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Effect of vegetation on soil profile formation: results of a 47-years experiment

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Typical soil formation period in boreal ecosystems takes over centuries or longer. However, the rates of individual processes vary and consequently soil horizons and properties have different development periods. To evaluate the effect of vegetation, as a single factor, on the development of organic horizons, we used the soils of the lysimeters at Moscow State University. We generalized own results and long-term observations published before.
In 1965 the lysimeters (S=9 m2, depth=1.5 m) were filled with carbonate free clay loam taken in Moscow region and originated from the Valday glaciation. The initial pH was 5.7, and Corg 0.07%. The following plant communities were created in the lysimeters: 1) Picea abies, 2) Picea abies + Quercus robur + Acer platanoides, 3) Quercus robur + Acer platanoides, 4) grasses (10 species with domination of Lolium and Trifolium) and 5) agricultural crops (9-field rotation). After 20, 33 and 47 years the morphological description of soil profiles was done and Corg was measured in the upper horizons. Additionally, the combined density and aggregate fractionation (>2000 μm, 250-2000 μm and <250 μm) of soils sampled from the upper 0-5 cm under three vegetation types (1, 3, and 5) was done after 47 years.
Only litter horizons were formed on forest plots after 20 years. The horizons had various thicknesses but similar structure: the litter horizons were 0-2 cm high under the coniferous and broadleaf forests and consisted of L and H layers. Under mixed forest however, it comprised 0-0.5 cm and consisted of moss litter permeated with fungi hyphens. Mineral part of profiles was slightly colored with organic matter, whereas under grassland the Ah horizon (0-5 cm) was developed.
After 33 years under forest, the Ah horizons (0-5 cm) were already developed and had a lot of roots and organic residues. The rates of Corg accumulation were different with the values varying between 0.08 and 0.38% Corg year-1. After 47 years of soil formation, the Corg in 0-5 of Ah reached 5.3%, 2.93%, 8.2%, 2.1% and 0.9% for coniferous, mixed, deciduous, grassland and agricultural crops respectively. The depth distribution of Corg is sharply decreases in all soil profiles.
The combined aggregate-density fractionation had shown, that 30-74% of Corg of aggregates were associated with heavy mineral fraction (>2 g cm-3). In agricultural soil, this fraction was higher than in forest soils. High amount of non-hydrolized C (literature data) also reflected the strong connections of Corg with mineral matrix. The light fraction (<1.6 g cm-3) comprised 15-40% of Corg in aggregates and was maximal in forest soils. This could reflect differences in chemical composition of plant residues and rates of their decomposition as well as differences in their annual amounts.
We conclude that vegetation type has strong effect on organic matter formation and C accumulation at early stages of soil development.