Biological Activity in Soil Under Various Forest Stands

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The investigations were aimed at obtaining information about the activity of the microflora in the soils of forest stands. The cellulolytic activity and microbial number were used as indexes of the soil biological activity. The cellulose biodegradation was assayed by Unger's cellulose test and the microbial number was determined using the dilution plate technique. The dilution plate technique is not accurate enough to determine the correct microbial numbers. For this reason, an attempt was made to obtain an overall picture of time and spatial changes in microbial numbers. As the investigations were to be carried out in forest stands, it was assumed that the cellulose biodegradation activity would be an important characteristic of the soil.

Methods

The stands investigated were:

1. Brennberg valley in the Sopron hills; 100-year-old Norway spruce stand on an acid non-podzolic brown forest soil /pH 4.3/; climate category: hornbeam-oak.
2. Vadkanárok valley in the Sopron hills; 100-year-old Norway spruce stand on a lessivated brown forest soil /pH 5.3/; climate category: hornbeam--oak.
3. Bögöte; 20-year-old Scotch pine stand on an acid non-podzolic brown forest soil /pH 4.3/; climate category: hornbeam-oak.

The climate categories are based on the Hungarian site-type classification system. Under Hungarian conditions the climate can be characterized by forest associations and their prevailing tree species. These are the so--called - "climatic test plants" -, ranked according to decreasing humidity requirements, as follows: beech, hornbeam, sessile oak, Turkey oak, and finally the forest steppe.

The samples were taken from the experimental areas in Sopron at the same time four times a year /February, May, August and October/ and at Bögöte three times a year. No samples were taken there in February. The samples were taken from three soil levels in Sopron: the decomposing litter,

the top 8 cm and the 8-16 cm layer of the soil. Samples were only taken from the top 8 cm of the soil in Bögöte.

Sampling was always followed by laboratory analysis within 24 hours. The microbial number was determined from each sample in 3 repetitions. The following nutrient media were used: Broth-pepton agar for bacteria; Jensen's nutrient agar for Actinomycetes; Martin's nutrient agar for fungi. The duration of the incubation period was 3 days in the case of bacteria, 6 days for ray fungi and 4 days for fungi. The incubation temperature was 28 ^{o}C.

The cellulose biodegradation was assayed by Unger's cellulose test. The 10x10 cm small test bags included 5 g cotton. The test bags were put into the soil layers described above.

Results and discussion

Comparisons were made between two Norway spruce stands in the same climate category on different soil types, and between a Norway spruce stand and a Scotch pine stand on the same soil type and in the same climate category.

Investigations on forest stands with similar tree species

As can be seen in Table 1, the bacterium numbers were higher by an order of magnitude beneath the Norway spruce stand on a lessivated brown forest soil than on an acid non-podzolic brown forest soil. 16-79 million cells of bacteria per g of soil were counted in decomposing litter on the lessivated brown forest soil and 1.8-8.6 million cells on the acid non-podzolic brown forest soil. This surplus was also noticeable in the soil samples, but the bacterium numbers were lower than in the decomposing litter. In the case of lessivated brown forest soil there were 1.9-8.7 million cells/g soil, while in the acid non-podzolic brown forest soil there were 120-290 thousand cells/g soil. In October the bacterium numbers were higher than in the summer. In summer there was a long dry period before sampling.

In the course of the investigations, fungal numbers were found to be a little higher on the very acid non-podzolic brown forest soil. On this area there were 170-350 thousand cells/g soil and these values were 15-40% higher than on lessivated brown forest soil. The likely reason for this was that the two areas had different chemical reactions. The number of fungi was highest in the decomposing litter, decreasing continuously with the depth of soil. The number of ray fungi was much higher than the number of fungi and bacteria. The reason for this is no doubt that the number of ray fungi included those in a state of dormancy. More ray fungi were found on the lessivated brown forest soil than on the acid non-podzolic brown forest soil. The decomposing litter contained the highest number, which then continuously decreased with depth. There were 19-850 million cells/g soil in the decomposing litter on the lessivated brown forest soil and 1.6-250 million on the acid non-podzolic brown forest soil. There were 1.6-250 million ray fungi in the top 8 cm and 5.4-45 million in the 8-16 cm layer in the lessivated brown forest soil, and 400-740 thousand and 290-630 thousand, respectively in the acid non-podzolic brown forest soil.

Cellulolytic activity was the highest in the top 8 cm soil layer of the acid non-podzolic brown forest soil. This coincided with the highest number of fungi. The value of cellulolytic activity was 50-60% higher in the top 8 cm soil layer than in the decomposing litter and 25-40% higher than in the 8-16 cm soil layer. 3 months after the experiment was set up it was 25-40%

Table 1

Investigations on forest stands of similar tree species

		Bacterium		Fungi		Actinomycetes		Cellulolytic activity	
		cells/soil						%	
		Bb.	Vk.	Bb.	Vk.	Bb.	Vk.	Bb.	Vk.
Spring	A_{oo}	1.8E6	1.6E7	1.0E5	8.9E4	1.8E6	3.7E8	30	28
	0-8 cm	2.3E5	4.7E6	1.8E5	1.5E5	4.0E5	1.6E6	72	55
	8-16 cm	1.8E5	7.6E6	2.2E5	2.0E5	3.1E5	5.4E6	58	32
Summer	A_{oo}	3.4E6	2.5E7	1.7E5	1.2E5	1.6E6	1.9E7	60	52
	0-8 cm	2.7E5	1.4E6	1.7E5	1.3E5	5.3E5	2.0E7	85	75
	8-16 cm	1.2E5	1.4E6	2.1E5	1.5E5	2.9E5	1.5E7	75	58
Autumn	A_{oo}	8.6E6	7.9E7	3.5E5	2.9E5	2.5E8	8.5E8	80	75
	0-8 cm	3.3E6	8.7E6	2.1E5	2.5E5	7.4E5	2.5E8	95	95
	8-16 cm	2.9E5	1.9E6	2.8E5	1.3E5	6.3E5	4.5E7	95	82

Bb. = Brennberg; Vk. = Vadkanárok; A_{oo} = decomposing litter

Table 2

Comparison of forest stands with different compositions

		Bacterium		Fungi		Actinomycetes		Cellulolytic activity	
		cells/soil						%	
		Bb.	B.	Bb.	B.	Bb.	B.	Bb.	B.
Spring	0-8 cm	2.3E5	1.3E5	1.8E5	9.2E4	4.0E5	6.3E5	72	53
Summer	0-8 cm	2.7E5	1.3E5	1.7E5	8.0E4	5.3E5	6.6E5	85	73
Autumn	0-8 cm	2.3E6	1.7E6	2.1E5	1.3E5	7.4E5	1.8E5	95	86

Bb. = Brennberg; B. = Bögöte

higher on the acid non-podzolic brown forest soil than on the lessivated brown forest soil, and 15-35% higher after a further 3 months.

Comparison of forest stands with different compositions

Because only the top 8 cm soil layer was studied on the experimental area at Bögöte this was compared with the same soil layer at Brennberg. The bacterial numbers ranged from 270 thousand to 3.3 million beneath the Norway spruce stand. This value was 34-51% higher than that beneath the Scotch pine stand /Table 2/.

The highest bacterial numbers were found in autumn. The number of fungi was 25-75% higher beneath the Norway spruce stand. There was a close connection between the cellulolytic activity and the counts of fungi. Cellulolytic activity was found to be 37% higher under the Norway spruce stand than in the soil of the Scotch pine forest stand 3 months after the start of the experiment. After 6 months the difference was only 16%.

The dilution plate counts of actinomycetes are seriously affected by the weather. It was the summer dryness rather than the biological activity that caused higher actinomycetes counts in the soil of the Scotch pine stand compared to the soil of the Norway spruce stand in summer.

Conclusions

On the basis of the examinations the Norway spruce stand seems to have a more intensive soil life than the Scotch pine stand, and this soil life is still more intensive if the site is not too acidic. Further investigations will be required to give a more exact picture of the situation.