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Cryptogamic communities in biological soil crusts in arid deserts of China: Diversity and their relationships to habitats in different scales

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Biological soil crusts (BSCs) are widespread communities of various diminutive organisms, including cryptogams such as cyanobacteria, algae, lichens and mosses, and other invisible organisms that are closely integrated with particles of topsoil. Few studies have considered their diversity and distribution pattern as related to environmental and climatic factors at different scales – in particular, little is known concerning the factors inducing the differences in crustal floral diversity for arid deserts in China. We investigated the distribution and characteristics of crustal communities with a total of 350 soil samplings in the main desert regions of northern China: the Horqin Sandland, Mu Us Sandland-Ordos Plateau, Tengger-Alxa Plateau, Qaidam Desert and Guerbantunggut Desert, which present a precipitation gradient, reducing from 450 mm in eastern to 80–100 mm in western deserts. The maximum cryptogamic species richness in crustal communities was 66, 42, 56, 22 and 54, respectively, in the above deserts. In general, species richness and biomass of crustal mosses were positive related with precipitation, while that of cyanobacteria and algae, as well as lichens were negative at a landscape scale. The results indicated topsoil physiochemical properties largely influenced the distribution pattern of crustal communities at the regional scale. Fine-textured and gypsum soils and soils with higher pH were favorable for various lichens, which were restricted by soils with higher total salt content. Moss species and biomass were closely related with soil water content rather than other properties, whereas there was higher diversity in cyanobacteria and algae at the site with relatively dry topsoil. In addition, the cover and biomass of mosses was positive correlated with the cover of C3 plants such as xerophytic shrubs due to providing shade. However, cover and biomass of lichens, cyanobacteria and algae were closely correlated with C4 plants, especially annuals, possibly as they created a relative stable and safe site for seed germination and survival in an aeolian environment, and increased carbon and nitrogen input into these nutrient-poor sandy substrates. At a small scale, diversity and biomass of crustal communities were largely determined by surface micro-geomorphology. Complex micro-geomorphology, such as small shrub-soil mounds and different location of stabilized dunes, has created various habitats that facilitate the maintaining of higher species diversity in BSCs due to re-allocation of dustfall deposition and surface water regime. These findings suggested that any disturbances will induce changes in cryptogamic diversity at the small scale. Variation of rainfall regime in future will result in conversion amongst the different types of BSCs, and may contribute to changes in desert ecosystem structure and function.

Keywords: cryptogam species; distribution characteristics; precipitation gradient; soil physiochemical properties; different scale; Chinese deserts