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Structures and processes of biological soil crusts during initial ecosystem genesis of an artificial watershed in Lusatia, NE Germany

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The influence of biological soil crusts (BSC) in natural ecosystems on structures and processes is well investigated. In southern Brandenburg (NE Germany) it was possible to study the development of BSCs during initial ecosystem genesis on the artificial water catchment “Hühnerwasser”. The experimental site is located in the recultivation area of the lignite open-cast mining district of southern Brandenburg (Germany).

The geomorphological differentiation at the site was related to crust development, where substrate-dependent water availability defined the crust types. The mosaic-like pattern of the BSCs was associated with the distribution of fine-grained material. We defined three types if BSC: (a) initial cyanobacterial crusts (BSC-I), (b) cyanobacterial and green algae crusts on the soil surface (BSC-CG) and (c) crusts with mosses (BSC-M) between dense vegetation. The chlorophyll A content as an index for the biomass of the cryptogams increased significantly with crust type from 0.97 mg m^{-2} (BSC-I), 6.34 mg m^{-2} (BSC-CG) to 13.32 mg m^{-2}(BSC-M).

The sandy substrates with high contents of silt and clay were poorly sorted and spatially re-distributed by fluvial and aeolian processes. The contents of silt and clay were 15.9%-23.8% in the cyanobacterial crusts (BSC-I, BSC-CG) and 30.5% in the moss-crust (BSC-M). The pH values were about 7 (neutral) in all BSCs. The heighest C_{org} contents were found in BSC-CG (0.51%), but were not significantly lower in BSC-I (0.47%) and BSC-M (0.44%), where C_{org} concentrations of the original substrate ranged from 0.16 to 0.22% at construction of the catchment. The BSC types were very heterogeneously distributed and developed. Different crust types occurred in small-scale patches.

Cyanobacteria which exude mucilaginous material and the rhizoids and protonemata of mosses contributed to aggregating sand grains and enhanced the topsoil stability. Furthermore, filamentous cyanobacteria and algae partially filled in the matrix pores and enmeshed sand grains, and in a wet condition extracellular polymeric substances (EPS) clogged the available pore space.

Once settled, the crusts influenced the water regime of the soils. They were not pronounced hydrophobic, yet surface polarity differed between the crust types. Water infiltration was influenced by two factors: (i) the crust type, where infiltration rates were highest on almost bare substrate (BSC-I) and least when cyanobacteria and green algae formed a dense cover on the surface (BSC-CG), and (ii) the texture. Compared to BSC-CG, infiltration rates were elevated in BSC-M, pointing to decline of surface sealing when mosses penetrated the dense microphytic crust. However, the relationships among crust types, water repellency, particle size composition and infiltration are complex and need further investigation on different scales.

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