At the fungal farmer's market, only the best cyanobacteria are for sale

August 21 2009

Cyanobacterial photobionts of tropical cyanolichens of the genera *Acantholichen, Coccocarpia, Dictyonema*, and *Stereocaulon*, belong to a previously unrecognized, exclusively lichenized, novel lineage with the name *Rhizonema*. These photobionts are shared between unrelated lichen mycobionts co-occurring in the same habitats, leading to improved strains by means of mycobiont and environmental selection, in a similar way as farmers domesticate and improve crops. Credit: Courtesy of Robert K. Lucking.

Lichens are the classic example of a symbiotic relationship. Both the fungal and photobiont components of the lichen benefit from the relationship and often are unable to survive without each other. Recent research by Dr. Robert Lücking (The Field Museum, Chicago), Dr. James Lawrey (George Mason University, Virginia) and a team of

colleagues from around the world has put a new spin on this relationship.

In a paper published in the August 2009 issue of the American Journal of Botany, Lücking et al. explore the possibility of lichens as domesticators, similar to early farmers domesticating grains. By investigating the evolutionary history of a group of cyanobacteria associated with lichens, Lücking and Lawrey and their team have made some surprising conclusions.

Although lichen fungi represent more than 1000 genera, most are associated with photobionts that represent only four genera, one of them believed to be the common and widely distributed cyanobacterial genus *Scytonema*. However, the identity of photobionts thought to be *Scytonema* has never been confirmed. Lücking and his colleagues used DNA sequence data to reconstruct evolutionary relationships among free-living members of *Scytonema* and putative *Scytonema* photobionts associated with three major fungal lineages.

They discovered that these lichenized photobionts are not members of the genus *Scytonema*, but form a novel, previously unrecognized, entirely lichenized, lineage of cyanobacteria. The members of this novel lineage, which bears the name *Rhizonema*, physically appear very similar to free-living members of the genus *Scytonema*, and members of the two genera can be found close to each other—one lichenized, the other not. Apart from being the first discovery of a completely novel photobiont lineage in lichens using molecular phylogenetics, this find has important implications for ecosystem research because a large proportion of nitrogen-fixing cyanobacteria previously believed to occur in both lichenized and free-living forms now appear to be restricted to lichen symbioses.

Lücking et al. also found that a wide range of lichen fungi that are distantly related with each other but co-occur in the same habitats are

associated with members of *Rhizonema*. This implies that the fungi "share" the cyanobacteria among them, as opposed to evolving in concert with the cyanobacteria, a process that would result in similar evolutionary patterns in the fungal and cyanobacterial components of the lichen.

The authors propose that photobionts are selected based on their compatibility with the mycobionts and their ability to contribute to the establishment and growth of the lichen. This results in an increase in the frequency of particular mycobiont-photobiont pairs, and likewise an increase in the frequency of particular photobionts, which then leads to an increase in the availability of these photobiont strains for other lichen associations. This process may be compared to crop domestication, where farmers develop improved crop varieties and share them with other farmers, leading to higher yields for the farmers and proliferation of the most widely-used varieties. Indeed, the North American lichenologist Trevor Goward has defined lichens as "fungi that discovered agriculture," and this study not only supports this view but adds a further dimension to it.

More information: The full article is available for no charge for 30 days following the date of this summary at www.amjbot.org/cgi/content/full/96/8/1409 .

Source: American Journal of Botany