Ochrolechia frigida (Swartz) Lynge
a cool lichen

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***Ochrolechia frigida* covering *Betula nana* and other vegetative matter on a barren mountaintop above the Arctic Circle in Norway. The yellow cups are the ascomata, or fruitbodies, for sporulation. The crust is made up of granules (soredia), containing both fungus and alga. From it arise several spiky projections-made up of fungus, which has been shown to spread over all available vegetation in relatively short order. Soon, however, normal thalli form, indicating that it has met up with and incorporated a suitable algal partner. The fungus is able to penetrate and kill vegetative host cells, which it does alone. When broken off and carried to other vegetation, what is not killed directly will die once covered, and then be decomposed by the fungus. (Photo: Maria Voitk)**

In May we spent a week in Tromsø, Norway, visiting our son and grandson well above the Arctic Circle. Each day we explored the countryside, noting unexpected similarities and surprising differences with our own mountains and barrens. Especially noticeable was the vast array of lichens, filling the Arctic landscape with colour at a time when most wildflowers had not started to bloom yet. However, the lichen that caught our eye was not a colorful one, but the white, crustose *Ochrolechia frigida* (Swatrz) Lynge. As with any new "discovery," soon we saw it everywhere on the tundra, easily recognized by patches of dead vegetation, varying from a few cm to several m in diameter, covered with a gray-white crust. All vegetation was covered indiscriminately: dwarf birches, mosses, lichens and other plants, whether live or dead. Actually, this was moot, because whatever was living soon died, when covered. Usually a white crust, on occasion it also had striking yellow saucer-like fruitbodies, hence its common names, Arctic saucer lichen or cold crabseye lichen.

Mycophiles are familiar with mycorrhizal mushrooms that form a partnership with photosynthesizing plants to supply their energy needs. A lichen is a fungus that has formed a similar association with photosynthesizing algae, bacteria or both to help supply its energy needs. Despite this obvious similarity, the world of lichens has been kept so separate and distant from the world of mushrooms that a student of one is not necessarily familiar with the other. Excluding a few lichenized basidiomycetes, lichens are almost totally unknown to me, so "discovering" this organism provided an opportunity to learn. I was so unfamiliar with lichens that I was unable to key it out in my lichen text. Thinking it a Scandinavian organism familiar to local experts, I asked Teuvo Ahti, a lichenologist with probably the largest collection of Newfoundland and Labrador lichens in the world. He identified it from the photo and told me that it was a common lichen in our province, represented in his herbarium by 50 collections from NL. Given a name, I was able to direct my reading and learn more about this organism. What I gleaned from reading was checked with Teuvo for accuracy.

Ochrolechia frigida has developed several coping mechanisms to enable it to thrive in what is normally a hostile environment. So effective have these mechanisms been that *Ochrolechia frigida* is found on mountaintops, tundra and extremely cold regions the world over, almost literally from pole to pole. The partners for most lichens have lived together so long that in the majority of instances they are unable to exist alone. Isolated colonies of *Trebouxia*, the algal partner of *Ochrolechia frigida*, have been described from nature, although some experts challenge these reports. At least under experimental conditions, the fungal partner has also been shown to be able to exist independently, albeit not reproduce. The lichen's many spiky branches are composed only of the fungal partner. These have been shown to break off and be carried elsewhere with wind or other vectors. They are able to colonize new host vegetative matter independently and have been shown to penetrate and kill host cells, as well as cover all host tissue. Just like most lichens, the fungus *Ochrolechia frigida* derives its energy from its algal partner. But unlike some lichens, the fungus can also derive its energy from saprophytic activity, and unlike most lichens, from parasitic activity. Since it decomposes all vegetative organisms, including other lichens, and since *Trebouxia* is the commonest algal partner of Arctic lichens, presumably the fungus can find a new algal partner in this way, even if established as a pure fungus. However, generally broken fragments include small granular soredia, which carry algal cells with them.

Ochrolechia frigida is particularly known for its ability to survive in extreme windy habitats (like hummock tops) where the snow cover may periodically disappear in the middle of the dark winter. *Trebouxia* is somewhat light intolerant. It is a good partner for a fungus located in dark polar regions and cold climates, covered by snow a large part of the time. The white pigment of the lichen thallus is most apt for the sunny days, because it reflects most of the light, protecting the photosynthetic partner. In the summer, mountaintops spend a lot of time in cloud and fog; lichens are excellent absorbers of atmospheric moisture, growing well in such weather in what would otherwise be very dry locales.

Thus, this lichen is very flexible, with alternative ways of getting energy and water and alternative methods of spread: particulate spread as fungal particles and sexual spread from spores. It utilizes these in different habitats, as circumstances allow. Saprophytic and parasitic augmentation of photosynthetic feeding is used in situations with ample vegetative material (e.g., very common in coastal and mountain heaths of Newfoundland and Labrador) and photosynthetic feeding alone where there is little vegetation (e.g., Antarctica). This is reflected in its morphology: many fungal spikes in Newfoundland and Labrador and mostly granules containing both partners in Antarctica. Its saproparasitic feeding is suited for the Arctic setting, where growth is slow. *Ochrolechia frigida* is absent from more temperate settings, where it is outcompeted by rapid vegetative growth. In boreal forest *Ochrolechia frigida* is only found on hummocks of larger open bogs, like in the interior of Newfoundland.

Clearly, this lichen is quite destructive of its environment. Vegetation slows down evaporation and its roots stabilize the thin Arctic soil. If all living vegetative matter is killed, the thin soil layer dries and becomes unstable against erosion by wind, rain, ice and snow. In the fragile Arctic, where reestablishing growth may take decades or even centuries, this can be a major catastrophe. Thus, it is a parasite both in the narrow sense (damaging its host) and the wide sense (damaging its environment). Its function or place in the Arctic ecosystem is not obvious. Although it is a decomposer, recycling carbon, doing so with living organisms is not necessarily a service. Much about this fungus remains a mystery, at least to me. It is considered a fine source of dye. Lichens commonly contain specific lichen acids, in this case gyrophoric acid, which cause a strong red reaction if the lichen is touched with a drop of hypochlorite solution, such as any bleaching agent used in washing clothes.

If you found this glimpse into lichens interesting and want to know more, you have two alternatives to climbing a mountaintop above the Arctic Circle in Norway to get to know a common Newfoundland and Labrador lichen. You can attend Mac Pitcher's Much About Lichens Workshop at the Brother Brennan Environmental Education Centre September 17-19, 2010 (see www.brotherbrennancentre.ca for more information). And, beginning 2011, you can learn about lichens at our mushroom foray. Realizing that lichens are a parallel form to mycorrhizal mushrooms, Foray Newfoundland & Labrador decided to add a lichen branch to our foray, to be organized by Mac Pitcher, with expertise offered by Teuvo Ahti, Stephen Clayden and other lichenologists. Meanwhile, you can join the Viking Foray on the Great Northern Peninsula, September, 10-12, 2010, to get prepared (see the Foray website <nlmushrooms.ca>).

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