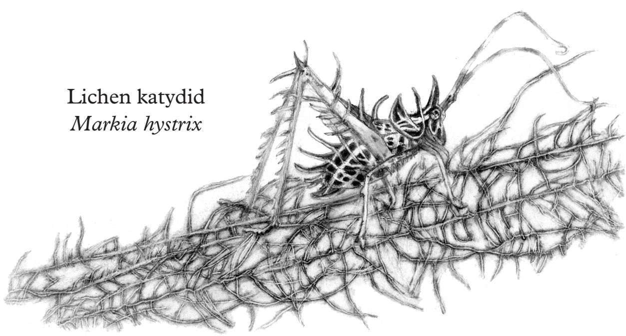
## Camouflage

Many animals use lichens for camouflage, taking advantage of their presence in almost every kind of habitat, from arctic to desert. Lichens have been around for millions of years—enough time for a variety of camouflage mechanisms to develop and become effective for different species on different continents.

Some animals' entire bodies resemble lichens in both color and form. For example, the lichen katydid, *Markia hystrix*, which lives among lichens (often *Usnea* species) in Central and South America, has a lichen-green body with numerous spiky projections exactly mimicking both the color and the form of the fruticose lichen it lives with. Similarly, the common bark katydid of Africa, *Cymatomera denticollis*, has lobed growths on its legs and thorax that resemble the shape and color of the foliose lichens in its habitat.

Many animals rely only on color for camouflage. One of the largest such animals is the Colugo, whose blotchy body blends with lichen patches on tree trunks. This



Lichen katydid
*Markia hystrix*

background matching is very common among *Lepidoptera* (mainly moths) larvae, adults, or both. Larvae that feed on lichens and nocturnal adults that hang out during the day on lichen-covered bark—such as the European tree-lichen beauty *Cryphia algae* and the gray-green Brussels lace moth *Cleora lichenaria*—use this method. In tropical rain forests, white lichens grow directly on living leaves, giving them a speckled appearance. The Costa Rican katydid *Rosophyllum colosseum* is green like the leaf and has the same whitish specks, allowing it to blend perfectly with the leaf. The tropical tree frog *Hyla rufitela* uses the same strategy.

Some spiders are adept at lichen camouflage. In the Wassaw Wildlife Refuge off the coast of Savannah, Georgia, I once found a little green spider (*Eustala sp.*) on the medallion lichen (*Dirinaria confluens*). Not only was the green a perfect match with the lichen, but the center of the spider's abdomen was black—exactly the color and size of the apothecia on the lichen. If it hadn't moved, I would not have noticed it.

Some moths hedge their bets by having both dark bark-mimic forms and pale or greenish lichen-mimic forms. Examples are the adult of the peppered moth, the caterpillar of Kent's geometer, and the caterpillar of the lunate zale.

Other creatures using lichen camouflage have to work to achieve the same result as creatures that are born disguised. Caterpillars of bagworm moths create cases of bits of plant debris and lichen—whatever is convenient. They retreat into these camouflaged cases when threatened or when resting. Some species of lacewing larvae, known as trash carriers, accumulate bits of wood, bark, remains of insects and spiders, and other debris into a pile that they carry on their backs. One lacewing species, *Leucochrysa pavida*, is a specialist: this lacewing collects only bits of lichen. Its lichen "coat" may be four times wider than its own body, making the coat look like a patch of lichen.

A singular example of lichen actually growing on an invertebrate is found in the New Guinea forest weevil (*Gymnopholus lichenifer*). When they first emerge as adults, these weevils are up to one and a half inches long, very slow moving, don't fly, and are free of lichens. A tiny microhabitat consisting of mites, nematodes, rotifers, bark lice, and lichens builds up on their backs. Some of those critters may bring in lichen fragments that later get established. It is thought that orabatid mites, which are voracious lichen eaters, keep the lichen in check.

*See also* colugo; hummingbird nest; peppered moth.

## Careers

Lichenology has emerged from obscurity, shaken off a somewhat dowdy image, and become an enticing field for young scientists. The new breed of lichenologists working today is typified by James Lendemer, Staff Lichenologist and Associate Curator of the Institute of Systematic Botany, New York Botanical Garden (NYBG). While no less disciplined in their science than their predecessors, these younger lichenologists are bringing lichen texts out of the academics-only arena to a place of general interest. In so doing, they engage budding naturalists and journalists in the popular media, who bring lichen stories to the general public where everyone can feel the wonder.

Lendemer's interest in lichens began when he was a teen helping with collections at the Academy of Natural Sciences in Philadelphia. He experienced the institution's stated mission of "encouragement and cultivation of the sciences" when he discovered a mistake in the naming of a lichen specimen. Despite his lack of status, lichenologists gave him respect for his observation. This experience led to other discoveries: lichens are pretty amazing, lichenology is in need of more attention, herbaria collections are important, there's plenty of room for newcomers, and there's support among peers. Lendemer was hooked, and he's now paying it forward. He's a lichen evangelist, in the best sense of the word.

In addition to the awesome responsibility of overseeing NYBG's lichen collection (the largest in the Western Hemisphere), Lendemer works on documenting the lichen diversity of North America and the importance of lichens in conservation strategies for land managers. His collaboration with other lichenologists, environmentalists, conservationists, and rock climbers has led to the discovery of new species, expanded the range of known species, encouraged habitat protection for threatened species, heightened awareness of endangered species, and produced user-friendly field guides.

The power of collaboration makes two recent field guides shine. *Urban Lichens*, Lendemer's collaboration with lead author Jessica Allen, Associate Professor of Biology at Eastern Washington University, not only opens readers' eyes to the fact of lichens in urban habitats but also details how to recognize them. It even includes an itinerary for "Fifty Lichens in One Day: A Whirlwind Tour of New York City."

The other is *Field Guide to the Lichens of Great Smoky Mountains National Park*, a collaborative effort between Lendemer and lead author Erin A. Tripp, Associate Professor, Ecology and Evolutionary Biology, and Curator of Botany, University of Colorado. The guide is more than user-friendly—it's lichen-friendly. The authors unabashedly express their personal feelings about lichens while still including the necessary formal details. "*Punctelia* is a wonderful genus of macrolichens whose species are quite at home in the Smokies, like many of the rest of us." The range maps show that this "wonderful genus" might also be at home where you live. They call one of the weediest species in the genus, *Punctelia rudecta*, not a weed but "Backyard Buddy." Their joy in lichens is infectious. These young lichenologists and their peers are spreading the love.

*See also* Parton, Dolly; rock climbing; Wyoming.

## Colugo

This curious animal, the "flying lemur" of Southeast Asia, neither flies nor is it a lemur. If it weren't for its excellent daytime camouflage, it might have been given a more accurate name, like "big-eyed, giant lichen lurker." Many animals lurk on and in lichens, but most are very small, and many are invertebrates. The colugo is a furry mammal somewhere in size between a gray squirrel and a household cat. It is a canopy-dwelling nocturnal animal that spends its days in tree hollows or clinging to tree limbs with its long, curved claws. Some individuals have reddish fur, and others have mottled gray or greenish-gray fur with blotches of a paler color that allow them to blend in with lichen-covered tree trunks and escape detection from predators, which include pythons, martens, macaques, and owls.

In Central and South America, the sloth is another arboreal mammal with greenish fur, owing to the green algae that live in its fur. In fact, there is a three-way dependency among the sloth, the algae, and a moth that also lives in the sloth's fur. It is a less intimate algal symbiosis than that of lichens. The algae seem to mainly function as a food supplement for the sloth and a specialized mini-habitat that supports the entire life cycle of the moth. Another function may be providing camouflage for the sloth.

Just how strange a mammal is the colugo? It is closer in its evolutionary history to primates than to bats (true flyers) or flying squirrels (furry gliders). Taxonomists have found no evidence to align it with any other mammals and have assigned it an order of its own, the Dermoptera, a name that means "skin wings." A skin membrane called a patagium connects the sides of the head, the front leg claws, and the hind leg claws; it runs all the way to the tip of the tail, giving the animal maximum surface area to support efficient gliding.

Whereas other mammalian orders include hundreds of species—or in the case of rodents over 2,000 species—the Dermoptera has only two for sure and maybe no more than eight. As members of the Primates, we may think of ourselves as distinctly different from the other 500 primate species, yet we have enough in common for the taxonomists to have lumped us all together. But there is nothing like a colugo except another colugo.

*See also* camouflage.

**Common Names**

I liken (pardon me, but it's unavoidable now and then) common names to nicknames. They indicate affection and familiarity, but in biology they are problematic because they are not uniformly agreed upon and differ across languages, regions, and cultures. Scientific names, on the other hand, are backed up with precise descriptions and worldwide acceptance but have a major shortcoming. They use Latin, which is not widely known and is alienating. In contrast, common names are often endearing, amusing, fanciful, and in any event, engaging.

Common names are extra important for lichens because they help interest people in a part of the natural world they have overlooked. In the northeast United States, birthplace of the American Revolution, many people who don't know lichens are aware of a red-capped one called British soldiers, but they have never heard of *Cladonia cristatella*.

Most lichens are diminutive with distinctive structures that have led to fanciful names like pixie cups, gnome fingers, elf ears, angel's hair, and witch's hair. The fairy puke lichen, with its blue-green thallus splattered with pink blobs, surely commemorates what happened when the fairy heard that its scientific name is *Icmadophila ericetorum*.

Yellow lichens in the genus *Vulpicida* are called sunshine lichens, and the bright orange lichens of the *Xanthoria* genus are known as sunburst lichens. Common names for individual species narrow down the description, but they're subjective. Some people may find the bare-bottomed sunburst just as elegant as the elegant sunburst.

Some common names are beautifully simple. The asterisk lichen looks exactly like a group of asterisks drawn with a black pen on the bark. The smoky-eye boulder lichen grows on boulders and each little gray "eye" looks ringed with black eyeliner. The Christmas lichen is red and green. When I have shown a collection of toadskin lichen, *Umbilicaria papulosa*, to a class of fifth-graders and asked what they would call it if they had to assign a name, someone always says, "It looks like a toad."

Animal names are popular. Reindeer lichens are well known, but there are also dog, wolf, owl, mouse, and centipede lichens. There are foxhair lichens and horsehair lichens. A favorite is the can-of-worms lichen.

Mealy pixie cup
*Cladonia chlorophaea*

My birding friends refer to birds by their common name. My lichen friends call lichens by their scientific names. Would we have broader lichen interest and awareness if we used common names? To say nothing of greater fondness for them? After all, lichens don't poop on your car.

*See also* British soldier.

## Coyote

Coyote features in many Native American legends, sometimes as the primary character and sometimes with other animals like Fox and Eagle. He can be foolish but is also resourceful and wily. Coyote is a compulsive trickster, a troublemaker, and, very importantly, a transformer.

A legend of the Okanangan-Colville people of inland portions of Washington State and British Columbia tells of the origin of the black tree-hair lichen (*Bryoria fremontii*). As happens in a culture of oral traditions, there are multiple variations of the legend. One version tells of Coyote and his son capturing some swans. He ties his son to the birds to hold them while he climbs a nearby pine to get kindling wood. When he is way up the tree, the swans fly off with his son. He tries to jump out of the tree, but his long hair braid catches on a branch and he is stuck. He eventually frees himself by cutting off his braid. Meanwhile, the swans have dropped his son, killing him. Coyote, the transformer, not only revives his son but also converts his hair into a long black stringy form of *Bryoria* lichen. He addresses it, "You, my valuable hair, will not be wasted. The people will gather you and the old women will turn you into food."

This lichen is one of the few that to this day is eaten out of choice rather than only in times of famine.

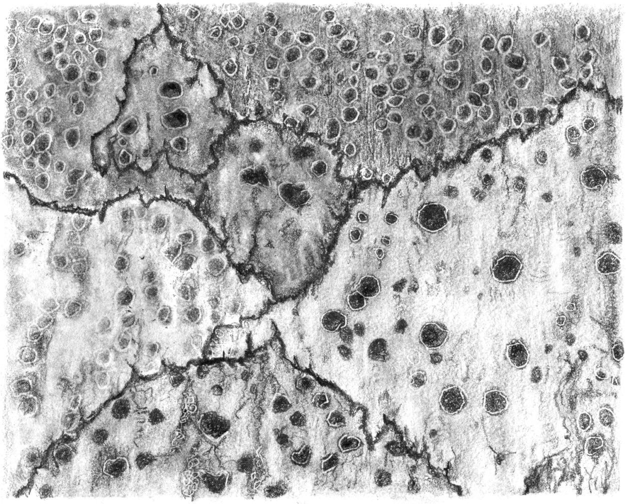
*See also* black tree-hair.

**Crustose**

One of the three major growth forms of lichens is called crustose. These lichens are bonded so closely to their substrate that they can't be collected without taking some of the substrate with them. Like foliose lichens, they have an upper cortex, but they differ in having no lower cortex. On the underside, microscopic fungal threads extend directly into crevices in the substrate and hold the lichen in place. Crustose lichens exist like a skin on the substrate. Some are thin and almost two-dimensional; others are thick and lumpy. Textures range from baby's bottom smooth to elephant trunk bumpy. Similarly, the surface may be smooth and continuous, coarse, lightly cracked, or deeply cracked.

Two types of crustose lichens stretch the definition of the group. One type is endolithic, meaning it grows within rock. The fungal threads and algal cells find enough space between the grains in the first few millimeters of the rock to survive and grow. Only the fruiting bodies (apothecia) are on the rock's surface. The other type is called leprose because the thallus is broken up into powdery fragments that create a rough, scurfy texture, typified by the genus *Lepraria*, known as dust lichens.

Crustose lichens can form colonies that cover large surface areas and are visible from a distance, especially brightly colored ones, like yellow map lichen, *Rhizocarpon geographicum*, on otherwise bald granite outcroppings; orange desert firedot, *Xanthomendoza trachyphylla*,



Wall-to-wall crustose lichen colonies on bark

on exposed rocks in very dry habitats; and maritime sunburst lichen, *Xanthoria parietina*, on coastal rocks.

Lichens of different species and different growth types are often found in very close proximity, growing into and over each other while they cover large rocky areas so thoroughly that the natural color of the rock is hidden. Crustose lichens on bark can completely obliterate the color and texture of the bark, interfering with identification of trees by bark. Erect (fruticose) types tower over crustose types on the same twig. Another feature of some crustose species, which is most apparent when colonies abut, is a black border outlining the boundary of each colony, like lines delineating countries on a map or patches on a crazy quilt. This border material, called a prothallus, is purely fungal and often black. You may also notice it in the fissures of crustose lichens with a cracked surface.

*See also* foliose; fruticose; thallus.

## Cudbear

The purple dye industry started as early as 1500 BCE in southern Europe, with Mediterranean shellfish as the source, and later moved on to *Roccella* lichens, the source of the dye called orchil. The dates are hazy, but we know that purple dyes were being extracted from other lichens in northern countries at roughly the same time. Much later, some of these dyes came to be known as cudbear.

Jump ahead to Scotland and the time of the Industrial Revolution. The Highland Clearances were driving tenants off the land to make way for higher-rent sheep farms for wool for the mills. Meantime, the Gordon family of Banffshire had figured out a process for making purple dye from Scottish lichens. Their patent application of 1758 read in part, "When these three Ingredients [lichens] are gathered, cleanse them from all their filth, by laying them severally in cold water, changing the water daily so long as any filth remains about them. Then dry and pound them in a mortar and dilute them with the spirit of urine & spirit of soot, to which add quick lime. Digest them together for fourteen days, and they will produce the Cudbear fitt for Dyers use." The Gordons called their dye "cudbear" for Cuthbert, which was Mrs. Gordon's family name. A benefit of cudbear over imported *Roccella* from Cape Verde and the Canary Islands was that it was entirely available from "Great Britain or His Majesty's plantations." They could set their own price.

While the Gordons prospered with cudbear factories in Edinburgh and Glasgow, the displaced Highlanders struggled. They collected the lichen *Ochrolechia tartarea* in the largest quantities they could find, and they saved their urine for sale. At one point, 2,000 to 3,000 gallons per day were needed. Collectors used hygrometers to prevent fraud. As Scottish sources of the lichen were depleted, imports from Norway and Sweden filled the gap. Eventually, the enterprise failed.

Cudbear manufacturing in England also sourced lichens from Norway and Sweden. The process was basically the same: it still involved ammonia and the common source was still urine. William Lauder Lindsay (1829–1880), a Scottish physician and botanist specializing in lichens, reported that English manufacturers had "learned by experience to avoid urine from beer-drinkers, which is excessive in quantity but frequently deficient in urea and solids, while it is abundant in water."

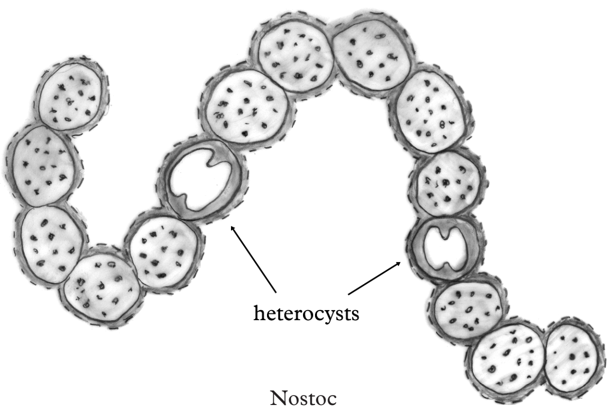
Lichen flora got a chance to recover starting in 1856 when a London teenager, William Henry Perkins, accidentally synthesized a purple dye while trying to make quinine for treating malaria. All dyes up to this time had come from natural sources. Perkins understood the significance of his discovery, started a dye business, and subsequently discovered other dyes.

*See also* dyes; orchil.

## Cyanobacteria

About 10 percent of all lichen species contain cyanobacteria, either as the sole photobiont or as a supplement to algae. Cyanolichens are relatively young in the tree of life, but cyanobacteria are older than the hills. They have been around for three and a half billion years. Some of them floating near the surface of the ocean stumbled upon the process of trapping solar energy and using it to construct organic compounds, giving off oxygen. Hello, photosynthesis! Among the compounds they made was the enzyme nitrogenase, which is used for fixing nitrogen. Over time other primitive life forms developed and engulfed cyanobacteria, presumably for food. The accepted theory is that some engulfed cyanobacteria continued to function inside the host. Eventually, they gave up free-living and nitrogen-fixing, kept on photosynthesizing, and evolved into chloroplasts.

Cyanobacteria are still with us, and many are free-living; some species (frequently *Nostoc*) are captured by fungi and form cyanolichens, for example, *Peltigera* or *Collema*. A few species are edible by humans. For example, *Spirulina*, which is high in protein, vitamins, and minerals, was a food source for Aztecs. Today it is




Nostoc

sold in the United States as a "health food" in powder or tablet form. NASA has used it as a dietary supplement for astronauts. Other edible examples are some *Nostoc* species that are used as food in the Philippines, Indonesia, Japan, and China. On the other hand, many species (in at least eleven genera) produce a variety of cyanotoxins that target the liver, skin, or nervous system.

Cyanobacteria used to be called "blue-green algae" because, like algae, they photosynthesize, but biochemistry and electron microscopy have shown them to be a form of bacteria. They contain chlorophyll *a*, and many also contain the blue pigment phycocyanin, which is also capable of photosynthesis and which gave them their name.

Cyanobacteria had a gigantic effect on the development of life on earth. They gave us chloroplasts and an atmosphere with oxygen. Sir Isaac Newton got a lot of things right, but he should have said, "We have come this far by standing on the shoulders of microbes."

*See also* cyanolichens; nitrogen fixing.

## Cyanolichens

The majority of lichens, around 90 percent, get their carbohydrates from algae. The remaining 10 percent, the cyanolichens, get some or all of their carbs from cyanobacteria. You can recognize a lot of cyanolichens just by looking at them or, for some species, by smelling them. If you come across a gray, brown, or black lichen that smells like fish or that you want to call a jelly lichen, chances are good that you have found a cyanolichen. As you might expect with lichens, however, it's not always that simple. One of the curveballs is that lichens with both algae and cyanobacteria are probably more green than gray, brown, or black. These three-part lichens (one mycobiont and two photobionts) rely on algae as the primary photobiont and contain cyanobacteria in nodules or galls called cephalodia, which appear as dark or bluish lumps. The main role of cyanobacteria in three-part lichens is nitrogen fixation. The frequency of special cells for nitrogen fixation, so-called heterocysts, is much higher in the cyanobacteria in cephalodia than in two-part cyanolichens. Examples of three-part cyanolichens are some of the dog lichens (*Peltigera*), foam lichens (*Stereocaulon*), and lungworts (*Lobaria*).

In two-part cyanolichens (one mycobiont and one photobiont), the cyanobacteria are not confined in cephalodia. If the lichen is gelatinous when wet, you can probably narrow its identity down to one of the jelly lichens (*Collema*) or jellyskins (*Leptogium*), in which the cyanobacteria are spread throughout the thallus. If the cyanobacteria are confined to a layer, you might have a nongelatinous shingle lichen (*Pannaria*).

If a lichen is dark brown or gray brown, foliose, and smells fishy, you have probably found a moon lichen (*Sticta*). James Lendemer, Staff Lichenologist (and Lichen Sniffer) as well as Associate Curator of the Institute of Systematic Botany at the New York Botanical Garden, has offered the appropriate nickname of "Stink-ta" for *Sticta beauvoisii*, one of the moon lichens.

Caribou are famous for consuming reindeer lichens, which don't have cyanobacteria, but they do resort to eating certain cyanolichens (*Stereocaulon*) in the winter in parts of the boreal forest where cyanolichens are the dominant ground cover.

Although cyanolichens produce glucose to feed the fungus, and lichens with green algae produce sugar alcohols of a kind similar to those used as sweeteners in the food industry, lichens do not taste sweet. Any sweetness is masked by the many bitter substances produced by the fungus.

*See also* cyanobacteria.

## Dermatology

The word "lichen" has been used to describe skin ailments for almost as long as the word has existed. Hippocrates (ca. 460–370 BCE) used the word to mean "eruptions of papules." Dioscorides (40–90 CE) used it to mean both the lichen *and* the "papular skin disease" it treated. Today the word is part of the official dermatology lexicon, which is no wonder given the visual similarity of some lichens to some skin ailments.

"Lichenification" is a general term for the secondary condition of hardened, thickened, cracked skin caused by chronic itching and scratching. The medical name is "lichen simplex chronicus." It is not restricted to humans; there are accounts of it on black bears, golden eagles, and bobcats. Crustose lichens described as areolate (for example, tile lichens in the genus *Lecideia*, or cobblestone lichens in the genus *Acarospora*) or rimose (such as map lichens in the genus *Rhizocarpon*) have a thick thallus and a cracked surface that resemble lichenification—at least in black and white.

Dermatologists use the term "lichenoid eruption" to describe several skin disorders that involve flat, shiny lesions called papules. "Lichen planus" is characterized by irritated areas with papules that could easily resemble a lichen thallus with apothecia. The discolored patches of "lichen schlerosus" contrast with surrounding healthy skin, making a pattern like a lichen on a rock or tree trunk. And so it goes with drug-induced lichenoid eruption, lichen nitidus, lichen scrofulosorum, lichen striatus, lichenoid pityriasis, and exudative discoid and lichenoid dermatitis!

Lichens have nothing to do with leprosy, but some species with no protective skin (upper cortex) have a powdery surface and are called leprose. They are typified by the *Lepraria* genus, aka dust lichens, and *Chrysothrix*, aka golddust lichens.

A few individuals are allergic to some species of lichens and can develop contact dermatitis. This is mostly seen in forestry workers.

If you don't want to experience a cringe-fest, skip the search for lichen-named skin diseases in image libraries.

*See also* etymology.

## Dispersal

Lichens seem to face massive challenges to their dispersal. Only the fungal partner reproduces sexually, and in North America around 23 percent of lichenized fungi never do. Spores resulting from sex are produced in apothecia and created over the long life of the lichen. Some species produce huge numbers of apothecia (more spores, more dispersal opportunities); some ground-dwelling species, such as *Cladonia*, produce apothecia on a stalk, where released spores have a better chance to catch a current of air.

The "celibate" ones are creative about vegetative reproduction. They have a variety of specialized reproductive propagules, all designed for dispersal. The propagules are easily dislodged by heavy weather, falling branches, wind, water, and animals. Almost all lichens are brittle when dry, such that any disturbance might break off a piece regardless of special structures.

Whatever the method, lichens are successful. They occupy 6 to 8 percent of the Earth's surface and an unknown percentage of tree bark and other surfaces.

*See also* isidium; reproduction; soredium; zoochory.

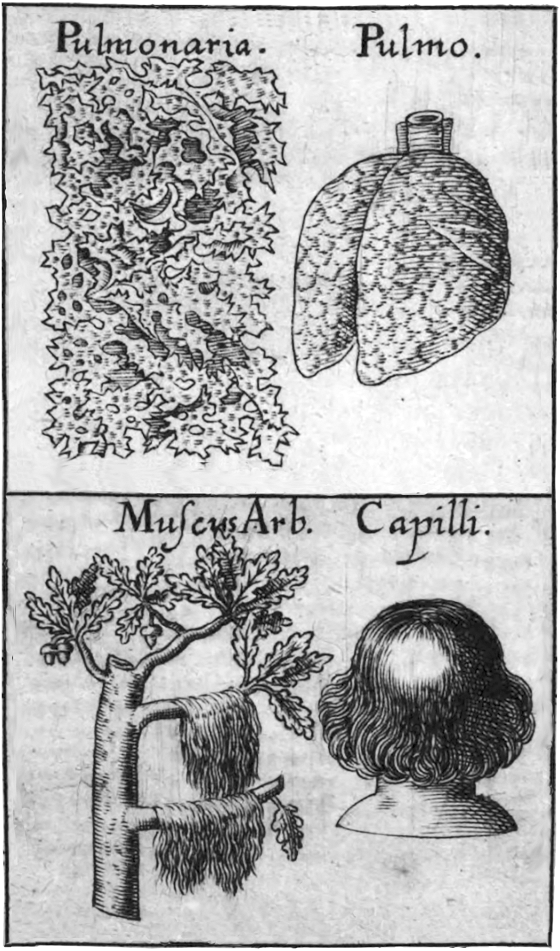
### Doctrine of Signatures

This medieval doctrine held that plants with useful medicinal properties had been marked by God such that their shape, color, smell, or texture indicated the body part or ailment that they could be used to treat. These beliefs were popularized and practiced at a time when lichens were still considered plants, so it's not surprising to find lichens in the doctrine.

Beard lichens (genus *Usnea*) are filamentous, and although green, their hairlike form suggested to these early observers that they could strengthen hair and treat conditions of the scalp. It turns out that beard lichens do produce an antibacterial compound, called usnic acid.

The maritime sunburst lichen, *Xanthoria parietina*, signaled its possible use for treating jaundice by its orange color. Many lichens are yellow or orange. Maybe this one was more prolific in an area with avid practitioners of the doctrine. None of the orange lichens are effective for jaundice.

The dog lichen, *Peltigera canina*, has apothecia that, with some imagination, look like dog teeth—albeit brown dog teeth. Another possible signature is the white




Depiction of lungwort and beard lichen by
Michael Bernhard Valentini, *Medicina nov-antiqua*, 1713

pointed rhizines on the lower surface that could resemble dog fangs. Either way, concoctions of dog lichen were recommended for the treatment of "canine madness" or rabies. John Lightfoot, an English botanist and parson who didn't subscribe to the doctrine of signatures, wrote in 1777: "It is much to be lamented that the success of this medicine has not always answered the expectation. There are instances where the application has not prevented hydrophobia; and it is even uncertain whether it has been at all instrumental in keeping off that disorder." Mr. Lightfoot was a master of understatement—his light touch matched his foot.

Lungwort, *Lobaria pulmonaria*, has a textured surface that is evocative of lung tissue and therefore indicated to believers in the doctrine a treatment for tuberculosis. Unlike the connection drawn between dog lichen and rabies, this association has some merit: lungwort contains antibacterial agents that do have an effect on tuberculosis.

Among the many compounds unique to lichens, some are truly medicinal.

## Dyes

Lichens have been used as a source of dye since classical Greek times and since unknown times by indigenous peoples. Materials dyed have included wool, silk, cotton, skin, basket reeds, spruce roots for baskets, and porcupine quills. The colors achievable cover the whole spectrum from reds and yellows to purples and violets. There is no relationship between the lichen color and the dye color; purple dye, for example, can be extracted from the gray-green lichen *Parmotrema tinctorum*, and blue dye from the orange lichen *Xanthoria parietina*. The dye color is a result of chemical changes in lichen compounds during the dye process. The dye compounds are of two types, each of which has its corresponding extraction process.

The boiling-water method typically yields yellows, golds, and a range of browns; it depends on compounds like stictic, norstictic, or salazinic acid. Dye lichens in the *Parmelia* genus (called "crottle" in Scotland and Ireland) contain salazinic acid, which converts to a dye compound that forms such a stable bond with wool proteins that no mordant is needed. The earthy tones and earthy aroma (some call it musty) of the original Harris Tweed came from crottle. Wool dyed this way had the added value of being too bitter for moth caterpillars.

The ammonia method involves steeping the lichen in the presence of ammonia for three to sixteen weeks, depending on the lichen species. The old-time source of ammonia, urine, was later replaced by ammonium hydroxide. This method depends on compounds like erythrin or lecanoric, gyrophoric, or alectoronic acids and yields pinks, purples, and fuchsias. Lichens historically used for these colors were *Ochrolechia* species, whose dye was called "cudbear," and *Roccella* species, whose dye was called "orchil." Because *Roccella* is very rare in North America, it should not be collected for any reason, least of all for dyeing.

Not all lichens work as a dye source. *Lichen Dyes: The New Source Book* by Karen Diadick Casselman names applicable species, which method to use, and gives detailed steps on the methods. Check online for workshops by Alissa Allen, who teaches the use of local fungi and encourages conservation of both lichens and mushrooms. It is important to learn identification to avoid inadvertently collecting something rare just to see if it works as a dye source.

Although there are guidelines for ethical collection, the most sustainable approach is not to collect at all. Even the weedy species are best left alone. We live in a time when flocks of passenger pigeons no longer darken the sky. May our descendants never live in a time when tree trunks, tundra, and rocks are devoid of lichens. All the colors you can achieve from lichen dyes can be derived from other natural sources.

*See also* cudbear; lichen substances; litmus; orchil.

## Etymology

The word "lichen" originated from Greek, was adapted into Latin, and then made its way into English (the same path taken by over half of all English words). Somewhere along the way, its definition split into a botanical meaning and a dermatological one, which continued to evolve in parallel.

The word started its journey as λειχήν, a noun derived from the verb λειω, "to lick." Its strict etymological definition would be "the licker." The earliest use of the word in surviving documents is by the dramatist and "Father of Tragedy," Aeschylus (ca. 525–456 BCE). He wrote of Apollo sending λειχήν as a punishment. In that instance, it meant a kind of blight that traveled the world destroying leaves. In another tragedy, he wrote of Apollo sending down λειχῆνας ἐξέσθοντας: the first word is the same lichen word in a different grammatical case, and the second is a qualifying participle best translated as "eating away." Together the two words are translated as "sores that eat away." Some translations are "what eats around itself." How we got there from "the licker" is probably obvious to a dog. The rest of us have to guess. Could it be that the lichen was "licking" its substrate and somehow consuming its surroundings? We may never know. The connection between leaf blight and sores on the skin is easily visualized. We also have to consider that dramatists are masters of metaphor.

Jump ahead a century to Hippocrates (ca. 460–370 BCE), who used the same word, λειχήν, the licker, in a medical context to mean ailments of the skin involving eruptions of papules (little bumps or warts). The anglicized version of the word, "lichen," has been carried forward into current-day dermatology with very specific meanings.

Jump ahead another century to Theophrastus (ca. 371–287 BCE). For the first time, the extant literature shows the word being used to describe what we know today as lichens (and probably including mosses and liverworts). It's not a giant leap to get from eruptions and bumps on the skin to crustose lichens with apothecia. It's as if the rock or the tree has a skin disease.

Roughly 300 years after the death of Theophrastus, lichens turn up in Roman records. Pliny the Elder (23–79 CE) and Dioscorides, his contemporary, both used the word to describe a lichen, and both suggested medicinal uses. They were not known to collaborate, but both drew heavily from the work of Theophrastus. In "Materia Medica," Dioscorides wrote: "Lichen grows on rocks and is also called bryon. It is a moss sticking to moist rocks. This is applied to stop discharges of blood, lessen inflammation, and heal lichen [papular skin disease], and applied with honey it helps jaundice. It also helps the fluids of the mouth and tongue [saliva].” He used the same word to mean both the lichen and the skin disease.

Despite the Aeschylus usage, the consensus among etymologists is that λειχήν did originally mean “lichen” or “moss” before it was carried over into the medical sphere as “rash” or “lichenlike skin growth.” We don’t have early enough botanical texts prior to Theophrastus to be certain. So many gaps—it’s got me licked.

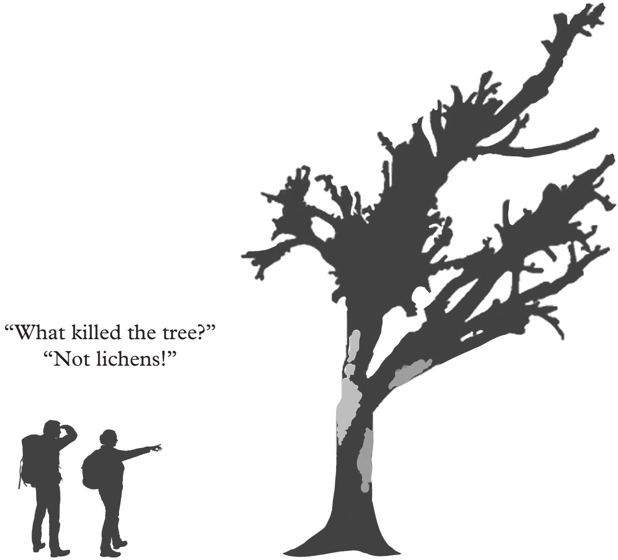
*See also* dermatology; Pliny the Elder; Theophrastus.

## FAQs

Every field has its most frequently asked questions, and two that are always near the top of the list for lichens are “Do they harm my trees?” and “How do I get rid of them?” The short answers are “No” and “You don’t need to do anything.” Good news and good news.

Lichens need a place to attach where they have access to sunlight (not necessarily direct sunlight) and moisture, which they get mainly from the air. With no roots to penetrate the bark, they can’t tap into the tree’s vascular system and siphon nutrients. They manufacture their own food. They attach via filaments (rhizines), which do go into the bark, but not far. The removal of lichens from bark doesn’t help the tree and increases the chances of damaging the bark, which does harm the tree.

Some lichen species need more light than others (old man’s beard, for example), and so if you see an increase in light-loving species on older trees that have lost some




branches and on dead trees, you may wonder if the lichens were responsible. The light came first, making a hospitable habitat, and the lichens followed. Lichen-covered trees, however, could also be hosting harmful fungi of the type that "eat" wood. Such fungi don't form lichens. Their lifestyle is independent of the lichens, although their effect on the tree could eventually let in more light by killing off some branches.

Lichens grow slowly, so you won't see them on young trees. This is another reason why people are led astray. "The trees were clean (!) when I planted them. It's only been five years, and now they have this stuff on them." That's more good news. Lichens don't do well in polluted air. If you have a lot of lichens on your trees, breathe deeply and give thanks to the environmentalists working on clean air regulations.

**Fiction**

The use of lichens as an agent in fiction is not a fertile field for novelists. John Wyndham, the author better known for *The Day of the Triffids* and *The Midwich Cuckoos*, is an exception. He combined his knowledge that lichens grow slowly, are long-lived, and are subject to overharvesting with his observations of the role of women in society, the short-term mentality of politicians, the worship of a youthful appearance, and the false claims of the cosmetics industry. What if something that slows the aging process could be extracted from a lichen? What if there were a skin care product that *actually* reduced signs of aging? What if the product had a known but undisclosed side effect that enabled people, starting with women, to live 200 to 300 years? What if supplies were limited and only the rich could afford it? What could possibly go wrong?

Wyndham's novel, published in 1960, is appropriately called *Trouble with Lichen*. Diana, his protagonist, has population growth and worldwide famine on her mind. "You know as well as I do that the world is in a mess and floundering deeper every day. . . . We are letting it drift toward that with an evil irresponsibility, because with our ordinary short lives we won't be here to see it. . . . There's only one thing I can see that will stop it happening. That is that some of us, at least, should be going to live long enough to be afraid of it for *ourselves*." Climate change, anyone?

Another novel, *The Collapse of Western Civilization* by the historians Naomi Oreskes and Erik M. Conway, published in 2014, is about climate change. The story includes a remedial role for lichens, which are known for their ability to grow in the harshest of conditions. It is the year 2393, the 300th anniversary of the "great collapse." The book's narrator, a scholar in the 2nd People's Republic of China, reports that back around the time of the collapse, a genetic engineer developed a fast-growing lichen with a superior ability to sequester carbon. "This pitch-black lichen, dubbed *Pannaria ishikawa*, was deliberately released from Ishikawa's laboratory, spreading rapidly throughout Japan and then across most of the globe. Within two decades, it had visibly altered the visual landscape and measurably altered atmospheric $CO_2$ . . . starting the world on the road to social, political, and economic recovery." Although *ishikawa* is an invented species of lichen, the authors chose a real genus, *Pannaria*, that contains nitrogen-fixing cyanobacteria, *Nostoc*. Lichens with an algal photobiont would also sequester carbon, but the needed algal partners would be hard to find on an overheated planet. Also, a damaged landscape would recover sooner with access to nitrogen; plus *Nostoc* is a possible food source. A cyanolichen is the better choice.

Wyndham thought of his work as "logical fantasy" rather than science fiction. I would call it social satire. To call the Oreskes-Conway book sci-fi minimizes the science. It is heavily science-based fiction. I would call it consciousness-raising and a "fable for tomorrow," in the genre of *Silent Spring* by Rachel Carson.

**Fluorescence**

Lichens glow. Not all, but some. In a process called "biofluorescence," chemicals convert high-energy ultraviolet (UV) light into lower-energy visible light. Of all the chemicals that lichens make (over 1,000), only some are photoactive (for example, lichexanthone and thiophaninic acid). It's known that UV radiation can harm photosynthesizing algae and that chemicals in the lichen cortex (the outer skin) act as a kind of sunscreen to protect the very important algae—the cooks in the lichen kitchen.

Many *non*-lichenized fungi glow in the dark owing to a different process called "bioluminescence." The difference is that luminescence is created by an enzymatic chemical process within the organism that releases energy as visible light. You can see it unaided in the dark. A mushroom example is the jack-o'-lantern. A well-known insect example is the firefly.

A long-wave UV black light (with a wavelength of 365 nanometers) is a useful part of a lichenologist's tool kit because the ability of a lichen to fluoresce and the color of the fluorescence are clues in the identification process—to say nothing of the joy that bioluminescent fungi can bring to a nighttime walk. Inexpensive battery-powered lights of the type used by rock collectors and other hobbyists serve the need and are sufficient for amateurs. Lichen colors that you see under UV light are quite different from the same lichen viewed in daylight. For example:

1. Typical green, gray-green, or whitish lichens may show up as vivid pink, blue, red, or orange under UV light. Some of these lichens are practically un-

detectable in daylight; a crustose gray matte lichen on the gray matte surface of Florida palmetto bark, for instance, is clearly defined in sharp-edged yellow patches under UV light. Similarly, *Pertusaria pustulata*, one of the wart lichens, is often close to the same color as the bark it is growing on; however, it is easily spotted at night because of its bright orange color under UV.

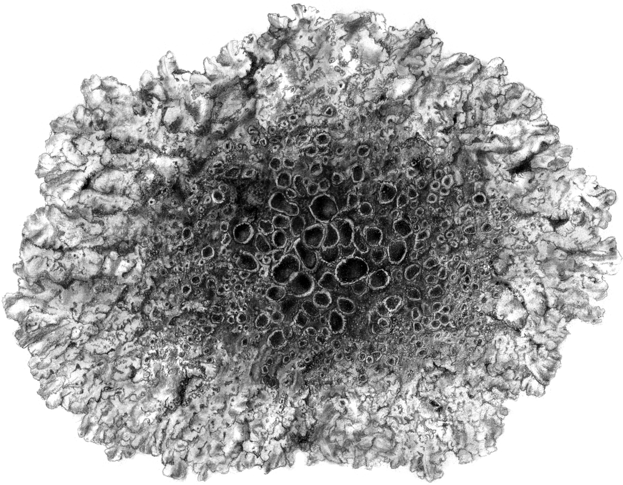
2. *Psilolechia lucida* is a Granny-Smith-apple-green crustose lichen that grows on high-humidity surfaces on the undersides of rocks in northeastern North America and west to the Great Lakes. It is easy to identify in daylight by its habitat, its color, and its powdery surface, but it also glows orange under UV.

In addition to fluorescence from chemicals in the fungal component of the lichen, chlorophyll in the algal component is capable of its own fluorescence, which provides a measure of photosynthetic productivity. Portable fluorometers are now available to measure and compare the productivity of different species (plants and lichens) at different locations in a habitat and at different heights in the canopy, all *in situ*.

## Foliose

One of the three major growth forms of lichens is called foliose. The words "foliose" and the more familiar "foliage" are both derived from the same Latin root, *folium*, meaning "leaf," but "foliage" is used for plants and "foliose" for lichens.

Foliose lichens have lobes that are thin like leaves and have a distinct upper and lower surface. The lobes usually lie flat on the substrate. Anyone familiar with plant



identification will know the importance of leaf shape, size, edge, color, ornamentation, attachment, etc. The same holds for foliose lichens. These physical characteristics help distinguish one species from another.

At the microscopic level, the tissue within the lobes is organized into distinct layers, most of which are fungal. The upper surface of the lobe is made of tightly packed fungal threads that form a cortex, or skin, which covers a layer of photosynthesizing cells (algae or cyanobacteria), below which is a layer of loosely packed fungal threads (medulla), and then usually at the bottom is a lower cortex. Fungal structures on the lower cortex, if present, hold the lichen to the substrate. When there is no lower cortex, threads from the medulla attach directly to the substrate.

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