

## Lichen FAQ

### Q. What is a lichen?

A. A lichen is a symbiosis between a fungus and a photobiont. The photobiont can be an alga (mostly green) and/or a cyanobacteria. About 10% of the lichens are considered to be cyanolichens – that is lichens that have cyanobacteria as the primary photobiont. In either case, the photobiont performs photosynthesis providing nourishment for the fungal partner. The fungal partner in turn provides a habitat for the photobiont that includes moisture and proper exposure to light.

### Q. What is the nature of this symbiosis?

A. There is no mistake that both partners get something out of the relationship – the photobiont is provided a habitat (moisture, filtered light) by the fungus and the fungus obtains nutrients (carbohydrates) from the photobiont. However, many feel like the photobiont gets the short end of the stick. It has been shown that the fungus kills photobiont cells but, because the photobiont reproduces faster than its cells are killed, the lichen persists. In some lichens the photobiont is actually penetrated by the fungus in order to transfer the carbohydrates produced via photosynthesis. So, it's not like the photobiont is a very "willing partner". When you look in a microscope and see the alga it really looks like it is imprisoned by the fungal hyphae.

### Q. How is a lichen classified?

A. A lichen is named according to the fungal partner. The photobionts have their own separate names. Most lichens are Ascomycetes, the cup fungi. About half of the 30,000 or so Ascomycete species form lichens. A handful of lichen species are Basidiomycetes, which are related to the common mushroom. There are about 14,000 species of lichens in habitats ranging from arctic to rainforest to desert.

### Q. What is known about lichen evolution?

A. Not much as they haven't left a very complete fossil record as they don't contain anything hard like a skeleton or shell that can be preserved in rock. Recently, however, the Chinese found a 600 million year old fungus symbiotic organism in marine fossils that they believe to be an ancestor of the land based lichens. Previously, the oldest fossil lichen (400 million years old) was found in Scotland as is land based. So, this new find provides evidence that the lichens could have had early ancestors in the sea. Because lichens are formed from diverse groups of fungi it is thought that they actually evolved on several distinct occasions so they cannot, as a group, be placed on a single branch on the tree of life.

### Q. Can a particular species of lichen have more than one species of photobiont?

A. For most cases, a particular lichen species is always composed of the same fungus and photobiont. There are, however, some interesting exceptions. There are some lichen species that associate with different photobionts in different geographical areas in their range. Also, some lichen species can have both alga and cyanobacteria as photobionts concurrently. Even more interesting, some lichens can actually change from having a green alga as their photobiont to having a cyanobacteria through their life cycle. Having said all this, the normal case is that there is just one species of photobiont that is associated with a particular fungal species. It should be noted that relatively few photobiont species take part in lichen partnerships resulting in many fungal partners having the same species of alga and/or cyanobacteria as their photobiont partners.

### Q. What kinds of algae are found in lichens?

A. Most are green algae, a few are golden algae, and one is a brown alga. Incidentally, the one with a brown alga is *Verrucaria tavaresiae* which was found right here on our coast by Dr. Richard Moe of UC Berkeley. In temperate areas there are three photobionts that are most common. *Trebouxia* is the most common green alga found in lichens and is rarely found free-living outside of a lichen. However, many other algae that are found in lichens are found free-living. *Trentepohlia* is the next most common alga and finally *Nostoc* is the most common cyanobacteria. Both *Trentepohlia* and *Nostoc* can be found in our area in free-living forms.

### Q. What is a cyanolichen?

A. A cyanolichen is a lichen with cyanobacteria as its photobiont. If you cut into a cyanolichen you can usually see (especially with a hand lens) that the photobiont is more of an intense blue-green color rather than the bright grass green of green alga. Quite often, but not always, cyanolichens are dark colors like brown, grey, or black.

### Q. What's so special about cyanolichens?

A. Cyanolichens contain cyanobacteria photobionts. Most of the known cyanobacteria photobionts perform nitrogen fixation. This means that cyanolichens produce nitrogen in a form that plants require from atmospheric nitrogen that plants cannot utilize. Cyanolichens are important in colonizing areas where plant life is absent such as newly exposed surfaces caused by volcanic eruptions, land slides, etc.

### Q. How can a lichen have both cyanobacteria and an alga as photobionts?

A. Most lichens containing both types of photobionts are very efficient and many can be found as some of the first life forms to inhabit newly exposed areas. For example some of the first colonizers at Mount St. Helens after the eruption of 1980 were lichens containing both cyanobacteria and a green alga. In this type of relationship, the green alga is usually contained inside the thallus as one would expect and the cyanobacteria is concentrated in separate structures that are often visible to the naked eye on the surface of the lobes. These are called cephalodia. They usually look like a darker patch or glob. In this way, in habitats void of nitrogen, the lichen can use its cyanobacteria to produce the necessary nitrogen while the green alga supplies carbohydrates.

### Q. Can the lichen forming fungi be free living? And what about the photobionts – can they live on their own as well?

A. Separated from its photobiont in culture, most lichen fungi are a blob looking nothing like the lichen. In many cases, cyanobacteria look pretty much the same whether they are free living or in a lichen. Green algae, however, can look very different free living in culture than they do inside a lichen.

**Q. Does the photobiont satisfy all the nutritional needs of the fungus?**

A. No, the photobiont provides starches and sugars, the results of photosynthesis but the lichen has other needs as well.

**Q. How does the lichen obtain nutrients other than that which the photobiont can provide?**

A. The lichen absorbs lots of substances through the air, rain, splashes of water, and even fertilizers in some cases in the form of man made chemical fertilizers as well as bird droppings, etc. Remember that the lichen has no roots like a vascular plant or mycelium like a mushroom to obtain nutrients.

**Q. How do lichens reproduce?**

A. The photobionts reproduce asexually right inside the lichen. However, when we talk about reproduction of a lichen we refer to how the fungus propagates. The fungus can reproduce either asexually or sexually or both. Some species of lichens are capable of both sexual as well as asexual propagation. Still others only reproduce by sexual means while others reproduce only vegetatively.

**Q. So how does asexual reproduction occur?**

A. There are a variety of structures that can be present on a lichen that contain both photobiont and fungus that can separate from the lichen and grow to form a new lichen thallus. Examples of such structures are soredia, blastidia, isidia, and lobules. Typically, they are scattered by small animals, mites, ticks, wind and rain to new locations. Additionally, spores that are capable of germinating called conidia are released from structures called pycnidia into the air and again may disperse by a number of means to an eventual landing place next to a suitable photobiont. There the conidia will germinate, forming fungal threads that it will use to seek out and envelope the photobiont to form a lichen.

**Q. What about sexual reproduction?**

A. This is complicated and nobody has actually observed it happen but here is what we think occurs. A spore called a conidia is released from a pycnidia structure on a lichen. The conidia spore finds its way to a tiny thread (trichogyne) on a lichen surface and attaches itself. Both the trichogyne and conidia are haploid. A fruiting body (ascmata) containing some diploid cells grows in this place. Meiosis occurs and haploid spores develop inside the ascmata that eventually are released into the air. The spore must find a partner of the right type of photobiont in order to make a new lichen. Now this next part has been observed – the spore germinates and sends out hyphal threads that explore for a photobiont. When the threads find the correct species then they envelope the photobiont and a new lichen is formed.

**Q. Are all fruiting bodies pretty much the same?**

A. Actually there are two main variations, apothecia and perithecia. Apothecia are usually disk or cup shaped and contain material in the center that contains the spores. The spores are expelled out of the disk into the environment. Apothecia can usually be seen easily with the naked eye and are usually on the upper surface of the lichen. Perithecia are flask shaped and contained largely under the upper surface of the lichen such that only a small pore is visible. Often a hand lens is necessary to see the pores. The spores are expelled through the pores. Most lichens are Ascomycetes which means that their spores are contained in flask shaped sacs (asci) inside the fruiting body. Usually there are 8 spores per asci but there can anywhere from one to hundreds of spores in an asci. At some point the asci eject the spores to the environment outside the fruiting body. There can be many asci within a single fruiting body.

**Q. What do spores look like and how big are they?**

A. Spores vary in size, shape, and color. In many lichens, particularly crustose lichens, spore characteristics are a very important trait used to identify species. Most spores are colorless although some contain pigment (mostly brown). Most spores are unicellular but some are multi-cellular. Usually a compound microscope is required to see spores. Size ranges from a few to 200 microns (millionths of a meter) in length. They are typically ellipsoid but some can be very long and thin like a string bean.

**Q. Does the lichen die after forming fruiting bodies?**

A. Some lichens keep growing and the larger they get the more apothecia they produce. Others, keep growing and produce apothecia at the same rate regardless of their size. Still others, quit growing after they produce apothecia.

**Q. Do lichens kill trees?**

A. No. Lichens are not parasites. They just hang on to a tree and really do no direct damage.

**Q. How fast do lichens grow?**

A. There is variability of course, but as a rule of thumb, lichens are slow growers. Generally, growth rates are somewhere between a few millimeters to a few centimeters per year. Species found in arctic/alpine or desert areas have much slower growth rates than specimens found in optimal habitats such as coastal-influenced regions. Some specimens have been found that are over 1000 years old. Our familiar *Ramalina menziesii*, dripping from our oaks, has shown growth rates of up to 90 mm/yr. Many crustose lichens that we commonly see on rocks grow about 2 millimeters per year. Lichen growth occurs in spurts when growing conditions are suitable due to the amount of light and water available. Lichens become dormant when growing conditions deteriorate and can stay viable for up to 10 years in this state at cool temperatures.

**Q. What kind of surfaces do lichens grow on?**

A. Bark, wood, rocks, mosses, soil, dead vegetation, leaves, pinecones, manmade objects, etc. Most lichens are particular as to the type of substrate they live on, with some species being more of a “generalist” than others. Some lichens are found only on a specific type of rock (calcareous, siliceous, sandstone, granite, etc) or the bark of a certain type of tree (smooth bark deciduous, conifer, oak, chaparral shrubs, etc.). Still others use manmade objects like wooden fences, barns, metal junk, sidewalks, mortar, roofing shingles, etc. as substrates. In the tropics many lichens are found growing on leaves.

**Q. In what kind of habitats do lichens grow?**

A. Lichens occur in very diverse habitats. Lichens are found on every continent in about every habitat you can think of from forest to desert to tundra to grassland to cities and towns. Not all lichens occur in all habitats, however. Most are very specialized due to environmental conditions, climate, geography, substrate. Furthermore, many lichens are particular to certain micro-habitats such as the north side of a rock, sunny surfaces exposed to lots of nitrogen, wet seeps, dry washes, even rabbit poop.

**Q. How do lichens break down rock to make soil?**

A. First of all, it takes a very long time for a lichen to break down a rock, but, this does happen and can be witnessed by studying rocks of various ages in volcanic regions. Lichens and mosses are the first colonizers after a volcanic eruption. Many lichens contain acids that help break down rock. Furthermore, the mechanical action of the fungal threads of the lichen penetrating the spaces between the rock crystals together with changes in temperature and moisture also help break down rock into soil.

**Q. Are lichens of any use to humans?**

A. Some examples of lichen usage by humans:

- ?? ancient Chinese and Egyptian medicines
- ?? a food to many native peoples
- ?? fabric dyes
- ?? a component of perfumes and cosmetics
- ?? the little “trees” you see in model railroad displays are lichens
- ?? a component in litmus paper
- ?? a means of dating old surfaces (the surface must be older than the lichen growing on it)
- ?? pollution monitors (some are quite sensitive to pollution)
- ?? possible sources of new antibiotics and medicines

**Q. It seems like there is a lot of variety in the lichen growth forms – do they have a name?**

A. Lichens can be lumped into three major growth forms for convenience. Foliose lichens are the “leafy” types that you see so frequently on trees and shrubs around here. These are somewhat loosely attached to the substrate and as such can be picked off the surface that they are growing on. Fruticose lichens attach to the substrate at one point and then form long dangling thalli or shorter shrubby thalli. The difference is that foliose lichens attach loosely at many points along the underside of the thallus and fruticose usually have one central point of attachment. The long green lichens you see so frequently dangling from the oaks in Sonoma County (*Ramalina menziesii*) are fruticose lichens. Finally, crustose lichens are most common growing on rock but many can be found on other substrates as well. They cannot be separated from the substrate without damaging the substrate – they actually grow into the surface they are on. In the case of rock, the fungal hyphae actually grow between the grains of the rock thereby anchoring the lichen to the rock.

**Q. What makes lichens different colors?**

A. Lichens manufacture a variety of different chemical substances, many of which are acids. These substances are often responsible for the coloration of the lichen. Identification of the substances in lichens is a valuable clue to the identity of the lichen. Additionally, the substances produced by some lichens can protect the lichen in the following ways:

- ?? substances with a bitter taste may prevent animals from eating a lichen
- ?? certain substances prevent the lichen from absorbing toxic metals by detoxification
- ?? some substance protect against too much UV radiation
- ?? some substances help to dissolve essential mineral nutrients
- ?? gas exchange within the lichen may be improved by the presence of certain substances.

**Q. I have heard that Hummingbirds construct their nests of lichens and spider silk. Do any other animals make use of lichens?**

A. Reindeer (caribou), deer, mountain goats, moose, pronghorn, squirrels, spruce grouse, and wild turkey eat lichens. Up to 50% of the caribou diet is lichens. Many arthropods, slugs and snails are efficient grazers of lichens. At least 50 species of birds (mergansers, thrushes, chickadees, hawks, etc.) use lichens as nesting material. I recently witnessed two Bushtits gathering tufts of *Usnea* and flying back to insert it into their nest. Northern Flying Squirrels utilize lichens as a major component in their nests as well. Lichens also provide a protective habitat for many insects. Birders often observe warblers, nuthatches, wrens, and other insectivorous birds foraging among lichens on a tree branch. Some moths have evolved to mimic lichens for protection – it is extremely difficult to see the moth against a background that is identical.

**Q. How sensitive are lichens to air pollution?**

A. They are very sensitive, especially to sulphur dioxide, which is a by-product of burning fossil fuels. Some species of lichens are very intolerant of air pollution where as others can stand varying degrees of it. Many of the lichen species that we see regularly around here (*Ramalina*, *Usnea*, *Teloschistes*, and most of the cyanolichens) are very intolerant which says something positive about the quality of the air in Sonoma County. Lichens have been used in many studies that document either deterioration or improvement of air quality depending on the trend in lichen growth. If lichens are disappearing or are reduced in numbers over time then the air quality is worsening. If, on the other hand, lichens are more numerous then the air quality is improving.

**Q. Can lichens be readily identified in the field?**

A. Some that are distinctive can, indeed, be identified right in the field by examination with a hand lens. Many, however, require collection and further study at home. Lichen keys guide you through the identification process. It varies depending on the type of lichen you have collected. Chemical tests are sometimes required where you place a small drop of either C (Clorox) or K (KOH) on the lichen and observe any changes in color. This will indicate the presence or absence of certain lichen substances. Examination of the general physical appearance of the lichen (the morphology) and color of the photobiont can be done with a hand lens and razor

blade. For crustose lichens a compound microscope is usually necessary to look at the spores. Other methods may be necessary as indicated by the key you are using.

**Q. How do I collect a lichen in the field?**

A. Note the details of the location that you have found the lichen. Things like date, time, GPS coordinates, substrate, exposure (north facing, shaded, sunny, splash zone, road cut, etc.), state, county, and any other information you find pertinent. Many people use a small bag or envelope to carry the lichen home. Either make careful notes describing the substrate or try to take a little of it home with you. How the lichen is attached to the substrate is often an important clue in the identification process. **CAUTION: never remove a lichen that is not obviously abundant in the area you are collecting from. Do not deface substrates, particularly along trails when trying to remove a lichen.** Furthermore, abide by the rules of the location – that is, if you are in a National Park or other location where taking anything is prohibited then don't collect. You can make notes and/or take a photo to help you remember what you saw.

**Q. What kind of equipment is required to get started in studying lichens?**

A. A good key is necessary to guide you through the identification process. Suggested is *Lichens of North America* by Brodo, Sharnoff, and Sharnoff. Simple tools are adequate for studying most foliose and fruticose lichens:

1. Single edged razor blades
2. C – plain bleach (avoid scented varieties)
3. K – KOH (potassium hydroxide). Household lye such as in plain DrainO works too.
4. Hand lens
5. Fine tipped forceps

Studying crustose lichens usually requires a compound microscope. A dissecting microscope isn't absolutely necessary, but makes the preparation of apothecial sections for observation under the compound microscope much easier.

**References**

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