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Factors controlling spatial distribution patterns of biocrusts in a heterogeneous and topographically complex semiarid area

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Biocrusts are widespread soil components in drylands all over the world. They are known to play key roles in the functioning of these regions by fixing carbon and nitrogen, regulating hydrological processes, and preventing from water and wind erosion, thus reducing the loss of soil resources and increasing soil fertility. The rate and magnitude of services provided by biocrusts greatly depend on their composition and developmental stage. Late-successional biocrusts such as lichens and mosses have higher carbon and nitrogen fixation rates, and confer greater protection against erosion and the loss of sediments and nutrients than early-successional algae and cyanobacteria biocrusts. Knowledge of spatial distribution patterns of different biocrust types and the factors that control their distribution is important to assess ecosystem services provided by biocrusts at large spatial scales and to improve modelling of biogeochemical processes and water and carbon balance in drylands. Some of the factors that condition biocrust cover and composition are incoming solar radiation, terrain attributes, vegetation distribution patterns, microclimatic variables and soil properties such as soil pH, texture, soil organic matter, soil nutrients and gypsum and $CaCO_3$ content. However, the factors that govern biocrust distribution may vary from one site to another depending on site characteristics. In this study, we examined the influence of abiotic attributes on the spatial distribution of biocrust types in a complex heterogeneous badland system (Tabernas, SE Spain) where biocrust cover up to 50% of the soil surface. From the analysis of relationships between terrain attributes and proportional abundance of biocrust types, it was found that topography exerted a main control on the spatial distribution of biocrust types in this area. SW-facing slopes were dominated by physical soil crusts and were practically devoid of vegetation and biocrusts. Biocrusts mainly occupied the pediments and NE-facing slopes. Cyanobacteria biocrusts were predominant in the pediments, probably because of their higher capacity to produce UV-protective pigments such as carotenoids and survive in zones of higher incident solar radiation. Lichen biocrusts showed preference for NE-facing slopes that, despite being less stable than the pediments, were exposed to less insolation and probably maintained moisture availability longer. Moreover, some differences were observed between lichen species. While Diploschistes diacapsis and Squamarina lentigera were widely distributed from gentle to steep NE-facing slopes, Lepraria sp. distribution was restricted to steep N-facing slopes, where shade predominance extended the periods of soil moisture availability.