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Limiting factors for soil microbial growth in climate change simulation treatments in the Subarctic

Mingyue Yuan, Meng Na, Lettice Hicks, and Johannes Rousk
Lund University, Faculty of Science, Biology, Sweden (mingyue.yuan@biol.lu.se)

Soil microorganisms play a crucial role in the regulation of nutrient cycling, and are thought to be either limited by low nutrient availability, or by labile carbon supplied by nutrient limited plant productivity. It remains unknown how climate change will affect the rate-limiting resources for decomposer microorganisms in the Arctic, rendering feedbacks to climate change highly uncertain. In this study, we focused on the responses of soil microbial community processes to simulated climate change in a subarctic tundra system in Abisko, Sweden, using litter additions to represent arctic greening and inorganic N fertilizer additions to represent a faster nutrient cycling due to arctic warming. We hypothesized that 1) the plant community would shift and plant productivity would increase in response to N fertilization, 2) microbial process rates would be stimulated by both plant litter and fertilizer additions, and 3) the growth limiting factors for decomposer microorganisms would shift toward nutrient limitation in response to higher plant material input, and towards C-limitation in response to N-fertilizer additions.

We assessed the responses of the plant community composition (vegetation surveys) and productivity (NDVI), microbial processes (bacterial growth, fungal growth, C and N mineralization) along with an assessment of the limiting factors for fungal and bacterial growth. The growth-limiting factors were determined by full factorial additions of nutrients (C, N, P), with measurement of microbial growth and respiration following brief incubations in the laboratory. We found that plant productivity was ca. 15% higher in the N fertilized plots. However, field-treatments had limited effects on bacterial growth, fungal growth and the fungal-to-bacterial growth ratio in soils. Field-treatments also had no significant effect on the rate of soil C mineralization, but did affect rates of gross N mineralization. Gross N mineralization was twice as high in N fertilized plots compared to the control. In control soils, bacterial growth increased 4-fold in response to C, indicating that bacterial growth was C limited. Bacterial growth remained C limited in soils from all field-treatments. However, in the N fertilized soils, the C limitation was 1.8-times greater than the control, while in soils with litter input, the C limitation was 0.83-times the control, suggesting that the N fertilized soils were moving towards stronger C-limitation and the litter addition soils were becoming less C-limited. The limiting factor for fungal growth was difficult to resolve. We presumed that the competition of fungi with bacteria decreased our resolution to detect the limiting factor. Therefore, factorial nutrient addition were combined with low amount of bacterial specific inhibitors.