Lone fighters or team players? How co-occurrence patterns shape the patchy vegetation in arid volcanic environments

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Abstract

Patchy vegetation is characteristic for harsh environments such as arid and semi-arid areas. Biotic interactions are suggested as one of the main drivers of patchiness in vegetation. The role of positive interactions between species (often referred to as *facilitation*) is even expected to increase with harshness and might thus have apparent impact on species composition of vegetation patches with harshness. However, differentiating facilitative interactions from further underlying mechanisms, e.g. microtopographic heterogeneity, is a non-trivial task. In this study we analyzed the co-occurrence relationships of vascular plant species that form a patchy vegetation in arid lapilli fields (tephra) from recent volcanic eruptions on La Palma, Canary Islands. Assuming a harshness gradient negatively correlated with elevation because aridity is high at low elevations, we expected pronounced co-occurrence (indicating positive biotic interactions) within patches close to the coast in contrast to more benign sites at higher elevations. Our study area offers the unique opportunity to analyze biotic interactions that lead to the formation of patchy vegetation, as lapilli soils are found at all selected sampling sites. We analyzed a total of 1280 shrubby vegetation patches in terms of species composition at 64 different elevational sampling points, ranging from the coast to around 700 m a.s.l. Further parameters regarding the shape, the biotic and the microtopographic neighborhood of the patches were recorded to consider their potential impact on the patch establishment, respectively. A co-occurrence analysis revealed that half of the analyzed species pairs relationships are distributed non-randomly. We furthermore even found

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three species which matched our strict requirements for a potential facilitator species and that likely enable the establishment of other species within individual patches. Subsequent linear models were used to analyze those patterns along an elevational gradient representing our assumed harshness gradient. Despite our expectations, we did not find the presumed harshness gradient towards coastal sites. This might rather highlight the homogeneity of the environmental conditions on dry lapilli fields on La Palma, even over long distances, than reject the predictions of the stress-gradient hypothesis.

Keywords: facilitation, Oceanic Island, plant plant interactions, stress gradient hypothesis, volcanic substrate