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Microbial biomass dynamics dominate N cycle responses to warming in a sub-arctic peatland

J.T. Weedon (1), R. Aerts (1), G.K. Kowalchuk (1,2), and P.M. van Bodegom (1)

(1) Department of Ecological Sciences, Vrije Universiteit Amsterdam, The Netherlands (j.t.weedon@vu.nl), (2) Department of Microbial Ecology, Netherlands Institute of Ecology (NIOO-KNAW), Wageningen, The Netherlands

The balance of primary production and decomposition in sub-arctic peatlands may shift with climate change. Nitrogen availability will modulate this shift, but little is known about the drivers of soil nitrogen dynamics in these environments, and how they are influenced by rising soil temperatures. We used a long-term open top chamber warming experiment in Abisko, Sweden, to test for the interactive effects of spring warming, summer warming and winter snow addition on soil organic and inorganic nitrogen fluxes, potential activities of carbon and nitrogen cycle enzymes, and the structure of the soil-borne microbial communities. Summer warming increased the flux of soil organic nitrogen over the growing season, while simultaneously causing a seasonal decrease in microbial biomass, suggesting that N flux is driven by large late-season dieback of microbes. This change in N cycle dynamics was not reflected in any of the measured potential enzyme activities. Moreover, the soil microbial community structure was stable across treatments, suggesting non-specific microbial dieback. To further test whether the observed patterns were driven by direct temperature effects or indirect effects (via microbial biomass dynamics), we conducted follow-up controlled experiments in soil mesocosms. Experimental additions of dead microbial cells had stronger effects on N pool sizes and enzyme activities than either plant litter addition or a 5 °C alteration in incubation temperatures. Peat respiration was positively affected by both substrate addition and higher incubation temperatures, but the temperature-only effect was not sufficient to account for the increases in respiration observed in previous field experiments. We conclude that warming effects on peatland N cycling (and to some extent C cycling) are dominated by indirect effects, acting through alterations to the seasonal flux of microbe-derived organic matter. We propose that climate change models of soil carbon and nitrogen cycling should explicitly incorporate realistic microbial biomass dynamics.