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Influence of biological soil crusts at different successional stages in the implantation of biogeochemical cycles in arid and semiarid zones

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Crusts (BSCs) are formed by a close association between soil particles and cyanobacteria, algae, lichens, bryophytes and microfungi in varying proportions. Their habitat is within or immediately on top of the uppermost millimetres of the soil and are the predominant surface cover in arid and semiarid zones. Among the diverse functions developed by BSCs in the ecosystem (hydrology, erosion, soil properties, etc.), one of the most important is its role in nutrient cycling. Within arid and semiarid environments, BSCs have been termed 'mantles of fertility' being considered hotspots of biogeochemical inputs, fixing C, N and P above- and below-ground. However, there are differences in N and C fixation rates between BSCs types. Early successional BSCs, dominated by cyanobacterial species, fix lower quantities of C and N than mature BSCs dominated by lichens. Although the positive effects of BSCs on biogeochemical soil cycles are widely accepted, no previous studies have evaluated the activities of the enzymes involved in C, N and P cycles of BSCs and how they are affected by the successional stage of the BSC.
In this work, performed in the Tabernas desert (SE Spain), we studied the hydrolase enzymes involved in C (invertase, CM-cellulase, β-glucosidase), N (urease, BAA-protease, casein-protease) and P (phosphomonoesterase) cycles in BSCs at different successional stages (cyanobacteria represents the first successional stage, lichen Diploschistes diacapsis in an intermediate state and lichen Lepraria crassissima, with the greatest successional state). Our results show that BSCs at lower successional stage enriched the surface geological substrate in hydrolase enzymes to a lesser extent than mature BSCs (Lepraria crassissima), which show the highest values in all enzymatic activities. In contrast, the specific enzyme activities (activity values expressed per unit of carbon) were higher in the BSCs at lower successional stage, decreasing in the direction: cyanobacteria > Diploschistes diacapsis-lichen > Lepraria crassissima-lichen. These results suggest a different role of BSCs depending on their successional stage with regard to the implantation of biogeochemical cycles during the surface substrate colonization. Our conclusions are highly relevant to improve the knowledge of biogeochemical cycles in arid and semiarid areas.

Keywords: Biological Soil Crusts, arid ecosystems, hydrolytic enzymes, biochemical activity