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New Phytologist
Volume 241, Issue 5
Mar 2024
Pages 1881-2308

ARTICLE

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CITE | Check for updates

https://doi.org/10.1111/nph.19519

Commentary

News from ‘black belt’ masters of symbiosis

The reputation of lichens as extremotolerant organisms is built on their occurrence in habitats where most other eukaryotes find it difficult to survive. Lichens withstand recurrent cycles of desiccation and re-wetting in their environments by reverting to a state without active signs of life during periods of drought, yet they are able to resume metabolism quickly with appropriate levels of hydration. In this stage, a substrate’s conditions, including chemistry, pH level, and water availability, determine the composition of lichen species in different habitats. Their sensitivity in metabolically active stages also explains the use of lichens as fine-tuned bioindicators of environmental conditions.

> *‘The study also revealed evidence for a wider ability of lichen mycobionts to process carbohydrates produced by the hosted photobionts, including their polysaccharides.’*

The intertidal zones along extratropical rocky coasts represent unique habitats for lichens. These are characterized by periodic inundation with sea water (and rainwater or heat and drought, depending on aerial meteorological conditions), in addition to variations in temperature and mechanic forces. Lichens adapted to this habitat form a clear belt-like zonation along rocky coasts of to its known cyanobacterial photobiont *Rivularia* (Nostocales), thalli of *L. pygmaea* regularly contain other cyanobacteria, in particular *Pleurocapsa* (Pleurocapsales), along with other cyanobacteria and eukaryote algae in minor amounts. Few metagenomic and transcriptomic studies on lichens have revealed the roles of either mycobiont or photobiont partners (Juntilla *et al.*, 2013; Wang *et al.*, 2015; Steinhäuser *et al.*, 2016; Armaleo *et al.*, 2019), or focused on the associated bacterial microbiome (Cernava *et al.*, 2017, 2019). A new paper by Chrismas *et al.*, published in this issue of *New Phytologist* (2024, 2243–2257) provides novel insights, by using rRNA-based metabarcoding and metatranscriptomic analyses, to investigate how two prominent cyanobacteria present in the thalli react by differential activity across inundation scenarios. The authors sampled this species at low- and high-tide. The analyses were consistent with their hypothesis, showing that *Rivularia* was more active when thalli were inundated at high tide, whereas the activity of *Pleurocapsa* dominated at low tide. The differences were observed both in the ribosomal RNA and in mRNA levels. These differences were generally less pronounced when thalli were hydrated from recent rainfall at low tide, which suggests that higher salt levels significantly contribute to photobiont task splitting.

The study also revealed evidence for a wider ability of lichen mycobionts to process carbohydrates produced by the hosted photobionts, including their polysaccharides. It is worth noting that the high abundance of trehalose metabolism-related genes in *Rivularia* could be correlated with a response to seawater stress. Both cyanobacterial photobionts produce disaccharides (trehalose in *Rivularia*; sucrose in *Pleurocapsa*). These appear to be exported as components of the extracellular polysaccharide matrix. Careful