# When it comes to genes, lichens embrace sharing economy

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Credit: University of Colorado at Boulder

University of Colorado Boulder researchers have discovered the first known molecular evidence of obligate symbiosis in lichens, a distinctive co-evolutionary relationship that could shed new light on how and why some multicellular organisms consolidate their genomes in order to co-exist.

The new study, which was published online today in the journal *Molecular Ecology*, finds that fungal organisms reduce their core genomic makeup while coalescing with algae to form a lichen partnership, one presumed to be "obligate" (i.e., requiring both partners) but had previously lacked direct genetic verification.

"Symbioses allows two different organisms to survive in areas where they otherwise might not be able to grow," said Erin Tripp, Curator of Botany at CU's Museum of Natural History and a co-author of the new study. "These findings are exciting because they illustrate a key genetic underpinning of this obligate pairing."

Lichens are omnipresent worldwide and may cover up to six percent of the Earth's land mass. There are over 20,000 known lichen species, some of which are well-suited to extreme environments like deserts and arctic tundra. Lichens play an important role in ecological processes such as soil formation and nutrient cycling and serve as bioindicators of environmental toxicity.

The genetic mechanisms and consequences of these fungal-algal unions, however, have remained poorly understood. Using samples collected from the southern Appalachian Mountains, the CU Boulder researchers sequenced DNA from 22 separate lichen species in order to better understand how the two unrelated organisms co-evolve on a molecular level.

The findings revealed that in some cases, the fungal partner of this symbiosis streamlined its mitochondrial genome, much like a couple moving in together might get rid of duplicate household furnishings.

"The fungus lost a crucial energy-producing gene while the algae retained a full-length copy of this gene," said Cloe Pogoda, lead author of the study and a graduate researcher in CU Boulder's Department of Molecular, Cellular and Developmental Biology. "We observed a parallel loss of this gene in three different lichen lineages: the fungus gives up this particular gene while its photosynthetic partner keeps it."

This obligate arrangement-in which one partner relinquishes its own mitochondrial power supply to likely become reliant on its partner for cellular energy-suggests a genetic division of labor that makes the resulting lichen more efficient, Tripp said, thereby perhaps conferring an ecological advantage.

The researchers plan to expand the study to include more lichen species in the future. The findings could also inspire new inquiries into the human gut microbiome, the complex bacterial colony that lives symbiotically inside each person and has been shown to influence various aspects of health.

"The implications are far-reaching, given how many symbiotic relationships we observe in nature," said Tripp, who is also an assistant professor in CU Boulder's Department of Ecology and Evolutionary Biology (EBIO). "Now we can expand our scope of study to look for genomic signatures of co-evolution in other organisms."

**More information:** Cloe S. Pogoda et al. Reductions in Complexity of Mitochondrial Genomes in Lichen-Forming Fungi Shed Light on Genome Architecture of Obligate Symbioses, *Molecular Ecology* (2018). DOI: 10.1111/mec.14519

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