Submitted Abstract

ID IMC22-FSAbstr- 748

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Country	Venezuela, Bolivarian Republic of
Region	South America
Title	Vegetation Assembly, Adaptive Strategies And Positive Interactions During Primary Succession In The Forefield Of The Last Venezuelan Glacier.
Keywords	Andes, Adaptive Strategies, Climate Change, Facilitation, Soil Development
Type	List Of Focus Session
Focus Session ID	33

Abstract

Glaciers are receding at unprecedented rates in the alpine tropics, opening-up new areas for ecosystem assembly. However, little is known about the patterns/mechanisms of primary succession during the last stages of glacier retreat in tropical mountains. Our aim was to analyze soil development and vegetation assembly during primary succession, and the role of changing adaptive strategies and facilitative interactions on these processes at the forefront of the last Venezuelan glacier (Humboldt Peak, 4,940 m asl). We established a chronosequence of four sites where the glacier retreated between 1910 and 2009. We compared soil organic matter (SOM), nutrients and temperatures inside vs. outside biological soil crusts (BSCs) at each site, estimated the cover of lichen, bryophyte and vascular plant species present, and analyzed changes in their growth-form abundance and species/functional turnover. We also evaluated local spatial associations between lichens/bryophytes and the dominant ruderal vascular plant (the grass Poa petrosa). We found a progressive increase in SOM during the first century of succession, while BSCs only had a positive buffering effect on superficial soil temperatures. Early seral stages were dominated by lichens and bryophytes, while vascular plant cover remained low during the first six decades, and was almost exclusively represented by wind dispersed/pollinated grasses. There was a general increase in species richness along the chronosequence, but it declined in late succession for lichens. Lichen and bryophyte communities exhibited a higher species turnover than vascular plants, resulting in the loss of some pioneer specialists as succession progressed. Lichen and bryophyte species were positively associated with safe-sites for the colonization of the dominant ruderal grass, suggesting a possible facilitation effect. Our results indicate that lichens and bryophytes play a key role as pioneers in these high tropical alpine environments. The limited initial colonization of vascular plants and the progressive accumulation of species and growth-forms (i.e. direct succession) could be linked to a combination of severe environmental filtering during early seral stages and limitations for zoochoric seed dispersal and entomophylic/ornitophylic pollination. This could potentially result in a slow successional response of these ecosystems to accelerated glacier loss and climate change.