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Warming and biocrusts alter soil P fractions in a semi-arid ecosystem

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Climate change is expected to increase the degree of aridity experienced by drylands worldwide. This increase will have a major impact on biogeochemical cycles and may produce an imbalance in the nitrogen (N): phosphorus (P) ratios. At the same time, the role of P as limiting factor of primary productivity in terrestrial ecosystems can be exacerbated and extended to those ecosystems affected by increasing atmospheric N deposition. Despite this, the resilience of organic and inorganic fractions of P in semiarid ecosystems is unknown. We hypothesized that in arid ecosystems warming might cause an increase in the inorganic P fractions versus the organic ones due to the decrease of biological activity, and that these changes may be modulated by the presence of biocrusts, a key biotic community in drylands worldwide. The aim of this study was to evaluate how warming, rainfall exclusion and biocrust cover affect inorganic and organic fractions of P in a 5-yr field experiment. We quantified proportions of organic and inorganic P in surface soils. Biocrusts had a strong influence in all P fractions, increasing both inorganic and organic fractions, but with a net increase in the inorganic:organic ratio. Soil warming significantly increased the labile inorganic P (NaHCO₃-P) fraction and altered the inorganic:organic ratio in the fractions associated with calcium carbonates and sulfates (HCl-P). Reductions in rainfall did not affect the P fractions measured. Our results suggest that climate change may influence the P biogechemistry both directly and indirectly, by influencing the cover and performance of biocrusts in drylands.

Understanding feedback processes between holm oak (Quercus ilex) and their ectomycorrhizal fungal symbionts in trace-element polluted soils in Mediterranean ecosystems

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Ectomycorrhizal (ECM) fungi might play a major role in host plant establishment in polluted soils, by increasing plant nutrient supply and providing protection against pollutants. At the same time, host plants modify soil environment and allocate C substrates to ECM fungi, influencing the composition of associated ECM communities. These bi-directional relationships between host tree species and ECM communities are largely unexplored for Mediterranean ecosystems. Here, we characterized ECM fungal communities associated to Holm oak (Quercus ilex subsp. ballota) saplings in soils with a broad range of pH and trace element pollution, in Southern Spain. ECM species composition and relative abundance varied significantly among the studied sites. Soil abiotic conditions, such as pH and Ca, were influential in the ECM species distribution. Moreover, we found significant relationships between host tree traits and the ECM species distribution pattern. Specific leaf area (SLA) and the concentration of K, Mn, Ni and Cd in leaves were significantly correlated with the main trend of variation of ECM communities. Root chemical traits also correlated with the distribution of ECM species; in particular the concentration of macronutrients such as Ca, Mg and P, and trace elements such as Mn, Co, Cu and Cd. We explored causal models, through a structural equation modelling (SEM), to elucidate whether the influence of soil chemistry on host functional traits is mediated by changes in ECM diversity.