Microbiological Characteristics of Forest Soils of Different Types in the West Balkan Range

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Studies on the microbial activity of forest soil in Bulgaria have mainly involved the regions of the Central Balkan Range, the North West Rhodopes, etc. The purpose of the present work was to investigate the microbial activities in brown, grey and mountain-meadow forest soils in a broad region of the West Balkan Range, at altitudes of 400 to 1800 m, which had not been studied previously. The relief was typically mountainous. The vegetation was represented mainly by beech, spruce, Scots pine, Macedonian pine /on brown forest soils/, Turkey oak /on grey forest soils/, and herbaceous species /on mountain-meadow soils/.

The plots and sections examined were established within stands of 90-140 years of age, with slopes from 0^{o} to 30^{o}, and a wide range of situations.

The investigation was carried out in 1988, in the middle of the growing season. Microbiological analyses were made following the dilution method by inoculations on hard nutritious media /in genetic horizons/. Ammonifying bacteria were distinguished on MPA, bacilli on MPA + malt agar, mineral nitrogen fixing actinomycetes and bacteria, both on CAA, and microscopic fungi on acidified Tchapek medium.

As far as the brown forest soils were concerned, the investigation included soil sections in the low mountain belt /400-600 m alt./, the medium mountain belt /600-1000 m alt./, and the high mountain belt /1500-1800 m alt./. In order to ensure the comparability of the data obtained, soils under grade II stands facing west were selected.

Results

The results showed that the total amounts of microflora in brown forest soils under beech stands increased with altitude /Table 1/. In brown forest soils in the high mountain belt, situated at the highest altitudes, these same amounts were about 5 times more /P 15/ than the amounts in soils in the low mountain belt /P 36/. The microflora was dominated by ammonifying bacteria on MPA.

In the adjacent mountain-meadow soils and grey forest soils the development of soil microorganisms showed deviations which were closely related

Table 1

Qualitative composition of soil microflora

Soil type	Horizon depth cm	Total micro-flora	Bact. on MPA		Bacilli, thou-sand/g	Actinomycetes		Fungi	
			thous-and/g	%		thous-and/g	%	thous-and/g	%
Grey forest soil	A-15	1255	362	29	191	851	68	42	3
	B-80	96	16	17	44	76	79	4	4
	C-150	35	8	23	1	25	71	2	6
Brown forest soil	A-3	721	453	63	103	124	17	144	20
/P 36/	B-14	394	317	88	23	73	11	4	1
	C-110	19,8	11	55	2	8	40	0,8	5
Brown forest soil	A-6	1450	975	67	150	375	26	100	7
/P 60/	B-19	670	236	35	97	426	64	8	1
	C-75	339	327	96	59	10	3	2	1
Brown forest soil	A-19	3999	3682	92	136	249	6	68	2
/P 15/	B-66	349	289	83	29	44	13	16	4
	C-121	22	15	68	8	6	27	1	5
Mountain-meadow soil	A-5	2962	1924	65	1393	836	29	202	6
	B-35	1106	895	80	474	132	12	79	8

to, and determined by, different combinations of ecological conditions, trophic factors, and physical and chemical soil properties.

The total amounts of microflora in grey forest soils were greater than those in brown forest soils in the low mountain belt. This increase was determined by the active development of actinomycetes and of the bacilli participating in the decomposition of hardly available organic matter. The active development of soil microflora in grey forest soils led to intensive microbial activity and accelerated mineralization processes, which appeared to be one of the factors that determined the formation of extensive humus and accumulation horizons.

By contrast, in brown forest soils in the low mountain belt the amounts of non-sporous bacteria and microscopic fungi were two and three times larger, respectively. In addition, the mineralization processes were less pronounced /Table 2/. These trends were preserved in depth, too. This was confirmed by data on the relative participation of various groups of microorganisms in soil microbiocoenosis.

The trends in soil microflora development in mountain-meadow soils were different. The total amounts of microflora were smaller than those in the adjacent brown forest soils in the high mountain belt. The active development of non-sporous bacteria in the latter indicated the active mineralization of easily available organic compounds, while the mineralization processes in mountain-meadow soils were in later but not so active stages /Table 2/, probably due to the more active development of other groups of microorganisms, i. e. actinomycetes, bacilli and microscopic fungi.

The distribution of microorganisms in deep soil sections provided different microbiological profiles in soils of different types. In grey forest soils this distribution fluctuated considerably from the A to B and C horizons /with about 36 times smaller amounts of microflora at a depth of 150 cm/. In the brown forest soils of the low mountain belt /P 36/, at

Table 2

Ratio of nitrogen-converting microorganisms

Soil type	Horizon	Bacteria on CAA	Bacteria on MPA	Mineralization coefficient
		thousand/g		
Grey forest soil	A	341	362	0.94
	B	85	16	5.3
	C	6	8	0.75
Brown forest soil /P 36/	A	239	453	0.64
	B	1225	317	3.86
	C	15	11	1.36
Brown forest soil /P 60/	A	3800	975	3.9
	B	683	236	2.89
	C	186	327	0.57
Brown forest soil /P 15/	A	6409	3682	1.74
	B	905	289	3.13
	C	200	15	13.33
Mountain-meadow soil	A	2506	1924	1.30
	B	918	895	1.02

almost the same altitude, this transition was more gradual /from the humus accumulation horizons to the B horizons/. In the C horizons a sudden decrease in the quantitative development of the microflora was again observed.

A similar trend was observed when comparing the development in depth of soil microorganisms in mountain meadow soils with that of the microorganisms in brown forest soils. All the soils were in the high mountain belt /P 15/. In mountain-meadow soils gradual transitions were observed to the C horizons, while in brown soils at the same altitudes the distribution of microorganisms underwent a sharper decrease with depth /10 times samller amounts/. The peculiarities in the morphological structures of mountain-meadow soils, and the fact that they generally have more extensive humus and accumulation horizons led to a more even distribution of microorganisms in depth.

Conclusions

The qualitative compositions of soils microflora were different for the forest soils examined. Brown forest soils and mountain-meadow soils were dominated by ammonifying bacteria /mainly non-sporous ones, on MPA/. Grey forest soils were dominated by actinomycetes.

The total amounts of microflora were largest in brown forest soils in the high mountain belt, followed by mountain-meadow soils and grey forest soils.

Forest soils of different types had different microbiological profiles, with a gradual quantity transition in depth for brown forest soils at altitudes of 400-600 m and for mountain-meadow soils, and a more sudden transition for grey and brown forest soils at altitudes of more than 1000 m.

Mineralization processes decreased with on increase in altitude, from grey forest soils to mountain-meadow soils.