Accumulation of carbon and nitrogen in relation to the ecosystem development in high-arctic Canada: effect of patterned ground

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Mud boils are a kind of the patterned ground which are associated with permafrost and widely distributed in high-arctic regions. Fresh mud erupts from the central part of mud boils during the winter and accumulates on the surface during the summer. This results in the disturbance of surface soils and could impede the colonization of mud boils by soil crust and vascular plants, leading to the local variation in the pattern of carbon and nitrogen accumulation in terrestrial ecosystems of the arctic regions. The purpose of the present study was to evaluate the effect of soil disturbance on mud boils on carbon and nitrogen accumulation in above- and belowground compartments of a deglaciated terrestrial ecosystem in high-arctic Canada.

The study was carried out in a deglaciated terrain in the front of Arklio Glacier of the Kreiger Mountains near the mouth of Oobloyah Valley (80^{o}50'N, 82^{o}45'E), Ellesmere Island, Canada. Arklio Glacier has developed at least five glacial moraines (moraines in relative ages 1, 2, 3, 4, and 5) with different development periods since the Last Glacial. In July 2004, a total of 4 plots (5x5m) were laid out at each of the ridge and bottom parts of the intermediate (relative age 3) and the oldest moraines (relative age 5). The ridge and bottom parts represented xeric and mesic habitats, respectively. Area and the stage of plant colonization were measured for all mud boils within the plots. We recognized three stages of plant colonization with reference to the eruption of fresh mud, the coverage of soil crust, and the colonization by vascular plants. Thus, mud boils in stage 1 had fresh mud eruption and cracks at the central part, stable peripheral parts covered by soil crust, and limited colonization of the edges by vascular plants; those in stage 2 had no mud eruption, coverage of the central part by soil crust, and colonization of peripheral parts by vascular plants; and those in stage 3 had colonization of the central parts by vascular plants. The coverage of fresh mud, soil crust, and vascular plants was determined and taxa of vascular plants were recorded for individual mud boils. Vascular plants, surface litter, soil crust, and mineral soils were sampled at the central and peripheral parts and analyzed for carbon and nitrogen contents.

Mud boils accounted for 30 to 63% of the plot area (25m^2). Fresh mud accounted for 10 to 23% of the area of mud boils in stage 1 and the remaining 77 to 90% was covered by soil crust. No fresh mud was observed in mud boils in stages 2 and 3 and the coverage by soil crust reached 100%. Coverage by vascular plants increased with the stage of plant colonization. No difference was found for the coverage of fresh mud, soil crust, and vascular plant between xeric and mesic habitats and between the intermediate and the oldest moraines. Four to six taxa of vascular plants were observed on individual mud boils, and the number of taxa was greater at mesic habitat than at xeric habitat. *Salix arctica* was the most frequent species at both habitats on both moraines. *Cassiope tetragona, Dryas integlifolia*, and *Luzula* spp. occurred more frequently at xeric habitat than at mesic habitat, whereas *Arctagrostis lactifolia, Alopecurus alpinus, and Carex* spp. occurred more frequently at mesic habitat.