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Climatically driven distribution patterns of soil crusts and their implications for climate change scenarios

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Biological soil crusts, consisting of cyanobacteria, algae, fungi, lichens, and mosses in varying proportions, inhabit the uppermost millimeters of the soil, occurring regularly in arid and semiarid regions around the world. They agglutinate soil particles, thereby effectively reducing erosion by wind and water, bring nutrients into the strongly depleted soils and promote plant growth.
Moss-dominated soil crusts (mainly consisting of Ceratodon purpureus (Hedw.) Brid.) were investigated in the semiarid region of the Succulent Karoo in South Africa. Within the study area we found a gradient from abundant moss vegetation towards the almost complete lack over a distance of only 10 kilometers. Along this gradient, the meso- and microclimatic characteristics experienced by the soil crust (temperature, light intensity, water conditions) were monitored with four climate stations in 5-minute intervals over a whole year. The results revealed drier conditions and increasing temperatures towards the moss poor region of the gradient.
In a second approach, the physiological characteristics of Ceratodon purpureus with regard to water-, light- and temperature conditions were analyzed by means of gas exchange measurements in a factorial analysis in the lab. These measurements revealed that Ceratodon purpureus has a rather narrow range of optimum water conditions and is severely limited by temperatures above 27°C. A combination of the microclimate and gas exchange data illustrated the humidity gradient to be largely responsible for the observed distribution patterns.
Future climate scenarios for the Succulent Karoo predict the local climate to become drier with more prolonged dry spells during the next decades. This implies for moss-dominated soil crusts to become largely repressed from the Succulent Karoo. Due to the role they play in soil stabilization and vascular plant growth, their repression may also put a major threat on the present vascular plant vegetation.