PhotobiontDiversity
Genetic diversity of lichen photobionts and related organisms

Green Algal Photobionts: Asterochloris.

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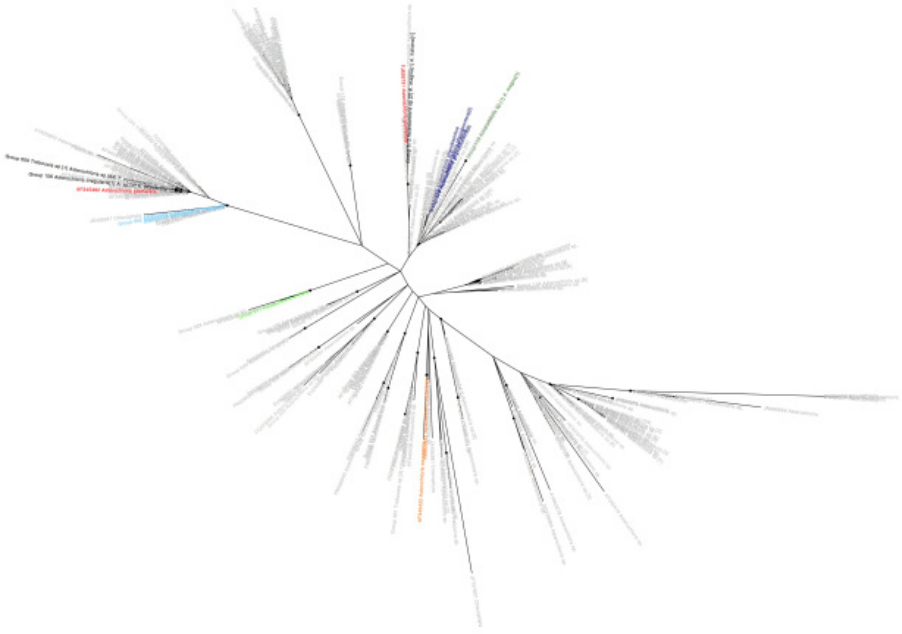
In this post I will be taking a look at the diversity of the junior partner to *Trebouxia*: *Asterochloris*. Originally described by Elisabeth Tschermak-Woess in 1980, *Asterochloris* was subsequently merged with *Trebouxia* before being split out again on the basis of sequence data in the late 1990s. For the most part, *Asterochloris* is thought to be restricted to associations with lichens in two closely related families, Cladoniaceae and Stereocaulaceae. However, this includes *Cladonia*, one of the more charismatic (and ecologically important) lichen groups, so *Asterochloris* has been extensively sampled.

Sequences were obtained and analysed as described previously, except that I decided to use a command-line application to remove redundant sequences instead of the GUI-based program MetaPIGA. In addition to being easier to automate, this has the advantage of being much better documented and WAY faster:

usearch -cluster_fast Asterochloris_ITS.fa -id 1 -centroids Asterochloris_ITS_nr.fa -uc Asterochloris_ITS_groups.txt

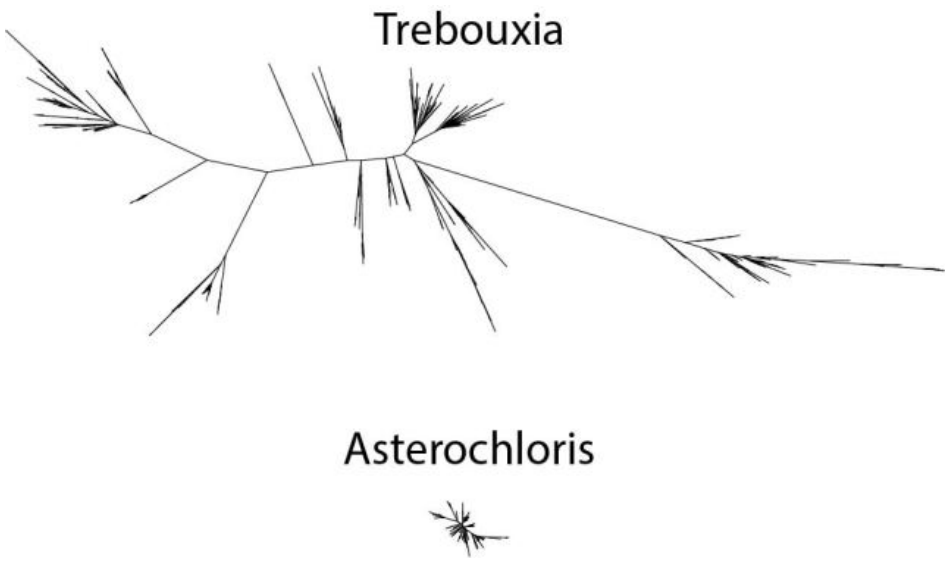
This works on unaligned sequences and produces a file of non-redundant sequences in addition to the list of groups, which can be used directly for alignment and phylogenetic inference. The detailed steps of this analysis are here. Datasets can be found here.

The resulting phylogeny, colour-coded by algal species names looks like this:



Asterochloris ITS phylogeny color-coded by species (light blue: A. irregularis, red: A. glomerata, dark blue: A. phycobiontica, dark green: A. magna, ornage: A. excentrica, purple: A. italiana, light green: A. erici, grey: A. sp.). Sequences recovered from multiple names species are in black. Black circles indicate aLRT support >= 0.9

The structure of the tree looks quite similar to that of *Trebouxia*, and this paper argues that many of these clusters represent distinct species. However, the sequence divergence within the genus is much, much lower than it is for *Trebouxia*:

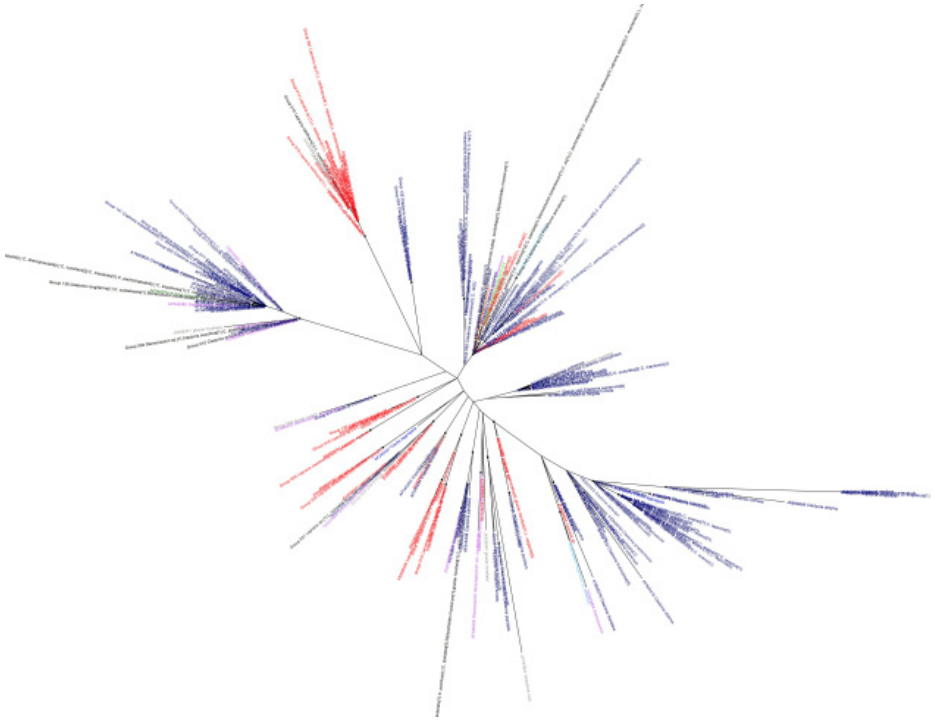


Trebouxia and Asterochloris ITS trees with branch lengths drawn to the same scale

This has more to do with the huge amount of sequence divergence within *Trebouxia* than it does any lack of diversity in *Asterochloris*. Most of *Asterochloris* clusters above have at least 2% sequence divergence from one another, so it's not unreasonable to consider them different species.

The named representatives of three species (*A. phycobiontica* (dark blue), *A. erici* (light green) and *A. excentrica* (light blue)) form coherent clusters in the tree. Strains identified as *A. glomerata* (red), *A. magna* (dark green) and *A. irregularis* (orange) each fall into two clusters, though it is difficult to see for the latter two species because some of the sequences are identical to those from representatives of other species and are thus labeled black. Two additional species, *A. italiana* and *A. pyriformis* are only represented by sequences that are identical to sequences from other species.

As for the host association patterns, the vast majority of isolates are from members of the genera *Cladonia* (blue), *Lepraria* (red) and *Stereocaulon* (purple):



Asterochloris ITS phylogeny color-coded by host genus (dark blue: Cladonia, red: Lepraria, purple: Stereocaulon, light blue: Pilophorus, dark green: Anzina, light green: Varicellaria, orange: Diploschistes, grey: unknown/other). Sequences recovered from multiple names species are in black. Black circles indicate aLRT support >= 0.9

There are also photobionts of *Cladia, Pilophorus, Pycnothelia, Anzina, Diploschistes, Ochrolechia, Varicellaria* and *Xanthoria*. The first three of these are closely related to *Cladonia*, while the others are a diverse assemblage of lichens. With the exception of *Xanthoria*, none of these genera have been found to associate with *Trebouxia*. *Xanthoria* is listed as the host for *A. italiana* in GenBank, but the authors make no mention of this in their paper and the host is not listed in the culture collection info, so it should probably be taken with a grain of salt.

Interestingly, there are also a number of *Asterochloris* sequences that were obtained from environmental sampling (one from limestone rock and two from forest soil and ten from a glacier forefield). It is certainly possible that these were derived from lichen fragments or vegetative propagules, but there was only a single *Trebouxia* sequence that was not from a lichen thallus despite almost three times as much sampling, so these results suggest that *Asterochloris* may be a facultative lichen photobiont while *Trebouxia* is obligately lichenized.

Other than the *A. phycobiontica* cluster which is associated with a diverse array of lichen genera, *Lepraria* tends to be associated with distinct lineages compared to *Cladonia* and *Stereocaulon*, while the latter genera overlap in their photobiont preferences. There is also a lot of interesting host association patterns at the species level for this group, a topic that I hope to explore in the future.

This entry was posted in Green Algal Photobionts and tagged Asterochloris, Cladonia, Cladoniaceae, Lepraria, Lichen, Stereocaulaceae, Xanthoria. Bookmark the permalink.