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Lichen-moss interactions within biological soil crusts

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Biological soil crusts (biocrusts) create well-known hotspots of microbial activity, being important components of hot and cold arid terrestrial regions. They colonize the uppermost millimeters of the soil, being composed of fungi, (cyano-) bacteria, algae, lichens, bryophytes and archaea in varying proportions. Biocrusts protect the (semi-) arid landscape from wind and water erosion, and also increase water holding capacity and nutrient content. Depending on location and developmental stage, composition and species abundance vary within biocrusts. As species live in close contact, they are expected to influence each other, but only a few interactions between different organisms have so far been explored. In the present study, we investigated the effects of the lichen *Fulgensia fulgens* whilst growing on the moss *Trichostomum crispulum*.

While 77% of *Fulgensia fulgens* thalli were found growing associated with mosses in a German biocrust, up to 95% of *Fulgensia bracteata* thalli were moss-associated in a Swedish biocrust. In 49% (Germany) and in 78% (Sweden) of cases, thalli were observed on the moss *T. crispulum* and less frequently on four and three different moss species. Beneath *F. fulgens* and *F. bracteata* thalli, the mosses were dead and in close vicinity to the lichens the mosses appeared frail, bringing us to the assumption that the lichens may release substances harming the moss. We prepared a water extract from the lichen *F. fulgens* and used this to water the moss thalli (n = 6) on a daily basis over a time-span of three weeks. In a control setup, artificial rainwater was applied to the moss thalli (n = 6). Once a week, maximum CO_2 gas exchange rates of the thalli were measured under constant conditions and at the end of the experiment the chlorophyll content of the moss samples was determined. In the course of the experiment net photosynthesis (NP) of the treatment samples decreased concurrently with an increase in dark respiration (DR). The control samples remained at the same stable level for both NP and DR over time. The chlorophyll content of the treatment samples was significantly lower than that of the controls. This supports our assumption that water extracts of *F. fulgens* may indeed cause a dieback of the host moss. In a next step of the project, the substances responsible for this detrimental effect on the moss will be identified.

The accelerated dieback of the moss probably causes increased CO_2 concentrations below the lichen thalli, improving their overall photosynthetic performance. Thus, both dead and living biomass in biocrusts increase upon this association, promoting microbial activity and the growth of vascular plant vegetation.