The complexity of symbiotic interactions influences the ecological amplitude of the host

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Model organism

Lichen-forming fungal genus *Stereocaulon* occures in very diverse environments from polar areas [1] to tropics [2], in a wide range of altitude, frequently on toxic substrata, tolerantes submersion [3] as well as aridity.

What is the diversity of phycobionts associated with the lichen-forming genus *Stereocaulon*?
Do phycobionts and mycobionts exhibit reciprocal specificity/selectivity and how does this affect the width of their climatic niches?

Diversity of phycobionts

The diversity of predominant phycobionts is exceptional: the three trebouxioid genera, *Asterochloris*, *Chloroidium* and *Vulcanochloris*, and several dozens of their species.

Specificity and selectivity

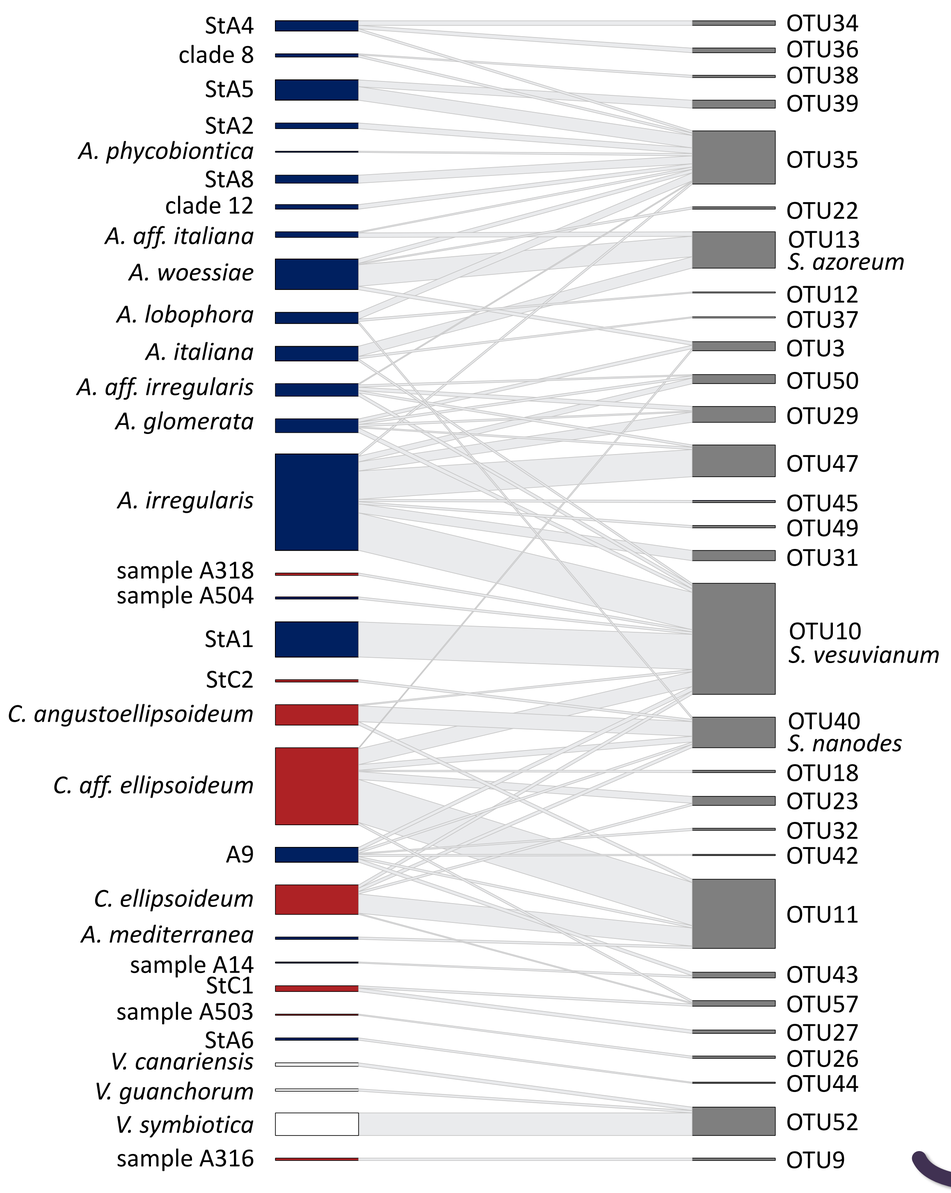
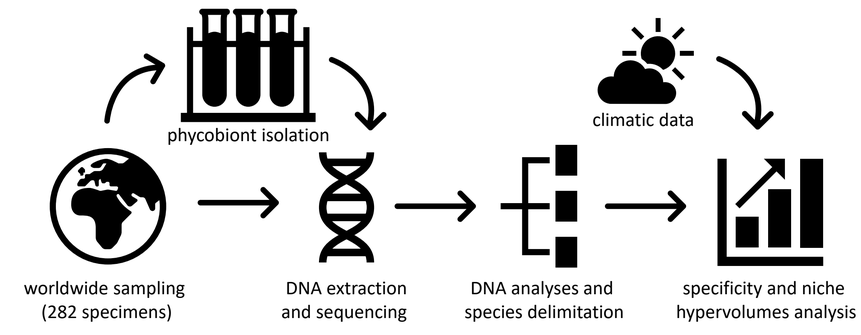


Fig. 1. Interaction network structure between phycobiont species-level lineages and mycobiont species-level lineages in the genus *Stereocaulon*. The width of the links is proportional to the number of specimens forming the association. The *Asterochloris* lineages in blue, *Chloroidium* in red, *Vulcanochloris* in white, mycobiont in grey.

Material and methods



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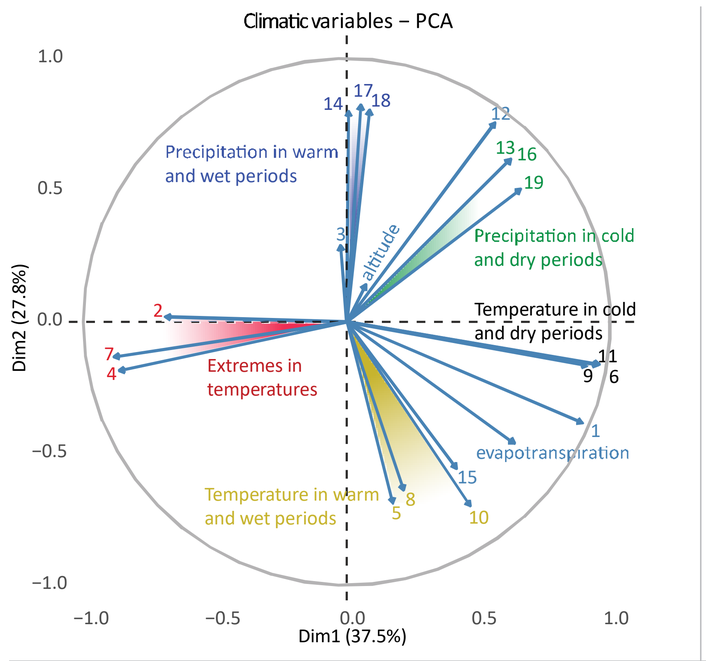
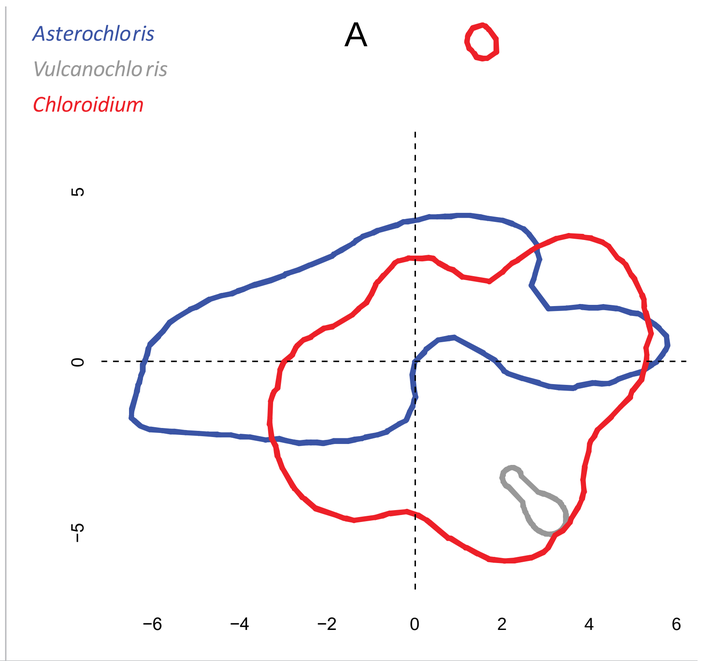
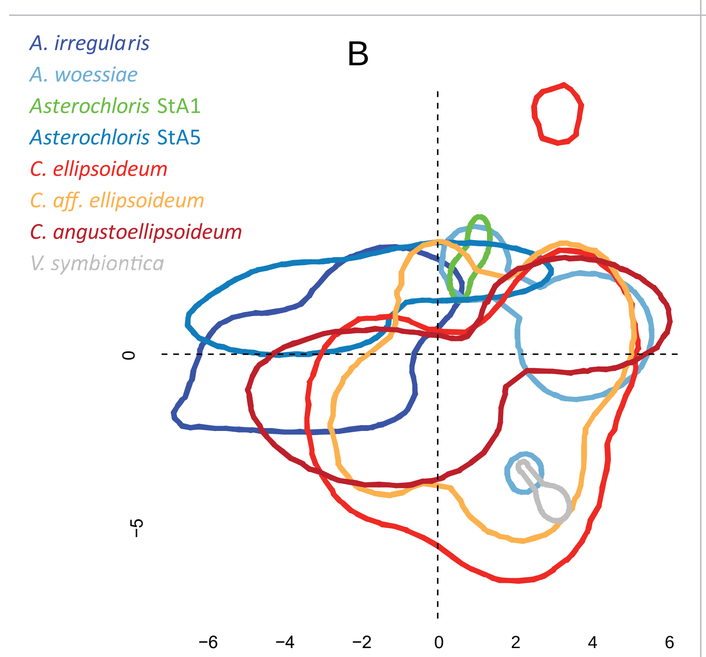
References: [1] C. Seo, J. H. Sohn, S. M. Park, J. H. Yim, H. K. Lee, and H. Oh, *J. Nat. Prod.*, vol. 71, no. 4, pp. 710–2, Apr. 2008.; [2] F. Ismed, F. Lohézic-Le Dévéhat, O. Delalande, S. Sinbandhit, A. Bakhtiar, and J. Boustie, *Fitoterapia*, vol. 83, no. 8, pp. 1693–8, Dec. 2012.; [3] A. Sadowsky, A. Hussner, and S. Ott, *Nov. Hedwigia*, vol. 94, no. 3, pp. 323–334, May 2012.; [4] D. N. Karger *et al.*, *Sci. Data*, vol. 4, p. 170122, Sep. 2017.

Climatic niches







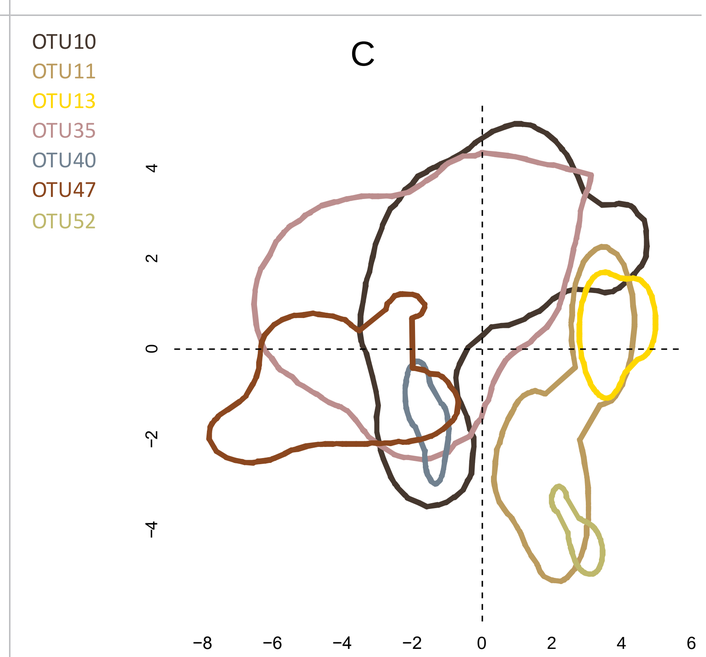


Fig. 2. Climatic niche hypervolumes for (a) algal genera *Asterochloris*, *Vulcanochloris* and *Chloroidium*, (b) eight most abundant algal species-level lineages (phycobionts), (c) seven most abundant fungal species-level lineages (mycobionts), (d) fungal OTU10 (grey filled) with its seven most abundant (of total 11) associating phycobionts, (e) fungal OTU35 (grey filled) with its seven most abundant (of total 12) associating phycobionts based on climatic PC1–PC2 axes (explaining 65% of variation). Climatic variables: 1 = annual mean temperature, 2 = mean diurnal range, 3 = isothermality, 4 = temperature seasonality, 5 = max temp. of warmest month, 6 = min temp. of coldest month, 7 = temp. annual range, 8 = mean temp. of wettest quarter, 9 = mean temp. of driest quarter, 10 = mean temp. of warmest quarter, 11 = mean temp. of coldest quarter, 12 = annual precipitation, 13 = prec. of wettest month, 14 = prec. of driest month, 15 = prec. seasonality, 16 = prec. of wettest quarter, 17 = prec. of driest quarter, 18 = prec. of warmest quarter, 19 = prec. of coldest quarter [4]

Species-level lineages, which accept more symbiotic partners, have wider climatic niches

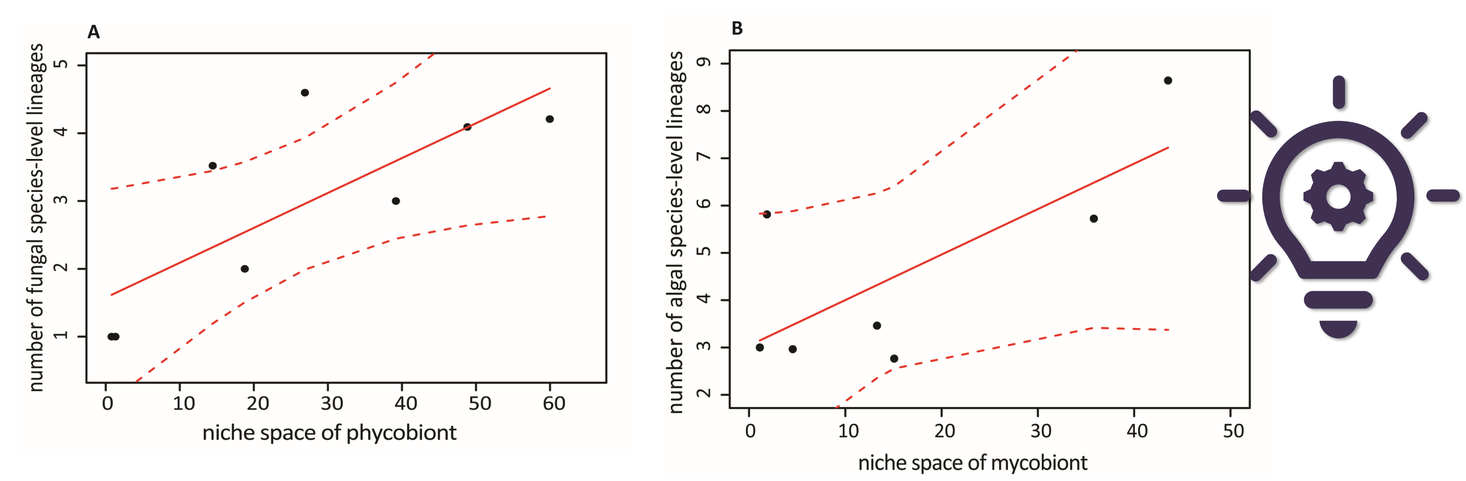


Fig. 3. (a) Bayesian linear regression of algal niche space (hypervolume) as a predictor of the number of accepted species- level fungal lineages. (b) Bayesian linear regression of fungal niche space (hypervolume) as a predictor of the number of accepted species-level algal lineages. Dashed lines show the 95% CRI around the regression line.

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