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Interactive comment on "Eco-physiological characterization of early successional biological soil crusts in heavily human impacted areas – Implications for conservation and succession" *by* Michelle Szyja et al.

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Referee #1, Thomas Fischer The particular value of the study is the comparison of the eco-physiological performance between a cyanobacterial and a green-algal biocrust from temperate habitats, which are somewhat underrepresented in the biocrust related literature. I recommend publication of the manuscript after minor revision.

Minor remarks

Remark #1: Figure 4: I guess the upper line in each graph is under light, and the lower

line in the dark? What was the PPFD?

We have edited figure itself and the figure caption as follows, to clarify which line represents which physiological process. Also, we have added information about the light intensity (PPFD) applied during the measurements.

"Figure 4: Responses of net photosynthesis (dots) and dark respiration (triangles) to normalized water content for intact BSC, the isolated dominant organisms and in soil at 12°C. Measurements were taken at saturating light and a temperature of 12°C. (a) C-BSC (985 μmol photons m-2 s-1) and (b) G-BSC (1260 μmol photons m-2 s-1)."

Remark #2: p. 7 l. 26 and Fig. 5: Water contents are given in mm here, but as normalized water content in the rest of the manuscript. I think the paper would benefit from providing some information on how many mm were 100% for each BSC type. For soils, water content expressed as mm links with volumetric water content (or water potential) through soil texture, depth and humus content, which are essential to relate to each other optimum moisture ranges for BSC_all, BSC_dom and BSC_soil. While, for example, the optimal ranges for G-BSC_dom and C-BSC_dom are similar, the difference between G-BSC_dom and G-BSC_soil is larger than the respective difference for the cyanobacterial crust: This could mean that the amount of fine particles, or sampling depth, or soil C, or all together, were greater for the Zygogonium crust. The authors are aware of that point (p. 9 l. 12-13): "A general difference between BSC_all and BSC_dom concerning optimal water content is likely owed to the different water holding capacities of the soil."

Remark #3: p. 8 l. 19-20: High abiotic CO2-release may point to carbonates being present in the soil solution and to high pH. The authors discuss that issue on p. 10 l. 20 ff.

Remarks #2 and #3 let me recommend to provide some information on soil texture class, pH, organic C content and sampling depth for each site in the M&M section.

According to this suggestion we have included information about soil texture, organic carbon content, pH, sampling depth and also water holding capacity of the soil. The results underline the reviewers suggestions that especially the fine particle size is responsible for the higher water holding capacity of the soil in the Zygogonium crust:

P.4, L. 14 - 16: "It is situated 320 to 340 m a.s.l. and soils are acidic (pH = 5.28), mostly due to their origin from red sandstone of the early Triassic (Landesamt für Geologie und Bergbau, Rhineland–Palatinate), with a loamy soil texture, very low organic carbon content (<1%) and a water holding capacity of 40%." P.4, L. 23 - 25: "The bedrock is composed of base rich (pH = 6.81) limestone that originates from early Triassic with a coarse gravel overlay, with a loamy sand soil texture, 6% organic carbon and a water holding capacity of 30%." P.4, L. 27 – 28: "Sampling depth at both sides was between 0.8 to 1 cm."

We would like to thank the reviewer for the suggestion to provide information about the maximum water holding capacities, as this helps to understand and interpret the gained data and makes the values available for comparison with literature. According to the suggestion the maximum water holding capacities of both BSCs were added, to make the optimum water content comparable to maximum saturation situations. The values were calculated as follows: maximum water holding capacity of BSCsoil added to maximum water holding capacity of BSCorg.

P. 8, L. 13-14: The maximum water holding capacity was 3.29 $\pm$ 0.89 mm for C-BSCall and 4.66 $\pm$ 1.38 mm for G-BSCall.

Remark #4: p. 10 l. 1-2: The authors state a higher water holding capacity (WHC) of the Nostoc crust than the Zygogonium crust and attribute this to exopolysaccharides (EPS), which is in full agreement with the literature. However, apart from its lower NP performance, the Zygogonium crust had higher amounts of chlorophyll (Table 1), which traditionally is interpreted as a biomass equivalent. Is it possible that high Zygogonium biomass compensates for high WHC of the EPS of Nostoc? I think that the statement of

higher WHC of the Nostoc crust could be substantiated by some experimental data, or, for example, from presenting some close-up photographs of the crusts to get a visual impression of crust development.

The referee is correct in saying that it would be only logical for Z. ericetorum to hold more water than N. commune, as the green algal crust has a higher chlorophyll concentration and therefore more biomass per area than the cyanobacterial crust. However, it is difficult to compare chlorophyll content between cyanobacteria and green algae. As we explain in our discussion (P. 11 L. 25-29), chlorophyll doesn't seem to be a suitable reference value to compare NP rates between green algae and cyanobacteria, because the current calculations exclude the phycobilisomes of cyanobacteria. Therefore, the photosynthetic active pigments in cyanobacteria are underestimated and their biomass as well, as this value is traditionally interpreted as biomass.

Additionally, the factor EPS masks the effect of more biomass generally being able to hold more water: Nostoc commune does possess very thick EPS layers, that are able to hold up to 20 – 30 times their dry weight, while Z. ericetorum can't take up as much water (SATOH, Kazuhiko, et al. Recovery of photosynthetic systems during rewetting is quite rapid in a terrestrial cyanobacterium, Nostoc commune. Plant and cell physiology, 2002, 43. Jg., Nr. 2, S. 170-176. SHAW, Eric, et al. Unusual water flux in the extracellular polysaccharide of the cyanobacterium Nostoc commune. Applied and environmental microbiology, 2003, 69. Jg., Nr. 9, S. 5679-5684.). In percent the cyanobacterial crust from Fig. 4 could hold up to 4562% H_2O compared to its dry weight while having 88% of its maximum NP rate. The green algal crust could only hold 435% H_2O compared to its dry weight while having 18% of its maximum NP rate. This is also now stated in the manuscript on page 8, lines 13-15.

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