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Successional patterns of ecosystem engineers at the upper altitudinal limit of the Dry Puna (Peru): a facilitation cascade process

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Facilitation processes constitute basic elements of vegetation dynamics in harsh systems. Recent studies in tropical alpine environments demonstrated how pioneer plant species, defined as “ecosystem engineers”, are capable of enhancing landscape-level richness by adding new species to the community through the modification of microhabitats, and also provided hints about the alternation of different ecosystem engineers over time. Nevertheless, most of the existing works analysed different ecosystem engineers separately, without considering the interaction of different ecosystem engineers. Therefore, these studies do not consider, at the scale of plant communities, the whole process of possible patch creation, alternation, coalescence and senescence, by means of the interaction of different ecosystem engineers and the degradation of microhabitat patches, that are key processes of vegetation dynamics in harsh environments.

Focusing on the altitudinal limit of Peruvian Dry Puna vegetation, we hypothesized that positive interactions structure plant communities by facilitation cascades involving different ecosystem engineers, determining the evolution of the microhabitat patches in terms of abiotic resources and beneficiary species hosted. To analyze successional mechanisms we used a “space-for-time” substitution to account for changes over time, and analyzed data on soil texture, composition, and temperature, facilitated species and their interaction with nurse species, and surface area of engineered patches by means of chemical analyses, indicator species analysis, and rarefaction curves. A successional process, resulting from the dynamic interaction of different ecosystem engineers, which determined a progressive amelioration of soil conditions (e.g. nitrogen and organic matter content, and temperature), was the main driver of species assemblage at the community scale, enhancing species richness. Cushion plants act as pioneers, by starting the successional processes that continue with shrubs and tussocks. Tussock grasses have sometimes been found to be capable of creating microhabitat patches independently. The dynamics of species assemblage seem to follow the nested assemblage mechanism, in which the first foundation species to colonize a habitat provides a novel substrate for colonization by other foundation species through a facilitation cascade process.