



Bryophyte-cyanobacteria associations contribute to ecosystem-N-budget of boreal forest

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Bryophytes frequently dominate the ground vegetation on the forest floor in boreal region. Northern ecosystems are often nitrogen limited, and therefore biological nitrogen (N_2) fixation of bryophyte-associated microbes is an important source of new N. In this study we estimated the N stock of bryophyte layer and the N input rate by N_2 fixation of bryophyte-cyanobacteria associations at the ecosystem level. We studied 12 intensively monitored forest ecosystem plots (ICP Forests Level II) along a latitudinal gradient in Finland during 2009–2013. The total biomass and N stock of the bryophytes varied 700–2000 kg ha⁻¹ and 9–23 kg ha⁻¹, respectively. N_2 fixation rate associated to bryophytes increased towards the north and was at highest 1–2 kg N ha⁻¹ year⁻¹ (based on the bryophyte biomass in the monitoring plots). This N input was at the same level as the N deposition in the northern Finland (1.5 kg N ha⁻¹ year⁻¹). In comparison, via needle litterfall and other tree litter c.a. 5 kg N ha⁻¹ is annually returned to the nutrient cycle. In southern Finland, very low rates of N_2 fixation were found probably because of inhibition by the anthropogenic N deposition. The upper parts of the bryophyte shoots showed 2–3 times higher N_2 -fixing rate than the lower parts, but differences between *Hylocomium splendens* and *Pleurozium schreberi* were minor. However, *Dicranum* species showed much lower N_2 fixation rates compared to these two species. The moisture level of bryophytes and light/temperature conditions regulated strongly the rate of N_2 -fixing activity. The results showed that the bryophyte layer significantly contributes to the N input and plays an important role in controlling the N and C balances of boreal forests.