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Carbon and nitrogen release in decomposition of boreal organic soils – Temperature sensitivity patterns

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Boreal forests and peatlands compose significant global carbon (C) storage. Decomposition of organic matter plays a key role in global greenhouse gas balance. Decomposition is a complicated process and is regulated by organic matter quality, physical conditions such as temperature, moisture and oxygen supply, nitrogen (N) availability, soil microbes and soil fauna. To reveal these interactions, multifactorial decomposition experiments are needed. We conducted such experiment in laboratory to quantify temperature sensitivity of C and N processes in decomposition of most common boreal organic soils. We incubated 36 mor and 36 slightly decomposed Carex-Sphagnum peat samples in constant moisture and constant ambient temperature for 6 months. The experiment included three temperature and two moisture levels, and two food web manipulations (samples with and without fungivore enchytraeid worms). The release of carbon dioxide (CO_2), dissolved organic carbon (DOC) in seven molecular size classes, together with ammonium N and dissolved organic N (DON) in low molecular weight (LMW) and high molecular weight (HMW) fractions were determined. Q10 temperature sensitivity function was fitted to the data. C and N release rate was almost an order of magnitude higher in mor than in peat. Soil fauna increased temperature sensitivity of C release. Soil fauna played a key role in release of N: in absence of soil fauna N immobilized throughout the experiment in peat samples. The wide range of the studied C and N compounds and treatments (68 Q10 -datasets) allowed us to recognize five different temperature sensitivity patterns. The most common pattern (37 out of 68) was a positive upwards temperature response, which was observed e.g. for CO_2 and DOC release. Negative downwards pattern was observed for extractable organic nitrogen and microbial C. Sixteen temperature sensitivity patterns represented a mixed type, where Q10-function is not applicable, because Q10 equation does not allow changing the sign of storage change rate within any temperature range. The mixed pattern was typical for intermediate decomposition products of N, in which input and output fluxes with different temperature sensitivities may simultaneously change the storage. The results support the carbon-quality-temperature –hypothesis.