

The hidden life of rock gnome lichen

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They are a natural fertilizer for the forest, great construction material for birds' nests and an important indicator of how polluted the air is. And yet scientists know very little about the genetic diversity of lichens—symbiotic life forms made up of two distinct, but interdependent organisms: fungi and algae.

A new study from researchers at The Graduate Center of The City University of New York is helping to answer some of those questions by shedding light on the genetic diversity and reproductive process of rock gnome [lichen](#) (*Cetradonia linearis*). It is one of only two varieties of lichens on the U.S. endangered species list and one of 14 on the International Union for the Conservation of Nature's Red List. The research appears online today in the *American Journal of Botany*.

There are roughly 20,000 identified lichen varieties around the globe. The Rock gnome species, however, is rare and known to exist only in the Southern Appalachian Mountains of Georgia, North Carolina, South Carolina, Tennessee, and Virginia. It populates along the sides of rocks in high-elevation areas with frequent fog or deep river gorges, but human-driven degradation of specialized habitat and an invasive tree pest have threatened the rock gnome's survival in recent decades.

"This research is the first genome-wide analysis of the rock gnome lichen, and the first population genomics study of any lichen species," said the paper's first author, Jessica Allen, who received her Ph.D. in biology from The Graduate Center—where she also began her study. "Lichens are important to our ecosystem because they support a lot of

biological activities, and they're also good indicators of air quality because where we find low levels of species diversity we tend to find high levels of lung cancer. Analyzing their genomics can help us understand how certain varieties reproduce, the amount of genetic diversity within their group, and the factors that allow them to thrive."

Methodology and Findings

For their study, researchers collected rock gnome lichen samples from 15 sites representing the diverse geographical and ecological range of its habitat. To perform the gene analysis and determine the diversity of this particular variety, they employed whole-genomics shotgun sequencing. This combination of two methods allowed researchers to efficiently sequence long DNA strands and simultaneously sequence all the DNA found in the lichen's chromosomes.

Next, researchers fed habitat, temperature, and precipitation data into an algorithm to determine the influence of geographical and environmental differences on the genetic variations found within the rock gnome lichen. Finally, researchers dissected fertile samples of the lichen to observe their reproductive structure.

The work enabled researchers to make three novel and important observations: the rock gnome lichen has become less widespread since the Last Glacial Maximum period; the genetic variations found in this variety are more a function of geography than environmental differences; and the rock gnome has a unisexual reproductive structure.

Significance

"This study ultimately shows that the rock gnome lichen is genetically distinct from one location to the next—even when the habitats are

similar," said Graduate Center biology professor Elizabeth Alter, whose lab conducted the study. "That suggests that if we destroy any of these areas through risky activities, we'll reduce the [diversity](#) and further jeopardize this lichen."

While this particular study broadens understanding of the factors shaping [genetic diversity](#) of [rock](#) gnome lichen and support continued conservation of this variety, the methodology used to identify the specie's genetic makeup and distinctive traits can be employed to gain a similar understanding of other endangered lichens.

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