

**Appendix S1.** Previously available photobiont data for lichens of South Africa. Cyan. = Chroococcidiopsidales cyanobacteria, Treb. = Trebouxiphyceae green algae; n = number of specimens. An additional six *Trebouxia* sequences from South African Physciaceae were included in Helms (2003), but those data were never accessioned to GenBank. Dal Grande et al. (2012) included four South African sites in a study of *Symbiochloris* sharing in *Lobaria pulmonaria*, but they used microsatellite loci and thus their results are not comparable to other data. Only a few Trentepohliaceae sequences are available for South Africa, all of which are from non-lichenized isolates (Lopez-Bautista et al. 2006). No molecular data are available for lichen photobionts from Namibia; Gorbushina et al. (2005) used two *Trebouxia* cultures from the Namib desert for experiments on fungus–alga interactions, but sequence data for those cultures are not available.

Photobiont	Type	Reference	n	Loci	Mycobiont
<i>Aliterella</i>	Cyan.	Jung et al. 2021	1	16S	<i>Peltula</i>
<i>Asterochloris</i>	Treb.	Pino-Bodas & Stenroos 2021	1	<i>act1</i>	<i>Cladonia</i>
<i>Myrmecia</i>	Treb.	Williams et al. 2017	2	ITS	<i>Psora</i>
<i>Trebouxia</i>	Treb.	Fryday et al. 2020	1	ITS	<i>Burrowsia</i>
		Moya et al. 2021	1	ITS	<i>Parmelia</i>
		Nyati et al. 2013, 2014	7	ITS, <i>rbcL</i>	<i>Xanthoria</i> s.l.
		Singh et al. 2017	5	ITS, <i>cox2</i>	<i>Protoparmelia</i>
<i>Symbiochloris</i>	Treb.	Fryday et al. 2020	1	ITS	<i>Scoliciosporum</i>

## References

- Dal Grande, F., I. Widmer, H. H. Wagner, and C. Scheidegger. 2012. Vertical and horizontal photobiont transmission within populations of a lichen symbiosis. *Molecular Ecology* 21: 3159–3172.
- Fryday, A. M., I. D. Medeiros, S. J. Siebert, N. Pope, and N. Rajakaruna. 2020. *Burrowsia*, a new genus of lichenized fungi (Caliciaceae), plus the new species *B. cataractae* and *Scoliciosporum fabisporum*, from Mpumalanga, South Africa. *South African Journal of Botany* 132: 471–481.

- Gorbushina, A. A., A. Beck, and A. Schulte. 2005. Microcolonial rock inhabiting fungi and lichen photobionts: evidence for mutualistic interactions. *Mycological Research* 109: 1288–1296.
- Helms, G. 2003. Taxonomy and Symbiosis in Associations of Physciaceae and *Trebouxia*. Ph.D. dissertation. Göttingen: Georg-August Universität Göttingen, Göttingen, Germany.
- Jung, P., K. Brust, M. Schultz, B. Büdel, A. Donner, and M. Lakatos. 2021. Opening the gap: Rare lichens with rare cyanobionts—Unexpected cyanobiont diversity in cyanobacterial lichens of the order Lichinales. *Frontiers in Microbiology* 12: 728378.
- Lopez-Bautista, J. M., F. Rindi, and M. D. Guiry. 2006. Molecular systematics of the subaerial green algal order Trentepohliales: an assessment based on morphological and molecular data. *International Journal of Systematic and Evolutionary Microbiology* 56: 1709–1715.
- Moya, P., A. Molins, P. Škaloud, P. K. Divakar, S. Chiva, C. Dumitru, M. C. Molina, et al. 2021. Biodiversity patterns and ecological preferences of the photobionts associated with the lichen-forming genus *Parmelia*. *Frontiers in Microbiology* 12: 765310.
- Nyati, S., D. Bhattacharya, S. Werth, and R. Honegger. 2013. Phylogenetic analysis of LSU and SSU rDNA group I introns of lichen photobionts associated with the genera *Xanthoria* and *Xanthomendoza* (Teloschistaceae, lichenized Ascomycetes). *Journal of Phycology* 49: 1154–1166.
- Nyati, S., S. Scherrer, S. Werth, and R. Honegger. 2014. Green-algal photobiont diversity (*Trebouxia* spp.) in representatives of Teloschistaceae (Lecanoromycetes, lichen-forming ascomycetes). *Lichenologist* 46: 189–212.
- Pino-Bodas, R., and S. Stenroos. 2021. Global biodiversity patterns of the photobionts associated with the genus *Cladonia* (Lecanorales, Ascomycota). *Microbial Ecology* 82: 173–187.
- Singh, G., F. Dal Grande, P. K. Divakar, J. Otte, A. Crespo, and I. Schmitt. 2017. Fungal–algal association patterns in lichen symbiosis linked to macroclimate. *New Phytologist* 214: 317–329.
- Williams, L., C. Colesie, A. Ullmann, M. Westberg, M. Wedin, and B. Büdel. 2017. Lichen acclimation to changing environments: Photobiont switching vs. climate-specific uniqueness in *Psora decipiens*. *Ecology and Evolution* 7: 2560–2574.