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Dynamics of Microbial Activity of the Highly Present Soil Types of Monte Negro

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Abstract: Some physiological microorganism groups and their activity per soil types frequently encountered in the continental part of Monte Negro were studied in terms of their number and distribution. 57 profiles of differing soil types were opened – brown district (acid), brown eutric, alluvial-deluvial, alluvial and lime-dolomite humus.

Distribution of the microbial activity per profiles of the soils was monitored by analysing quantitative and qualitative content of the microorganisms and proteinase activity.

In all the soil types, the number of the microorganisms (the total number, ammonifiers, actinomycetes, oligonitrophiles, fungi) increased by the soil depth all to the lowly-lying horizons (60 cm and lower), when their number abruptly decreased. Except for lime-dolomite humus, proteinase activity increased as the soil depth increased to visibly decrease in the deeper horizons. Positively correlated microorganism number and proteinase activity existed only in the alluvial-deluvial and in the alluvial soil to some extent. No correlation was revealed between the profile altitude of each of the soil groups and proteinase activity.

Key words: soil, profile, microorganisms, enzyme.

Introduction

Over the analysis of the chemical processes taking place in the earth crust, the role of human beings, particularly of the microorganisms has to be considered. Living beings are open systems being in the continual process of the matter and energy exchange with the surrounding non-living matters. In this

regard, living beings help chemical elements motion and the earth crust's atoms transfer, migrate and concentrate in it.Chemical elements enter living beings leaving them after their death to return into the new generations of the organisms after their propagation. These elements exist within the superb process of circulation, with living beings playing a significant role in it. Basically, by reflecting the growth of living matter over the individual limits such a process implies one of the fundamental characteristics of the biota and its being largely spread all over the Earth, particularly when conquering new and uninhabited areas.

A continual transmission of life, its geochemical energy, the speed of which is specific for each of the organisms, represents a constant and may be numeriacally expressed, being, at the same time, far greater for the microscopic organisms than it is for the other ones (Vernadski, 1960).

The soil is the part of the symbiosis in which microorganisms are playing an important role.; soil is the key basis of human life, plants and animals, satisfying their needs (Bidwell, Hole, 1965) but with the key role of the microorganisms, which, thanks to a short generative time, impart the biogeochemically most active living system with the decisive role in the matter and energy circulation in the nature.

This research, as the subject matter of this paper, can be of help to the experts from agriculture and forestry, for planning their development and production, establishing biological productivity and suitability of soil utilisation in the particular production, fertilizers to be used for agro-, hydro- and forestry melioration and soil erosion, too.

Therefore, the characteristics of relief, climate and the most important elements of the biological productivity of the most spread soil types in Monte Negro were examined and determined.

Materials and Method

The study conducted over 2000, included river-basin of Lim 220 km long with its 123 km flowing on the territory of Monte Negro and gravitating the territories of the towns Gusinje, Plav, Andrijevica, Berane and Bijelo Polje. The fundamental microbiological characteristics of some soil types of Monte Negro were studied.

Fifty-seven profiles of the various soil types were opened [brown district (acid), brown eutric soil, alluvial-deluvial soil, lime-dolomite humus] their description made and soil samples taken from the genetic horizons. In the boundaries of each of them the places and depths of sampling had previously been marked (Fig.1)

The analysis of the physico-chemical soil properties of the horizons of the studied soil types was made in the Soil Research Centre of the Biotechnical Institute in Podgorica, and micro- and biological analyses performed in the Laboratory of Microbiology of the Faculty of Agronomy, Cacak.

Physical and physico-chemical properties of the soil of the genetic horizons of the profiles were determined following the standard JDPS methods

"A Handbook for Soil Research", 1966 (the content of soil-alkalia carbonates determined after Schibler's method, 1960; humus after the method of Kotzman, 1960, and readily-available phosphorus and potassium with Al-method of Egner-Riehm, 1960).

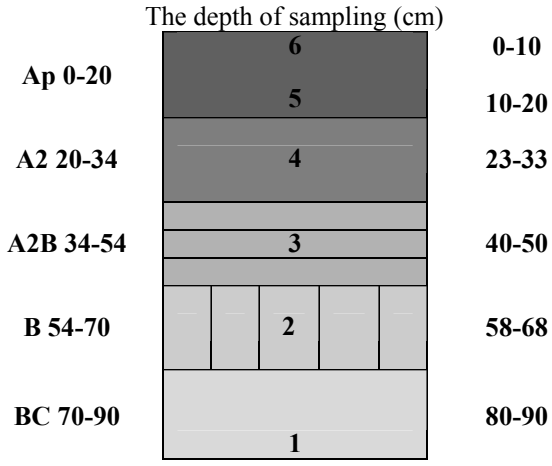

Fig.1. Sequence and mode of sampling from the genetic horizons of the soil

Distribution of the microbiological activity per profile of the soil types, was monitored by the analysis of quantitative and qualitative content of the microorganisms and proteinase activity.

Soil samples for microbiological analysis were taken from the genetic, bottom up to the surface layer, following the asepticity requirements. The ingredients of organic origin, roots, stones etc.. were removed from soil, dryed up, ground, sifted through the sieve 2mm in diameter, and kept in the refrigerator at +4^{o}C till the analysis.

The total number of microorganisms, actinomycetes, ammonifiers, oligonitrophiles and fungi and proteinase activity were determoned.

The total number of the microorganisms was determined on the nutritive stock for the total of bacteria («Torlak») that of ammonifiers on the synthetic agar Krasiljnikov (1949), those of fungi on the Capek and oligonitrophiles on the Fjodorov agar.

The stocks for the total microorganism and ammonifier number determination were sown with 0,5 cm^3 per 10-6 dilution of the soil suspension, Capek and synthetic agar of Krasiljnikov and Fjodorov nutritional stock were sown with 0,5 cm^3 10^{-3} dilution soil suspension.

Incubation was performed in the thermostat at the temperature of 28^{o}C over 7 days for the total of the microorganisms and actinomycetes, 5 days for fungi and 4-5 days for oligonitrophiles.

All the microbiological analyses were made with three replicates, and the microorganism number was calculated per 1 g of the absolutely dry soil.

Proteinase activity was determined by titration method after Romeiko (1969).

The amount of $FeCl_3 \cdot 6\ H_2O$ helped calculate proteinase activity, with 0,2 cm^3 of the used titration means corresponding 10 gelatinous units. Proteinase activity was calculated per 1 g of air dry soil.

Results and Discussion

Natural ecosystems have existed for hundreds and hundreds of years and are featured by a remarkable stability and viability both, in time and space. This is the result of stable trophic ties and of a well-balanced matter and energy cycling between an organism and environment. That it is not an absolute stability is beyond question. Populations of the microorganisms may increase or decrease, which will not oust the ecosystems from the balance, but it will keep them in the dynamic equlibrium so that they may be able to withstand the environmental changes and maintain balance all thanks to their being open and so further enable solar energy and chemical elements to constantly reach the autotrophs,on the one hand, while the process of synthesis is being continually accompanied by degradation, on the other. The equlibrium or stability should be regarded in the dynamics of a hystorical development allowing for incidental and occasional changes. Biocenosis can both, adapt to the species chosen to suit the existing living conditions and alter them in its favour ensuring their relative sustainability. However, natural and antropogenous factors cause slow, but dynamic and constant changes in the ecosystems being so developed, in other words, the biocenoses are successively taking place within the same isotype.

The character of sequence of the biocenoses is determined by the environment influenced by the community. The populations, tending to modify the environment and providing conditions to favour the other populations, have been exerting the species to change in successions until the equilibrium is made between the organisms and abiotic environmental elements influenced by internal (genetic variability, the state of the populations' being oversupplied with various mutations, mutation process, natural selection, adaptations, evolution in terms of the species competition, community evolution etc) and external factors (geological and climatic changes). In such a way, all the organisms are responsible for keeping dynamic equilibrium with the environment (Varlamov, Habarov, 1999).

In this regard, soil microorganisms deserve mention, their number and activity being related not only to the presence of the mineral nutrition elements, but also to the exo-osmosis, pH and to the entire effect of differing ecological factors, too.

Microbial activity of the types of soil studied

The studies have shown that microbiological activity of all the soil types depends on their physico-chemical properties, horizon's depth and on other factors, too tab.1)

Tab1. Chemical properties of the genetic horizons of the soil types studied

Place, Section,Square / River basin, the Lims tributary		Locality	Tipe of soil	Altitude	No of profile	Depth cm	pH		$CaCO_3$%	Humus %	Soluble		Moisture %
							H_2O	KCl			P_2O_5 mg/ 100g	K_2O mg/ 100g	
1.		2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1	Đurička rijeka	Đurička rijeka	I	1400	1/1	0-15	6.74	6.00	0.00	9.80	10.87	36.62	2.40
2					1/2	15-30	6.45	5.71	0.00	4.98	5.05	9.64	2.23
3	Bijeli potok	Brezojevice	II	1050	3/1	0-5	6.72	6.17	0.00	5.41	9.07	9.05	2.03
4					3/2	5-10	6.87	6.21	0.00	4.07	1.05	2.64	1.67
5					3/3	10-40	7.02	6.18	0.00	2.64	0.40	1.52	1.49
6	Novšićki potok	Novšići	I	990	4/1	0-8	4.83	3.89	0.00	5.61	2.96	27.00	2.25
7					4/2	8-30	5.11	4.23	0.00	1.67	0.49	6.00	1.78
8	Velička rijeka	Velika (Radevići)	I	1500	5/1	0-10	5.10	4.21	0.00	9.92	1.29	42.43	2.93
9					5/2	10-30	5.19	4.01	0.00	2.17	0.10	21.23	1.43
10	Dragovo vrelo	G.Ržanica	II	1150	6/1	0-30	6.51	5.96	0.00	3.27	28.96	8.67	1.31
11	Pepička rijeka	Pepići	II	850	7/1	0-10	6.73	6.29	0.00	6.40	13.97	22.27	2.88
12					7/2	10-30	6.79	6.17	0.00	4.74	1.66	10.00	2.53
13	Krivački potok	Mašnica (Krivače)	III	1200	8/1	0-10	6.22	5.88	0.00	6.59	3.42	29.57	1.91
14					8/2	10-30	6.24	5.86	0.00	3.53	0.74	6.81	1.20
15	Murinska rijeka	Goleš	III	1220	9/1	0-10	7.12	6.75	0.00	6.96	62.06	52.65	2.73
16					9/2	10-30	7.01	6.62	0.00	5.88	42.17	33.73	2.22
17	Šeremetski potok	Kruševo	II	1000	10/1	0-10	6.89	6.45	1.30	7.66	16.56	59.38	3.77
18					10/2	10-30	7.27	6.75	3.20	6.83	5.71	22.83	2.97
19	Zorin potok	Gračanica(Dušanova česma)	I	1070	11/1	0-10	6.45	6.02	0.00	6.97	2.04	38.86	2.65
20					11/2	10-30	6.26	5.80	0.00	5.73	0.82	11.93	2.40
21	Duboki potok	Ulotina(Šoškići)	II	1150	12/1	0-10	6.09	5.46	0.00	7.52	1.51	12.26	3.13
22					12/2	10-20	6.10	5.30	0.00	3.74	0.50	2.64	1.74
23	Piševska rijeka	Luke	I	980	13/1	0-40	6.53	5.84	0.00	5.48	30.51	44.31	2.96
24	Zim potok	Sutjeska	II	1030	14/1	0-15	7.57	7.11	3.00	7.22	117.1	57.78	2.80
25					14/2	15-40	7.55	7.00	1.70	4.93	119.8	34.37	2.08
26	Seočko vrelo	Seoce	II	940	15/1	0-8	6.90	6.52	0.00	5.82	20.84	80.22	2.12
27					15/2	8-30	6.50	6.14	0.00	5.05	14.73	59.38	2.09
28	Zlorečica	Kuti	III	1100	16/1	0-10	8.00	7.24	1.10	6.74	2.08	11.93	2.68
29					16/2	10-20	8.00	7.68	3.00	2.24	0.28	1.36	0.77
30					16/3	25-35	7.88	7.44	1.50	1.88	0.32	3.60	0.90
31	Kraštica	Peovac	I	900	17/1	0-10	6.31	5.79	0.00	6.33	35.10	37.26	2.53
32					17/2	10-30	6.07	5.12	0.00	5.24	15.26	13.54	2.24
33	Malski potok	Trešnjevo	I	800	18/1	0-5	7.14	6.69	0.00	6.75	93.01	46.56	2.63
34					18/2	5-40	7.15	6.83	0.00	4.67	62.44	60.00	1.80
35	Trepčanska rijeka	Trepča (Vasovići)	IV	820	19/1	0-10	6.18	5.64	0.00	5.77	0.29	4.06	2.11
36					19/2	20-40	7.09	6.65	0.00	1.36	1.54	1.36	1.01
37	Šekularska rijeka	Marsenića rijeka	II	800	20/1	0-30	7.05	6.71	0.00	4.97	47.48	14.82	2.01
38	Navotinski potok	Navotina	II	800	21/1	0-40	6.84	6.30	0.00	3.16	6.63	15.14	1.74
39	Vinicka rijeka	Vinicka	II	760	22/1	0-10	7.01	6.61	0.00	11.87	20.08	40.15	3.76
40					22/2	10-30	7.27	6.94	0.00	6.20	2.82	8.67	2.74
41	Rovački potok	Bijedanj	II	980	23/1	0-20	7.29	6.92	0.00	5.66	3.26	8.73	2.31
42					23/2	20-60	8.03	7.42	0.00	1.56	2.58	3.92	1.96
43	Krivaja	Buče	III	750	24/1	0-10	7.28	6.92	0.00	5.79	163.7	69.32	2.23
44					24/2	10-30	7.23	6.85	0.00	4.89	141.1	50.93	2.09
45	Bistrica	Lužac	II	850	25/1	0-10	5.71	5.30	0.00	7.46	9.29	27.61	3.09
46					25/2	10-30	5.90	5.27	0.00	3.30	17.28	10.86	2.32
47	Kaludarska rijeka	Kaludara (Aluge)	III	1050	26/1	0-10	6.07	5.62	0.00	4.99	1.45	5.51	1.88
48					26/2	10-40	6.10	5.64	0.00	1.46	2.73	1.87	1.04
49	Makva	Luge	III	700	27/1	0-30	7.40	6.98	1.30	6.64	0.73	2.11	2.70
50					27/2	30-60	8.14	7.74	3.90	1.46	0.33	1.00	0.66
51	Šušica	Beranselo	V	960	28/1	0-15	7.07	6.71	2.16	5.28	4.41	20.08	1.92
52					28/2	15-30	7.55	7.07	2.50	4.21	1.21	5.27	1.79
53	Dapsićka rijeka	Jasikovac	II	750	29/1	0-5	7.25	6.77	1.73	9.37	3.33	17.90	5.56
54		(Batuni)			29/2	5-20	7.65	7.00	4.75	6.95	1.77	12.80	4.27
55					29/3	20-40	7.52	6.65	1.30	5.49	1.89	15.71	5.01
56	Crepulja	Luke (Lučka rijka)	I	850	30/1	0-10	5.79	5.21	0.00	6.30	2.01	25.43	1.89
57					30/2	10-40	4.99	3.94	0.00	3.01	0.00	8.18	1.38

KEY: I-brown district (acid) soil II- brown eutric soil; III- alluvial deluvialsoil; IV- alluvial soil ; V- lime dolomite humus

The number of microorganisms in brown (acid) soil

The number of the microorganisms in the soil represents an index of its biogenity. However, that number is also determined by other factors (physico-chemical soil properties, plant areal etc.) so that no reliable correlation exists between the number of microorganisms and soil biogenity.

Microorganisms, developed within the entire number (on the agarised soil extract), represent the group which is the major bearer of the mineralisation process of the organic matter that has largely been transformed. The higher microorganism number is, the higher decomposition of organic matter and prevalence of the mineralisation processes, is.

Except for the profile 48, with characteristically abrupt acidification with the depth (tab.1.), the total of microorganisms increased by pedological profiles (22) of brown district (acid) soil all up to 80 cm depth, when their number suddenly dropped (tab.2.).

The lowest total number was recorded in the 0-5 cm and 80-120 cm deep horizons due to large amounts of untransformed organic matter, i.e. anaerobic conditions and acidification, which led to poorer quantitative and qualitative content of the microorganisms in these profiles. In contrast to that, in the 30-40cm deep horizon of this soil type, a greater microorganism number was recorded, as the result of the largely transformed organic matter and more stable ecobiotrophic conditions benefiting the growth of differing microorganism groups.

Except for the profile 48, with its being characteristically abruptly acidified by depth, to which actinomycetes responeded highly sensitively, their number was increasing all up to 60cm, i.e. 80 cm deep soil, when it declined (tab.2).

Ammonifiers make up a numerous group of bacteria and fungi, which transform proteins and other organic compounds at which ammonia is released (Govedarica, Jarak, 1996). Optimal conditions favouring ammonifiers growth are 50-75% MVK and temperature of 40oC. Compared to the total of the microorganisms, a relatively high number of the ammonifiers has been manifested, suggesting the organic matter decomposition processes to being normally proceeding, whereas the mineralisation process has been slowed down (Rakicevic,2000).

Except for the profile 48, with its characteristically abrupt acidification with depth, ammonifiers were found to abruptly increase with depth to suddenly decrease in number in lower 80-120 cm, i.e. 60-100cm deep layers (tab.2).

Oligonitrophiles belong to the nitrogen fixing bacteria, utilising the mineral nitrogen but in small amounts and often accompanying Cyanobacteria and being found in their mucous sheaths where their number may reach from $3\text{-}5 \cdot 10^6$/1g mass of algae (Milosevic, 1988; according to Pesakovic, 2002).

Likewise, excepting 48. profile with its characteristic abrupt acidification by depth, in all the remanining profiles oligonitrophiles grew in number by depth all up to the lowly-lying horizons (30-60, i.e. 80-120cm) when their number suddenly decreased. (tab.2.).

Excluding 48.profile., with its characteristic abrupt acidification per depth, favouring fungi growth, all the other profiles indicated their higher number, but only up to the depth of 60 cm, when it suddenly dropped (tab.2.). All that was likely to be in harmony with their physiological function and ecological conditions, chracterised by

a high osmotic potential (Misustin, Jemcev, 1983) and a pronounced competitiveness compared to the other microorganisms (Franz, 1973)

No correlation was found between the number of the studied microorganisms and the altitude of the soil profiles under way.

Tab.2. Microbial activity of the brown acid soil profiles

No profiles	Profile depth	Total of number	Number of actino-mycetes	Number of ammonifiers	Number of oligonitrophiles	Number of fungi	Proteinase activity
1/1	(0-15)	33	56	30	7	25	0
1/2	(15-30)	53	158	60	75	72	50
4/1	(0-8)	12	52	26	31	29	40
4/2	(8-30)	51	60	41	78	85	15
5/1	(0-10)	30	12	27	6	6	0
5/2	(10-30)	52	32	34	56	42	5
11/1	(0-10)	8	16	33	7	11	35
11/2	(10-30)	76	70	113	76	49	5
13/1	0-40	15	21	13	12	14	10
17/1	(0-10)	10	33	39	7	10	25
17/2	(10-30)	67	67	65	49	27	25
18/1	(0-5)	2	23	30	9	10	15
18/2	(5-40)	79	81	48	89	30	15
30/1	(0-10)	93	25	42	40	8	30
30/2	(10-40)	115	50	97	98	18	5
31/1	(0-10)	82	27	31	36	7	30
31/2	(10-20)	109	38	75	50	12	15
31/3	(20-30)	156	48	169	75	6	10
34/1	(0-30)	55	0	38	31	38	25
36/1	(0-10)	46	43	47	31	10	5
36/2	(10-30)	128	46	78	49	19	20
36/3	(30-40)	185	94	150	125	15	15
42/1	(0-10)	68	40	53	19	41	25
42/2	(15-30)	118	62	86	24	16	-
43/1	(0-10)	53	23	22	30	27	15
43/2	(20-30)	78	28	42	39	26	45
45/1	(0-8)	96	85	65	17	31	35
45/2	(0-30)	89	38	75	54	39	20
45/3	(30-60)	120	50	82	84	53	30
46/1	(0-5)	62	25	46	20	14	45
46/2	(5-50)	92	31	53	27	16	25
47/1	(0-15)	40	137	34	32	52	30
47/2	(15-80)	78	97	56	46	57	35
48/1	(0-15)	54	86	41	50	14	50
48/2	(30-60)	45	78	31	37	33	25
49/1	(0-8)	43	93	48	24	44	15
49/2	(20-30)	57	15	52	52	55	20
50/1	(0-15)	102	73	135	32	61	5
50/2	(15-30)	117	85	145	43	66	45
51/1	(0-15)	32	39	25	32	48	30
51/2	(20-40)	45	63	28	38	59	30
53/1	(0-15)	31	83	19	54	58	5
53/2	(15-80)	45	124	36	63	78	20
53/3	(80-120)	20	74	18	51	49	5
54/1	(0-30)	34	32	72	162	11	20
54/2	(30-60)	60	82	142	86	5	5
54/3	(60-100)	80	71	67	238	4	20

56/1	(0-8)	27	18	48	39	3	20
56/2	(8-40)	38	33	171	88	10	35

The number of microorganisms in the brown eutric soil

The number of microorganisms to be distributed in the profiles of the brown district (acid) also applies to those of the brown eutric soil, allowing for their lowest number found in 0-15 cm deep profile 14, and the highest one in the 10-30cm deep profile 35, and its sudden decline found but not shallower than 60cm of the depth (tab.3).

Tab.3. Microbiological activity of the brown eutric soil profiles

No profiles	Profile depth	Total of number	Number of actinomycetes	Number of ammonifiers	Number of oligonitrophiles	Number of fungi	Proteinase activity
3/1	(0-5)	27	47	42	13	12	15
3/2	(5-10)	37	71	44	50	114	10
3/3	(10-40)	57	118	34	43	Ø	15
6/1	(0-30)	13	30	50	40	20	25
7/1	(0-10)	4	12	18	11	9	20
7/2	(10-30)	54	118	54	70	19	15
10/1	(0-10)	8	21	23	19	7	10
10/2	(10-30)	58	199	66	80	11	25
12/1	(0-10)	3	25	14	31	13	15
12/2	(10-20)	54	74	46	62	14	35
14/1	(0-15)	2	29	10	13	8	5
14/2	(15-40)	73	99	60	71	65	0
15/1	(0-8)	11	34	29	11	24	0
15/2	(8-30)	67	117	64	43	62	25
20/1	(0-30)	15	28	26	7	12	10
21/1	(0-40)	10	29	10	9	7	25
22/1	(0-10)	27	8	38	9	11	15
22/2	(10-30)	49	75	49	89	43	35
23/1	(0-20)	5	3	2	8	3	20
23/2	(20-60)	18	6	3	10	4	5
25/1	(0-10)	17	33	43	81	25	20
25/2	(10-30)	53	39	74	90	48	20
29/1	(0-5)	45	57	49	4	19	5
29/2	(5-10)	63	168	113	12	43	10
29/3	(20-40)	42	79	68	7	33	10
33/1	(0-20)	32	27	31	19	28	25
35/1	(0-10)	60	56	38	37	51	5
35/2	(10-30)	145	103	66	86	61	5
37/1	(0-40)	58	57	49	49	11	15
40/1	(0-15)	78	75	93	102	38	0
40/2	(15-60)	46	86	41	22	20	5
41/1	(0-10)	96	38	0	122	21	20
41/2	(10-30)	99	90	8	237	48	20

44/1	(0-5)	32	73	23	33	37	25
44/2	(5-40)	72	36	41	34	26	15
52/1	(0-20)	87	16	40	30	44	15
52/2	(30-60)	77	24	50	40	51	15

Excluding the profile 44, with its being characteristically abruptly acidified by depth (tab.1.) to which actinomycetes respond highly sensitively, their number increased by depth up to the 60 cm deep horizon (tab.3.).

In all the profiles studied, an increase in ammonifiers, oligonitrophiles and fungi was registered by depth, except for the lowest ones 3, 29 and 40 (tab.3.)

No correlation existed between the number of these microorganisms and the altitude of the soil profiles under way.

Microorganism number in the alluvial-deluvial soil

The lowest total microorganism number was found in the 0-10cm deep horizon of 24. profile, and the highest in that of the 57.profile (tab4). Likewise, the total of microorganisms was found to incerase by the depth in this soil type all up to somewhat lower horizons 25-30 cm deep of the profile 16, i.e., 50-80 cm in 57.profile, which resulted from the presence of the organic and mineral components in the soil, lower moisture and aggravated oxygen regime.

In the profiles of this soil type, with its characteristically high oxydo-reduction potential, actinomycetes grew in number with the depth up to the lowest 50-80cm deep horizon (tab.4.)

Tab.4. Microbiological activity of the alluvial-deluvial soil profile

No profiles	Profile depth	Total of number	Number of actinomycetes	Number of ammonifiers	Number of oligonitrophiles	Number of fungi	Proteinase activity
8/1	(0-10)	40	16	18	6	7	15
8/2	(10-30)	58	49	63	31	42	45
9/1	(0-10)	10	119	10	11	14	0
9/2	(10-30)	53	189	85	49	26	55
16/1	(0-10)	3	29	27	23	17	25
16/2	(10-20)	75	69	90	110	72	20
16/3	(25-30)	48	50	43	76	34	25
24/1	(0-10)	4	12	2	7	4	30
24/2	(10-30)	8	22	6	8	7	20
26/1	(0-10)	23	9	30	20	8	10
26/2	(10-40)	35	16	31	29	13	50
27/1	(0-30)	23	33	16	12	15	0
27/2	(30-60)	31	47	17	19	16	15
32/1	(0-15)	86	26	65	38	49	20
32/2	(15-30)	150	51	131	43	81	15
38/1	(0-40)	61	59	76	56	14	20
57/1	(0-10)	189	36	196	162	4	15
57/2	(15-30)	47	53	78	50	2	10
57/3	(50-80)	157	109	47	36	1	20

Except for the deepest profile (57) where the number of ammonifiers, oligonitrophiles and fungi was continually decreasing with the depth, in other, shallower profiles, the number of these microorganisms was on increase with the depth (tab.4.).

No correlation existed between the number of these microorganism groups and the altitude of the soil profiles under way.

Microorganism number in alluvial soil

In this soil type, just one profile was opened (19) in the total microorganism number declined with depth, most likely due to decreased oxydo-reduction potential in the lower horizon 15-30cm deep (tab.5.).

Tab.5. Microbial activity of the alluvial soil profile

No profiles	Profile depth	Total of number	Number of actinomycetes	Number of ammonifiers	Number of oligonitrophiles	Number of fungi	Proteinase activity
19/1	(0-10)	58	70	59	31	37	5
19/2	(20-40)	47	72	52	46	48	35

The number of actinomycetes in the given profile increased with the depth (tab.5.), which was characteristic of the number of ammonifiers, oligonitrophiles and fungi.

In this case, correlation was established between the studied microorganism groups and the altitude of the soil type.

Microorganism number in the lime-dolomite humus

Only one profile (28) was opened in this type of soil with the two horizons (0-15 and 15-30cm) in which the total of microorganisms increased with the depth (tab.6.)

Tab 6. Microbiological activity of the lime-dolomite humus profile

No profiles	Profile depth	Total of number	Number of actinomycetes	Number of ammonifiers	Number of oligonitrophiles	Number of fungi	Proteinase activity
28/1	(0-15)	29	16	16	15	14	40
28/2	(15-30)	67	43	18	26	15	15

Due to highly suitable distribution of pH values of 7,07 in the horizon 0-15 cm deep and 7,55 in the one 15-30cm deep (tab.6) actinomycetes increased rapidly with the depth of the profile (tab.6.).

As being in the previous soil type, ammonifiers, oligonitrophiles and fungi were found to grow in number with the depth (tab.6.)

No correlation was found between the number of these microorganism groups and the altitude of the soil type concerned.

Proteinase activity of the soil types concerned

Despite frequent reduction of the microorganism number with pedological profiles, it was not the case with proteinase activity, as confirmed in the study, meaning that irrespecive of microorganism number (moisture deficit, extreme droughts etc.) soil solution represents no inert substrate but the state of the highly active microorganisms in such conditions (Zvjagincev, Zajceva, 1979; saric, Mrkovacki, 1988, Jemcev, Djukic, 2000). In acid soils, a significant decline in enzymatic acitivity may take place, which need not be in correlation with general soil biogenity, expressed in the total number or otherwise.

Proteinase activity in brown acid soil

Except for 48. soil profile, which gets abruptly acidified with the depth, regular rise in proteinase activity was noticed(tab.2).

Increase in proteinase activity was noticed in a range of profiles with depth, with exceptions of the deepest horizons of the 45. (30-40cm) and 53.profile (80-120cm deep) with the lowest proteinase activity detected (tab2.).

No positive correlation existed between the number of all the microorganism groups and proteinase activity (tab.2.).

No correlation was observed between proteinase activity and altitude of the soil profiles.

Proteinase activity in brown eutric soil

In general, except for the one in the deepest horizons of the profiles 41 and 52., proteinase activity mainly increased with depth (tab.3) No distinct correlation was found between the number of microorganisms and proteinase activity (tab.3) nor between proteinase activity and the altitude of the soil profiles concerned.

Proteinase activity in alluvial-deluvial soil

Proteinase activity may increase with the depth of the profiles (tab.4.) Except for 24. and 32. profile, the correlation existed between the miroorganism number and proteinase activity (tab.4.). No correlation was evidenced between the altitude of the profiles and proteinase activity (tab.4)

Proteinase activity in alluvial soil

In this soil type with oxidized conditions, proteinase activity increased with the depth, which is in agreement with the results of other authors (Ladd. Paul, 1973). In addition, direct correlation existed between the microorganism groups and proteinase activity (tab.5.) but none of it between proteinase activity and the soil altitude.

Proteinase activity in lime-dolomite humus

Inverse correlation was observed between the number of microorganisms and proteinase activity (tab.6) due to, contrary to the previously described soil, the soil of the mechanically heavier composition with lower Eh- value, which might have induced reduction processes giving rise to the changes in the valent states in some of the soluble elements (Fe, Mn, Al and the like) with toxic effect on the majority of saprophite microorganisms (Misustin et al., 1978) and consequently inevitably lower proteinase activity. No correlation was found to exist between proteinase activity and the altitude of lime-dolomite humus.

Conclusion

Based on the research results and references, the following conclusions could be inferred:

- the number of the microorganism groups increased with depth in all the soil types all up to lowly lying 60 cm deep or lower horizons when it suddenly decreased;
- except for alluvial-dolomite humus, proteinase activity increased with the depth in all the remaining soils to start decreasing in the deeper horizons;
- somewhat direct correlation between the microorganism groups and proteinase activity existed only in the alluvial-deluvial and in the alluvial soil;
- no correlation existed betwen the altitude of the profiles under way and proteinase activity

The results obtained and conclusions drawn suggest certain recommendations for implementing appropriate ammendment procedures in order to control or hinder erosion, raise soil biological productivity and use it purposefully – in agriculture, cattle raising, forestry etc.

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DINAMIKA MIKROBIOLOŠKE AKTIVNOSTI NAJZASTUPLJENIJIH TIPOVA ZEMLJIŠTA CRNE GORE

- originalni naučni rad -

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Rezime

Proučavana je distribucija brojnosti nekih fizioloških grupa mikroorganizama i njihova aktivnost po profilima najčešćih tipova zemljišta kontinentalnog dela Crne Gore. Otvoreno je 57 profila različitih tipova zemljišta – smeđe distrično (kiselo), smeđe eutrično, aluvijalno-deluvijalno, aluvijalno i krečnjačko-dolomitna crnica.

Distribucija mikrobiološke aktivnosti po profilima izučavanih tipova zemljišta praćena je na osnovu analize kvantitativnog i kvalitativnog sastava mikroorganizama i aktivnosti proteinaze.

U svim tipovima zemljišta brojnost ispitivanih grupa mikroorganizama (ukupan broj, amonifikatori, aktinomicete, oligonitrofili, gljive) raste po dubini, sve do niželežećih horizonata (60 cm i niže), kada dolazi do naglog sniženja njihove brojnosti. Izuzev u krečnjačko-dolomitnoj crnici, u svim ostalim tipovima zemljišta proteinazna aktivnost je rasla po dubini, da bi se tek u dubljim horizontima njena aktivnost snizila. Samo se u aluvijalno-deluvijalnom i aluvijalnom zemljištu može, donekle, tvrditi da postoji upravna srazmera između brojnosti ispitivanih grupa mikroorganizama i proteinazne aktivnosti. Između nadmorske visine profila svih proučavanih tipova zemljišta i proteinazne aktivnosti nije utvrđena korelacija.