

PhotobiontDiversity

Genetic diversity of lichen photobionts
and related organisms

Gunnera symbionts do not cluster with lichen photobionts

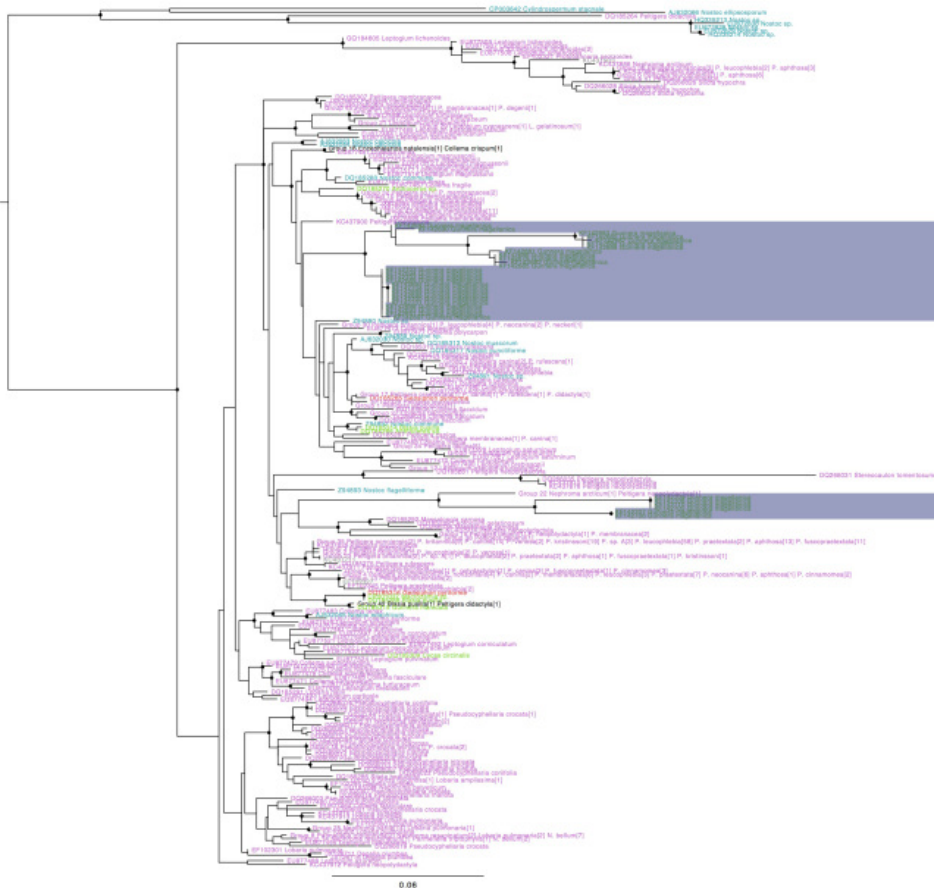
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I have been kicking around the idea of setting up an online catalog of lichen photobionts for years before I started doing this. The main impetus to finally start was this paper:

Fernández-Martínez, M., de los Ríos, A., Sancho, L., & Pérez-Ortega, S. (2013). Diversity of Endosymbiotic *Nostoc* in *Gunnera magellanica* (L) from Tierra del Fuego, Chile *Microbial Ecology* DOI: [10.1007/s00248-013-0223-2](#)

I have been interested in the relationships between lichenized *Nostoc* and those that form symbioses with ferns, cycads, liverworts and the flowering plant *Gunnera* for a long time, but [my efforts](#) to address the issue were hampered by inadequate sampling and others who had [better sampling](#) used a genetic marker with a [complex history](#) that made such comparisons difficult. Finally, here was a paper with extensive sampling across the range of a plant host of *Nostoc* who used the same genetic marker that has been widely adopted in work on lichen photobionts. Unfortunately, while the paper has a lot of interesting things to say about the *Nostoc-Gunnera* symbiosis (genetically monomorphic within individuals, lots of variability among individuals, reduced symbiont diversity in recently deglaciated areas, etc), they included very few lichen photobionts in their analyses, so I wasn't able to get the answers to the questions I'm interested in from the paper.

Now that I've developed a [decent phylogenetic framework for symbiotic *Nostoc*](#), it should now be possible to address these questions. Here is how the *G. magellanica* symbionts fit in:



Nostoc rbcX phylogeny with *Gunnera magellanica* symbiont highlighted, coloured by type of association (purple: lichen photobionts, green: plant symbionts, blue: free-living, red: fungal endosymbiont). Names in black indicate genotypes found in more than one group. Circles on internal nodes indicate aLRT ≥0.9.

A few things about this tree are interesting. For one, *G. magellanica* symbionts form two well-supported lineages to exclusion of all other strains. This contradicts the results from the paper, where two *G. magellanica* symbiont haplotypes did not group with the others and where one lichen photobiont was nested within one of the *G. magellanica* symbiont clusters, though resolution and support were low for these nodes in their tree. Secondly, the *G. magellanica* symbionts do not group with any other plant symbionts, including the other *Gunnera* symbiont. Thirdly, the *G. magellanica* symbionts are on relatively long branches, suggesting that the evolutionary rate is higher in this lineage.

One major note of caution are in order when interpreting this tree, however: all of these *G. magellanica* symbionts were collected in the southern tip of South America, while the vast majority of the sampling of other lineages, including many of the plant symbionts, is from the northern hemisphere. Indeed, several of the symbionts of tropical plants were isolated from botanic gardens in Europe, well outside of the native range of the plants. It is certainly possible that lichens and other plant hosts from South America would associate with some of the same *Nostoc* strains isolated from *G. magellanica*.

So, in conclusion, it's fair to say that these data support the notion of frequent host shifts between lichens and plants in the evolutionary history of *Nostoc*, but that there is no evidence that the same strains of *Nostoc* routinely form symbioses with lichens and with *Gunnera*. However, more geographically appropriate sampling may provide this evidence in the future.

Methods:

Sequences KF142679 to KF142710 were downloaded from genbank and added to the *Nostoc* rbcX dataset.

These 32 haplotype sequences represent 110 specimens, but it is not clear how many specimens each haplotype represents. Details of the analysis can be found [here](#). Data files are [here](#).

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