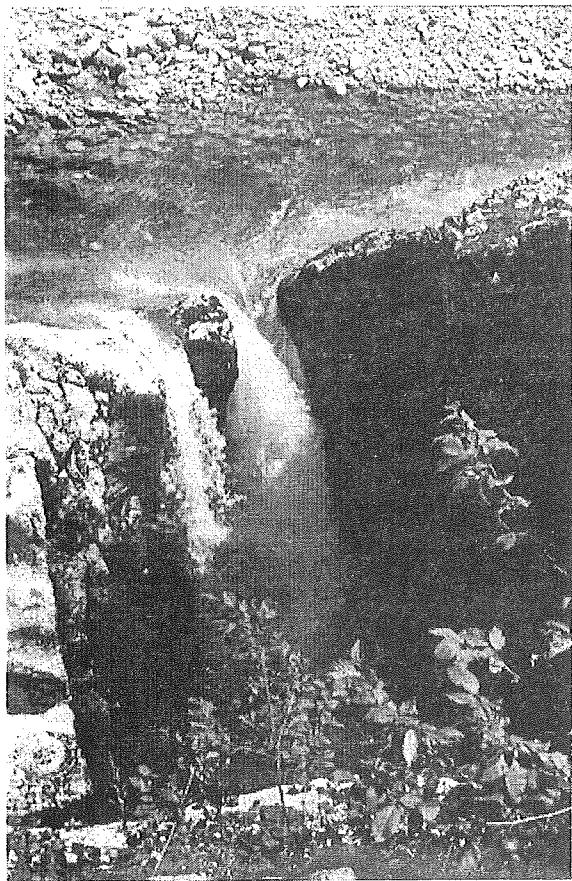
The Grlja Canyon is of an erosive origin and belongs to the fluvial-karst forms of relief. At the beginning, it was the lost riverbed, created by the erosion of a sub-glacial creek. The canyon polished sides

above the gigantic water basins are the witnesses of the above. The canyon is identical to the form of Pont des Que Ues on Rhone river bellow the Geneva lake (Cvijic, 1933). The two natural bridges are the witnesses that the Grlja Canyon is the result of the erosion, of the same named river ground water-flow. The canyon cross-section profiles, marked with No. 1, 2, 3, 5 in Figure 1, also confirm the above. The profiles indicate that the canyon is widened at the bottom, narrower in the upper part close to its edges. The canyon width, at the level of the gigantic water basins and the lakes, amounts to 13 m, while, above the respective, at the topography surface, it partially amounts to 2-3 m.

The altitude difference, from the point of Skakavica entering the canyon (1,005 m/a/s/l) to the Grlja point of leaving the canyon (940 m/a/s/l), is 65 m in length. The Grlja riverbed total drop is of the same length too. The river drop mainly consists of the vertical rocky cuts with waterfalls, bellow which, are the deep gigantic water basins. In the southwestern part Suka is cut by an additional gorge, that, as a difference to Grlja, is dry and is named Grlic. The later is also considered to be of an erosive origin. The two gorges were not created by the same river. Namely, Grlja was deepened by Skakavica (Grlja), and Grlic was the result of the Socnica, the sub-glacial creek erosion during the glaciation, respectively (Milojevic, B., 1937). Savino Oko is strong karst spring, braking out from the hollow in the bottom of the Ropojanska glacial valley, at 1,050 m above sea level. Its maximum capacity is 10 m³/s (Stankovic, S., 1972). Minimum depth of the spring lake-surface, when losing the arm of the river, is 6m (measured Oct. 20, 1986), and maximum 12 m, when Skakavica river flows out with the largest flow capacity. At the canyon entrance, Skakavica falls down, through vertical karst cut, into the gigantic water basin and makes a waterfall (A) some 15 m high. The waterfall noise, especially during the period of high water level and the river flow, could be heard far away around. The gigantic water basin - cauldron, whose depth is not measured yet, and according to some estimates, during the river mid water level, is some 5 m. Its width is some 10 m. The next waterfall (B) is some 5 m high. From the waterfall left side, there is a spring breaking out with the maximum capacity of 10 liter per second. The waterfalls marked C (Figure 2) are 2-3 m high. Downstream the waterfall, in the Grlja riverbed, there is a rock of the waterfall height, and further bellow there is a smaller rock too. The Grlja river greatest deep, over 13 m, is in the lowest erosion expansion, at the canyon exit, with a huge rock in the riverbed (Miljkovic, Petrovic, 1989). a) The Grlja and Ropojansko-Vrujska Glacial Valley Tourist Value Within the Ropojansko-Vrujska glacial valley geographic complex frame and within the Gusinje part of Prokletije, the Grlja Canyon represents a complementary tourist value. However, it could obtain the elements of independent geomorphologic-tourist values, if prepared for tourist visits.



Ropojane valley (Original drawing)
Ropojskoi valov (Originalni crtež)



Figur 3. The Skakavica Waterfall on the entrance of the Grlj Canyon



Figur 4. The Vruja River (Grlja) on the exit of the Canyon

The Ropojansko-Vrujska glacial valley, as a complex and polyvalent valley, has got favorable natural predisposition for the development of many types of tourism (fishing, hunting, weekend-excursion, excursion, mountaineering, Alpinism_ Kicovic, 1995). The tourist value of the Grlja Canyon and its glacial valleys is, mainly, based on its characteristics and the utilization elements, its rarity and diversity. The utilization possibility results from the valley and closer surrounding characteristics and possibilities in satisfying the tourist movement needs, such are: recreation, education, esthetics, etc. Recreational and psycho-physical needs could be satisfied here through walking, fishing, hunting, mountaineering, natural attraction visits, medicinal herb collecting, etc. The Ropojansko-Vrujski glacial valley, and its closer surrounding, represents a real didactic polygon and science laboratory for the field lecture and research, under the open sky. Therefore, it is often visited by pupils and students, numerous scientists, especially geo-morphologists, hydrologists, geographers, botanists and geologists. Typical forms of glacial erosion and accumulations could be found here in a relatively small area. Among these, the marking ones are the glacial valleys and circues, sharp and toothed crests, moraines and peaks. The karst forms of relief - the canyons, hollows, caves, pits, windows, etc. These are often combined with the glacial relief, giving the glacial valley a specific characteristics. The geologist attention is attracted by the layer profiles at the eastern side of Karanfili, Vrujski saddle, by the rock and mineral formations, as well as, by the polymetal sulfide phenomena (copper, lead, zinc, etc.) in direct surrounding. The Gusinje part of Prokletije is characterized by a great number of endemic and relict floral species. Recently, a new discovered species of the family Cruciferae , Draba bertiscea - the Prokletije portulaca, with Maglic being the unique one and the only known area, attracted the botanist and the scientific public attention. However, Prokletije, with its 150 floral species at 2,500 m², represents the major center of florist diversity in the FR of Yugoslavia (Stevanovic V. et all., 1995). The original, landscape, especially geo-morphological, hydrographic and phytogeographic diversity, make the Ropojansko-Vrujski glacial valley to be the one of the most beautiful and the most attractive valley in the FR of Yugoslavia. Such resource of diverse esthetic space elements, composed into the landscape, could be rarely found elsewhere, but here. The slogan "diversity is beauty" in the valley has its full and real meaning. The miraculous relief forms, as are the sharp peaks like the Maja Scokiste and Karanfili, windows, vertical cuts in circues, canyon cuts in the dams, cave holes, then, the rivers with waterfalls, strong karst springs and direct touches of bare rocks and greenery, give the Ropojansko-Vrujski glacial valley and the Gusinje part of Prokletije, a magic visual impression and evoke emotive and mystic experience of high degree. This part of Prokletije originality, diver-

sity, rarity and fame of the natural resources and specifics, are the inexhaustible inspiration and challenge for many writers, painters and photographers. Despite the resources and the potentials indicated, nothing has been done so far, regarding the tourist organization of the Ropojansko-Vrujski glacial valley and the Grlja Canyon. There is no organized sight spot along the canyon, from where, the interior of the geomorphologic area with waterfalls, gigantic water basins and lakes could be seen. The canyon, however, is invisible, unless its high, vertical and, largely, inverse leaned side, is directly reached. The canyon bottom could be seen from two, or three spots, only. As there is the shortage of the sight spots and of the fans, the watching of the canyon is a risky one. It evokes fear and dizziness in certain visitors. There were tragic outcomes too. The Project preparation is needed for the tourist organization of the canyon, that would project the construction of the suspension bridges along the canyon, with several cross bridges, that would also serve as the sight spots. Technical organization also supposes the lighting up of the canyon, the construction of access paths an (waterfalls with the gigantic water basins, rocks, meanders, etc.). An adequate tourist organization of the canyon would enable the visitors to do the sightseeing, to get acquainted with, and to experience the most unusual morpho-structural and morpho-sculptural forms and hydro-geographic curiosities that can be found in the canyon. The later would enable the tourist longer staying and greater consumption, and consequently, the economic feasibility of the canyon tourist exploitation. Thus, the canyon, as an exceptional geomorphologic rarity and natural resource, would become the tourist value that makes profit. An adequate advertising activity, as well as, a well organization of tourism in the area considered, would be of great significance for the tourist animation of the canyon. It should be mentioned, that, technical organization should not disturb, or degrade the natural appearance of the canyon.

DISCUSSION AND CONCLUSION

Based on the above, the Ropojansko-Vrujski glacial valley with the Grlja Canyon is characterized with exceptional natural resources, especially geo-morphological, hydrographic and floral ones. The values, according to their quality and significance, no doubt, exceed local and regional character and are of greater significance. There are here, not only, the Balkan's, but also the European and, even, the World's natural rarities. Therefore, the valley was declared to be the reservation of the natural region that should be activated from the point of tourism. It should be expected that it is going to be included in the zone of strict protection of the future National Park of Prokletije.

Whether the natural values of the valley and the canyon considered, include the tourist value too, the

answer is affirmative, although, there are opposite opinions too. The Ropojansko-Vrujski glacial valley and the Grlja Canyon are the integral part of the Plav receptive tourist zone, the Plavsko lake respectively, and the Gusinje locality zone too. It is an area of primary tourist exploitation of the Plavsko-Gusinjski part of Prokletije. The Grlja Canyon is 17 km far from Plav by road, 6km from Gusinje respectively. Its most frequent visitors are the guests of "The Plavsko Lake" hotel in Plav, excursionists from Andrijevica and Berane and the excursionists and mountaineers from various parts of our country. Its natural values (the relief, water, air, flora and fauna) represent primary attractive factors of the area tourist offer. Its essential attractive attributes are: originality, rarity, diversity, specificity and representativeness, as well as, the esthetic and curiosity characteristics. Thanks to the ski grounds in the near by Bor, there are favorable conditions for winter-sport tourism too. In order to enable the canyon and the glacial valley obtain higher tourist value, i.e., the respective are more successfully evaluated, the Phase one would, apart from the canyon organization, require the construction of a high quality road along the glacial valley and a motel, or a hotel in the glacial valley itself.

REFERENCES

- Cvijić J., 1933. Ledeno doba u Prokletijama i okolnim planinama. Glas srpske kraljevske akademije, XCI, Beograd.
- Kićović D., 1995. Turizam i zaštita prirode Gornjeg Polimla. Unireks. Nikšić.
- Knežević M., 1979. Plavsko-gusinjski region - uslovi za razvoj turizma. Posebna izdanja SGD, Knj. 50, Beograd.
- Knežević M., 1995. Turistički resursi i potencijali Prokletija. NIJP Panorama, Priština.
- Milojević B., 1937. Visoke planine u našoj kraljevini. Državna štamparija. Beograd.
- Miljković Ij. I Petrović J., 1990. Dolina Vruje sa posebnim akcentom na kanjon Grlje. Četvrti skup geomorfologa Jugoslavije, Geografski fakultet PMF u Beogradu. Pirot - Beograd.
- Stanković S., 1972. Kraško vrelo Oko kod Gusinja. Glasnik Republičkog zavoda za zaštitu prirode - Prirodnočaškog muzeja, br. 5, Titograd.
- Stevanović V., Jovanović S., Lakušić D. i Mirjana Niketić, (1995): Diverzitet vaskularne flore Jugoslavije sa pregledom vrsta od medjunarodnog značaja. - In:
- Stevanović V., Vasić V. (eds.): Biodiverzitet Jugoslavije sa pregledom vrsta od medjunarodnog značaja. Biološki fakultet i Ecolibri, Beograd.
- Geotektonska karta šire okoline Gusinja. Geološki glasnik, III, Zavod za geološka istraživanja Crne Gore, Titograd.

REZIME**KANJON GRLJE KAO PRIRODNA I TURISTIČKA VREDNOST**

KNEŽEVIĆ Marko, KIĆOVIĆ Dragomir

Južno od Gusinja, u ropojansko-vrujskom valovu, kojim se u pleistocenu kretao najduži prokletijski lednik, usečen je kanjon Grlje. Dubok je 40-50 m a prosečno širok 2-5 m. Predstavlja jedinstven prirodan kompleks sa džinovskim loncima dubokim do 5 m, prirodnim mostovima, kraškim vrelima (Savsko oko s maksimalnom izdašnosti od 10 m³/s i tri vodopada (najduži oko 15 m a najkraći 2-3 m). Levo i desno od

kanjona izdižu se šiljati vrhovi Maja Šćokišta i Karanfila, džinovski prozorci u stenama, vertikalno usećeni cirkovi, kanjonski odseci sa prečagama i pećinski otvori. Ove osobine kanjona Grlje mogu se koristiti u lovnom, ribolovnom, izletničkom i ekskurzivnom turizmu, a pogodne su i za nastavu u prirodi. Ropojansko-vrujski valov sa kanjonom Grlje može se pretvoriti i u pravi naučno-istraživački poligon.

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The Elements of the Pristina Bio-climatic Characteristics

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ABSTRACT

Bio-climatic analysis of Pristina was made on the basis of equivalent temperatures (Et) and Charles's method (the sultriness clime-gram), and the Kruger's anthropo-climatic classification, amended and adjusted, served for the determination of bio-climatik characteristic. The equivalent temperatures were calculated for the

Pristina meteorological station (1950-1985 period), classified in five bio-climatic classes and two weather types.

Cold ($5^{\circ}\text{C} < \text{Et} < 22^{\circ}\text{C}$) and pleasant ($22^{\circ}\text{C} < \text{Et} < 50^{\circ}\text{C}$) weather types were present with the classes: cold, quite chilly, cool, pleasant and warm.

Key words: Equivalent temperatures, the sultriness clime-gram, bio-climatology, anthropo-climatic classification, weather types and classes.

INTRODUCTION

Bio-climatology, with its disciplines (climate-therapy, climate-pathology, climate-physiology), studies various relations between the organisms and the perinnial atmosphere condition, as well as, multiple interaction with the dominating influence of physical environment in relation to human retroactive reaction. The bio-climatic influence in perceived by the introduction of various complex climatic values, obtained by the combination of certain climatic elements (equivalent temperatures, cold-weather index, air enthalpy, air-cooling ability, radiation-equivalent-effective temperature etc.), being of special significance to the selection of sanitarium location, or recreation destination from the aspect of medicine and multiple climate influence on health (Pecelj, et al., 1996).

METHOD

The bio-climatic analysis is based on the combination of temperature and water vapor pressure ($\text{Et} = t + 2e$), being the basis for the determination of the heat physiologikal sensation and the weather types in accordance with the Kruger's anthropo-climatic classification, amended and divided in three weather types and nine heat physiologikal sensations (Table 1). Such combination, in addition to the temperature and the water steam pressure, also considers the air stream and the air pressure, and is know as the equivalent tem-

perature (Et), (Milosavljevic, 1985). The significance of the equivalent temperatures in bio-climatology is that, the respective could evoke various heat sensations in healthy and sick people, that could be used as basis for weather classification regarding the recreation and tourism, especially from the medicine point. Pristina (590 m a/s/l) is an urban, economy, management and administration center of Kosovo and Metohija with significant historic-tourist locations and certain natural resources in its vicinity, that could be complementarily evaluated. Thus, one of such bio-climatic analysis could be of great use.

Apart from the equivalent temperatures for the completion of bio-climatic characteristics, the sultriness clime-gram (Charles's s method) is also used and it combines the temperature and relative air humidity. The essence of this method is that the heat is easily transferred if the weather is dry and windy, and more difficult, if its humid and windless. Such unbearable heats are known in climatology as the sultriness. Thus, in cases of the same temperature, a person has various sensations of the heat, depending on the air the humidity and air pressure values (Dukic, 1981).

The equivalent air temperature, practically, represents a supposed dry air temperature that would exist if, the whole water vapor had condensed in a humid air, thus, releasing all the heat that had been previously consumed within the processes implementing the

Table 1. The Classification of Physiologikal Heat Sensations and the Weather Types

Et in $^{\circ}\text{C}$	$< 5^{\circ}$	$5 - 18^{\circ}$	$18 - 22^{\circ}$	$22 - 30^{\circ}$	$30 - 40^{\circ}$	$40 - 50^{\circ}$	$50 - 58^{\circ}$	$58 - 70^{\circ}$	$> 70^{\circ}$
Physiological Heat sensation	Quite cold	cold	Quite chilly	Fresh	Pleasant	Warm	Slightly sultry	Sultry	Quite sultry
Weather type	Cold			Pleasant			High Heat		

Table 2. The Equivalent Temperatures Annual Trend in $^{\circ}\text{C}$ (Pristina 1950-1985)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9.7	12.1	16.8	25.2	36.3	45.6	47.8	47.8	40.1	29.6	20.4	12.4	28.8

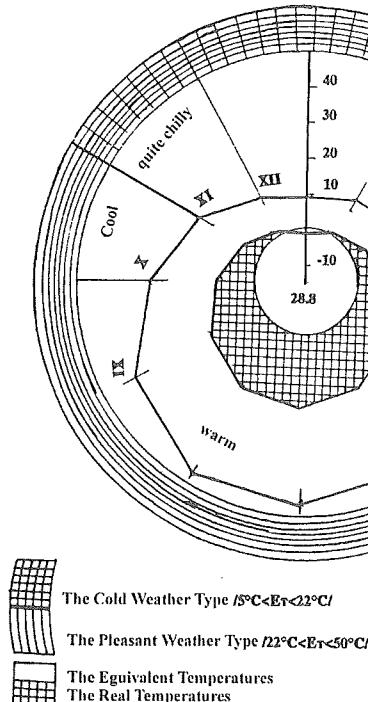
water vapor inflow in the atmosphere. The respective acknowledgementes the latent heat expected within the condensation-sublimation processes. The water transfer from one to the other aggregate condition is followed by the release or the consumption of energy, that creates grandiose processes in the geographic cover. An energy of $2.533 \times 10^3 \text{ J}$ is required for 1 gram of water be transferred into vapor condition (Milosavljevic, 1985).

RESULTS AND DISCUSSION

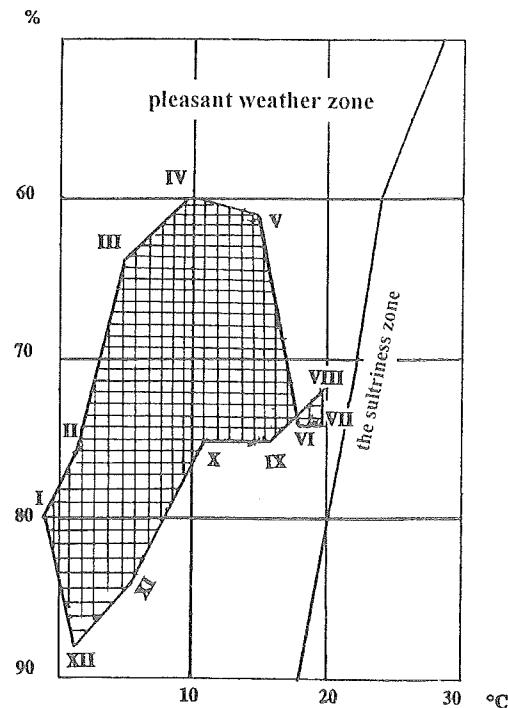
The respective bio-climatic analysis was based on the meteorologikal data for the Pristina station within the period 1950-1985. By applying the temperature, the water vapor and the relative air humidity corellation mentioned, the weather types, the physiological heat sensations (equivalent temperatures) and the sultriness clime-gram (Table 1 & 2, Supplement 1 & 2) were selected.

The two weather types (cold and pleasant) and five physiological heat sensations (from the sense of cold to the sense of warm) were selected within the equivalent temperatures.

The Cold Weather Type ($5^{\circ}\text{C} < \text{Et} < 22^{\circ}\text{C}$) is presented within the period of November -- March. The



Supplement 1. Polar diagram of the equivalent temparatures with the types and classes (Pristina)



Supplement 2. The sultriness clime-gram (Pristina)

physiological heat sensations *Cold* ($\text{Et} = 5-18^{\circ}\text{C}$) dominates during the three winter months (December, January and February). The physiological sensations *Very chilly* ($\text{Et} = 18-22^{\circ}\text{C}$) during March is ($\text{Et} = 16.8^{\circ}\text{C}$), with the November of ($\text{Et} = 20.4^{\circ}\text{C}$). The class of *Quite cold* ($\text{Et} = 5^{\circ}\text{C}$) is not presented, but in January its values are partly close ($\text{Et} = 9.7^{\circ}\text{C}$). Winter is the seanson with the least accumulated heat during the year. As well as the major part of the winter, January is also characteristic regarding the dominating influence of Mid-European anti-cyclone bringing dry and gloomy weather. That is the period of inversive manifestations, primarily of a radiation type, being the consequence of the relief composition and local conditions.

Pleasant Weather Type ($22^{\circ}\text{ C} < \text{Et} < 50^{\circ}\text{ C}$) characterizes the whole Summer (June-August) and most of the Spring (April, May) and Fall (September, October). All the classes of the weather type are presented too. The class *Cool* ($\text{Et} = 22-30^{\circ}\text{C}$) is presented during the start and the end months (April $\text{Et} = 25.2^{\circ}\text{C}$ and October $\text{Et} = 22-30^{\circ}\text{C}$). The class *Pleasant* ($\text{Et} = 30-40^{\circ}\text{C}$) is presented in May ($\text{Et} = 36.3^{\circ}\text{C}$) and September ($\text{Et} = 40^{\circ}\text{C}$). Finally, the class *Warm* ($\text{Et} = 22-30^{\circ}\text{C}$) is presented during summer months, from June to September. The above mentioned is the period of anti-cyclone activities, but favorable bio-climatic

characteristics too. Then, there is the most of accumulated latent heat, being the consequence of thermal characteristics whose annual trend finally follows the water vapor pressure.

Overheated Weather Type ($50^{\circ}\text{C} < \text{Et} < 70^{\circ}\text{C}$) is not presented during the whole year round. The sultrines clime-graph (Supplement 2) does not state the presence of any form of sultriness, that, again confirms the absence of the weather type.

CONCLUSIONS

Pleasant Weather Type dominates and lasts for seven months. All of its classes are presented. The type covers the whole vegetation period and extends to October. The class warm dominates during the summer, partly covering September ($\text{Et} = 40.1^{\circ}\text{C}$). The cold Weather Type lasts for five months and the classes *cold* and *quite chilly* are presented. None of the classes specified as *sultry* is presented, thus, the presence of the *overheated weather type* is excluded.

Using the Charl's method of the sultriness determination, through the combination of the relative air humidity and the temperature, at the sultriness clime-graph a closed form of the curve is observed, being quite distant from division lines of *the sultry zone* and *the comfortzone* (pleasant sensation). Therefore, the sultriness in classic form is absent even in the case of high summer temperatures. The respective resulted in a low relative air humidity during summer months. Naturally, certain sultry days can not be excluded on the basis of monthly averages (that again relatively applies within the framework of the procedure itself, the method respectively).

In addition to the enclosure of the equivalent temperature diagram with the weather types, classes and the sultriness clime-gram for Pristina (Supplement 1 & 2), it should be also mentioned that, quality weather and climate monitoring is of an essential significance for the bio-forecasts. Pristina could establish the respective, considering the fundament existing in its meteorological observing scheme.

Pristina and its surrounding could be regarded a favorable area from the bio-climatic point, recognizing the equivalent temperatures and the sultriness clime-graph and evolving the physiological effects of the climatic influence, that could be complementarily amended and adequately evaluated in accordance with other physical-geographic and anthropo-geographic pre-dispositions. As the respective is the matter of the scientific research, it should apply to the terms of the medicine policy, the tourist plans and interests, as well as, to contemporary ecological demands.

REFERENCES

- Ivnović, R., (1995). Klimatske i hidrološke osnove melioracija na Kosovu i Metohiji. Doktorska disertacija, Priština.
- Milosavljević, M., (1985). Klimatologija. "Naučna knjiga", Beograd.
- Dukić, D., (1981). Klimatologija. "Naučna knjiga", Beograd.
- Palagiano, C., (1995). Le Politiche Sanitarie e le attuali prospettive. "Geografija medica", Quinto cennario Internazionale, Perugia.
- Pecelj, M., Popara, S., Jović, G., Stevanović, B., (1996). Bioklimatske karakteristike Podunavlja, Zbornik radova naučnog skupa "Podunavlje u Srbiji -- uređenje, zaštita i razvoj", Novi Sad.
- Šarlau, K., (1941). Die Schwu und Beheglichkeit als Klimagroßen. Z. Hygiene u Inf... Krankh 123.
- Vujević, P., (1948). Meteorologija, Beograd.

REZIME

ELEMENTI BIOKLIMATSKIH KARAKTERISTIKA PRIŠTINE

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Priština (590 m n.v.) je urbano, ekonomsko, upravno i administrativno središte Kosova i Metohije u čijoj blizini su značajni istorijsko-turistički lokaliteti i određene prirodne lepote koje bi se mogле komplementarno valorizovati, pa bi jedna ovakva bioklimatska analiza bila od koristi.

Bioklimatska analiza Prištine rađena je na osnovu ekvivalentnih temperatura (Et) i Šarlovog metoda (klimogram zapare), a antropoklimatska klasifikacija Krigea, dopunjena i prilagođena, poslužila nam je za određivanje bioklimatskih karakteristika. Ekvivalentne temperature su izračunate za meterološku stanicu Priština (period 1950-1985. god.), svrstane u pet bioklimatskih klasa i dva vremenska tipa.

Zastupljeni su *bladni* ($5^{\circ}\text{C} < \text{Et} < 22^{\circ}\text{C}$) i *prijatni* ($22^{\circ}\text{C} < \text{Et} < 50^{\circ}\text{C}$) vremenski tip, sa klasama: *bladno, veoma prohladno, sveže, ugodno, i toplo*.

Dominira *prijatni vremenski tip* i traje sedam meseci. Zastupljene su sve njegove klase. Ovaj tip obuhvata celi vegetacioni period i proteže se na oktobar. Dominira klasa toplo tokom leta, delimično prelazeći u septembar ($\text{Et} = 40.1^{\circ}\text{C}$). *Hladni vremenski tip* traje pet meseci i zastupljene su klase *bladno* i *veoma prohladno*. Nije zastupljena nijedna klasa koja se normativno significira kao zaporno, pa se na taj način isključuje prisustvo *pregrejanog vremenskog tipa*.

Koristeći Šarlov metod za određivanje zapare, preko kombinacije relativne vlažnosti vazduha i temperature, na klimogramu zapare se uočava zatvoren oblik krive, koji je prilično udaljen od granice razdvajanja *zone zapare* od *zone konfora* (ugodnih osećaja). Zato i pored visokih letnjih temperatura zapare nema

u klasičnom obliku. Razlog je u maloj relativnoj vlažnosti vazduha tokom letnjih meseci. Naravno da se na osnovu mesečnih srednjaka ne isključuju pojedini dani sa zaparom (što je opet relativizirano u okvirima samog postupka, odnosno metode).

Sa bioklimatskog stanovišta, koja uvažava ekvivalentne temperature i klimogram zapare, koje evoluiraju fiziološke efekte klimatskih uticaja Priština sa okolinom može se smatrati povoljnim prostorom, što

se u skladu sa drugim fizičkogeografskim i antropogeografskim predispozicijama može komplementarno dopunjavati i adekvatno valorizovati. To je stvar ozbiljnih razmišljanja, što pripada domenima medicinske politike, turističkih planova i interesa, kao i savremenih ekoloških zahteva.

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Determination of the Insolation Relative Duration The Example of Prizren, Pec and Pristina

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ABSTRACT

Operating with relative insolation duration is more rational in case of the climatic analysis. The insolation duration is determined on the basis of effective measured and calculated potential. However, operating time of heliograph is not equal to the duration of the daylight, it always starts operating before sunrise and stops before sunset, even within good weather conditions. The respective is caused by the limits of the instrument itself and the geographic horizon too. Therefore, relative insolation duration, cosidered without these limitations, is not a realistic one. The paper, for example, considers three locations in Kosovo and Metohija (Prizren, Pec and Pristina) and its effective, potential and,

finally, relative daily, monthly and annual insolation duration has been determined. The values obtained represent "minimal" relative insolation duration, therefore, one may properly state, --relative annual insolation duration in Prizren is more than 46.3% ($I_r > 46.3\%$), in Pec more than 43.4% ($I_r > 43.4\%$), and in Pristina more than 47.5% ($I_r > 47.5\%$). How much more, the relative insolation duration really is, should be determined by decreasing potential insolation duration, based on the recordings of extreme moments of the hilograph operating time per months, directly from the tape within a perennial period.

Key words: insolation, effective insolation duration, potential insolation duration, relative insolation duration.

INTRODUCTION

An **effective insolation duration** during the day (I_e) is expressed in hours, as a sum of time intervals, during which, a given position was lighted by direct sunlight. It is measured by heliograph. Based on daily measured values, monthly and annual sums are later determined, as well as, are the average daily, monthly and annual values within a perennial period. An effective insolation duration depends on the latitude and the altitude of the place, the opening of the geographic horizon (i.e. the place relief, --the view line form in the sector limited by the solstitial points of the sunrises and sunsets), as well as, the conditions of the atmosphere. The greatest daily effective insolation duration is equal to the daylight duration, -- to the time interval from the sunrise to the sunset. This is called A **potential insolation duration** (I_p), and is determined mathematically-geographically, and is not dependent on the atmosphere condition. The quotient of an effective and potential insolation duration, expressed in %, represents A **relative insolation duration** (I_p).

The effective insolation duration is still most frequently given, although for the majority of analyses,

the insolation duration given in relative form is by far more purposeful. For example, direct comparisons are possible with relative insolation duration only, in case of places located on various latitudes.

The determination of relative could be broken down into three phases, that will be discussed based on the example of three places in Kosovo and Metohija, whose meteorological stations do the measuring of the effective insolation duration. The places are Prizren, Pec and Pristina.

The Determination of the Effective Insolation Duration

Monthly and annual sums of the effective insolation duration, expressed in hours, has been given in the meteorological yearbooks (the effective insolation duration per days and per hours during single day, is given in the yearbook chapter titled as The Sun Radiation). Average values of the effective insolation duration within the period of 1960-1984 (Table 1) are determined for the three places, based on the records from the Meteorological Yearbook1.

1 According to climatological practice, the 3rd, 4th and 5th months are considered the spring, the 6th, 7th and 8th months, the summer, the 9th, 10th and 11th months, the fall (autumn), while 12th, 1st and 2nd, the winter, although the distribution od 1st -- 3rd, 4th, 6th, 7th -- 9th -- 12th is closer mathematics-geographic limits of the seasons

Table 1. The Effective Insolation Duration, Total Monthly and Average Daily (I_{ed}), in Hours, in Prizren, Pec and Pristina, within the period of 1960-1984.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
PRIZREN	Iem	67.90	92.45	141.74	175.94	222.46	256.37	298.23	284.45	215.60	165.70	93.16	52.54
	I _{ed}	2.19	3.30	4.57	5.86	7.18	8.55	9.62	9.18	7.19	5.35	3.11	1.69
PEC	Iem	70.08	93.85	141.66	170.02	205.26	226.18	268.53	261.58	200.22	154.68	89.28	55.37
	I _{ed}	2.26	3.35	4.57	5.67	6.62	7.54	8.66	8.44	6.67	4.99	2.98	1.79
PRISTINA	Iem	73.66	99.58	145.89	180.97	226.61	252.84	296.50	285.53	218.21	174.94	101.84	60.49
	I _{ed}	2.38	3.56	4.71	6.03	7.31	8.43	9.56	9.21	7.27	5.64	3.39	1.95

Tabela 2. The Potential Insolation Duration (in hours) Regarding latitudes of Yugoslavia.

φ	42°	42°30'	43°	43°30'	44°	44°30'	45°	45°30'	46°
PERIOD									
JANUARY	294.60	293.12	291.62	290.09	288.53	286.94	285.32	283.67	281.99
FEBRUARY	295.67	294.90	294.12	293.33	292.52	291.70	290.86	290.01	289.14
MARCH	369.26	369.16	369.07	368.97	368.87	368.77	368.67	368.57	368.46
1 st QUARTILE	959.53	957.18	954.81	952.39	949.92	947.41	944.85	942.25	939.59
APRIL	399.90	400.57	401.25	401.94	402.65	403.36	404.10	404.84	405.60
MAY	450.89	452.29	453.72	455.18	456.66	458.17	459.72	461.29	462.90
JUNE	455.50	457.24	459.02	460.84	462.69	464.58	466.52	468.49	470.52
2 nd QUARTILE	1306.29	1310.10	1313.99	1317.96	1322.00	1326.11	1330.34	1334.62	1339.02
JULY	462.17	463.80	465.45	467.15	468.87	470.63	472.43	474.27	476.15
AUGUST	430.07	431.07	432.09	433.13	434.19	435.27	436.37	437.49	438.63
SEPTEMBER	375.71	375.95	376.19	376.43	376.68	376.93	377.19	377.45	377.72
3 rd QUARTILE	1267.95	1270.82	1273.73	1276.71	1279.74	1282.83	1285.99	1289.21	1292.50
OCTOBER	344.54	344.01	343.46	342.91	342.34	341.77	341.19	340.60	340.00
NOVEMBER	295.87	294.65	293.41	292.15	290.87	289.56	288.23	286.87	285.49
DECEMBER	284.77	283.10	281.40	279.66	277.89	276.08	274.24	272.36	270.44
4 th QUARTILE	925.18	921.76	918.27	914.72	911.10	907.41	903.66	899.83	895.93
WINTER SEMESTER %	1884.71	1878.94	1873.08	1867.11	1861.02	1854.82	1848.51	1842.08	1835.50
	42.27	42.13	41.99	41.85	41.70	41.55	41.40	41.25	41.09
SUMMER SEMESTER %	2574.24	2580.92	2587.72	2594.67	2601.74	2608.94	2616.33	2623.83	2631.50
	57.73	57.87	58.01	58.15	58.30	58.45	58.60	58.75	58.91
ANNUAL % according to (365h24 ^h)	4458.95	4459.86	4460.80	4461.78	4462.76	4463.76	4464.84	4465.91	4467.04
	50.90	50.91	50.92	50.93	50.94	50.96	50.97	50.98	50.99

Table 3. Total Monthly (I_{pd}) and Average Daily (I_{pd}) Potential Insolation Duration (in hours) at the latitudes of Prizren, Pec and Pristina.

		II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Prizren (φ=42°13')	Iem	293.96	295.34	369.22	400.19	451.50	456.25	462.87	430.50	375.82	344.31	295.34	284.05
	I _{ed}	9.48	10.55	11.91	13.34	14.56	15.21	14.93	13.89	12.53	11.11	9.84	9.16
Pec (φ=42°40')	Iem	292.63	294.64	369.13	400.79	452.77	457.83	464.35	431.41	376.03	343.83	294.24	282.54
	I _{ed}	9.44	10.52	11.91	13.36	14.61	15.26	14.98	13.92	12.53	11.09	9.81	9.11

Table 4. The Relative Insolation Duration per Months (in %) at the Latitudes of Prizren, Pec and Pristina, for the Period of 1960-1984.

		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Prizren	Ie	67.90	92.45	141.74	175.94	222.46	256.37	298.23	284.45	215.60	165.70	93.16	52.54	2066.54
	Ip	293.96	295.34	369.22	400.19	451.50	456.25	462.87	430.50	375.82	344.31	295.34	284.05	4459.35
	Ir	23.10	31.30	38.39	43.97	49.27	56.19	64.43	66.07	57.37	48.12	31.54	18.50	46.34
Pec	Ie	70.08	93.85	141.66	170.02	205.26	226.18	268.53	261.58	200.22	154.68	89.28	55.37	1935.29
	Ip	292.63	294.64	369.13	400.79	452.77	457.83	464.35	431.41	376.03	343.83	294.24	282.54	4460.19
	Ir	23.95	31.85	38.38	42.42	45.33	49.40	57.83	60.63	53.24	44.99	30.34	19.60	43.39
Pristina	Ie	73.66	145.89	145.89	180.97	226.61	252.84	296.50	285.53	218.21	174.94	101.84	60.49	2117.06
	Ip	292.63	369.13	369.13	400.79	452.77	457.83	464.35	431.41	376.03	343.83	294.24	282.54	4460.19
	Ir	25.17	39.52	39.52	45.15	50.05	55.23	63.85	66.18	58.03	50.88	34.61	21.41	47.47

Table 5. The Effective (hours, Potential and relative Insolation Duration (%)) per Quartiles and Semesters at the Latitudes of Prizren, Pec and Pristina, for the Period of 1960-1984.

Period →		1st quartile	2nd quartile	3rd quartile	4th quartile	Winter semester	Summer semester	Year
↓ Place								
Prizren	Ie	302.10	654.77	798.28	311.40	613.50	1453.05	2066.54
	Ip	958.52	1307.94	1269.19	923.70	1882.22	2577.13	4459.35
	Ir	31.52	43.97	62.90	33.71	32.59	56.38	46.34
Pec	Ie	305.59	601.45	730.33	299.33	604.92	1331.78	1396.71
	Ip	956.40	1311.39	1271.79	920.61	1877.01	2583.18	4460.19
	Ir	31.95	45.86	57.43	32.51	32.23	51.56	43.42
Pristina	Ie	319.14	660.42	800.23	337.27	656.40	1460.65	2117.06
	Ip	956.40	1311.39	1271.79	920.61	1877.01	2583.18	4460.19
	Ir	33.37	50.36	62.92	36.64	34.97	56.54	47.47

Instead of giving the sums and averages per calendar months and quartiles, it would be more natural that the respective are given in time intervals, between each 21st day of a month, and later per seasons within their mathematics-geographic limits. The effective insolation duration for each day should be known for the purpose of such a review.

The Determination of Potential Insolation Duration

Daily duration of potential insolation is equal to the daylight duration. Observing the upperedge of the Sun disk and considering the influence of the astronomic refraction, a potential insolation duration could be determined according to well-known formula,

$$I_p = \frac{2}{15} \arccos\left(\frac{-\sin 51' - \sin \varphi \sin \delta}{\cos \varphi \cos \delta}\right) \quad \dots(2)$$

in which φ is the place latitude, a δ the Sun declination are given for each day in the astronomic ephemeris, a year in advance, at least. When these values are applied in one of computer programs for table calcula-

tions, such, for example, is The Quattro Pro program, then, according to Formula (2), the potential insolation duration could be quickly determined for each day, followed by the sums between any of the two days. The results of such calculations for our country are given in Table 2.

Table 2 values are obtained by calculations based on the 1995 declinations. The values are correct of course. There are tables with similar data too, for example (Vujevic, 1948; Milosavljevic, 1988). In case of leap year, February sum should be added with the daylight length of the 29th day, with an average of 11.11 hours.

The potential insolation duration at the latitudes of Prizren, Pec and Pristina, the sample places has been determined in the way mentioned (Table 3).

The potential insolation duration determination could be speeded up by creating special computers programs. One of such was published in 1984, September issue of The Sky & Telescope Magazine, titled SUNSHINE BAS. The places latitude in degrees, the ordinal number of the start and the end day, within the given period of the year, should be inserted. For example, the determination order of the total potential inso-

lation duration within the period of January 1, to March 21, in Pristina is ($\phi = 42^{\circ}40'$), as follows:

LATITUDE (DEGREES)?	42.667
START DAY IN 1986	? 1
END DAY IN 1986	? 80
SUNSHINE =	
50 044 MINUTES	
834 HOURS	

The potential insolation duration is obtained in minutes and hours. The values are correct, according to the Sun declination values for 1986.

The Determination of the Relative Insolation Duration

When the effective insolation duration is measured and the potential insolation duration calculated, the relative insolation duration could be easily determined according to Formula (1). The relative insolation duration for the sample places was given in Tables 4 and 5.

DISCUSSION

However, there is a question arising regarding the authenticity of such determined relative insolation duration? The potential insolation duration refers to the time interval limited by the moments of the sunrise and the sunset for the illusory horizon of the place given, but not regarding its actual appearance of the horizon line. Therefore, in practice, the Sun always rises later, and always sets earlier, compared to the moments determined by the Formula (2), i.e., the potential insolation duration for each day is just a little shorter, than the duration determined in a way already described. In order to determine the potential insolation duration without idealizing the horizon, the horizon line should be constructed first, as it is seen from the standing point given. The respective could be implemented by a theodolite measuring the polar coordinates of the horizon line part braking points, within the azimuth range of solstitial points of the sunrises and the sunsets, or in a cabinet manner, from the topographic map. When the horizon line is constructed in the selected cartographic projection, then, its cross-sections are determined with the projections of the Sun illusion trajectory (Radojkovic, 1996). The insufficiency of this method is that the Sun is shadowed not only by the hills, but the buildings, the trees too.

Besides, even in the case of an ideal horizon, the heliograph can not collect sufficient beam of the Sun

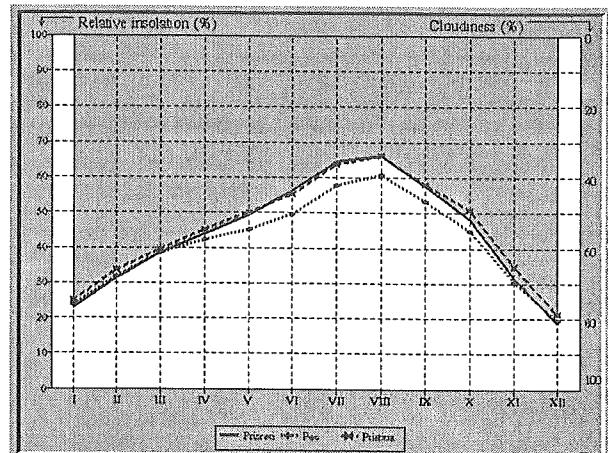


Figure 1. Comparative Presentation of the Annual Relative Insolation Duration in Prizren, Pec and Pristina

ray that could burn the tape, neither during the sunrise, nor the sunset. The Sun radiation intensity must rise to the point equal to the point equal to one tenth of the solar constant (An Instruction for Observation... 1974). In other words, the Sun must rise to the height (h), at which, it achieves the point of direct radiation, The height results in the atmosphere condition, and is not equal in the morning and the evening, respectively. Up to the moment, the heliograph registers no effective insolation duration.

The above means that, measuring would not indicate the effective insolation duration, equal to the potential one, even in the case of ideal conditions. The respective further means that, while determining the relative insolation duration, a decreased potential insolation duration must be operated with. However, how much decreased?

This is most effectively determined by a direct, -- measuring of extreme, morning and afternoon moments with the heliograph tape burns (average values over perennial period), then, by finding out at what Sun heights this happened, and finally, by determining the shortening of the potential insolation duration. In this manner, the horizon line and the limitation if the heliograph are simultaneously taken into consideration².

Unless the respective is done, the relative insolation duration determined in previous way, should be considered as "minimal". Thus, a proper statement is: *The relative annual insolation duration in Prizren is more than 46.3% (Ir>46.3%), In Pec more than 43.4% (Ir>43.4%), and in Pristina more than 47.5% (Ir>47.5%).*

2 The date obtained by checking the heliograph tape, for each day, within the perennial period. The respective data are still missing in case of Prizren, Pec and Pristina. For example, there are data for Kraljevo, but only for 1996. Thus, the average Sun height in this station, during starting operation of the heliograph of the year given, amounted to $h = 7^{\circ}40'$, and $h = 6^{\circ}06'$ during the latest end of operation. The respective results in the decrease of the potential insolation duration in 1996 amounting to 13%.

REFERENCE

1. Anonymous, 1960-1984, *Meteorološki godišnjaci*, SHMZ, Beograd.
2. Milosavljević, M.: 1988, *Klimatologija*, Naučna knjiga, Beograd.
3. Radojković, S.: 1996, *Određivanje tačaka izlaska i zalaska Sunca na geografskom horizontu Raške* (diplomski rad), Odsek za geografiju PMF-a u Prištini, Priština.
4. Tadić, M.: 1996, *Matematička geografija sa gnomonikom*, ABC-Grafika, Beograd.
5. Šegota, A.: 1976, Klimatologija za geografe, Školska knjiga, Zagreb.
6. Anonymous, 1974, *Uputstvo za osmatranje i merenje na glavnim meterološkim stanicama*, Savezni hidometeoroški zavod, Beograd.
7. Vujević, P.: 1984, *Meteorologija*, Prosveta, Beograd.

REZIME

ODREĐIVANJE RELATIVNOG TRAJANJA INSOLACIJE NA PRIMJERU PRIZRENA, PEĆI I PRIŠTINE
TADIĆ Milutin

Relativno trajanje insolacije se određuje na osnovu izmjerenoj efektivnog, i izračunatog potencijalnog trajanja insolacije. Potencijalno dnevno trajanje

insolacije jednak je dužini obdanice, dok je radno vrijeme heliografa uvjek kraće, -- zbog ograničenosti samoga instrumenta, i zbog geografskog horizonta. Zbog toga bi trebalo umanjiti potencijale trajanje insolacije, što sa sobom povlači povećanje relativnog trajanja insolacije.

Prvo je određeno efektivno trajanje insolacije (Tab. 1), onda potencijalno trajanje insolacije za pomenuta mjesta (Tab. 3) i za geografske širine naše zemlje (tab. 2), i na kraju relativno trajanje insolacije po mjesecima i kvartalima (Tab. 4, 5). Na taj način se došlo do saznanja da je relativno godišnje trajanje insolacije u Prizrenu 46.34%, u Peći 43.42% i u Prištini 47.47%. To su, ustvari, "minimalne" vrijednosti relativnog godišnjeg trajanja insolacije u ovim mjestima.

Korekciju ovako nađenog relativnog trajanja insolacije najefektnije je odrediti posredno, -- zabilježiti ekstremne, prijepodnevne i poslijepodnevne, trenutke u kojima je nagorela traka heliografa (prosječne vrijednosti u višegodišnjem periodu), potom naći pri kojim se to visinama Sunca desilo, i na kraju odrediti skraćenje potencijalnog trajanja insolacije. Na ovaj način se istovremeno uzima u obzir i vidikova linija, i ograničenost heliografa.

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The Gamma Dose Rates of Radiation in the Air and Closer and Further Surrounding of the Kosovian Coal Power Plants

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ABSTRACT

The results of the values gauged, concerning the gamma radiation dose rates in the air and of the natural phone level at 20 selected locations in closer and further surrounding of the Kosovian coal power plants, are presented below. The gauging was done by an autonomic ADL - drill "Gamma Tracer", the system for long term-

continual gauging of the natural radiation level. The existence of an increased radiation level was determined in the settlements, located in closer surrounding, compared to the radiation levels in the places out of the reach of the coal power plants influence.

Key words: the gamma radiation dose rates in the air, coal power plants.

INTRODUCTION

Natural soil radioactivity is highly significant source of the population exposition by the ionized radiation. The processing and use of the soil materials results in an additional natural radiation. Some of the materials, such as coal, oil, are used for the production of electric energy. By drilling and using the coal, its radioactivity is redistributed from the depth of the coal layers, that did not affect the people and the bio-sphere significantly, and is brought to the land surface, thus, significantly changing the radioactivity quantity and radio-ecological picture of the living environment [1]. By burning the coal, as well as, during the process of drying, grinding and gasification, numerous chemo-toxic and radio-toxic pollutants are released into the environment. Coal power plants represent one of the causes of the natural radioactivity redistribution, as by burning the organic components of the coal, the coal volume decreases to the slag and ash, inevitably leading to the concentration of radioactive material of the respective. Therefore, the concentration of natural radio-nuclides in ash and slag from the coal power plants is significantly higher, compared to their concentration in the earth core. Kosovo A coal power plant belongs to an old type of coal power plants. There are five energetic blocks, emitting over 15% of the ash, produced through its chimneys, into the atmosphere [2]. An annual production of the waste material amounts to some 1,200.000 ton from the Kosovo A coal power plant, while the Kosovo B coal power plant produces some 1,000.000 ton of ash and slag annually. Depositing of such enormous quantities of electro-filtered ash and slag represents a great problem as to the operation and functioning of the coal power plant, and conse-

quently regarding the jeopardizing of working and living environment of the Obilic, Kosovo Polje, Pristina and near by settlements population. Numerous waste material deeps have been created within the direct vicinity of the coal power plants, with their height making them look like real small mountains. These ugly increasing deeps disturb the beauty of spacious and fertile flat, and permanently attack the health of people with its physical-chemical composition. The Kosovo A coal power plant emitting flying ash, composed not only of chemo-toxic but also of radio-toxic contaminants, from its chimneys, represents the greatest danger for the population of Obilic, Kosovo Polje, Pristina and wider area. The Kosovo A coal power plant represents a real ecological challenge for the region [3].

MATERIAL AND METHODS

The gauging of the equivalent gamma radiation dose rates in the air was implemented by an autonomic ADL - drill "Gamma Tracer", the system for the continual gauging of the natural radiation level. The autonomic radiation doze gauging instrument Gamma Tracer (- registers continually within the time intervals selected. The electronic set and the power supply are located in the water-proof box. The chip technology for power supply is free of any maintenance within full operation of the Gamma TRACER device within the three year operation with no recharging required [4]. Registered values can be, at any moment, disposed through the interactive infrared port. The gamma professional software operation communication program,

as well as the analysis software, guarantee simple, fast and safe approach to the data collected and their visualization. Figure 1 indicates the most important components of the Gamma TRACER system. The drill was located 1 meter above the land surface on IC Transmitter Two way IC Optical Link GM Detector 1 GM Detector 2 Long-Life Lithium Battery

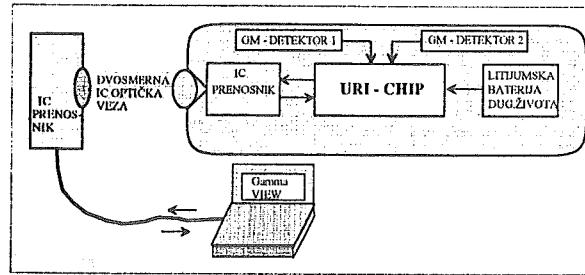


Figure 1. The gamma TRACER System General Components all of the gauging points.

Since, only one gauging drill was available, the data register time interval per gauging location duration averaged to about 2 hours. The gauging at certain location was done in longer time intervals also. The respective primarily refers to the locations with the test gauging indicating somewhat higher gamma doze radiation rates, compared to the average dozes of other gauging points. The longer time interval gauging was also done by the ADL instrument in the locations with the climate condition changing fast during the gauging. The gauging was first done within the coal power plant yard, then in the settlements near by: Krusevac, Kosovo Polje, Plementina, Obilic, Ade and Mazgit village, then in more remote places: Babin Most, Lebane, Belacevac, Kuzmin, Pristina town, as well as, in the places 10-18 km far away from the coal power plants: Sofalija, Breznica, Laplje Selo and Janjevo. For the purpose of the gauging result comparison, three gauging points were considered: Batlava, Dobrotin and Mramor, with the Kosovian coal power plant influence being negligible.

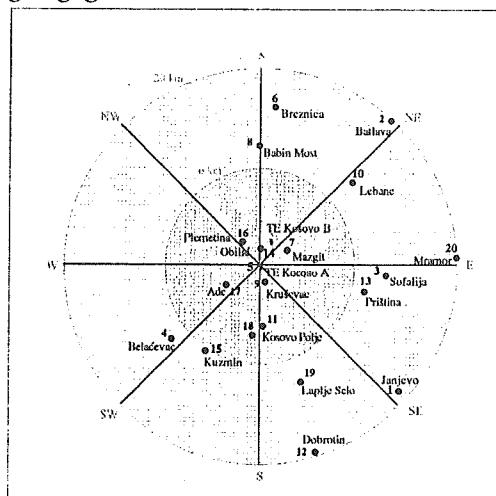


Figure 2. indicates the gauging location position.

Figure 2. The gauging location positions near by the Kosovian coal power plants.

RESULTS AND DISCUSSION

Table 1 indicates the gamma radiation doze rate values gauged at 20 representative locations at various distances around the coal power plants within the 20 km diameter.

Table 1. The gamma radiation equivalent doze rates in the air of the locations around the Kosovian coal power plants.

Br. lokacije	Lokacija	Jačina ekvivalentne doze gama zračenja (nSv/h)		
		Sred. vrednost	Min	Max
1	Janjevo	82	30	135
2	Batlava	80	40	154
3	Sofalija	106	30	149
4	S.Belačevac	139	79	187
5	TE Kosovo A	206	124	294
6	Breznica	151	62	222
7	S.Mazgit	163	83	247
8	Babin Most	130	40	181
9	S.Kruševac	199	100	295
10	Lebane	125	62	185
11	Kosovo Polje I	165	97	208
12	Dobrotin	83	14	165
13	Pristina	116	43	182
14	Obilić	161	88	229
15	Kuzmin	170	86	278
16	Plementina	217	136	335
17	S. Ade	176	96	264
18	Kosovo Polje II	158	85	252
19	Laplje Selo	108	39	186
20	Mramor	77	30	165

Location No. Location The gamma radiation equivalent doze rates (nSv/h)

Mid value Min Max

As indicated in the Table given, the highest gamma radiation equivalent doze rates in the air have been gauged in the Plementina settlement - location No. 16, with its mid values for the 10 hour gauging time interval amounted to 217 nSv/h. The settlement is located 4 km NW of the coal power plant. An insignificantly lower doze was gauged in the industrial yard of the Kosovo A coal power plant - location No. 5. The equivalent doze rate mid value at the location amounted to 206 nSv/h (Figure 3). The location was of a great research interest, thus, the doze rate gauging had been repeated several times, and at some periods the gauging was done in close time intervals simultaneously with some other locations.

**A: The Doze Rate
B: Temperature**

**The KosovoA CPP
C:**

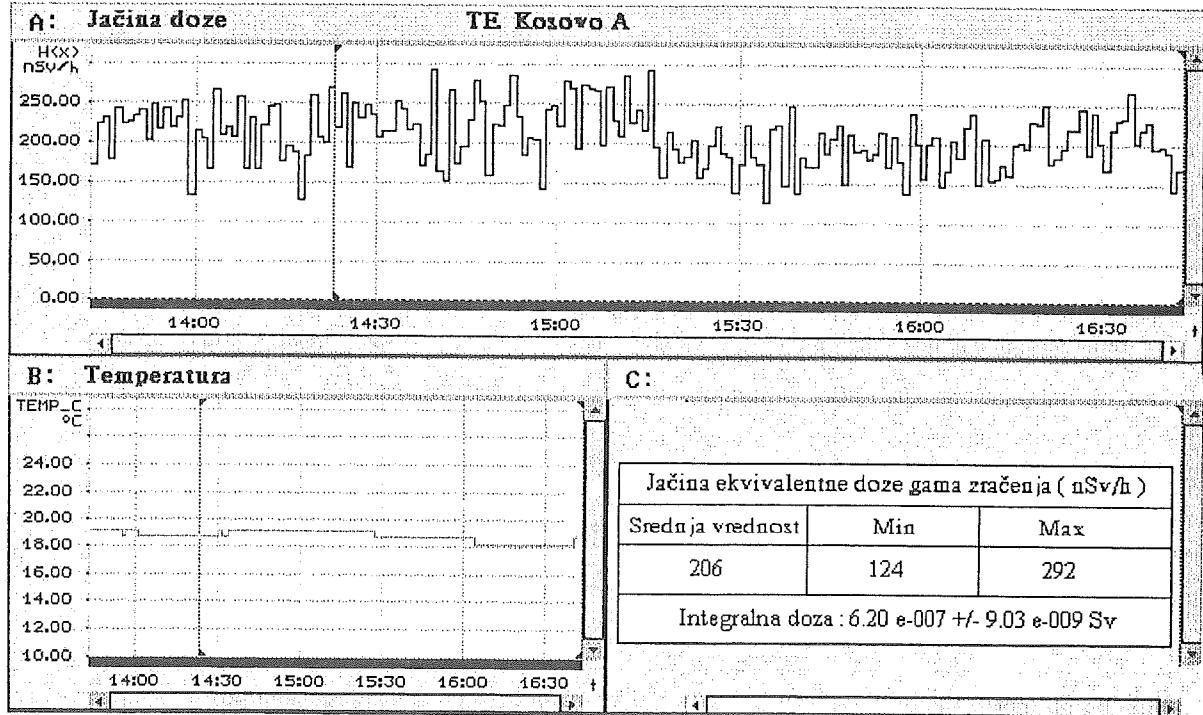
Gamma radiation equivalent doze rate (nSv/h)

Mid Value Min Max

Integral Doze: 6.20 e-007+/-009Sv

The location No. 9 - Krusevac settlement the equivalent doze rate mid value at the location amounted to 199 nSv/h. The settlement is located directly near by the Kosovo A CPP, and enormous deeps of ash and slag are located at the very end of the

Figure 3. The gamma radiation equivalent doze rates in the air of the location No. 5 - The Kosovo A CPP.



settlement [5]. The other locations, being directly near by the coal power plants, are also indicated with an increased gamma radiation equivalent doze rates, rather than the locations that are more remote from the plants. The Kosovo Polje, Obilic, then, Mazgit, Ade settlements equivalent doze rate values are almost equal, ranging from 158 - 176 nSv/h. The places mentioned are especially exposed to enormous quantities of the flying ash during the fog and windless periods. The location is SSE of the coal power plant, with an insignificant wind frequency directed from the plants and amounting to 28 (annually). The location No. 13 - Pristina the equivalent doze rate mid value in the air amounted to 116 nSv/h. As the location had the gauging done almost every day, it was observed that the doze rates changed slightly during constant weather conditions, and the doze rates increase was observed during the days of an increased ash cover from the Kosovian coal power plant toward the town. Compared to the gauging points used for comparison, an increase of the equivalent doze rate was registered on the locations being even over 15 km remote from the plants. Location No. 6 - Breznica could be used as an example with the doze rate mid value amounting to 151 nSv/h. The location is N from the plants, and the wind frequency in the direction amounts to 66 (annually). However, the location No. 1 - Janjevo, some 20 km SE far from the plants, the equivalent doze rate mid value amounted to 95 nSv/h. The wind frequency in the direction amounts to 27 (annually). The gamma radiation doze rate values, gauged in the air of the places used for comparison, were ranging within the limits of natural variations of the general phone. The doze rate mid values of the gauging points were very

close, ranging within an interval of 77-83 nSv/h. The registration of technologically increased levels of natural radioactivity, with the values, within the Kosovian coal power plant zone of influence, that were previously slightly above the present spacious variations of the natural phone, was enabled thanks to the fact that the gauging was done by the most comprehensive, fully computerized Gamma TRACER gauging system of high sensitivity (2 x 0.2 implsa/sec at 100 nSv/h).

CONCLUSION

The gamma radiation doze rate values gauged in the air surrounding the Kosovian coal power plants, using the autonomous device ADL Gamma TRACER, undoubtedly indicated the existence of the natural phone level difference between an undisturbed natural environment of the gauging places selected for comparison, and the natural radioactivity level within the Kosovian coal power plants zone of influence. The difference observed between the meteorological parameters in various time periods, explained the existence of various values of the gamma radiation doze rates, gauged in the air at the locations being within the various zones of influence of the Kosovian coal power plants. No doubt, there is a risk of the living environment radioactive pollution in near by urban and agricultural environment, caused by the Kosovian coal power plants. As natural radio nuclides concentrate in the soil, and then, are metabolically incorporated into the flora, or are directly transferred into the animals and humans, being fed by the contaminated plants, energetic steps are required regarding the efficient coal power plant electro-filter systems, full-scale re-cultiva-

tion of enormous non-conserved deeps of ash and slag, in order to decrease the consequences against the surrounding population health.

ACKNOWLEDGMENT

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LITERATURE

[1] Anonymous, UNSCEAR (1982). Sources and Effects of Ionizing Radiation, The United Nations Scientific Committee on the Effects of Atomic Radiation, The United Nations, New York 1982.

[2] Anonymous, The INKOS Project: "The Determination of the Elements in the Solution Trace after the Ash Dissolution from the Gasification and the CPP Ash", Pristina 1982.

[3] Adrovic, F., Todorovic, D., Ninkovic, M., & Prokic, M.: Investigation of the Contents of Natural Radionuclides in Coal and Ashes from Kosovian Power Plants, IRPA9, International Congress on Radiation Protection 1996, Vol. 2, pp. 681-684, Vienna, Austria.

[4] Volker Genrich,: Long-term Observation of the Natural Gamma Background Radiation, IRPA International Congress on Radiation Protection 1996, Vienna, Austria.

[5] Adrovic, F., Papovic, R., Ninkovic, M. M., & Todorovic, D.: The Research of Radioactive Elements Content in the Soil within the Zone of Influence of the Kosovian Coal Power Plants, Univerzitetska Misao (University Thought), Pristina, 1997.

REZIME

MERENJE JAČINE DOZE GAMA ZRAČENJA U VAZDUHU U NEPOSREDNOJ I DALJOJ OKOLINI KOSOVSKIH TERMOELEKTRANA

ADROVIĆ F., PAPOVIĆ R. , NINKOVIĆ M.

Sagorevanjem uglja u termoelektranama, usled eliminacije organske komponente zapremina uglja smanjuje se na pepeo i šljaku, što neminovno dovodi i do povećanja koncentracije radionuklida u produktima sagorevanja. Glavni izvori povećane doze zra-

čenja za populaciju koja živi u blizini termoelektrana su: udisanje letećeg pepela, unošenje hrane sa kontaminiranog zemljišta, ili direktno izlaganje povećanoj deponiranoj aktivnosti. Izmerene su jačine doza gama zračenja u vazduhu u okolini kosovskih termoelektrana pomoću autonomnog uređaja ADL Gamma TRACER -a . Izvršena su merenja na 20 lokacija oko termoelektrana u krugu poluprečnika 20 km. Registrovane su razlike nivoa prirodnog fona nenarušene prirodne okoline izabranih mernih mesta koja su poslužila za komparaciju, i nivoa prirodne radioaktivnosti u zoni uticaja kosovskih termoelektrana. Uočen je veliki uticaj meteoroloških uslova (formiranje i kretanje oblaka lebdećeg pepela iz dimnjaka termoelektrana, padavina, brzina veta), tako da postoje velike varijacije koncentracija efluenata i jačine doze u odnosu na neku prosečnu, dugotrajnu vrednost. Ovo potvrđuje značaj detaljnih analiza u slučaju urbane zone sa termoelektranama u blizini, kao što je slučaj kod kosovskih termoelektrana. Termoelektrana Kosovo A, koja ima pet energetskih blokova, pripada starom tipu termoelektrana. Pojedini energetski blokovi ove termoelektrane preko svojih dimnjaka ispuštaju u atmosferu i preko 15 % letećeg pepela, što predstavlja glavnu opasnost od uticaja termoelektrana za stanovništvo Obilića, Kosova Polja, Prištine i okolnih mesta. Osim toga , zbog slabog kvaliteta kosovskog lignita, prilikom njegovog sagorevanja, stvaraju se ogromne količine pepela i šljake, koje se odlažu na obližnje deponije. Deponije ovog otpadnog materijala, izložene su eroziji usled dejstva veta, površinskih i podzemnih voda, a kada se ima u vidu i permanentno izlaženje gasovitim potomaka uranove i torijumove serije , radona i torona iz ovih nepokrivenih deponija, može se proceniti da ovi nivi radioaktivnosti, iako relativno niski , nisu zanemarljivi sa aspekta zaštite stanovništva od ionizujućeg zračenja. Dobijeni rezultati ukazuju na potrebu redovne kontrole radioaktivnosti okoline temoelektrana i korišćenje sakupljenih podataka za sistematski pristup istraživanju korelacije koje postoje između povišenog stepena radioaktivne kontaminacije životne sredine i meteoroloških uslova, jer najznačajnije opterećenje okoline od termoelektrana dolazi preko atmosferskog zagađivanja.

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Theoretical Approach which Predicts the Possible Existence the Tenth Planet in Solar System

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ABSTRACT

The Bohr's model of the Hydrogen atom has supplemented by means of the electron whose the picture in nonrelativistic case could not be like as spherical symmetric particle. With the help of the results of the quantum mechanical theory [5,6] it has been shown the meaning of the definition of the Fine Structure Constant and it has been explained the concept of the classical

radius of the electron. On the basis of the proposed classification of Solar System it has been shown that the dimensions and the position of each planet in Solar System are connected with the Fine Structure Constant and the existing Solar System could to be possesses one additional planet whose dimensions and position are given.

Key words: Solar System, Fine Structure Constant

In this work we shall discuss and prove the physical foundation of the basic suppositions what are the reasons of introducing the fine structure constant as a parameter that controls the size and the position of planets in Solar System.

We shall tray the answers in the frame of quantum mechanics. In our consideration we should to find the space dimension of the nonrelativistic electron. In previous works [5,6, 10] analyzed the physical state of Cooper pair and found the following equation for the electrical current density for one electron

$$(1) \quad \vec{J}_e = 2 \frac{e^2 A_\varphi}{m_o} (\Psi^* \Psi)$$

where vector potential A_φ is equal to

$$(2) \quad \vec{A}_\varphi = \frac{1}{2} B \cdot \rho \vec{e}_\varphi, \quad A_\rho = 0, \quad A_z = 0$$

The field B comprehends as actual value of magnetic field of an electron [5]

$$(3) \quad B = \frac{m_o c^2}{\mu_B}$$

where e is the electron charge
 m_o is electron mass in the rest

μ_B is Bohr's magneton The wave function Ψ for the electron is determined by relation

$$(4) \quad \Psi = R(\rho) \Phi(\varphi) Z(z)$$

(5)

$$\iiint \Psi^* \Psi \rho d\rho d\varphi dz = 1, \quad \int_0^\infty R^* R \rho d\rho = 1, \quad \int_0^{2r_o} \Phi^* \Phi d\varphi = 1,$$

$$\int_0^{2r_o} Z^* Z dz = 1$$

$$(6) \quad R(\rho) = \frac{1}{x_o} e^{-\frac{\rho^2}{4x_o^2}}, \quad x_o = \hbar / 2 m_o c$$

$$(7) \quad \Phi(\varphi) = \frac{1}{\sqrt{2\pi}}$$

$$(8) \quad Z(z) = const.$$

The differencial element of the intensity of electrical current for one electron is

$$dI_e = J_e d\rho dz = e \omega_o \rho R^2 d\rho \Phi^2 Z^2 dz$$

and the total current is

$$(9) \quad \vec{I}_e = \iint dI_e = \frac{e^2 B}{m_o} \int_0^\infty \rho R^2 d\rho \Phi^2 \int_0^{2r_o} Z^2 dz \vec{e}_\varphi =$$

$$\frac{e \omega_o}{2\pi} \vec{e}_\varphi = \frac{e^2 B}{m_o} \frac{1}{2\pi} \vec{e}_\varphi = \frac{e c}{2\pi x_o} \vec{e}_\varphi$$

The differential element of the electrical current produces the differential element of the magnetic momentum of the electron

$$(10) \quad d\mu_B = dI_e S = 2 \frac{e^2}{m_o} A_\phi \Psi^* \Psi d\rho dz \pi \rho^2 \\ = e \frac{c}{x_o} \rho^3 R^2 d\rho \Phi^2 \pi Z^2 dZ \\ = e \frac{c}{x_o} \rho^3 R^2 d\rho \frac{1}{2\pi} \pi Z^2 dZ \\ = e \frac{c}{2x_o} \rho^3 R^2 d\rho Z^2 dZ$$

and the total magnetic momentum of the electron will be by definition

$$(11) \quad \mu_B = \iint d\mu_B = e \frac{c}{2x_o} \int_0^\infty \rho^3 R^2 d\rho \int_0^{2r_o} Z^2 dZ$$

The integral represents the average value of the operator ρ^2 expressed by relation

$$\int_0^\infty R^* \rho^2 R \rho d\rho = \langle R | \rho^2 | R \rangle = \frac{1}{x_o^2} \int_0^{2r_o} \rho^3 e^{-\frac{\rho^2}{2x_o^2}} d\rho$$

This integral we will solve using the following exchange:

$$(12) \quad \rho^2 = 2x_o^2 t, \quad \rho = \sqrt{2} x_o t^{1/2}, \quad d\rho = \sqrt{2} x_o \frac{1}{2} t^{-1/2} dt$$

$$\langle \rho^2 \rangle = \frac{1}{x_o^2} \int_0^\infty 2x_o^2 t \sqrt{2} x_o t^{1/2} e^{-t} \sqrt{2} x_o \frac{1}{2} t^{-1/2} dt \\ \langle \rho^2 \rangle = 2x_o^2 \int_0^\infty t e^{-t} dt = 2x_o^2 \Gamma(2) = 2x_o^2 \Gamma(1) = 2x_o^2$$

Using (12) we get magnetic momentum

(13)

$$\mu_B = \frac{e c}{2x_o^2} 2x_o^2 = e c x_o = e c \hbar / 2 m_o c = e \hbar / 2 m_o$$

which coincides with the Bohr's magneton.

In the first step we shall calculate the electrical current using the Hall resistance formula [8]

$$(14) \quad R_H = \frac{b}{e^2 i}, \quad (i = 1, 2, 3, \dots)$$

We shall suppose for $i = 1$ that the equation (14) gives the Hall resistance for single electron. Making the elementary transformation in (14) one obtains

$$(15) \quad \frac{b}{e^2} = \frac{1}{\nu \epsilon_o} = \frac{1}{2 \alpha \cdot c \cdot \epsilon_o}$$

If we consider the linear velocity v within the frame of classical physics we get

$$(16) \quad v = r_o \omega_o = r_o \frac{c}{x_o} = 2 \alpha c$$

That velocity will be the linear velocity of the points at such a distance of the electron center that it rotates with the angular velocity of ω_o .

The meanings of the magnitudes in (16) are :

c is the speed of light,

α is the Fine Structure Constant.

Applying the law of classical electrodynamics and considering an electron as is a circular current carrying loop we find for the electrical current

$$(17) \quad I_c = e v o = e \frac{\omega_o}{2\pi} = \frac{e \cdot c}{2\pi \cdot x_o}$$

which is equivalent to the quantum mechanical value expressed by (9).

If we try the limit point in the space of an electron we shall get the space dimension using the following relation

$$(18) \quad c = x_o \omega_o$$

$$x_o = \frac{c}{\omega_o}$$

According to (17), (18) and (9) immediate follows that the proposed quantum mechanically procedure is in agreement with the relativistic theory.

The angular velocity we can get using (15) in the form

$$(19) \quad \frac{\hbar}{e^2} = \frac{1}{2\pi r_o \epsilon_o \omega_o} = \frac{1}{c_e \omega_o}$$

Obviously the relation (19) is similar to a capacity impedance with capacitance c_e that satisfy the rest energy of the electron

$$(20) \quad E = m_o c^2 = \frac{1}{2} \frac{e^2}{c_e}, \quad (r_o = \frac{e^2}{4\pi \epsilon_0 m_o c^2})$$

The other way for the angular velocity is

$$(21) \quad \omega_o = \frac{eB}{m_o} = \frac{e}{m_o} \frac{m_o c}{x_o e} = \frac{c}{x_o}$$

On the base of the theory of quantum mechanics [4] follow that an nonrelativistic electron is not a point charge, but a distribution of that charge characterized by linear dimension of

$$(22) \quad r = \hbar / m_o c = 2 x_o$$

Using relation (14) we can conclude that the space dimensions of the electron, in one plane, according to classical physics, are limited within the area of πx_o^2 .

According to the quantum mechanical theory the average area within which appears the quantum of magnetic flux is determined by relation [10]

$$(23) \quad \langle \Psi | \Phi | \Psi \rangle = B \langle S \rangle = B \pi \cdot \langle \Psi | \rho^2 | \Psi \rangle = \\ = B \pi \int_0^\infty \rho^2 R^2 \rho d\rho \int_0^{2\pi} \Phi^2 d\phi \int_0^{2r_o} Z^2 dz = B \pi (\sqrt{2} x_o)^2 = \pi \hbar/e$$

This quantum of magnetic flux is the cause of that one predicted by BCS theory[1].

We can notice that the quantum mechanical average value (24) is equal to the square root of the product x_o and $2 x_o$

$$(24) \quad \sqrt{\langle x^2 \rangle} = \sqrt{(x_o)(2x_o)} = \sqrt{2} x_o$$

In order to find the third dimension of the electron we shall use the following formula [10]

$$(25) \quad \mu_B \Phi_o = E \pi (\sqrt{2} x_o)^2 = \mu_B B \pi (\sqrt{2} x_o)^2$$

$$(26) \quad E = m_o c^2 = H B V = \mu_B B$$

$$(27) \quad V = \frac{\mu_B}{H} = (2r_o) \pi (\sqrt{2} x_o)^2$$

where Φ_o is quantum of magnetic flux and V is the volume of the electron in the standstill.

According to (27) follow that nonrelativistic electron could not be a spherical symmetric particle and we can see that the dimensions of nonrelativistic electron are under control of the Fine Structure Constant. Namely, the ratio between half of depth of the electron and the diameter of its base is in the classical sense (18)

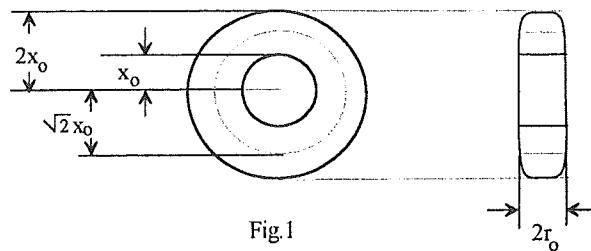


Fig.1

$$(28) \quad \frac{r_o}{2x_o} = \alpha = \frac{1}{137}$$

In Fig. 1 is shown the approximate estimate of the aspect of the nonrelativistic electron where the space dimension with radius x_o is according with the picture of classical physics (18) and $2 x_o$ belongs to the quantum mechanical one. Using the relation (18), (22), (23) and (27) we can draw the picture of the nonrelativistic electron.

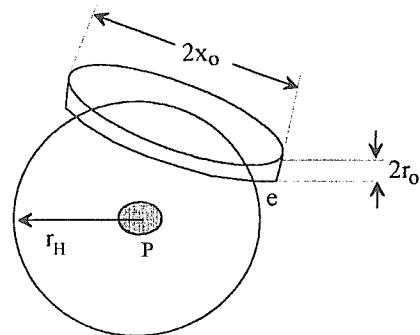


Fig.2

The Fig.1 we can throw into Bohr's model of the hydrogen atom. In that case aspect of the supplemented Bohr model of the hydrogen atom would be as it is shown in Fig.2.

N. Bohr derived for the hydrogen atom the following formula

$$(29) \quad \frac{r_o}{r_H} = \alpha^2 = \frac{1}{(137)^2}$$

where r_H is the classical radius of the Bohr's orbit.

This formula we can transform by the following manner

$$(30) \quad \frac{r_o}{2x_o} \cdot \frac{2x_o}{r_H} = \alpha \cdot \alpha$$

and the derived relation immediate follows from Fig.2.

In Fig.3 it is shown the part of Solar System : Earth-Sun-Moon.

n	$-\infty$	0	1	2	3	4	5	6	7	8
planets	Mercury	Venus	Earth	Mars	As. Belt	Jupiter	Saturn	Uranus	Neptune	Pluto

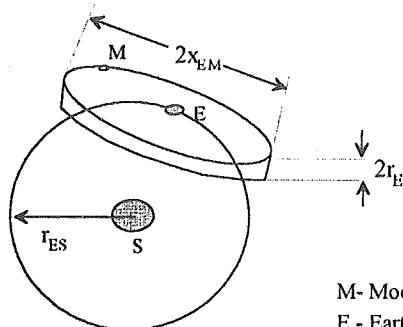


Fig.3

The question is now : can we use the formula (30) for the calculation of the parameters of the orbits of Earth and Moon ? We shall try it is to see what are the results.

(31)

$$\frac{r_E}{2X_{EM}} \cdot \frac{2X_{EM}}{r_{ES}} = \frac{r_E}{r_{ES}} = \left(\frac{1}{137-19} \right) \left(\frac{1}{137+58} \right) = \left(\frac{1}{137+14} \right)^2$$

where

r_E is the Earth radius

X_{EM} is the distance between the Earth and Moon

r_{ES} is distance between the Earth and the Sun

We shall compute the a numbers for the remaining planets of Solar System introducing the rules for the choice the following reference system :

a) The formulas (30) we shall use for the following planets: Mercury, Venus, Earth and Jupiter. We take reference point for them to be the center of the Sun.

b) The center of the nearest planetoid from the Asteroid belt let is the reference point for Mars.

c) For the following planets: Saturn, Uranus, Neptune and Pluto the rule for the choice the reference points are as follows : The center of the Pluto is reference point for Neptune. The center of the Neptune is the reference point for Uranus. The center of the Uranus is the reference point for Saturn.

All calculations have connected with the planets ordered in one plane taking into account the average distance from the Sun.

In Astronomy there is the well-known Tycius-Bode law discribing the distance between planets and the Sun. Is determined by the following empirical relation [15]

$$(32) \quad R_n = 0.4 + 0.3 \times 2^n \quad (\text{in A. U.})$$

where the values of n are shown in Table 1.

Also with respect to the volume density of the matter we choose the Venus as a reference planet for the row of planets under a). For the planets under c) the reference planet would be planet Saturn.

Introducing the reference planets into account we get :

$$(33) \quad \frac{\bar{r}_n}{R_n} = \frac{r_n}{R_n} \sqrt[3]{\frac{\rho_n}{5.2}} = \alpha_n^2$$

where the integer n has the following meaning:

n = 1 Mercury

n = 2 Venus

n = 3 Earth

n = 4 Jupiter

ρ_n is the volume density of the planet matter and \bar{r}_n is the actual value for planet's radius taking into account its volume density of matter. For Venus $\rho_2 = 5.2 \text{ g/cm}^3$.

For the row of the planets : Saturn, Uranus, Neptune and Pluto we have

$$(34) \quad \frac{\bar{r}_n}{R_{nm}} = \alpha_n^2 = \frac{r_n}{R_{nm}} \sqrt[3]{\frac{\rho_n}{5.2}},$$

n = 1 Pluto

n = 2 Neptune m = 1

n = 3 Uranus m = 2

n = 4 Saturn m = 3

where R_{nm} is the distance between appropriate neighboring planets.

For Saturn $\rho_4 = 0.7 \text{ g/cm}^3$

$$R_{11} = 39.1 - 30.07 = 9.17 \text{ A. U. (Pluto- Neptune)}$$

$$R_{22} = 30.07 - 19.18 = 10.84 \text{ A. U. (Neptune - Uranus)}$$

$$R_{33} = 19.18 - 9.54 = 9.64 \text{ A. U. (Uranus - Saturn)} \\ (1 \text{ A. U.} = 149.6 \times 10^6 \text{ km})$$

This distances have been calculated under the condition that the planets order in on plane with respect there half of the big axis.

If we takeng into consideration the derived rules we shall obtain the results for a numbers is shown in Table 2.

Table 2 . Calculated α numbers,
Tabela 2 . Izračunati α brojevi

Object	α number
Mercury	$\frac{1}{137 + 15}$
Venus	$\frac{1}{137 - 3}$
Earth	$\frac{1}{137 + 14}$
Mars	$\frac{1}{137 + 51}$
Jupiter	$\frac{1}{137 + 16}$
Saturn	$\frac{1}{137 + 19}$
Uranus	$\frac{1}{137 + 54}$
Neptune	$\frac{1}{137 + 37}$
Pluto	?
X new planet	?

For the planet Pluto there is not the possibility for computing it's α number. According to our knowledge it is rear planet of Solar System. The impossibility for computing α number for Pluto might be to mean that our knowledge about Solar System is not full. In the other words Solar System is not complete. Under such circumstances immediate follows that in Solar System could be one more planet. If this does then the center of new planet will be the reference point for Pluto. If the planet X is rear planet of Solar System it could be as the same as Pluto. Then the center of Pluto will be the reference point for planet X. This means that Solar System might to be completed by a pair of equal planets placed at its back side. In that case theirs a number is mutual. If we take for instance the possible value for α number with respect to T.1 for Pluto and planet X.

$$\alpha = \frac{1}{137 + 29}$$

then the distance between them would be approximately in the range , according to their half of the big axis

$$(35) \quad R_{1x} = (35 - 45) \times 10^6 \text{ km}$$

and the diameter of the planet X would be as the same as diameter of Pluto

$$(36) \quad d_x = 3000 \text{ km}$$

The small probability would be for $\alpha = 1/137$. In that case the distance between them would be

$$(37) \quad R_{1x} = 28.153.500 \text{ km}$$

The proposed approach has an advantage with respect to the Tycius - Bode law giving the possibility for determining both the distances and radius of planet simultaneously and it points out that all planets of Solar System possess a numbers that have connected with the Fine Structure Constant. Because of the necessity for computing the appropriate a number for the planet Pluto immediate follows the possible existence one more planet in Solar System. We notice that this computation comprehends the isolated Solar System. The influence of other system on the Solar System, probably in reality, can change this ideal picture.

Supplement 1

The equations of dynamically motion for three bodies in baryocentrical coordinate system has the form [15].

(1.1)

$$m_j \ddot{\xi}_j = \frac{\partial U}{\partial \dot{\xi}_j}, m_j \ddot{\eta}_j = \frac{\partial U}{\partial \dot{\eta}_j}, m_j \ddot{\zeta}_j = \frac{\partial U}{\partial \dot{\zeta}_j}, (j=1,2,3)$$

and

$$(1.2) \quad U = f\left(\frac{m_1 m_2}{r_{12}} + \frac{m_1 m_3}{r_{13}} + \frac{m_2 m_3}{r_{23}}\right)$$

is the force's function.

$$r_{jk} = \sqrt{(\xi_k - \xi_j)^2 + (\eta_k - \eta_j)^2 + (\zeta_k - \zeta_j)^2}$$

The integrals of the areas have the form

$$(1.3) \quad \sum_{j=0}^2 m_j (\eta_j \dot{\zeta}_j - \zeta_j \dot{\eta}_j) = c_1$$

$$\sum_{j=0}^2 m_j (\zeta_j \dot{\xi}_j - \xi_j \dot{\zeta}_j) = c_2$$

$$\sum_{j=0}^2 m_j (\xi_j \dot{\eta}_j - \eta_j \dot{\xi}_j) = c_3$$

The projections of the appropriate forces on the coordinate axis are:

$$(1.4) \quad \sum_{j=0}^2 m_j \ddot{\xi}_j = 0, \sum_{j=0}^2 m_j \ddot{\eta}_j = 0, \sum_{j=0}^2 m_j \ddot{\zeta}_j = 0,$$

$$\sum_{j=0}^2 m_j \xi_j = a_1, \sum_{j=0}^2 m_j \eta_j = a_2, \sum_{j=0}^2 m_j \zeta_j = a_3,$$

$$\sum_{j=0}^2 m_j \xi_j = a_1 t + b_1, \sum_{j=0}^2 m_j \eta_j = a_2 t + b_2,$$

$$\sum_{j=0}^2 m_j \zeta_j = a_3 t + b_3,$$

where c_1, c_2, c_3 are constants dependent of the direction of the baryiocentral coordinate system. No matter how that directions change, invariant form holds only for the total integral of motion

$$(1.5) \quad c = \sqrt{c_1^2 + c_2^2 + c_3^2}$$

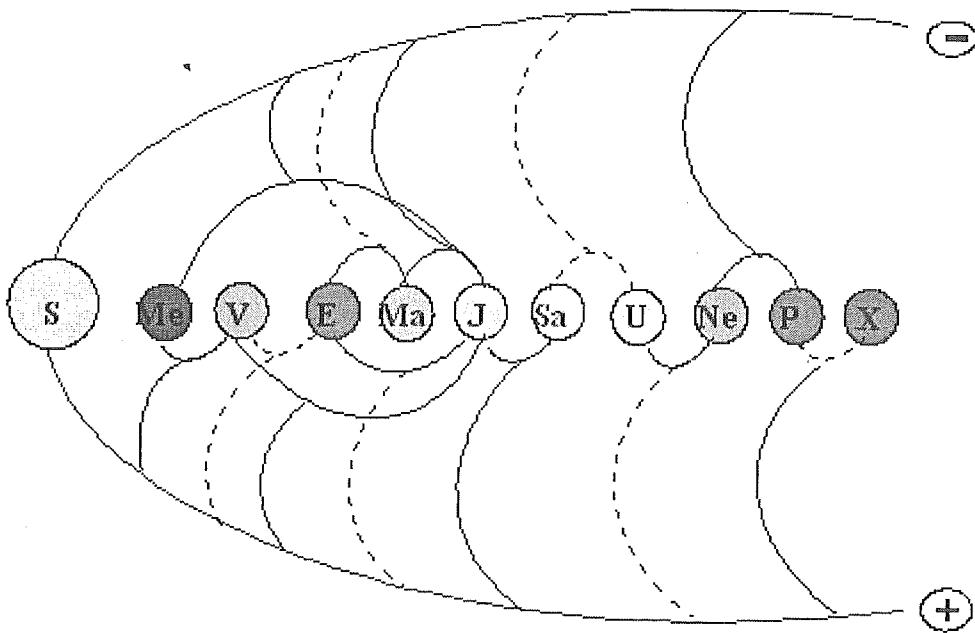
If we do not go deeper into that theory, we can see, that all equations (1.1-1.5) comprehend the existence of all bodies at the same time and any instance from the beginning of such system. In the other words, the absence only one body of that system, could mean the impossibility of holding the Hill's criterion of absolute stability for the system.

The examples of the three bodies system Sun-Neptune-Pluto

The calculation shows the absence of the absolute stability by Hill [15]. It means that they could not exist at the time from their genesis.

The absence of the absolute stability could mean that the Pluto is not rear planet of Solar System. In the other words, the considered Solar System which is consisted of nine planets is not completely. It means that in Solar System must exist a additional planet or several ones.

Fig.4. The expected supplement of the calculations for the absolute stability by Hill designated by broken lines. The minus signs mean unstable system.



REFERENCES

- [1] J. Barden, L.N. Cooper and J.R. Schrieffer, *Phys.Rev.vol.108.N0 5, P.1175, 1957.*
- [2] L. D. Landau, and M. Lifshic, *Quantum Mechanics*, Moscow, 1963.
- [3] A.A. Sokolov, et al., *Quantum Mechanics*, Moscow " Nauka ", 1979.
- [4] A. Messiah, *Quantum Mechanic*, Interscience Publishers, Inc. New York, 1961.
- [5] Z. Todorović, *Collection of the papers*, 9. Congress of the Yugoslav Physicists, Petrovac na Moru (1995), p. 37.
- [6] Z.B.Todorović, *An approach for determining the quantum of magnetic flux*, Annales de la Fondation Louis de Broglie, (accepted and in press), Paris, 1997
- [7] J. F. Cornwell, *Group theory in Physics*, Vol.II, Academic press, New York, 1984.

- [8] K. V. Klitzing, *New Method for High-Accuracy Determination of the Fine-Structure Constant Based on Quantized Hall Resistance*, Physics Rev. Lett., Vol. 45, No 6, 1980.
- [9] W. Pauli, *The Works in Quantum Theory*, Nauka, Moscow, 1977.
- [10] Z. B. Todorović, *About the extension of Einstein's relation for nonrelativistic electron*, Annales de la Fondation Louis de Broglie, submitted, Paris, 1997.
- [11] V.G. Golubaev, E.A. Grebenikov, *Three bodies problem in Heavenly Mechanics*, P.214-225, Moscow University, 1985.
- [13] Kittel, C., et.al., Berkley Physics Course, vol.4.p.40-41, Mc Graw-Hill Book Co New York, 1964.
- [14] R. Doll, M. Nabauer, *Phys. Rev. Letters*, 7, 51(1961)
- [15] Baculyn, P., et.al, *Fundamentals of Astronomy*, "Nauka", Moscow. 1983.

REZIME

TEORIJSKI POSTUPAK KOJIM SE PREDVIDA MOGUĆNOST POSTOJANJA DESETE PLANETE U SUNČEVOM SISTEMU

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U poznatom udžbeniku fizike pod nazivom "Berklejevski kursevi fizike" [13] namenjeno studen-tima fizike na američkim univerzitetima, eksplisitno su navedene neke pojave u fizici koje do danas nisu dobile zadovoljavajuće objašnjenje. Prva među njima je konstanta fine strukture za koju se kaže da predstavlja empirijsku konstantu. Pominje se zatim klasični radijus elektrona, za koga se kaže da ima neko fizičko značenje ali se za sada ne zna kakvo.

Za sada nemamo osnova da možemo da elektron predstavimo u obliku strujne petlje a sva nastojanja da se konstruiše klasični model elektrona su pretrpela neuspeh. Takođe se navodi da za sada nemamo zadovoljavajuću kvantnomehaničku teoriju elektrona. Nedavno je predložena kvantnomehanička teorija jednog elektrona [6], koja kao glavni rezultat ima tačno izračunatu vrednost kvanta magnetnog fluksa [1], a kao novi rezultat u fizici određuje površinu na kojoj se pojavljuje taj fluks.

Iz formule za kvant magnetnog fluksa, Sokolov [3] kaže da je izvor kvanta magnetnog fluksa u Kuperovom paru, magnetni moment jednog elektrona:

$$(a) \quad \Phi_0 = \pi \frac{\hbar}{e} = \mu_0 \frac{\mu B}{2 r_0} = \mu_0 \frac{I_e}{2 r_0} S$$

U daljem transformisanom obliku, vidi se da se tu pojavljuje intenzitet električne struje I_e i površine S . Na osnovu predložene kvantnomehaničke teorije izračunata je električna struja elektrona I_e [10]. Ona se poklapa sa vrednošću dobijeno iz Klicingoove formule [8], na osnovu zakona klasične elektrodinamike. Krajnji transformisani oblik formule za kvant magnetnog fluksa sugerira na neposredan način oblik zakona za magnetno polje nerelativističkog elektrona. Uopšteno govoreći, polje elektrona u oblasti obuhvaćenoj površinom S je nehomogeno [10]. Međutim, dejstvo tog nehomogenog polja može se zameniti efektivnim

poljem B , skoro homogenim u pomenutoj oblasti. Iz toga proizlazi da bi mogli sa stanovišta klasične elektrodinamike da elektron predstavimo u obliku strujnog kola kružnog oblika, kroz koji teče struja intenziteta I_e i da ona stvara skoro homogeno polje u površini obuhvaćenoj tom konturnom strujom, a koja iznosi tačno $\pi (\sqrt{2} x_o)^2$.

Prema kvantnomehaničkoj teoriji [4], nerelativistički elektron nije tačkasto nanelektrisanje e , već je on "razmazan" u oblasti određen radijusom $r = 2 x_o$. Predložena teorija [6] računanjem kvanta magnetnog fluksa, dobija da bi radijus elektrona mogao biti $\sqrt{2} x_o$, i to bi bila projekcija u jednoj ravni. Treću dimenziju elektrona možemo da vidimo iz relacije (27). Relacija (25) predstavlja proizvod dve izmerene kvantne mehaničke veličine: jedna je magnetni moment elektrona, poznat kao Borov magneton, i druga kvant magnetnog fluksa. Ovaj proizvod pokazuje da se energija mirovanja elektrona $m_o c^2$ javlja u prostoru oblika diska sa bazama od $\pi (\sqrt{2} x_o)^2$. Za procenu treće dimenzije elektrona, iskorišćena je relacija (a). Iz nje neposredno sledi da je treća dimenzija elektrona $2 r_o$. Dakle, to je ona vrednost u formuli (b), koja bi prema klasičnoj elektrodinamici predstavljala, saglasno Amperovom zakonu integral cirkulacije magnetnog polja H kroz konturu koja obuhvata struju I_e

$$(b) \quad \int_0^{2r_o} H dl = I_e$$

Iz dobijenih prostornih dimenzija (27) sledi da elektron ne bi mogao biti čestica sa sfernom simetrijom. Ako sačinimo odnos između dimenzija elektrona (28), dobicemo vrednost za konstantu fine strukture $\alpha = \frac{r_o}{2 x_o}$.

Sada u svetu predložene teorije vidimo značenje klasičnog radijusa elektrona. Dakle, to nije radijus u klasičnom smislu te reči. To je poludebljina treće dimenzije nerelativističkog elektrona. Naziv klasični radijus elektrona unosi je zabunu, pa su prvo Lorenc, a zatim i Pauli [9] računajući linearu brzinu rotacije spoljašnje površine elektrona, posmatrajući ga kao

sferu radijusa r_0 , dobili da bi ona iznosila skoro 70 c. Naravno, kao sto je poznato klasičnu sliku ovakvog elektrona, ova dva fizičara su odbacili, jer se rezultat kosi sa teorijom relativnosti.

Kao što se može videti brzina (16) je sa stanovišta klasične fizike jednaka dvostrukoj vrednosti brzine elektrona u Borovom modelu atoma vodonika, što je u saglasnosti sa teorijom relativnosti.

Sa stanovišta ovako predložene teorije, za atom vodonika su sačinjeni odnosi (30) u kojima se vidi da je treća dimenzija elektrona bila "sakrivena" u samoj Borovoj formuli. Formulu za Borov model atoma vodonika možemo primeniti na deo Sunčevog sistema: Sunce, Zemlja, Mesec. Ovde planetu Zemlju i Mesec posmatramo kao prostorni pojas oblika diska debljine jednak prečniku Zemlje i radijusa baze jednak srednjem udaljenju Meseca od Zemlje. Ostale planete posmatramo na isti način, ali bez satelita, direktno primenjujući formulu (29).

Prema saznanjima u današnjoj astronomiji, broj planeta, koje ulaze u sastav sunčevog sistema, iznosi devet. Njihove pozicije u odnosu na središte Sunca su definisane velikim poluosama, vrednost kojih se računa prema poznatom Ticijsu - Bodeovom zakonu (32).

Ideja je bila da se koristeći formulu (29) odredi pozicija planeta u Sunčevom sistemu. Za razliku od Ticijs-Bodeovog zakona, ona povezuje radijus planete sa njenom pozicijom preko α broja, poznatog kao konstanta fine struktur, koji je približno jednak 1/137. Drugim rečima, ideja se sastoji u tome da se odredi za svaku planetu njen α broj. Dakle, veza između radijusa planete i njene pozicije u Sunčevom sistemu treba da daje jednu brojnu vrednost α broja.

Da bi se izračunao α broj za svaku planetu, pošlo se od sledećeg razmatranja :

Prvo je zaključeno da je zbog nejednakosti radijusa planeta i različitosti njihove gustine materije, Sunčev sistem složen. Ovo znači da se sistem mora sastojati od podsistema. Prvi podsistemi su planete koje u nizu čine skup sa rastućim poluprečnicima. To su : Merkur, Venera, Zemlja i Jupiter. Drugi podsistemi čini skup planeta sa opadajućim radijusima. To su : Saturn, Uran, Neptun i Pluton. Treći podsistemi čine: Mars i Asteriodni prsten.

Sledeći korak je bio u određivanju referentne planete. Ona se određuje na osnovu dobijene najbolje vrednosti za α broj prema formuli (29). Za prvi podsistemi to je planeta Venera. Za drugi Saturn a za treći podsistemi planeta Mars. Zatim je izvršena redukcija formule (26), uzimajući u obzir gustinu materije referentne planete. Tako su dobijeni efektivni radijusi planeta, izraženi formulama (33) i (34). Efektivni radijusi planeta podrazumevaju one radijuse planeta koji bi odgovarajuća planeta imala pod pretpostavkom da je njen materijalni sastav identičan materijalnom sastavu referentne planete.

Postavljeno je zatim pravilo izračunavanja a broja. Ono je povezano sa izborom referentne tačke. Za prvi podsistem referentna tačka je Sunce. Za drugi podsistem referentna tačka se uzima kao središte planete na sledeći način : Središte Plutona predstavlja referentnu tačku za Neptun; središte Neptuna je referentna tačka za Uran; središte Urana je referentna tačka za Saturn.

Prema primenjenoj metodologiji računanja α broja, ispaljeno je da se za planetu Pluton α broj ne može odrediti. Nemogućnost određivanja α broja za Pluton sugerisala je mogućnost postojanja neke referentne tačke van poznatog Sunčevog sistema. Ta referentna tačka u tom slučaju trebala bi da predstavlja središte nepoznate planete i to bi bio uslov za određivanje α broja za planetu Pluton. Isto tako i za nepoznatu planetu je potrebno odrediti njen α broj. Ako je ona zadnja u Sunčevom sistemu, onda bi po veličini i materijalnom sastavu trebala biti identična Plutonu. Pod tom pretpostavkom središte Plutona bi bila referentna tačka za planetu X. Pozicija nepoznate planete, može se odrediti uzimanjem idealne vrednosti za α broj 1/137. U tom slučaju srednje rastojanje između Plutona i planete X iznosilo bi 28.153.500 km. Međutim ako uzmemo u obzir moguće odstupanje od idealne vrednosti α broja, recimo 1/(137+29), onda bi to rastojanje iznosilo oko 35 miliona kilometara.

Primenjujući zakone klasične fizike, određene su prostorne dimenzije elektrona [formula 14 i formule a) i b) iz rezimea]. U skladu sa zakonima klasične fizike dobijen je dopunjena izgled Borovog modela atoma vodonika (slika 2). Van svake je sumnje da između njega i dela Sunčevog sistema (Sunce-Zemlja-Mesec), na prvi pogled, postoji određena sličnost (slika 3). Naravno da u realnosti takva sličnost ne bi značila ništa, ako ne bi postojao matematički dokaz da su prostorne dimenzije oba sistema, jednog koji pripada mikrosvetu i drugog iz makrosvetra, pod kontrolom jednog zajedničkog parametra. Ispostavilo se da je taj zajednički parametar jednak 1/137, poznat kao konstanta fine strukture. Na osnovu pomenute sličnosti, prirodno se nametnulo pitanje da li se formula (30) može primeniti kako na pomenuti deo Sunčevog sistema, tako i na ceo sistem. Ako može, šta je krajnji rezultat?

Očigledno je da nije dobijena idealna vrednost alfa broja za sistem S-E-M, već postoji određeno odstupanje. Postavlja se pitanje, ako postoji realna fizička zasnovanost na osnovu koje alfa broj kontroliše dimenzije čestica mikrosvetu i prostorne dimenzije makrosvetu, zašto za sistem Sunce-Zemlja-Mesec nije postignuta idealna vrednost? Odgovor bi mogli da potražimo u sledećem razmatranju: Poznata je činjenica da se Mesec udaljava od Zemlje, godišnje oko 15 cm. Prema formuli (31), ako se pretpostavi da je $r_E = \text{const}$ vidi se da će količnik $2 X_{EM} / r_E$ vremenski konvergirati ka idealnoj vrednosti alfa broja tj. 1/137.

Ako bi smo se vratili u prošlost, mogli bi da zaključimo da je to odstupanje tada bilo veće od idealne vrednosti, nego što smo ga danas konstantovali. Matematički gledano, sasvim je očigledno da su divergencija i rotor vektorskog polja brzine Meseca na njegovoј orbiti različiti od nule. Za osobine ovakvih polja se kaže da su vrtložna i da imaju izvor i ponor. Za vektorsko polje Meseca izvor bi bio središte Zemlje. Ova konstatacija ide u prilog poznatoj tvrdnji u savremenoj fizici da je Mesec nastao od Zemlje.

Neregularan karakter ostatka alfa broja prema T.1 bi mogao da se poveže sa vremenom nastanka planeta. To znači da ova neregularnost bi mogla da znači da planete verovatno nisu iste starosti. U dopuni 1 analizirani su proračuni apsolutne stabilnosti vezane za teoriju problema dinamičkog kretanja tri tela po Hillu [15].

Tu se posebno ističe:

- a) neispunjene kriterijuma stabilnosti po Hillu: Sunce-Merkur-Jupiter. Razlog: smatra se da je Merkur Venerin satelit, što ukazuje na mogućnost postojanja određene verovatnoće da Merkur i Jupiter nisu iste starosti.
- b) neispunjene apsolutne stabilnosti sistema Sunce-Mars-Jupiter. Razlog: ova činjenica potvrđuje opravdanost uvođenja klasifikacije Sunčevog sistema prema kojoj Mars i asteroidni pojas predstavljaju poseban subsistem. Ovakva klasifikacija opravdava postojanje određene verovatnoće neistovremenog nastanka Marsa i Jupitera.
- c) izostanak apsolutne stabilnosti po Hillu za sistem Sunce-Neptun-Pluton.

Razlog: izvršeni proračuni stabilnosti po Hillu idu u prilog tvrdnji da planeta Pluton nije zadnja planeta Sunčevog sistema. Da je zadnja, ona ne bi bila ovakva kakva jeste, niti na tom rastojanju. Proračuni bi morali biti pozitivni po pitanju stabilnosti Sunčevog sistema. Međutim, oni to nisu. Ostali proračuni koji pokazuju pozitivnu vrednost apsolutne stabilnosti po Hillu, takođe idu u prilog izvršenoj klasifikaciji Sunčevog sistema.

Za konstantu fine strukture $\alpha=1/137$ u udžbeniku fizike Univerziteta u Berkliju, Kvantna fizika (sveska4, strana 40-41) se kaže da je ona za sada čisto empirijska konstanta u smislu da nemamo teorijskog objašnjenja za njenu veličinu, koja je definisana formulom :

$$\alpha = e^2 / [4 \pi \epsilon_0 (\hbar / m_o c) m_o c^2] = r_o / 2 X_o = 1/137$$

Prema navodima u citiranoj knjizi se kaže : To je konstanta koja meri veličinu vezivanja elektrona sa elektromagnetskim poljem ili bi to bila elektrostaticka energija odbijanja dva elektrona razdvojenih za prirodnu jedinicu dužine $\hbar / m_o c = 2 X_o$. Prema predloženoj teoriji proizilazi teorijsko objašnjenje za konstantu fine strukture, gde se vidi da je njena izvorna definicija prirodno povezana sa prostornim dimenzijama elektrona (formula 28).

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On the Eigenvalue Problem of some Coupled Equations of Motion

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ABSTRACT

The subject of the paper is the eigenvalue problem of a system of coupled equations describing mechanical vibrations of some complex continuous systems. Instead of separating the unknown response functions, the analysis of such mechanical systems is performed in the matrix form. The property of selfadjointness of the matrix operator is proved and the ortho-

gonality condition is constructed. The eigenvectors are then used to solve the nonhomogeneous problem in the series form. Contrary to the procedure of initial parameters, the technique used in this presentation gives a much better insight into the physical ground of the solution as well as the simplicity in handling the appropriate eigenvalue problem.

Key words: Differential equations, eigenfunctions, eigenvalues, matrix operators, selfadjointness, orthogonal functions, vibrations.

INTRODUCTION

The eigenvalue problem is an inevitable part of the analysis in mechanical vibrations. It seems to be a relatively simple problem when we deal with the discrete systems, but it appears to be a complex one if the continuous systems are to be analyzed. Further on, the coupling in the equations of motion makes the eigenvalue problem even more complex.

In order to make the solution procedure simple, a few steps should be followed. Instead of dealing with a system of equations describing mechanical vibrations, a functional vector should be formed with the unknown functions as elements. Next, the whole system and the resulting eigenvalue problem should be treated in matrix form. To do so it is needed to answer if the matrix operator fulfils the property of selfadjointness. Resolving this question, the basis to construct the orthonormality condition is formed. With the orthonormality condition at hand, we can solve the nonhomogeneous problem as well.

This approach originated when dealing with vibrations of curved thin-walled beams. The motion in this case is described with two coupled differential equations of the forth order with two unknown response functions. The purpose of this article is not to investigate different dynamic aspects of the problem, instead it is oriented toward mathematics as a tool to yield a most elegant solution. It is worth mentioning here how other authors approached the same problem. A solution for the dynamic response of a curved beam to a moving load, using the variation of initial parameters approach, was given in [1]. With the use of Rayleigh-Ritz method, the frequency spectra were calculated for the various boundary conditions in [2]. A consideration of the eigenvalue problem was given in [3], but the problem was substantially simplified by

neglecting the warping and torsional inertia terms. A rigorous analysis, with a comparative study of the influence of different inertia and rigidity terms is presented in [4]. None of these authors was concerned with the relevant eigenvalue problem in a matrix form nor examined its properties, what is actually the objective of the present analysis. The resulting elements could be used in a solution for the frequencies and for the dynamic response of a curved beam applying, for example, the mode superposition technique.

The homogeneous problem

If in the case of lateral vibrations of curved beams we attempt to perform any analysis by separating the unknown functions, we will come to the differential equations of the eighth order which will bring many difficulties and make the analysis impractical. For this reason it is advisable to proceed the analysis in a matrix form, introducing a displacement vector

$$(1) \quad \Psi (\theta, t) = \begin{Bmatrix} \bar{\eta} \\ \beta \end{Bmatrix}$$

where: $\bar{\eta} = \eta / R$ is a nondimensional function representing lateral displacements, β is a function representing the angle of twist, R is the constant radius of curvature of the central line, and t is the time.

The resulting matrix equation will have the form

$$(2) \quad A \Psi^{IV} + B \Psi'' + C \Psi + D \dot{\Psi} + F \ddot{\Psi} = C_2 Q$$

with primes indicating differentiation with respect to the geometric coordinate θ and with the dots indicating the time differentiation.

The meaning of the constant matrices $\mathbf{A}, \mathbf{B}, \mathbf{C}, \mathbf{D}, \mathbf{F}$ and the load vector \mathbf{Q} in (2) is as follows (3)

$$\mathbf{A} = \begin{bmatrix} 1 + A_w & A_w \\ A_w & A_w \end{bmatrix}, \quad \mathbf{B} = -\begin{bmatrix} A_K & 1 + A_K \\ 1 + A_K & A_K \end{bmatrix}, \quad \mathbf{C} = \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix},$$

$$\mathbf{D} = \begin{bmatrix} K_1 & 0 \\ 0 & K_2 \end{bmatrix}, \quad \mathbf{F} = -\begin{bmatrix} K_3 & K_4 \\ K_4 & K_4 \end{bmatrix}, \quad \mathbf{Q} = \begin{cases} P_y(\theta R, t) \\ M_c(\theta R, t) \end{cases}$$

The constant C_2 in (2) and all other parameters in (3) represent geometrical and physical properties of the mechanical system as well as the external force distribution. There is no need to comment on these parameters since the mathematical aspects are of our interest at present. The only important property we should notice here is the symmetric form of all matrices in (3). It is the consequence of energy conservation principle in linear elastic materials.

To analyze the case of free vibrations, we introduce

$$(4) \quad \Psi(\theta, t) = \Psi_\theta \sin \omega t$$

and the appropriate eigenvalue problem is described by the equation

$$(5) \quad \mathbf{A} \Psi_\theta^{IV} + \mathbf{B} \Psi_\theta'' + \mathbf{C} \Psi_\theta = \omega^2 (\mathbf{D} \Psi_\theta + \mathbf{F} \Psi_\theta'')$$

In this equation $\Psi_\theta^T = [Y_{(0)} \quad B_{(0)}]$ is an eigen-

vector and in the theory of vibrations it is named as the mode-shape vector. The frequency is an eigenvalue of the problem.

Introducing some symbolic matrix operators, for the left and the right side of equation (5), we can write that equation in the form

$$(6) \quad \mathbb{L}(\Psi_\theta) = \omega^2 \mathbb{IN}(\Psi_\theta).$$

It should be pointed out that the eigenvalue problem for linear scalar operators is already very well established. On the contrary, the matrix operators still need some precise statements. The conditions for the property of selfadjointness, which L. Collatz [5] stated for a linear scalar operator, are generalized in this presentation and applied to the matrix operators in eq.(6). Due to the symmetry of operators, for two eigenvectors $\Psi_{\theta K}$ and, the following holds $\Psi_{\theta n}$

$$\int_0^{\theta_1} \Psi_{\theta K}^T \mathbb{L}(\Psi_{\theta n}) d\theta = |L.B.C.| \int_0^{\theta_1} \Psi_{\theta n}^T \mathbb{L}(\Psi_{\theta K}) d\theta$$

$$\int_0^{\theta_1} \Psi_{\theta K}^T \mathbb{IN}(\Psi_{\theta n}) d\theta = |N.B.C.| \int_0^{\theta_1} \Psi_{\theta n}^T \mathbb{IN}(\Psi_{\theta K}) d\theta$$

The symbols $|L.B.C.|$ and $|N.B.C.|$ represent two equations resulting from the partial integration and they contain the boundaries of the vibrating system. It can be proved that for any boundary conditions, i.e. for any mechanical constraints, these two boundary equations are equal to zero. If these two terms disappear, then the equations (7) are stating that the present eigenvalue problem is selfadjoint. As a direct consequence of this property, the orthogonality condition of eigenvectors follows. Also, it can be proved that for any eigenvector $\Psi_{\theta n}$ the integral

$\int_0^{\theta_1} \Psi_{\theta n}^T \mathbb{IN}(\Psi_{\theta n}) d\theta$ has the same sign. With this, the existence of real eigenvalues is assured.

For two different eigenvalues, $\omega_K \neq \omega_n$, the respective eigenvectors and $\Psi_{\theta K}$ and $\Psi_{\theta n}$ fulfill the orthonormality condition

$$\int_0^{\theta_1} \Psi_{\theta K}^T \mathbb{IN}(\Psi_{\theta n}) d\theta = 0$$

$$(8) \quad \int_0^{\theta_1} [\mathbb{L}(\Psi_{\theta K}) - Y_{\theta K}^2 \beta_{\theta K} \beta_{\theta n} - Y_{\theta K} (K_3 Y''_{\theta n} + K_4 \beta''_{\theta n}) - \beta_{\theta K} (K_1 Y''_{\theta n} + K_4 \beta''_{\theta n})] d\theta = \begin{cases} 1, & n = K \\ 0, & n \neq K \end{cases}$$

in which besides the eigenfunctions Y_θ and β_θ , the constants are related to the geometry and material properties of the vibrating system. At this point different degrees of approximation are possible but those are dynamic problems in its essence.

The nonhomogeneous problem

The orthogonality condition has to serve as a tool to derive the uncoupled equations of motion and to construct the nonhomogeneous solution. If the mode superposition technique is used, which means the use of eigenfunction series, the nonhomogeneous solution may be written in the form

$$(9) \quad \Psi(\theta, t) = \sum_n \sum_i z_{ni}(t) \Psi_{\theta ni}$$

where z_{ni} is the so-called normal coordinate. Summation over i means that for every eigenfunction representing the lateral mode n , there are two possible twisting modes, $i = 1, 2$. Also, the term on the right side in eq. (2), which in mechanics has the meaning of a load vector, has to be expressed in the series form

$$(10) \quad \mathbf{Q}(\theta R, t) = \sum_n \sum_i q_{ni}(t) (\mathbf{D} \Psi_{\theta ni} + \mathbf{F} \Psi_{\theta ni})$$

where $q_{ni}(t)$ is the generalized load function. Using the orthonormality condition (8), q_{ni} can be calculated from the equation

$$(11) \quad q_{ni}(t) = \int_0^{\theta_i} \mathbf{Q}^T \Psi_{\theta ni} d\theta.$$

Entering eq.(2) with (9) and (10), differential equations in normal coordinates follow

$$\ddot{Z}_{ni} + \omega_{ni}^2 Z_{ni} = C_q q_{ni}(t), \quad n = 1, 2, \dots \infty \\ i = 1, 2.$$

Equations (12) can be understood as the result of the uncoupling procedure of the original equations of motion (2). With this, all the basic elements for a nonhomogeneous solution are derived. The physical ground of this solution, i.e. the dynamic side of the problem, was presented and explained in [6].

CONCLUSION

In mechanical vibrations of some complex continuous systems, the analysis becomes simple and elegant if it is performed in matrix form with a functional vector which has system's responses as its elements. The eigenvalue problem of the resulting matrix differential equation asks for some statements which are similar to those in linear scalar operators. Above all, the statement has to be made regarding the property of selfadjointness. Due to the symmetry of operators, this property is proved to exist. Based on this property, the orthogonality condition for the eigenvectors is constructed which makes the nonhomogeneous solution in series form possible.

It has to be stated here that, despite of the mathematical elegance of the considered eigenvalue problem, practical dynamic analysis is difficult to perform. For all boundary conditions different from the simple supports, an iterative approach has to be employed in order to find the frequencies. Still, the present eigenvalue analysis offers some valuable conclusions. It was used in Š4Č to derive some quantitative and qualitative data regarding dynamics of curved beams.

REFERENCES

1. Tan, C. P., Shore, S., Dynamic Response of a Horizontally Curved Bridge, J. Struc. Div., Vol. 94, No. ST3, March, 1968.
2. Culver, C. G., Natural Frequencies of Horizontally Curved Beams, J. Struc. Div., Vol. 93, No. ST2, April, 1967.
3. Ojalvo, I. U., Coupled Twist-Bending Vibrations of Incomplete Elastic Rings, Int. J. Mech. Sci., Vol. 4, Pergamon Press, 1962.
4. Basic, D., On the Modal Response of Curved Beams to Moving Loads, Contributions, Section of Mathematical and Engineering Sciences, Macedonian Academy of Sciences and Arts, Skopje, 1985.
5. Collatz, L., Eigenwertaufgaben mit Technischen Anwendungen, (Russian translation), Akademische Verlagsgesellschaft, Leipzig, 1963.
6. Basic, D., On the Eigenvalue Problem of Curved Thin-Walled Beams, ZAMM - Z. angew. Math. Mech., Vol. 66, 1986.

REZIME

O SOPSTVENOM PROBLEMU NEKIH VEZANIH JEDNAČINA KRETANJA
BAŠIĆ Dragoslav

U ovome radu se tretira sopstveni problem jednog sistema vezanih jednačina koje opisuju mehaničke vibracije nekih kompleksnih kontinualnih sistema. Umesto da se izvodi separacija nepoznatih funkcija odgovora, što bi dovelo do jednačina veoma visokog reda, analiza ovakvih mehaničkih sistema se izvodi u matričnoj formi i to preko vektora sopstvenih funkcija. Svojstvo samoadjungovanosti matričnog operatora se ovde dokazuje a na osnovu tog svojstva gradi se uslov ortogonalnosti sopstvenih funkcija. Sopstveni vektori se zatim koriste da bi se rečio nehomogeni problem u obliku reda. Suprotno postupku početnih parametara, postupak korišćen u ovome radu pruža bolji uvid u fizičku stranu rešenja kao i jednostavnost u tretiranju odgovarajućeg sopstvenog problema.

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On the Equation of the Focusing Mirror

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ABSTRACT

In this paper we shall describe a new approach to the derivation of the focusing mirror differential equation.

Key words: focusing mirror, reflected ray, incoming ray, Fermat's principle

1. Introduction

From mathematical aspect, the problem of the focusing mirror reduces to the determination of the equation of its vertical section. The vertical section equation we are going to find on the form $y = y(x)$.

Dimitrovski and Mijatović in [1], and Nikolić in [2] solved this problem. They assumed that the incident ray intersect y -axis at an angle φ , strikes the mirror at the point $M(x, y)$, reflects from its and comes to the focus $O(0, 0)$.

The authors [1,2] solved this problem in three steps:

(a) First, they determine the reflected ray equation

$$(1.1) \quad Y - y = \frac{y'^2 - 2y' \operatorname{tg} \varphi - 1}{y'^2 \operatorname{tg} \varphi + 2y' - \operatorname{tg} \varphi} (X - x).$$

(b) Then, by using the equation of the reflected ray (1.1), and fact that all reflected rays pass through the focus, they obtain the differential of the problem

$$(1.2) \quad y = \frac{y'^2 - 2y' \operatorname{tg} \varphi - 1}{y'^2 \operatorname{tg} \varphi + 2y' - \operatorname{tg} \varphi} x.$$

(c) At the end, they solve the equation (1.2).

The equation (1.2) was solved both by Dimitrovski [1] and Nikolić [2]. Dimitrovski's solution is fourth degree equation, while Nikolić's is given by

$$(1.3) \quad \sqrt{x^2 + y^2} - y \cos \varphi + x \sin \varphi = C.$$

2. New method

Our intention are to show that using another approach this problem can be solved much simpler. Also, we will show that the reflected ray equation (1.1) is not necessary in obtaining of the differential equation of the mirror.

The direction cosines of the incident ray are (Fig.1)

$$\begin{cases} \cos \alpha_i = \cos \left(\frac{\pi}{2} - \varphi \right) = \sin \varphi, \\ \cos \beta_i = \cos(\pi - \varphi) = -\cos \varphi, \end{cases}$$

and reflected ray

$$\begin{cases} \cos \alpha_r = -\frac{x}{r}, \\ \cos \beta_r = -\frac{y}{r}, \end{cases}$$

where $r = \sqrt{x^2 + y^2}$, and the units vectors of the same rays are

$$\vec{a}_0 = (\sin \varphi, -\cos \varphi), \quad \vec{r}_0 = \left(-\frac{x}{r}, -\frac{y}{r} \right).$$

Besides the tangent vector of the curve $y = y(x)$ in point $M(x, y)$ is $\vec{t} = (1, y')$.

Using the Fermat's principle*, it follows that $\angle(\vec{t}, -\vec{a}_0) = \angle(-\vec{t}, \vec{r}_0)$ or

$$(2.1) \quad \angle(\vec{t}, \vec{a}_0) = \angle(\vec{t}, \vec{r}_0).$$

Construct the parallelogram with vertex $M(x, y)$ and sides \vec{a}_0 and \vec{r}_0 . This parallelogram is rhombus, and the direction vector of its diagonal with the initial point $M(x, y)$ is

$$\vec{d} = \vec{a}_0 + \vec{r}_0 = \left(-\frac{x}{r} + \sin \varphi, -\frac{y}{r} - \cos \varphi \right),$$

and clearly satisfies the equality

$$(2.2) \quad \angle(\vec{d}, \vec{a}_0) = \angle(\vec{d}, \vec{r}_0).$$

This situation is graphically described in Fig.1.

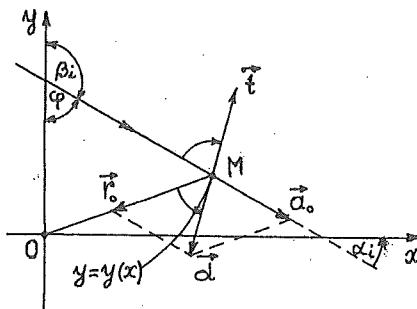


Fig.1.

From (2.1) and (2.2) it follows that the vectors \vec{t} and \vec{d} are collinear, that is

$$\frac{1}{-\frac{x}{r} + \sin \varphi} = -\frac{y'}{\frac{y}{r} + \cos \varphi}.$$

From the last equation we obtain the required differential equation in form

$$(2.3) \quad y' = \frac{y + \sqrt{x^2 + y^2} \cos \varphi}{x - \sqrt{x^2 + y^2} \sin \varphi}.$$

* The incident and reflected rays are equally inclined to tangent of the curve $y = y(x)$ at its point $M(x, y)$.

If we transform the equation (3.2) into polar coordinates (ρ, ϑ) , we have

$$\frac{d\rho}{\rho} = \frac{\cos(\vartheta - \varphi) d\rho}{1 - \sin(\vartheta - \varphi)}.$$

By integrating we obtain

$$\rho = \frac{C}{1 - \sin(\vartheta - \varphi)}.$$

Returning into rectangular coordinates, we find

$$\sqrt{x^2 + y^2} - y \cos \varphi + x \sin \varphi = C,$$

and this is the equation (1.3).

3. Conclusion

1^o It is clear that differential equation (2.3) derived in this paper has much simpler form than the equation (1.2), and therefore its solution is simpler too.

2^o Rotating the coordinate system, for the angle φ , it is easy to verify that the curve given by (1.3) is a parabola, and its canonical equation is

$$\eta = \frac{\xi^2}{2C}.$$

References

- [1] Dimitrovski, D. and Mijatović, M. (1986), *Diferencijalne jednačine problema zaštite Sunčanih kolektora*, (Predavanje održano na VI konferenciji primenjene matematike), Tara.
- [2] Николић, Р. (1994), *Одређивање једначине фокусирајућег огледала заштићеног паралелном плочом*, Универзитетска мисао (природне науке) 1:1, 33–38.

О ЈЕДНАЧИНИ ФОКУСИРАЈУЋЕГ ОГЛЕДАЛА

Радован Николић

ИЗВОД

У овом раду је, на оригиналан и једноставнији начин, састављена диференцијална једначина траженог фокусирајућег огледала. Осим тога, овако добијена једначина је и једноставнија за решавање од једначине (1.2).

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BOOK REVIEWS - PRIKAZI

Stevan M. Stanković, 1997.

PUTEVIMA JUGOSLAVIJE - TURISTIČKO- GEOGRAFSKE EKSKURZIJE, Geografski fakultet, pp. 267, Beograd

UDC 911: 338.48(497.1)(033)

Malo je dogadjaja u životu koji toliko gode ljudskoj duši kao turistička putovanja, posebno ako su to učeničke i studentske ekskurzije. Neki ljudi nastoje da one budu česte i sadržajne. Počasno mesto među njima, bez sumnje, pripada dr Stevanu M. Stankoviću, redovnom profesoru Geografskog fakulteta u Beogradu. Ovaj veliki srpski i jugoslovenski geograf objavio je 20 knjiga i više od 400 radova u domaćim i stranim časopisima iz oblasti limnologije, geografije Jugoslavije i turističke geografije. Početkom ove godine pojavilo se iz štampe treće izdanje knjige PUTEVIMA JUGOSLAVIJE, koje po obimu, koncepciji i ilustracijama prevazilazi ranije objavljena. Upoznavanje prirodnih i antropogenih vrednosti naših prostora putem ekskurzija je njena osnovna tematika, a rezultat je višegodišnjeg naučnog istraživanja i bogatog profесorskog iskustva autora. Njegova želja, kako sam ističe u predgovoru je "da napiše priručnik koji se čita pre odlaska na ekskurziju, koji se čita na ekskurziji i koji se čita posle ekskurzije". Knjiga ima 267 stranica teksta, ilustrovanog sa 72 fotografije, 32 tabelarna priloga i 5 šematskih prikaza. Autor nakon predgovora, stilizovanog na njemu, i samo njemu svojstven način, jednostavno i slikovito, poput rezimea, slaže mozaik koji počinje od žitorodne ravnice i salaša Bačke, Palickeg jezera, Novog sada i fruškogorskih manastira ("srpske Svetе Gore"), Banata i Dunava od Bezdana do Prahova, a onda ide "Beogradu u pohode, veličanstvenom gradu da ga nije moguće opisati", izraslom na obalama Save i Dunava sa neponovljivim geografskim položajem koji mu je uslovio isto tako neponovljivu burnu istoriju i izuzetne dogadjaje_ A onda, severozapadna Srbija sa ravnom Mačvom, Cvijićevom Loznicom, Vukovim Tršićem i Desankinom Brankovinom.

Sa puta po Šumadiji i istočnoj Srbiji ko može odoleti: Topoli i Oplencu, Kragujevcu i Šumaricama, Velikom Pomoravlju, rekama Mlavi, Peku i Timoku i Boru sa okolinom. Odavde nas put vodi dolinom Zapadne Morave, ka Kruševcu i crkvi Lazarici, Trsteniku i manastiru Ljubostinji, Kraljevu i Gornjoj Trepči, Čačku i Ovčarsko-kablarškoj klisuri, Vrnjačkoj Banji, Dragačevu i saboru trubača, Ibru, Studenici, Raškoj, Novom Pazaru, Rasu i Sopoćanima, Banjskoj, Zvečanima i Samodreži do Kopaonika, turistički najpoznatijeg centra Srbije i Jugoslavije. Prirodnim i antropogenim vrednostima Kosova i Metohije je s pravom, uz punu i pravu potvrdu tradicije, poklonjena pažnja koja nas lako i nenametljivo seli iz vremena u vreme, od nastanka u novo nastajanje: Priština - grad kontrasta, manastir Gračanica, gazimestan, Pećka patrijaršija, manastir Dečani, Prizren, Djakovica i pet metohijskih Bistrica, šireći dalje svoje vidike lepote i jednostavnosti kotlinama i klisurama Južne Morave, Niša, Leskovca, Bujanovca, Sićevačke klisure do Dimitrovgrada i Gradine. Putovanje od Srbije za Crnu Goru vodi "gvozdenim putem" kroz Užice, živopisnim Zlatiborom, kanjonom Morače i preko podgorice do Jadranu. Autor kroz Plavsko-gusinjsku kotlinu: Gusinje, Plavsko jezero i Plav, dolinom Lima: Berane, Bijelo Polje, Prijepolje, manastir Mileševa, Pribojska Banja, i Priboj, Bjelasicom i njenim jezerima, Durmitorom, Lovćenom i prestonicom cetinjem, Skadarskim jezerom i njegovim priobaljem prisno i upečatljivo zahvata u biće tog dela Crne Gore, završavajući svoje kazivanje ekskurzijom Crnogorskim primorjem. Plemenito je i veliko, a nadasve je to i obaveza, poznavati svoju zemlju, a užvišeno je upoznati je na pravi način. Uz knjigu PUTEVIMA JUGOSLAVIJE znači putovati svojom zemljom, a ne udarati štapom po pomračini. Knjiga je namenjena turističkim i prosvetnim radnicima, ali i svim ljubiteljima prirode. Ona će čitaocu omogućiti dočaravanje prostora, pojava i procesa. Retka ove vrste, višestruko opravdava svoje postojanje.

M. Kićović

Budislav Tatić i Goran Kostić, 1996.

NAŠA PRIRODNA DOBRA I POTREBA NJIHOVE ZAŠTITE, Centar za ekološke akcije - CEA i Zavod za izdavanje udžbenika i nastavnih sredstava, pp. 100, Beograd

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U nekoliko prethodnih godina kod nas je publikовано више dela u kojima se govori o bogatstvu naše prirode i potrebi njene zaštite. Krajem 1996. godine publikovana je i ova knjiga, nevelikog obima, ali izuzetno bogata sadržajem. Autori su na zaista znalački način ukazali na najznačajnija prirodna dobra naše zemlje: šume, vodu, geološku podlogu, zemljiste i vazduh. Nedostaje samo tekst o životinjama. Ne radi se o propustu autora već o činjenici da smo jedina evropska zemlja koja nema uradjenu nacionalnu faunu. Najveći deo teksta je posvećen šumama. Sa pravom, one i jesu najveće bogatstvo naše prirode. Vrsnim stilom i nemametljivo autori govoreći o našim šumama afirmišu i Josifa Pančića, ali i druga značajna imena naše dendrologije. Stilom koji je razumljiv svakom čitaocu iznete su brojne činjenice i zapažanja, koji pored toga što informišu ujedno i podstiču na razmišljanje. Priložene fotografije šumskih predela i motiva skladno upotpunjuju tekst i estetski ga oplemenjuju. Na sličan način su obradjena i ostala navedena prirodna dobra naše zemlje. U posebnim poglavljima se govori o

oblicima zaštite prirode i o zaštiti biodiverziteta. Govoreći o zaštiti biodiverziteta autori iznose podatak da teritorija SR Jugoslavije čini svega 0,07% svetskog kopna, a da na njoj živi 1 - 12% predstavnika biljnih i životinjskih vrsta planete. Ali, u iznošenju tih brojčanih podataka napravljene su i neke greške. Tako, na 85. Str. Autori navode da u našoj zemlji ima oko 1000 vrsta kičmenjaka, a na 87. Str. Navode da ih ima 619. Izneta je i procena da svakog dana nestane sa planete oko 36.000 vrsta, što je predimenzionirano. To bi značilo da bi za 100 dana nestalo 3.600 000 vrsta, tj. Duplo više od danas poznatog broja vrsta. Edward Wilson (The Diversity of Life, Harvard Univ., Press, 1992) iznosi prihvatljivije mišljenje da godišnje nestane 27.000 vrsta, tj. 74 dnevno, što je takodje poražavajuće za život na planeti.

Opšti je utisak da ovo delo odiše duhom čoveka koji je nošen uzletima i padovima zapadne civilizacije shvatio da treba proživeti ljudski život, ali i da treba bogatstva prirode ostaviti i potomcima. U podsticaju na razmišljanje o imperativu našeg opstanka najveća je vrednost ove knjige. Suština knjige je ukazivanje na globalne vrednosti planete oko kojih treba da se gradi strategija borbe za opstanak ljudske vrste. Ubedjeni smo da će ova knjiga biti višestruko korisna različitim profilima korisnika i sa zadovoljstvom je preporučujemo.

P. Jakšić

Radonjić S. i Markišić H., 1996.

ENCIKLOPEDIJSKI LEKSIKON EKOLOGIJE I ZAŠTITE ŽIVOTNE SREDINE. Pobjeda, pp. 474, Podgorica

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Današnja biološka nauka je skup heterogenih disciplina koje sa različitim aspekata i različitim metodama izučavaju različite manifestacije života na našoj planeti. Nagomilana brojna znanja nužno iziskuju i njihovo precizno pojmovno i leksičko definisanje. Na srpskom jeziku je do sada publikovano vrlo malo takve literature. Možemo kao takva dela pomenuti rečnike, tj. Leksikone Huga Rota (1973), M. Dizdarevića (1974), Leonarda Spalatinu (1980), M. Jablanovića (1994) i Enciklopedijski herbološki rečnik (grupa autora, 1995). Naravno, tumačenja brojnih termina su data i u pojedinim monografijama, udžbenicima i dr. literaturi. Enciklopedijski leksikon ekologije i zaštite životne sredine Radonjića i Markišića je do sada najam-

biciozniye zamišljen i najpotpunije realizovan rečnik ekoloških pojmoveva. Metodom slučajnog odabira na deset stranica smo izbrojali 80 obradjenih termina, što znači da bi se na 470 strana leksikona moglo nalaziti 3700 - 4000 pojmoveva. Pojmovi su dati po abecednom redu. Pojedine odrednice, pored toga, sadrže i vrlo detaljna tumačenja, sa prikazanim elementima strukture. Osim ekoloških pojmoveva obradjeni su i pojmovi iz domena biogeografije, ekofiziologije, biohemije i dr. srodnih disciplina. Ceneći Crnu Goru kao proglašavanu ekološku državu autori su kao odrednice u tekstu naveli i niz gradova i predela Crne Gore (Budva, Cetinje, Durmitor, Podgorica i dr.). Vrednost leksikona bi bila još veća da su za pojedine odrednice autori dali i njihov latinski ili grčki koren. Ovo se delo može bezrezervno preporučiti i sigurno je da će zнатно unaprediti terminološku osnovu naučnih i stručnih radova.

P. Jakšić

Novi časopisi

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Entomološko društvo Srbije promovisalo je 26. februara 1997. godine, na Poljoprivrednom fakultetu u Zemunu, časopis Društva ACTA ENTOMOLOGICA SERBICA. Odluka o pokretanju ovog časopisa doneta je na XXI godišnjem skupu entomologa, održanom u Beogradu 17 - 18. novembra 1993. godine. Ovaj entomološki časopis nastavlja tradicije predratnih entomologa. Naime, 1926. godine je tadašnje Društvo pokrenulo časopis *Glasnik Entomološkog društva Kraljevine Srba, Hrvata i Slovenaca*. Izmedju dva svetska rata izašle su četiri sveske. Obnova izdavačke delatnosti je usledila tek 1971. Godine (*Acta entomologica Jugoslavica*). Poslednji volumen *Acta* _ je publikovan neposredno pre rušenja prethodne Jugoslavije (Vol. XXIII od 1991.). Tako, konstituisanjem Entomološkog društva Srbije ovaj časopis, kao nacion-

alni, reprezentuje delatnost entomologa u Srbiji, kojih je na promociji časopisa bilo pedeset a verujemo da ih ima barem još toliko. Ovaj volumen sadrži deset originalnih naučnih radova, pisanih na engleskom jeziku. Autori su razmatrali sledeće grupe insekata: Diptera (Šimić Smiljka & Vujić A., (1) i Šimić Smiljka & Vujić A., (2); Božičić-Lothrop B. & Vujić A.; Kekić V., M. Andjelković & G. B(chli); Coleoptera (Mesaroš G.); Odonata (Adamović Ž.R. (1), Adamović R.Ž.(2) i Branković G.); Heteroptera (Protić Ij.) i Hymenoptera (Petrov I.Z.) Naučni i stručni nivo radova je uglavnom vrlo visok i kada je prvi broj u pitanju moramo biti blag nakloni u odnosu na kvalitet pojedinih radova. Uredništvu čestitamo na izvanrednom tehničkom izgledu časopisa i izražavamo nadu da će časopis ući u mirnije izdavačke vode posle ovih godina krize, kao i da će poživeti dugo. Uostalom, to zavisi od nas entomologa!

P. Jakšić

INSTRUCTIONS TO AUTHORS

The "University of Pristina publication in Natural Sciences" periodical, a publication of natural sciences, publishes original scientific papers and review articles as well as book reviews and "in memoriam" type articles from the field of theoretical and applied natural sciences. All articles have not been published before.

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