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lichen habitats and communities of the upland southeast

The Upland Southeast hosts an incredible diversity of natural communities, some of which occur nowhere else. These communities have been characterized well from the standpoint of vascular plants and animals, but less so for lichens and especially crustose species. This reflects a dearth of in-depth and detailed study across the entire region until recently. Based on our observations, lichen distribution patterns and communities follow broadly defined vegetation types but are less distinct. For instance, different types of high-elevation hardwood-dominated forests differ considerably in their woody-plant composition and soil chemistry, but the lichen communities in these different forests are quite similar, with many shared species.

This section is designed as a general guide to the broadly defined lichen habitat types that are discussed in the species accounts throughout this book and referred to in the identification key. For each habitat type, important components, such as woody vegetation and rock outcrops, are discussed in the context of the lichens that commonly occur on them. The habitat types fall into two major groups: those of the high elevations (above 3,500 feet or 1,100 meters), and those of the middle and low elevations (below 3,500 feet). For each habitat type, an overview of the history and vegetation is provided, background on the lichen communities is given, and then locations are suggested where good examples of the habitat type can be visited easily.

THE HIGH ELEVATIONS

The high elevations of the Upland Southeast are home to some of the most iconic habitats in the region. But what is a high elevation? For this book, high elevations are broadly defined as areas above 3,500 feet (1,100 meters). The goal of this definition was to include widely recognized and charismatic habitats from the Southern Appalachians found at or above 4,500 feet (1,400 meters), such as spruce-fir forests and shrub balds, together with similar habitats in the Central Appalachians that extend into lower elevations because of different, more northern climates.

Intuitively, high-elevation habitat covers much less area than the lower elevations. But compared to lower elevations, much more remains as intact natural habitat, is protected as natural areas, and is in public ownership. This is due to a combination of remote location, harsh weather conditions, steep topography, lack of easily arable land, distance from transportation infrastructure, such as railroads, and widespread public perception of scenic beauty. It is not to say that high elevations and the lichen communities found there have not been profoundly affected by human activity.

The foundation for our understanding of high-elevation lichens in the Upland Southeast was established through periodic study during the twentieth century, but it focused on either conspicuous macrolichens or a small number of locations with tourist infrastructure. High elevations drew lichenists because of the scenic beauty and unique vegetation. Some of the earliest lichen collections were made by the French botanist André Michaux on Grandfather Mountain, North Carolina, in 1794. But the first attempt at a complete lichen inventory for any area of Upland Southeast was made by the Swedish lichenist Gunnar Degelius in the 1930s, who focused on several of the highest peaks in the Great Smoky Mountains (hereafter “Smokies”) of North Carolina and Tennessee (Degelius 1941). It was only in the 1970s that Jonathan Dey, a graduate student at Duke University, intensively studied the macrolichens of the most remote high-elevation peaks of the Smokies. Likewise, Paula DePriest’s 1983 thesis on the macrolichens of Unaka Mountain remains one of the few detailed studies from eastern Tennessee outside the Smokies.

While better studied than their lower-elevation counterparts, high-elevation lichens are still far from completely known. As of this writing, species new to science are still being found routinely, and many areas above 3,500 feet in elevation remain unexplored. There is still much left to do!

Spruce-Fir Forests

Overview. Although the trees and shrubs that make up the spruce-fir forests vary between the central and southern parts of the Appalachians, the lichen communities are similar throughout. Conifer forests dominated by red spruce (*Picea rubens*) and fir (*Abies* spp.) are among the most iconic and threatened high-elevation habitats in the Upland Southeast. These are typically cool, dark, shaded forests with a thick layer of humus. Historically, they covered large areas of the high elevations, but extensive logging followed by fires promoted their replacement with hardwood-dominated forests (Adams et al. 2010; Pielke 1981). Spruce-fir forests now cover less than half of their original extent, and those that remain are imperiled by invasive species such as the balsam woolly adelgid (*Adelges piceae*), acid rain or fog, and climate change (Nicholas, Eager, and Peine 1999).

Southern Appalachian spruce-fir forests occur in North Carolina and Tennessee and extend as far north as Mount Rogers in southern Virginia. These habitats are dominated by red spruce and the endemic Fraser fir (*Abies fraseri*), often mixed with smaller amounts of hardwoods, such as striped maple (*Acer pensylvanicum*), mountain maple (*Acer spicatum*), yellow birch (*Betula alleghaniensis*), fire cherry (*Prunus pensylvanicum*), and mountain ash (*Sorbus americana*). There is also usually a dense shrub layer that includes rhododendron (often Catawba rhododendron, *Rhododendron catawbiense*), hobblebush



The largest remaining intact southeastern spruce-fir forest occurs in the Great Smoky Mountains, NC.



Lichens overgrow mosses and wood in the damp, dark understory of spruce-fir forests on Mount Rogers, VA.



Fruticose and bushy foliose lichens cover every available substrate in light gaps of the high ridges of the spruce-fir zone in the Great Smoky Mountains, NC and TN.

(*Viburnum lantanoides*), highbush cranberry (*Vaccinium erythrocarpum*), and a tangle of blackberry (*Rubus* spp.). Farther north in the Central Appalachians of Virginia and West Virginia, spruce-fir forests are dominated by red spruce. Fir is much less frequent, and is a different northern species (balsam fir, *Abies balsamea*).

Lichens. Somehow the best habitats, and lichens, rise to the top. Spruce-fir forests are where the fun stuff is: rare and threatened species, narrow endemics, disjunct species hundreds or thousands of miles from their nearest kin. Even the most common species take on a special presence, whether dust lichens like *Lepraria oxybapha*, which dominate the spindly young firs in dank regenerating forests, or large splotches of crusts like *Loxospora ochrophaea* on mature spruces and firs. A large cohort of species are widespread at many elevations in temperate eastern North America and attain remarkable size and profusion in this habitat (e.g., *Flavoparmelia caperata*, *Lecanora hybocarpa*, *L. strobilina*, *Porpidia albocaerulescens*, *Punctelia caseana*, *P. rudecta*, and *Usnocetraria oakesiana*). Then there are disjunct species that are primarily distributed much farther north and are widespread in northern temperate or boreal regions of the Northern Hemisphere (e.g., *Lobaria scrobiculata*, *Lecidea nylanderii*, *Mycoblastus caesius*, *M. sanguinarioides*, and *Usnea subfloridana*). Some of these disjuncts are frequent and found in every spruce-fir forest (*L. nylanderii*, *U. subfloridana*), while others are very rare (*L. scrobiculata*). The Southern Appalachians also host a smaller number of disjunct species that occur in high-elevation mountain habitats farther south in Central and South America, as well as the Caribbean. The square pants or square britches lichens, species of *Hypotrachyna*, exemplify this group.

Finally, there are species endemic to the spruce-fir forests of this region and that occur nowhere else. Most are highly threatened. Hot Dots (*Coniarthonia kermesina*) is a crustose lichen that is almost

Hypotrachyna virginica at
Grandfather Mountain, NC, 1×.



entirely restricted to mature red spruce trees in the Southern Appalachians. Virginia Square Britches (*Hypotrachyna virginica*) is a large foliose lichen entirely restricted to mature Appalachian spruce-fir forests in the Upland Southeast. Many of these unique treasures escaped notice until recently because they required focused attention to parse out of the frenetic bustle that is the spruce-fir lichen party. *Karinomyces saulskellyana* is a great example of this. It is the most common crustose lichen in shaded, mossy spruce-fir forests, easily recognized by its bright green, sorediate thallus and black lecideine apothecia. Yet somehow it almost entirely escaped attention until 2022. Once we recognized it, we were shocked to find it growing abundantly when we revisited mountaintops we had trod many times before.

Where to see them. These forests and their lichens can be explored easily using a hand lens during visits to Great Smoky Mountains National Park, Mount Mitchell State Park, and Spruce Knob in Monongahela National Forest.

Balds: Grassy, Heath, and Shrub

Overview. If the spruce-fir forests are among the most iconic habitats of the Upland Southeast, then mountain balds may be the most scenic because of the panoramic views they often afford. Balds are treeless areas, occur mostly above 4,500 feet of elevation (1,400 meters), and are restricted to the Southern Appalachian Mountains of North Carolina, Tennessee, and adjacent Virginia. Grassy balds are open areas dominated by herbaceous plants with few shrubs and trees. Shrub balds are dominated by shrubs and small trees, often developing as grassy balds are invaded by woody vegetation. Heath balds are an impenetrable morass of ericaceous shrubs and stunted trees where there is little or no exposed rock. Rocky summits

Classic grassy bald at Jane Bald, near Roan Mountain, TN.



with heath vegetation in the Central Appalachians can be considered balds, but these are treated as rock outcrops for the purpose of this book. The distinction between a heath bald and a rock outcrop with heath vegetation is imperfect but is used here because habitats with extensive exposed rock have unique and distinct lichen communities. The age and origin of Southern Appalachian balds have been the subject of debate, but it is generally agreed that European settlers maintained them through grazing into the early twentieth century. When many balds were transferred into public ownership and grazing ceased, the open grassy balds began to undergo succession and disappear (Duernberger 2017; Mark 1958).

Though important for biodiversity and scenic beauty, the herbaceous plants that dominate the balds do not support lichens. However, the absence of trees, combined with occurrence on high mountaintops and ridges, provides two things that lichens love: ample light and frequent immersion in fog and mist. As a result, woody plants, rock outcrops, and organic matter host a profusion of lichens in this habitat. The woody plants found on balds are mostly ericaceous shrubs, such as mountain laurel (*Kalmia latifolia*), flame azalea (*Rhododendron calendulaceum*), Catawba rhododendron, and highbush blueberry (*Vaccinium corymbosum*). Trees are a mixture of high-elevation species including Fraser fir, smooth serviceberry (*Amelanchier laevis*), hawthorns (*Crataegus* spp.), fire cherry, and mountain ash. Occasional sugar maple (*Acer saccharum*) and yellow birch also often occur mixed into shrub-bald vegetation. All balds occur on non-calcareous rock types, and isolated boulders and small rock outcrops are typically granite or gneiss.

Lichens. Balds host some of the most spectacular lichen communities in the Upland Southeast. Boulders and rock outcrops are covered by diverse mosaics of species that do not tolerate deep shade. Rock-dwelling communities are a mix of common, widespread species that occur at many elevations in temperate eastern North America (e.g., *Acarospora fuscata*, *Aspicilia cinerea*, *Buellia badia*, *Rhizocarpon rubescens*, and a mix of *Xanthoparmelia* species) and species more typical of northern areas and disjunct at high elevations of the Appalachians (e.g., *Lecidea tessellata* and *Rhizocarpon geographicum*). Where organic matter is exposed, it is also often covered by a carpet of early-successional, disturbance-tolerant species that are widespread in temperate eastern North America (e.g., *Cladonia* spp., *Dibaeis baeomyces*, *Placynthiella icmalea*, and *Trapeliopsis granulosa*).

While the lichens on rocks and organic matter are conspicuous and attractive, the truly spectacular displays are on the bark of shrubs and trees that are exposed to light. Every square inch of bark is covered by large, foliose, and fruticose species forming tangles that protrude and dangle in every direction past a continuous sheen of crustose lichens. These woody substrates host a distinctive community of crustose lichens that include common, widespread species found at many elevations (e.g., *Amandinea punctata*, *Japewiella dollypartoniana*, and *Lecanora strobilina*), disjunct species typical of northern regions (e.g., *Lecanora pulicaris*, *L. rugosella*, *L. symmicta*, and *Lecidea roseotincta*), and the Southern Appalachian endemic *Lecanora masana*. Foliose and fruticose species of Parmeliaceae are also diverse and abundant, often with a mixture of widespread species with broad distributions in temperate eastern North America (e.g., *Flavoparmelia caperata*, *Pseudevernia consocians*, *Punctelia rudecta*, *Usnea ceratina*, and *U. subgracilis*) and species that are restricted to high elevations or oceanic



Lichens cover the stems of rhododendron in shrub balds like Grassy Ridge of Roan Mountain, TN.

habitats elsewhere (e.g., *Pseudevernia cladonia* and *Usnea subrubicunda*). Species of *Hypotrachyna* are particularly abundant and diverse in these habitats, with a single branch often hosting half a dozen species (e.g., *H. afrorevoluta*, *H. horrescens*, *H. kauffmaniana*, *H. mcmulliniana*, *H. minarum*, and *H. showmanii*, among others).

Where to see them. Grass and shrub balds, as well the lichens that grow in these scenic habitats, can be explored with a hand lens at Roan Mountain in Cherokee National Forest and Mount Rogers National Recreation Area in Virginia. During an Appalachian Trail thru hike, you encounter many balds in Great Smoky Mountains National Park.

Northern Hardwood Forests

Overview. Northern hardwood forests are defined here in a broad sense to include all various high-elevation forests dominated by hardwoods. This is because while the forests may differ in composition and appearance, the lichen communities generally do not. In this sense, they cover large areas of the Upland Southeast in comparison to spruce-fir forests or balds. In the Southern Appalachians, these forests occur predominantly in a band between 4,000 and 5,000 feet of elevation (1,200–1,500 meters), extending higher in areas where past disturbance of spruce-fir forests promoted the regrowth of hardwoods (USDA 2014). Farther north in the Central Appalachians, these forests occur above 3,000 feet of elevation (900 meters) (Fleming, Patterson, and Taverna 2021).

Northern hardwood forests have relatively rich soil, a lush herbaceous understory, and a wide diversity of woody species more typical of northeastern North America—for example, mountain, striped, and sugar maple, smooth serviceberry, yellow buckeye (*Aesculus flava*), yellow birch, American beech (*Fagus grandifolia*), white ash (*Fraxinus americana*), witch hazel (*Hamamelis virginiana*), wild hydrangea (*Hydrangea arborescens*), mountain holly (*Ilex montana*), cucumber magnolia (*Magnolia acuminata*), white basswood (*Tilia americana*), and hobblebush. These forests also often include red oak (*Quercus rubra*), whether as an occasional solitary tree or as a dominant part of the forest. When red oak becomes frequent, or even dominant, it can be recognized as a specific forest type. Locations with more acidic soils also incorporate ericaceous shrubs into the understory—for example, bear huckleberry (*Gaylussacia ursina*), mountain laurel, flame azalea, Catawba rhododendron, and rosebay (*Rhododendron maximum*).

Lichens. Even if the vegetation may vary from site to site, you can always tell a northern hardwood forest by the presence of numerous disjunct lichens that grow abundantly on the bark and branches of the



Lichens cover the trunks of trees in a northern hardwood forest on the approach to Big Bald in the Bald Mountains, NC.



Northern hardwoods on Blue Knob,
near Marlinton, WV.

woody substrates. Some of these species are common in northeastern North America and the Great Lakes region but are still endemic to eastern North America. These include the brown foliose *Melanohalea halei* and the gray foliose *Punctelia appalachensis*. As soon as you see these species on a hike up the mountain, there can be no doubt you entered a northern hardwood forest. Other species in this habitat are widespread in the Northern Hemisphere, or at least in northeastern North America and Europe. These include the tiny crustose *Dictyocatenulata alba*, commonly found on the bases of yellow birch and beech.

Even though most lichens can be found in other habitats, or are widespread, the communities they form on the bark of mature hardwoods can be truly extraordinary due to the frequent, albeit brief, periods of moisture from low-hanging clouds and rain. Large sugar maple, yellow birch, white ash, and red oak trees are cloaked with a thick layer of huge foliose lichen colonies (e.g., *Heterodermia leucomela*, *H. neglecta*, *H. speciosa*, *H. squamulosa*, *Leptogium cyanescens*, *Lobaria pulmonaria*, *Parmotrema crinitum*, *P. stuppeum*, *Punctelia appalachensis*, *P. rudecta*, *Ricasolia*

quercizans, *Sticta beauvoisii*) that nestle in epiphytic mosses and ferns. Younger, smooth-barked trees are similarly clothed in stunning mosaics of crustose lichens (e.g., *Japewiella dollypartonianana*, *Lecanora hybocarpa*, *L. rugosella*, *Lepra pustulata*, *L. trachythallina*, *L. waghornei*, *Pertusaria appalachensis*, *P. neoscotica*, *P. propinqua*, and *Vainionora americana*). The shrubs and branches of trees similarly are often laden with *Usnea* species (*U. ceratina*, *U. subgracilis*, *U. subfloridana*, and the Appalachian endemic *U. subfusca*) intermixed with smaller *Ramalina americana* and a patchwork of common foliose species (e.g., *Myelochroa galbina* and *Physcia stellaris*), as well as crusts (e.g., *Lecanora strobilina*, *Pertusaria neolecania*, *Xanthosyne varians*, and *Scoliciosporum chlorococcum*).

Where to see them. Many excellent examples of northern hardwood forests are along the Blue Ridge Parkway and Cherohala Skyway in North Carolina, Skyline Drive in the Central District of Shenandoah National Park in Virginia, and the Cranberry Wilderness of Monongahela National Forest in West Virginia. Whether during a brief stop at an overlook or a long hike into the forest, there are plenty of lichens to be seen with and without a hand lens.

Rock-Dominated Habitats: Cliffs, Granite Domes, Outcrops, Boulderfields, and Talus

Overview. All habitats described above include some amount of rock, usually small, shaded outcrops or boulders. The lichens that occur on those shaded rocks are the same as those that would occur on the shaded or sheltered faces of rocks in the rock-dominated habitats described here. For this book,

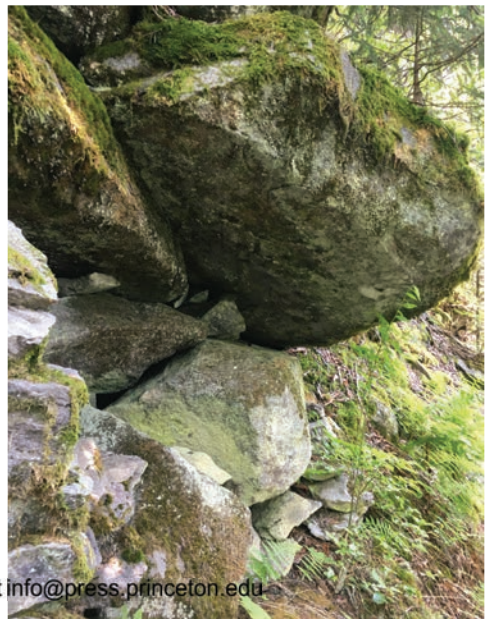


Although most high elevations are forested, there are some areas of extensive rock outcrops for lichens to colonize, such as Grayson Highlands, VA.

rock-dominated habitats are those with large amounts of exposed rock and where woody vegetation is stunted, limited in extent, or completely absent. The vegetation is often confined to pockets of soil that accumulate in crevices between the rocks, and woody species are mostly coniferous trees—spruce and fir at the highest elevations, pines and Canadian hemlock (*Tsuga canadensis*) lower down—and ericaceous shrubs (mountain laurel, various rhododendron species, blueberry and huckleberry, among others), with a sprinkling of stunted hardwood trees (various maples, smooth serviceberry, yellow birch). Wiser, Peet, and White (1996) provide an excellent overview.

Most high-elevation rock-dominated habitats in the Upland Southeast are composed of non-calcareous rock types with varying degrees of acidity and are represented by five main habitat types: cliffs, granite domes, outcrops, boulder fields, and talus. Cliffs are characterized by a relatively flat, sparsely vegetated, upper plateau or lip and then an abrupt, steep, vertical face, below which fallen rock accumulates to form talus or scree (Bogges, Harrison, and Bishop 2021). Within the vertical face of the cliff, there are surfaces that can be strongly exposed to the sun, areas shaded by nearby vegetation, and ledges or overhangs that create darker, protected microhabitats. Granite domes, especially in the Highlands-Cashiers area of North Carolina, are perhaps the best-known high-elevation rock outcrops because of the scenic beauty of their steep, sparsely vegetated faces. High-elevation outcrops can include a cliff or vertical face, but here refer mainly to the larger, shaded rock faces that occur within forests. Talus is the loose accumulation of rocks that forms below an outcrop or cliff and can

Sheltered spaces in rock overhangs host abundant dust lichens, like the greenish *Andreiomyces morozianus* here on Mount Sterling in the Great Smoky Mountains, NC.



vary considerably in slope, rock size, extent, and degree of shading. Boulderfields are usually associated with streams or creeks and shaded by surrounding forest or interspersed trees in the Upland Southeast.

Lichens. High-elevation rock-dominated habitats differ markedly from similar low-elevation habitats, such as granite flatrocks or glades, in their lichen communities. Lichens here grow either over soil and humus or directly on the rock. Bark-dwelling lichen communities are comparable to those of the surrounding vegetation and are described in the sections above.

Although many members of rock-dominated lichen communities are widespread in high elevations of the Upland Southeast, specialists and narrowly endemic species hide among the crowd. Glance at the accounts of these species, and you will be able to pick them out on a hike. *Lepraria lanata* is a dust lichen narrowly restricted to high-elevation sheltered rock microhabitats in the Southern Appalachians. *Lepa andersoniae* is a crustose lichen that grows only on shaded rocks and cliff faces of several mountains. In Great Smoky Mountains National Park, the Anakeesta Formation is an unusual rock type that is exposed at high-elevation sites and is rich in metals. In addition to many disjunct species, it supports several narrow endemics, including *Buellia sharpiana* and *Cladonia appalachensis*, which grow in profusion at just a few locations.

The lichens found on soil or humus of rock outcrops are mainly widespread species that are easily outcompeted and persist because the lack of vegetation and stable conditions favor early colonizers or pioneer species. This includes a wide array of *Cladonia* species that can form extensive multispecies mats in areas with sun exposure. Experts refer to these alternately as lichen raves or lichen frustrations, depending on their personal perspective. The most frequent and conspicuous species form large thalli with podetia—for instance, *C. arbuscula*, *C. rangiferina*, *C. squamosa*, and *C. uncialis*. As shade increases, *Cladonia* species form large tufts or cushions, rather than mats, and the most common species are *C. furcata* and *C. squamosa*. Exposed organic matter is also colonized by a cohort like that found in balds, including smaller *Cladonia* (usually *C. grayi*, *C. ochrochlora*, *C. pleurota*) and crustose lichens (*Dibaeis baeomyces*, *Placynthiella icmalea*, *P. uliginosa*, *Pycnothelia papillaria*).

Lichens that grow directly on rock fall into three main groups: those that grow on sun-exposed faces, those that grow on shaded faces, and those that grow in shaded or sheltered overhangs in highly protected microhabitats. High-elevation rock-outcrop lichen communities are mostly composed of species that are widespread across elevations in the Upland Southeast mixed with those that are restricted to high elevations but are common and widespread in more northern or boreal areas outside the Upland Southeast. Examples of common and widespread species from sun-exposed rocks include many crustose lichens (e.g., *Aspicilia cinerea*, *Buellia badia*, *Lepraria neglecta*, *Porpidia subsimplex*, *Rhizocarpon reductum*, *R. rubescens*, *Rhizoplaca subdiscrepans*, and *Rimularia badioatra*), together with a smaller number of foliose species, especially *Xanthoparmelia* and *Physcia thomsoniana*. But remember, the frequency and abundance of these species do not diminish their potential for beauty and wonder. Species with more restricted distributions include *Lecanora polytrapa*, *Miriacidica leucophaea*, and *Porpidia cinereoatra*. Common and widespread species of shaded rocks include many crustose lichens (e.g., *Aspicilia laevata*, *Fuscidea arcuatula*, *Porpidia albocaulerulescens*, *Rhizocarpon grande*, *R. subgeminatum*, *Rinodina tephrae*), together with foliose species such as *Myelochroa aurulenta*, *M. obsessa*, and *Phaeophyscia adiastrata*, as well as the fruticose *Usnea halei* and members of the genus *Stereocaulon*. The most charismatic members of shaded rock communities are the umbilicate lichens, which include common widespread species (*Lasallia papulosa*, *Umbilicaria mammulata*), rarer species (*L. pennsylvanica*, *U. americana*), and the nearly endemic *L. caroliniana*. Always keep in mind that many foliose and fruticose lichens that typically grow on trees will also occasionally be found on shaded rocks.

Sheltered and protected rock microhabitats host an array of unusual species and are dominated by asexually reproducing species, most of which are widespread in the Appalachian Mountains or temperate eastern North America. Most frequent are members of the dust lichen genus *Lepraria* (*L. caesiella*, *L. cryophila*, *L. finkii*, and *L. oxybapha*). Viewed from a distance, sheltered rock faces often

appear to be painted white, and this coloration is due to the crustose species *Phlyctis petraea*. Dark brown or pinkish patches on sheltered faces are typically *Opegrapha gyrocarpa* and *O. zonata*. Another very common species is *Fuscidea recensa*, which forms tile-like thalli that alternate between zones of black and gray.

Where to see them. Rock-dominated habitats are extremely sensitive and easily damaged by trampling. When visiting these areas, take extra care to remain on established trails and to obey barriers or official signage. The beautiful, fragile lichen communities of high-elevation rock-outcrop habitats can be explored at Whiteside Mountain in Nantahala National Forest and Grandfather Mountain State Park, both in North Carolina, Mount Le Conte in Great Smoky Mountains National Forest, in Tennessee, and Dolly Sods Wilderness in Monongahela National Forest, in West Virginia. Excellent examples of talus can be viewed from a distance on the mountainsides along Interstate 81 in Virginia, but these habitats can be highly treacherous, and visitation is not recommended.

MIDDLE AND LOW ELEVATIONS

Middle- and low-elevation forests of the Upland Southeast are considered by many, including the pioneering ecologist E. Lucy Braun, to be where the deciduous hardwood forests reach their pinnacle of stature and beauty (Braun 1950). The old-growth rich cove forests with their luxuriant spring wildflower displays and stately tulip poplar, yellow buckeye, sugar maples, white ash, and white basswood are often highlighted, as were the acid cove forests before invasive hemlock adelgid (*Adelges tsugae*) caused widespread decimation of these iconic trees, leading to fundamental changes to the dark, cool climates they fostered. While dense rhododendron and mountain laurel thickets may be impenetrable to the average human, they explode with colorful blooms in summer.

Most of the Upland Southeast lies below 3,500 feet in elevation (1,100 meters). These middle- and low-elevation areas host incredibly scenic habitats, as well as the highest diversity of many organisms, including lichens. That the middle and low elevations host the highest diversity reflects a combination of climate and geological history. The low elevations are connected to adjacent areas of the Piedmont and Coastal Plain, so many species from that region creep inland and upslope in climatically similar microhabitats, especially along waterways and in swamps. The same is true of the middle elevations, which host some high-elevation species that can survive in climatically suitable microhabitats. Add the interlopers from adjacent elevations and you have a biodiversity hot spot.

Unfortunately, the middle and low elevations of the Upland Southeast have also been greatly affected by human activity. Human settlement in the region has long been concentrated in the flatter valleys, as has infrastructure such as roads and railroads. European settlement, population growth, and increased infrastructure in turn spurred industrial development. Most major population centers, including large metropolitan areas, are now located in the middle and low elevations, as are the highways and interstates that link them. Damming of rivers for hydroelectricity flooded large areas of prime habitat and permanently altered unique riparian ecosystems. The proximity of middle and low elevations to industrial centers and transportation infrastructure also meant that these areas were often intensively logged or mined before the more remote and difficult-to-access high elevations.

Despite the impacts to the natural landscape, lichens are abundant and diverse throughout much of the middle and low elevations. Presumably, they were able to recolonize from remnant patches of intact habitat, as well as from adjacent areas upslope where logging and resource extraction may have been less severe. By no means does this imply that the lichens have reattained the full grandeur they had prior to industrialization and the era of large-scale air pollution and resource extraction. Pollution- and disturbance-sensitive species, especially **cyanolichens** and bark-dwelling fruticose macrolichens such as old man's beard (*Usnea*) appear to have been lost from large areas where they previously occurred.

Surprisingly, even though human infrastructure has been concentrated in middle and low elevations, these areas have mostly not been intensively studied by lichenists. Instead, there is a more than century-old tradition of lichenists traveling through these elevations to reach the apparently more scenic and biologically unusual high elevations. Hence, while there is a good baseline for lichens from the high elevations, lichens found below 3,500 feet were virtually unstudied until recently. New discoveries are routinely made, and many rare species have been found to be associated with remnant old-growth stands as well as unique rock formations, such as flatrocks and glades. Anyone, either on a casual walk or an intense backpacking adventure, can find something that has been overlooked or is entirely new.

Rich Forests

Overview. Rich forests are those with moist, nutrient-laden soils and are characterized by a high diversity of hardwood trees and lush herbaceous understory with many spring wildflowers. This habitat type includes the iconic rich cove forests of the Southern Appalachian Mountains. Rich forests in the region often occur on slopes, and characteristic trees include American beech, basswood, black cherry (*Prunus serotina*), Carolina silverbell (*Halesia tetraptera*), cucumber magnolia, sugar maple, tulip poplar (*Liriodendron tulipifera*), white ash, white basswood, and yellow buckeye. A shrub layer is usually lacking, which gives these forests a lofty feel, as the tall canopy trees preside over a dense green carpet of ferns and wildflowers. Small, shaded rock outcrops and boulder-strewn seeps are also often intermixed in rich forest habitats. These rocky areas provide a wide diversity of microhabitats where specialized lichens can grow.



Rich cove forest with mossy tree bases and herbaceous understory at Pocosin Hollow in the Blue Ridge Mountains, VA.

As you transition from core areas of the Appalachian Mountains into the Cumberland Plateau and Piedmont, rich forests are often found in wet areas, especially on slopes along rivers and creeks. These forests include many of the same lichens as are found in more mountainous rich forests, but the composition of the forest communities changes as some species, such as Carolina silverbell, drop out while others, such as big leaf magnolia (*Magnolia macrophylla*) and redbud (*Cercis canadensis*), appear or become more prevalent.

Lichens. The lichen communities of rich forests are interesting because a quick glance during a hike might give the impression that few species are present. Shaded rock outcrops and seeps are interlaced with herbaceous plants, and only the most conspicuous and abundant crustose lichens stick out, species such as *Porpidia albocaulerulescens*, *P. crustulata*, or *Rhizocarpon sylvaticum* on exposed surfaces, and various dust lichens (*Leparia* spp.) or *Phlyctis petraea* on sheltered and protected faces. At the same time, the bases of the trees are often laden with mosses or small herbaceous plants, so there is not the conspicuous growth of lichens seen in other habitats. The trunks of the canopy trees are also dominated by a relatively small number of shade-tolerant, humidity-loving species, such as dust lichens (*Leparia finkii*, *L. normandinoides*) and *Bacidia schweinitzii*. Any smaller trees and shrubs are similarly usually covered with a mosaic of what appears to be only a few crustose species, such as *Graphis scripta*, *Lecania croatica*, and *Nadvornikia sorediata*.

All of this is deceptive, however, because careful searching will reveal a smattering of species present as solitary individuals here and there amid the sea of more common lichens. Moreover, the real diversity in rich forests is in the canopy, where branches are covered by a plethora of species vying for light and humidity. A single canopy branch can host dozens of lichen species, ranging from large *Usnea* species and shorter *Ramalina americana* or *R. culbersoniorum* to a tangle of foliose lichens amid the usual patchwork of crusts. Foliose species such as *Physcia pumilior* and *P. stellaris* are common, as are *Hypotrachyna livida* and *Myelochroa galbina*. *Parmotrema* species with their ruffled, ciliate margins also are usually abundant. Beautiful yellow *Candelaria fibrosa* and orange *Xanthomendoza hasseana* can be found on the branches in more mature stands. The crusts are a mix of common species, such as *Amandinea polyspora*, *Lecanora hybocarpa*, *L. strobilina*, and *Scliciosporum chlorococcum*, together with more unusual taxa, such as *Rinodina pyrina*, which is more typical of the Great Plains.

Where to see them. The low elevations of Great Smoky Mountains National Park in Tennessee are the ideal place to see rich forest lichens. Go during early spring and enjoy the bounty of colorful wildflowers. If you are close to Atlanta, then venture into the Chattahoochee River National Recreation Area in Georgia. For those in Charlotte, North Carolina, there is Crowder's Mountain State Park. Pilot Mountain State Park and Stone Mountain State Park are accessible from the Raleigh–Durham–Chapel Hill region, as well as Winston-Salem and Greensboro.

Acid Forests

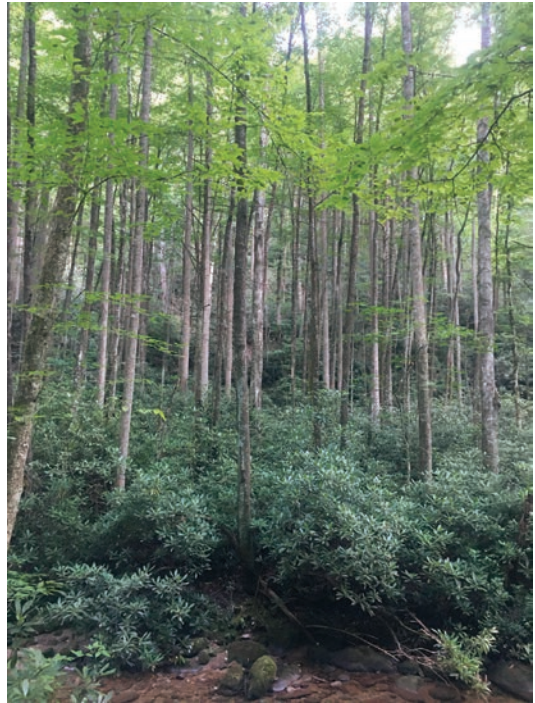
Overview. Turn the bend in a trail and you leave a rich forest and enter an acid forest. The transition is that abrupt. Acid forests are usually dominated by an understory of ericaceous shrubs, where rhododendron (especially rosebay) and mountain laurel form dense thickets or even vast continuous stands called “slicks” or “hells.” Anyone who has tried to make their way even a short distance through those would agree the names are apt. The canopy is a mixture of conifers and hardwood trees adapted to acidic soils. In the Upland Southeast, the hardwoods most frequently include red maple (*Acer rubrum*), yellow birch, cucumber magnolia, Fraser magnolia, various hickory species (*Carya*), sourwood (*Oxydendrum arboreum*), and tulip poplar. Other common hardwoods include black gum (*Nyssa sylvatica*), sassafras (*Sassafras albidum*), chestnut oak (*Quercus montana*), and red oak. Conifers typically include hemlock and several species of pine, especially white pine (*Pinus strobus*), Virginia pine (*P. virginiana*), shortleaf pine (*P. echinata*), and pitch pine (*P. rigida*).

Acid forests are particularly common at low elevations in the Cumberland Plateau and Piedmont, areas that, while outside the core mountainous areas of the Appalachians, nonetheless have very similar lichen communities. In these areas, acid forests are dominated by pines with scattered oak and hickory, which are most abundant in damper areas. The pines are predominantly shortleaf, loblolly (*Pinus taeda*), and Virginia. Difficult to distinguish when they lack fruits, the hickories include pignut (*Carya glabra*), red (*C. ovalis*), and mockernut (*C. tomentosa*). Oaks get diverse in these habitats; at least five or six species frequently occur.

There are also often small boulders and rock outcrops in acid forests, and these are invariably of non-calcareous rock types such as sandstone, schist, or granite. When completely shaded by overstory shrubs, relatively few lichens grow on the rocks, but in light gaps or areas with less direct shade, there is a rich community of rock-dwelling crustose lichens, as well as otherwise typically corticolous macrolichens. Often there is also an abundance of dry organic matter or humus in acid forests, especially at the bases of conifers, and this provides ample habitats for ground-dwelling lichens.

Fire plays an important part of many ecosystems in the Upland Southeast, and middle- to low-elevation acid forests are adapted to varying fire frequencies. Like other organisms, lichens have also evolved to live in these fire-influenced landscapes. After a fire, lichens in tree canopies and those that persist on unburned trees or higher trunks provide sources for recolonization. Charred wood and snags of dead trees provide unique substrates used by some specialist species. Areas of the ground cleared of leaf litter and humus provide open space for lichens to grow with minimal competition. At the same time, smoke and heat from fires can damage or kill individual lichens, and intense fires that burn across large areas of can affect entire lichen communities.

Lichens. Lichens seem more abundant in acid forests than rich forests, presumably because conspicuous macrolichens coat just about every conifer and shrub. Densely shaded rhododendron and mountain laurel may appear devoid of lichens when viewed from a distance, but a close look will reveal extensive colonies of small crustose species, especially *Biatora pontica*, *B. printzenii*, *Catinaria atropurpurea*, *Micarea prasina*, and *Ropalospora viridis*. Even just a little less shade results in the growth of many species also found on the trunks and branches of adjacent canopy trees. The most common foliose lichen is *Canoparmelia caroliniana*, followed by a wide diversity of *Cetrelia*, *Hypotrachyna*, and *Parmotrema*. *Usnea* species are also often present on shrubs and trees of all kinds, especially shrubby species like *U. pennsylvanica* and *U. subscabrosa*. Conifers support a mix of different *Micarea* species, especially *M. prasina*, *M. neostipitata*, and *M. soralifera*, which are intermixed amid dust lichens, especially *L. harrisiana* and *L. normandinoides*. Hardwoods are also sheathed with vibrant mosaics of foliose lichens



Wet, low-elevation acid forests in the mountains at Ivy Gap in Shelton Laurel, NC.

and a huge diversity of crustose lichens belonging to *Lecanora*, *Lepra*, and *Pertusaria*. Larger hardwood trees will also usually have abundant cyanolichens, such as *Leptogium cyanescens* and *L. corticola*, *Lobaria pulmonaria*, *Nephroma helveticum*, *Ricasolia quercizans*, and, occasionally, *Sticta beauvoisii*.

The bases of large hardwoods have their own cohort of species, including *Anisomeridium polypori*, *Parmeliella triptophylla*, *Rinodina buckii*, and abundant *Lepraria finkii* or *L. vouauxii*. The humus that accumulates around the bases of conifers will also be colonized by various *Cladonia*, such as *C. squamosa* and *C. didyma*, as well as by the brown crustose lichen *Placynthiella icmalea*. Small boulders and rock outcrops are covered with common crustose species, including *Porpidia albocaerulescens* and *P. subsimplex*, as well as *Rhizocarpon sylvaticum* and *Trapelia placodioides*. Stabilized soil, such as roadbanks, sometimes will support large colonies of *Dibaeis baeomyces*, with its white thallus and pink fruiting bodies. The forest floor is also often littered with fallen branches that host large thalli of *Platismatia tuckermanii* and *Tuckermanopsis ciliaris*, in addition to the same cohort of other foliose and crustose lichens found on fallen branches in rich forests.

Where to see them. Lichen communities of acid forests can be easily seen throughout the Upland Southeast. Particularly good examples of intact, old acid forests include Gorges State Park in North Carolina, Big Frog Mountain Wilderness of Cherokee National Forest in Tennessee, the Cohutta Wilderness of Chattahoochee National Forest in Georgia, and the South District of Shenandoah National Park.

Creeks, Rivers, and Waterfalls

Overview. Few lichens grow fully submerged in water. Nonetheless, habitats associated with waterways have unique lichen communities because they tend to have very high, constant humidity. For the purposes of this book, all habitats associated directly with water are grouped together because they have similar environmental conditions and lichens. There are innumerable creeks and rivers throughout the Upland Southeast, and these vary greatly from small, seasonal mountain trickles to larger rivers, such

Streams and rivers create moist habitats where humidity-loving lichens thrive, including on rhododendron leaves along Hickey Fork in Shelton Laurel, NC.





Lichen-covered rocks along Big Laurel Creek, near Hot Springs, NC.



Rocks periodically flooded with water along the Haw River, NC, are the unique habitat for a host of lichens, including *Dermiscellum oulocheila*.



Tranquil pools in mountain streams are great potential habitat for aquatic lichens, such as the *Peltigera hydrothyria* here in the heart of the Great Smoky Mountains, TN.

as the Nolichucky or Sipsey, and even the massive expanse of the Tennessee River. Most rivers have headwaters high in the mountains and then tumble down cascades and through rocky gorges before widening and slowing in the flatter low elevations.

In the mountains, creeks and smaller rivers are interspersed with boulders and outcrops of various sizes, composed of rock types such as granite or quartz that are relatively resistant to weathering. Rocks directly in the waterways are exposed to the sun and periodically inundated by water, so only lichens and bryophytes are able to grow on them. Waterway edges are similarly lined with boulders and outcrops, but these are shaded by vegetation, especially thickets of rosebay, mountain laurel, and doghobble (*Leucothoe fontanesiana*) interspersed with shrubs such as witch hazel and hazel alder (*Alnus serrulata*). Ironwood (*Carpinus caroliniana*) is often abundant in forests directly adjacent to waterways, including in the floodplains, as are a mixture of hardwoods, such as American holly (*Ilex opaca*), American sycamore (*Platanus occidentalis*), birches—yellow birch, river birch (*B. nigra*), and sweet birch (*B. lenta*)—green ash (*Fraxinus pennsylvanica*), sweetgum (*Liquidambar styraciflua*), tulip poplar, and white oak (*Quercus alba*). Hemlock is the conifer most commonly associated with riparian forests, and although pines can grow in wetter forests, those trees are usually found in directly adjacent uplands.

Waterfalls and the spray zones they create have a special community because of the extremely humid environments favored by certain lichen species, especially those that grow on leaves. These habitats are special; you could even say magical. But they do not differ radically in terms of lichen communities from the otherwise humid streams and rivers that are often located nearby. Think of a waterfall and its spray zone as just concentrating into one place all the lichens found sporadically in very humid pockets along the length of a waterway—more creekly than creeks, more riverine than rivers, more seepy than seeps. Interestingly, this is not the case in other mountainous areas, which is just another thing that sets the Upland Southeast apart.

Lichens. The lichens found in and along waterways can be divided into two main groups: those that grow on rocks directly associated with water, and those that grow on various substrates along the margins or in the floodplains of the waterway. The only lichen in the Upland Southeast that lives fully inundated in water is *Peltigera hydrothyria*, which grows attached to rocks in small mountain streams. Rocks that are frequently inundated with water but still regularly dry out have a unique community of lichens that includes foliose *Dermatocarpon luridum* and *Placynthium flabellulosum*, together with an assortment of crustose species, such as *Ionaspis lacustris*, *Porpidia macrocarpa*, and *Rhizocarpon laevatum*. The rare species *Pilophorus fibula* also grows on periodically inundated rocks, especially in damp areas where streams cross trails at high elevations.

Large rocks that are exposed to some sun and only rarely inundated by water host communities of lichens that would typically be found on outcrops not associated with water. *Xanthoparmelia* species are often abundant, as are *Physcia subtilis* and *P. thomsoniana*. Crustose lichens like *Aspicilia cinerea* and *A. laevata* mixed with an array of other common species also occur. Shaded rocks have a different set of species, including *Bryobilimbia ahlesii*, various *Fellhanera*, and *Porpidia albocaularescens*. Shaded vertical faces can host large colonies of *Micareopsis irriguata*, while horizontal or more level surfaces usually abound with mosses and cushions of *Cladonia furcata* or *C. squamosa*. Damp rocks with a layer of mosses can also be covered by a carpet of *Peltigera*, often *P. neopolydactyla*, *P. seneca*, or *P. praetextata*.

Smooth-barked shrubs and trees, especially ironwood, alder, and witch hazel, are covered by a dense mosaic of crustose lichens that love both shade and high humidity. The most common species include *Graphis scripta*, *Lecanora layana*, *L. thysanophora*, *Megalospora porphyritis*, and an assortment of *Pyrenula* species, especially *P. leucostoma*. The bark of larger hardwoods is covered by foliose lichens, such as *Canoparmelia caroliniana*, *Flavoparmelia caperata*, *Myelochroa aurulenta*, and *Punctelia rudecta*, together with shade-tolerant crustose lichens, especially *Bacidia schweinitzii*

and *Megalospora porphyritis*. Shaded tree trunks in humid riparian habitats are also covered with dust lichens, especially *Leparia finkii* and *L. normandinoides*.

The extreme humidity associated with waterways can favor the growth of abundant cyanolichens. Even in somewhat disturbed or polluted environments, *Leptogium cyanescens* will usually be present, and areas with less pollution and disturbance host a huge number of cyanolichens, especially on the trunks of older hardwoods. *Lobaria pulmonaria* and species of *Sticta* regularly form large colonies in some regions, especially on mature hardwoods. *Coccocarpia palmicola*, *Nephroma helveticum*, and *Leptogium corticola* are very common. The highest-quality habitats will host multiple species of Pannariaceae, including *Fuscopannaria leucosticta*, *F. sorediata*, *Pannaria tavaresii*, and the very rare *P. lurida*. *Pseudocyphellaria epiflavoides* and *P. holarctica* are also rare species of these habitats, as is *Crocodia aurata*.

The branches of small trees and shrubs that are shaded by the higher canopy also have a unique assortment of lichens that includes humidity-loving foliose species like many *Heterodermia*, *Myelochroa galbina*, *Pyxine sorediata*, and the rare species *Myelochroa metarevoluta*. Conifer branches, especially those of young hemlocks, are almost always covered in these species, together with *Lepa pustulata*, *L. multipunctoides*, *L. trachythallina*, and *Tuckermanopsis ciliaris*. Canopy branches in riparian habitats are almost always covered in *Usnea* species, especially *U. strigosa*, which can form colonies of hundreds of individuals that coat the entirety of a given branch. In the mountains, other abundant fruticose lichens are often on canopy branches, including the rare species *Usnea angulata*. *Pseudevernia consocians*, *Platismatia tuckermanii*, and *T. ciliaris* are also very common and can form large colonies. At first glance, it can even appear that there are so many macrolichens on canopy branches that crustose lichens are entirely lacking, but they are also abundant, particularly on younger growth that has not yet been colonized by larger lichens. The crustose lichens on canopy branches are like those found in other habitats that are not directly associated with water.

In especially humid habitats, such as narrow stream ravines and waterfalls, the leaves of evergreen shrubs like rosebay and doghobble are covered in crustose lichens. The most common is *Fellhanera boutillei*, although others, such as *Byssoloma subdiscordans* and *Tricharia santessonii*, are also frequent.

Where to see them. Waterways and their lichen communities can be enjoyed in a number of ways, such as during a tube ride down Big Creek in the Great Smoky Mountains of North Carolina or a paddle along the Sipsey River in Alabama or Chattooga River in Georgia. Waterfalls are popular destinations, and care should always be taken not to damage their unique lichen communities.

Rock-Dominated Habitats I: Cliffs, Talus, and Non-calcareous Outcrops

Overview. While all rock-dominated habitats were combined in one section for the high elevations, the discussion of similar habitats in the middle and low elevations is subdivided because two very distinct types can be separated by whether the rock and associated soils are acidic to neutral in pH or strongly basic and calcareous. Most rock-dominated habitats at middle and low elevations consist either of cliffs or bluffs, sometimes with associated talus, or are large outcrops in an otherwise forested area. Cliffs and bluffs are steep vertical faces with little vegetation and dominated mostly by lichens. Although the sheer face may lack woody vegetation, the upper edge of the cliff or bluff is usually a series of sun-exposed rock outcrops forested with a mixture of hardwoods and conifers. Since the parent rock in much of the Upland Southeast is non-calcareous, the thin soils on the edges of cliffs and bluffs usually support extensive lichen colonies intermixed with stunted trees or shrubs adapted to acidic soils. This can include various pines (commonly pitch pine, Table Mountain pine, *Pinus pungens*, and Virginia pine), as well as oaks (commonly red oak and chestnut oak), red maple, and black gum. More basic rocks can also support eastern red cedar (*Juniperus virginiana*). Mountain laurel and rhododendrons are also typically associated with rock cliffs and bluffs.



Reindeer lichens and other species colonize the acidic low-elevation rock outcrops near Shuckstack in the Great Smoky Mountains, NC.

Talus slopes can vary in size and extent, and there are large examples at middle elevations in Virginia. Although some talus slopes can be forested, many are open and have only sparse woody vegetation, again usually with the same species that would be found on the top of a cliff or bluff. Sandstone and quartz talus slopes are common, and lichens dominate these habitats. Nonetheless, talus that is completely exposed to the sun and, consequently, extremely dry can be colonized by only a few hardy species except in the most shaded or protected areas.

Large rock outcrops not directly associated with cliffs or talus also occur sporadically in the forests at middle and low elevations. If the outcrop is large enough, portions of it may be exposed to the sun and have conditions like those of a cliff edge. More often, though, the outcrop is fully shaded and covered with mats of bryophytes and ferns, sometimes with a few shrubs or stunted trees. An excellent overview of rock-outcrop habitats in the Upland Southeast was published by Quarterman, Burbank, and Shure (1993).

Lichens. Lichens of middle- and low-elevation rock outcrops can be grouped into several categories by where they grow: on flatter ledges and cliff edges, on sun-exposed vertical faces or talus, or in shade.

Cliff-edge and ledge lichen communities tend to be a mixture of species that grow directly on rock and those that grow on accumulated soil or organic matter. *Cladonia* species form extensive mats that can include well over a dozen species, the most common being *Cladonia arbuscula* (at middle elevations), *C. caroliniana*, *C. grayi*, *C. macilenta*, *C. rangiferina*, *C. strepsilis*, *C. squamosa*, *C. subtenuis* (at low elevations), and *C. uncialis*. Exposed soil and organic matter are also covered by a veneer of crustose lichens, including *Placynthiella icmalea* and *Trapeliopsis granulosa*. Every surface of exposed rock



Overhanging outcrops host a different cohort of lichens than the fruticose and foliose lichens growing on top of the same outcrop here, along Cataloochee Creek in the Great Smoky Mountains, NC.

should also be coated with a fabulous mosaic of species with different colors and patterns. Green-yellow *Flavoparmelia baltimorensis* and *Xanthoparmelia* species are very common and grow intermingled with *Physcia subtilis* and *P. thomsoniana*, as well as small, tufted colonies of *C. stipitata* and *Rhizoplaca subdiscrepans*. Map-like crustose lichens with tiled thalli include *Buellia spuria* and *Lecanora oreinoides*, and these are often interspersed with *Porpidia subsimplex*, *Rhizocarpon rubescens*, and *Rimularia badioatra*. Rosettes of *Lepraria neglecta* are also inevitably present, as are green-yellow bull's-eyes of *Dimelaena oreina*. Vertical faces are usually dominated by a mixture of large umbilicate lichens (*Umbilicaria mammulata*, *U. muhlenbergii*, *Lasallia papulosa*, *L. pensylvanica*), dust lichens (especially *Lepraria normandinoides*), *Fuscidea arcuatula*, and, sometimes, *Chrysothrix susquehannensis*. Sheltered overhangs also host an array of dust lichens, together with *Caloplaca reptans*, *Fuscidea recensa*, and *Opegrapha zonata*.

Sun-exposed talus slopes are cliffs in miniature, shrunk down to the size of individual boulders. Flatter surfaces of talus rocks and organic matter that accumulates in pockets or crevices host the same species that would grow on the edge of a cliff, perhaps with the addition of *Stereocaulon glaucescens* and *S. saxatilis*. The sides of the talus boulders are akin to the vertical face of a cliff, just as the crevices under the boulders provide protected nooks and overhangs.

Shaded non-calcareous rock outcrops host a suite of common species. Accumulated humus will be colonized by *Cladonia*, the most common being *C. furcata* and *C. squamosa*, usually with some *C. grayi* mixed in. Rock surfaces not covered by mosses and *Cladonia* host an array of shade-tolerant crustose lichens that includes *Acarospora fuscata*, *Aspicilia laevata*, *Porpidia albocaerulescens*, *P. subsimplex*, *Rhizocarpon sylvaticum*, *Rinodina tephraeispis*, and *Trapelia placodioides*. Sheltered faces and protected overhangs are always dominated by dust lichens, such as *L. finkii*, *L. caesiella*, *L. cryophila*, and *L. normandinoides*.

Where to see them. Cliff and talus habitats are ecologically sensitive and easily damaged by frequent trampling during visitation. In addition, talus habitats are dangerous due to the instability of the rocks. Talus is best viewed from a distance, and you should always stick to the trail in rock-dominated habitats. Excellent talus slopes can be seen along the Appalachian Trail at Trayfoot Mountain and Turk Mountain in Shenandoah National Park. There are ample cliffs to be seen in the Ocoee River Gorge in Cherokee National Forest, Tennessee, and in Little River Canyon National Preserve in Alabama. Large rock outcrops are best encountered as a surprise on a hike through the woods.

Rock-Dominated Habitats II: Calcareous Outcrops and Glades

Overview. Rock-dwelling lichens are highly adapted to the substrates they live on, and the communities differ markedly depending on whether the rock is calcareous (i.e., basic) or non-calcareous (i.e., neutral to acidic). Calcareous rock rarely occurs at high elevations in the Upland Southeast, but it is frequent at middle and low elevations, especially at the bottom and lower slopes of valleys. For instance, in northern Alabama, calcareous rock dominates in streambeds and lower slopes but is overlain by more weather-resistant sandstones on upper slopes and ridgetops. Many calcareous rock outcrops are extensive and large, even if they are exposed in only a comparatively limited area.

Limestone and dolomite glades are unique calcareous rock habitats that are relatively flat, dry, and sparsely forested with fire-adapted vegetation amid patches of grassland. Eastern red cedar is the only conifer that is well suited to survive on calcareous rocks and so is frequent. These habitats are referred to as cedar glades where they occur in northern Alabama and central Tennessee. In addition to cedars, limestone glades are forested with stunted oaks—chinquapin oak (*Quercus muhlenbergii*), southern red oak (*Q. falcata*), and post oak (*Q. stellata*)—and redbud. An excellent review of limestone-outcrop vegetation in the Upland Southeast was published by Baskin, Baskin, and Lawless (2007).

Lichens. Viewed from a distance, calcareous outcrops and glades appear surprisingly lacking in lichens. This is because they are dominated by a dizzying array of unassuming crustose lichens, rather than the abundant foliose and fruticose lichens of comparable non-calcareous habitats. In fact, these habitats appear so devoid of lichens primarily because *Cladonia* species are almost entirely absent. Also, many of the crustose lichens have pale thalli, or thalli that are immersed in the rock; they make these habitats appear even less lichen-rich until you take a closer look.

Without a doubt, the most common crustose lichen on calcareous rocks in the Upland Southeast is *Bagliettoa baldensis*. Close runners-up would be the yellow *Caloplaca flavovirescens* and the dark brown-gray *Willeya diffractella*. *Kephartia crystalligera* is also locally common in some locations and can form extensive colonies on calcareous boulders in stream channels. You often see lichen colonies that appear to form large concentric brown rings of minute lobes, and these are *Placynthium petersii*, another common species in the region. *Placynthium petersii* is one of many cyanolichens that grow on calcareous rocks, but most of these lichens are small and inconspicuous. A particularly unusual species is *Scytinium apalachense*, which has thick, narrow lobes and resembles something from another world. Calcareous rocks also have their own version of rock tripe, the most common species of which is *Dermatocarpon muhlenbergii*. Unfortunately, most lichen diversity on calcareous rocks is composed of crustose lichens with small, brown or black, lecideine apothecia, and these can be very difficult to distinguish from each other in the field. *Bacidia granosa* and *Catillaria lenticularis* are two of the most common such species. Shaded and sheltered rock faces are also usually covered with *Lepraria finkii* and the calcareous rock endemic *L. disjuncta*.

Lichen-covered limestone boulders and cliffs along Little Coon Creek on the Cumberland Plateau, AL.



Where to see them. Calcareous rock outcrops and cedar glades are fragile ecosystems, but their unique lichens can be seen at some particularly scenic locations, such as Cedars of Lebanon State Park in central Tennessee and the Walls of Jericho or Russell Cave National Monument in northern Alabama.

Rock-Dominated Habitats III: Flatrocks and Non-calcareous Glades

Overview. Not to be outdone by its mountain neighbor, the Piedmont is home to a remarkable series of lichen-dominated habitats on large granite and gneiss outcrops. These can take the form of expansive flat outcrops known as flatrocks, small granite domes, or large isolated mountain-like granite domes. The difference between flatrocks and domes is more or less one of scale, because both consist of large amounts of exposed rock interspersed with humus mats that support grasses or other herbaceous plants. Soil accumulates in small depressions that allows shrubs and trees to grow. Burbanck and Platt (1964) published an overview of granite outcrops in Georgia, and a similar account for North Carolina was published by Wyatt and Fowler (1977). Sandstone outcrops in Alabama and Georgia are also very similar to granite and gneiss outcrop habitats in their overall appearance and lichen communities. Some of these sandstone outcrops, especially in the areas near Bankhead National Forest in Alabama, are referred to as glades.

In both sandstone and granite or gneiss habitats, lichens are the dominant vegetation in areas with exposed rocks. Areas with accumulated soil are forested with a mixture of pines (especially Virginia pine, shortleaf, and loblolly), eastern red cedar, fringe tree (*Chionanthus virginicus*), a wide variety of oaks, redbud, winged elm (*Ulmus alata*), and an understory of shrubs that usually includes sparkleberry (*Vaccinium arboreum*).

Lichens. Non-calcareous rock habitats scream, "Lichens," although maybe in millions of tiny voices that can be hard to hear from a distance. Almost every inch of a flatrock, granite dome, or sandstone glade is covered by conspicuous lichen growth. These are truly the habitats where *Cladonia* reach their pinnacle of diversity in the Upland Southeast. You can always find huge, sprawling mats made up of dozens of species growing together. The most common mat-forming species are *Cladonia caroliniana*, *C. leporina*, *C. rangiferina*, *C. subtenuis*, *C. squamosa*, and *C. uncialis*. Cushions of *C. strepsilis* and *C. robbinsii* also abound near depressions in the rock, and any area with humus will host a variety of species, such as *C. grayi* and *C. macilenta*. With all the *Cladonia*, it can be hard to focus on everything else. Green-yellow *Xanthoparmelia* species grow profusely on any exposed rock amid colonies of



Sandstone glades are lichen wonderlands, with luxurious mats of *Cladonia* and moss, sun-bathed crustose lichens, and light-loving epiphytes in the shrubs and trees stunted by the poor soil, as here at Corinth Glade, AL.

Physcia subtilis and *P. thomsoniana*. Wet seepage tracks and depressions in the rock are often lined with colonies of *Dermatocarpon arenosaxi* and tiny black crustose Lichinaceae. The latter are very difficult to identify. *Porpidia subsimplex* might be the most common crustose lichen on rocks, but it grows with a wide assortment of friends, including *Buellia spuria* and *Lepraria neglecta*. With luck, you will even find patches of the endemic crustose species *Acarospora piedmontensis*. Shrubs and trees in non-calcareous rock-dominated habitats host communities of lichens similar to those of low-elevation acid forests, albeit often in lush, crowded communities, presumably due to the large amount of sunlight.

Where to see them. There are many flatrocks in the Piedmont of Georgia and the Carolinas, some of which have been developed into highly visited parks. Stone Mountain State Park and Arabia Mountain near Atlanta are examples. Wonderful sandstone glades can be visited in Bankhead National Forest or at the Little River Canyon National Preserve in Alabama.

Anthropogenic Habitats: Fields and Forest Edges

Overview. Fields and forest-edge habitats are common throughout the Upland Southeast, especially in suburban and rural areas. Depending on the soil conditions, these habitats will be dominated either by hardwoods or conifers, although both are often present. Conifers include eastern red cedar and a mixture of pine species, such as loblolly, shortleaf, and Virginia pine. Hardwoods are a mixture of red maple, hickories, oaks, sweetgum, and tulip poplar. Solitary trees in fields and along forest edges can be laden with lichens because of the amount of available light, although this must be balanced with the potential for air pollution.

Lichens. Open patches of soil and humus are typically colonized by *Cladonia*, especially cushions of *C. subtenuis*. If there is a lot of *C. subtenuis*, then there will often be a plethora of other *Cladonia* species, such as *C. leporina*, *C. grayi*, *C. didyma*, members of the *C. subcariosa* group, and *C. macilenta*. Open soil will be colonized by *Dibaeis baeomyces*, whose white thallus will cover large expanses, though toward the

Lichens thrive in the abundant light available in trees at the edge of fields, like these *Usnea*-covered tulip poplars along White Oak Creek in the Great Smoky Mountains, NC.



southern edge of its range these often lack the distinctive stalked, pink fruiting bodies. Sun-exposed small pebbles host a unique community of light-loving, disturbance-tolerant crustose lichens, including *Leimonis erratica*, *Lecidea cyrtidia*, *Porpidia crustulata*, *Rhizocarpon reductum*, and *Trapelia glebulosa*.

Trees in fields and forest edges can be imagined to be one large canopy branch, hosting lichens that are typically found higher up on similar substrates in closed-canopy forests. *Ramalina culbersoniorum* and *Usnea strigosa* are common and usually grow with an abundance of *Canoparmelia caroliniana* and *Punctelia rudecta*, as well as *Flavoparmelia caperata*. Slightly less frequent but by no means rare are *Canoparmelia texana*, *Myelochroa aurulenta*, and *Punctelia missouriensis*. *Parmotrema* species, especially *P. perforatum* and *P. hypotropum* or *P. hypoleucinum*, are also common, as are *P. reticulatum* and *P. subsidiosum*. In some areas, like the Georgia Piedmont, *C. texana* in particular is the dominant lichen on pine trees. Smaller foliose lichens are often a mixture of *Physcia millegrana* and *P. pumilior*, sometimes with *P. americana* and *Pyxine subcinerea* mixed in. Small patches of yellow foliose lichen are usually *Candelaria concolor*, although the crustose species *Candelariella xanthostigmoides* is also common and must be carefully distinguished. Young growth of branches and saplings host pale white thalli of the non-lichen species *Arthonia quintaria*, which is quickly outcompeted by a crew of fast-growing crustose lichens that take advantage of the time before larger foliose lichens can become established. Among the first crustose lichens to arrive is inevitably *Xanthosyne varians*, followed by *Lecanora hybocarpa*, *L. strobilina*, *Pertusaria pustulata*, and *P. texana*. *Amandinea polyspora*, *A. punctata*, *Bathelium carolinianum*, and *Buellia erubescens* also are common, as are *Caloplaca cerina* and *Chrysothrix caesia*. If you happen on an American holly, it is impossible to miss *Viridothelium compositum*.

Where to see them. Fields and forest edges abound throughout the low elevations of the Upland Southeast, and many local parks include these habitats. Lichens in these habitats can easily be seen at just about any state park in the Piedmont of Georgia and the Carolinas. The same is true for the many historic battlefields of the Shenandoah valley in Virginia.

Anthropogenic Habitats: Urban Areas

Overview. Urbanization has strong effects on biodiversity. The abundance of planted trees, asphalt, traffic, and human-made materials creates unusual ecological conditions that filter for lichens that may be less common in surrounding natural areas. As was discussed in the section on lichen conservation, air pollution drove the extirpation of lichens from most large American cities during the last century. Passage of the Clean Air Act in 1963 led to improvements in air quality, especially reducing sulfur dioxide, which resulted in a slow recolonization of cities by stress-tolerant lichens.

Now lichens can be found in most urban areas on substrates that are not subjected to regular cleaning and disturbance. The most noticeable lichens in urban areas are usually on trees and rocks in parks where shade and humidity conditions more closely resemble natural habitats. Planted street trees host lichens in all but the most densely developed and heavily trafficked areas. Trees and parks probably seem like the most obvious places to find lichens, but the possibilities are endless. Cement barriers in parking lots host lichens, as do stone retaining walls and other building materials. The best places to look will have a little shade and moisture.

Lichens. Humans routinely move lichens into urban environments inadvertently on newly planted trees, stone used for landscaping, and other building materials. Sometimes the lichens can come from locations hundreds of miles of away. Even when introduced from local areas, lichens moved in this way usually do not survive very long in urban settings because the climate conditions are so different from those in the area they came from. You will often see newly planted trees in a city adorned with conspicuous foliose or fruticose lichens that look quite out of place. Many times, these will be removed by animals or curious citizens even before they succumb naturally from their move. Exceptions to this rule do exist, though, as *Parmotrema austrosinense* and *P. cristiferum* appear to persist in urban Atlanta when brought in on nursery stock.

Ornamental trees are a great place to find *Canoparmelia texana*, as here at Western Carolina University, NC.



Even pressure-treated wood is soon colonized by a diversity of lichens, as seen at the Great Smoky Mountains Institute at Tremont, TN.



Not infrequently, lichens are intentionally moved into cities for use as decoration and displays. Again, these lichens usually do not survive, and, in fact, their intended use is temporary. Unfortunately, the commercial collection and sale of lichens is largely unregulated, even though there is presently no sustainable method through which it can be done. Any lichens used for such decorative purposes were harvested from the natural environment, likely harming the source populations.

City trees in the Upland Southeast host a subset of lichens that grow on bark in open forest-edge habitats. The most frequent large foliose lichens are *Flavoparmelia caperata*, *Canoparmelia texana*, and *C. caroliniana*, with occasional *Punctelia rudecta*. *Physcia millegrana* and *P. pumilior* are also common, as are other stress-tolerant species like *Parmotrema hypotropum* or *P. hypoleucinum*. *Pyxine subcinerea* and *Phaeophyscia rubropulchra* are also not infrequent. Yellow colonies, even if they appear crustose, almost always turn out to be *Candelaria concolor*. Crustose lichens include *Amandinea* species and *Lecanora strobilina*. It is important to keep in mind that when bark-dwelling lichens grow in urban areas, they usually have a different appearance than the same species would have in a less stressful environment. Thalli are often smaller and may frequently be sterile or discolored. Substrate preferences for bark-dwelling lichens also often shift in urban areas where acidification allows species like *C. texana*, which are typical of pines, to abundantly colonize hardwood trees and just about any other stable substrate, such as road signs.

Where to see them. A walk in the nearest city park or even your own backyard! There are any number of excellent urban green spaces; two are Piedmont Park and Westside Park in Atlanta.

IDENTIFICATION KEYS AND SPECIES ACCOUNTS

This guide is organized mainly into sections based on growth form: fruticose, foliose, and crustose. The organization of each section has been modified to make identification in the field with nothing more than a hand lens as practical and feasible as is possible.

In the case of fruticose lichens, each genus is readily distinguished from the others using characters that can be seen in the field. As such, that section is organized into separate treatments for each genus that contain accounts of the included species. An initial key to fruticose lichens will lead to a given genus. Each genus for which there are multiple species has its own more detailed key to species.

Like fruticose lichens, most genera of foliose lichens can be distinguished using characters observed in the field, but some of these characters are variable or difficult to see, especially for those just beginning to learn them. Certain genera are also frequently confused, because they include a small number of species that share characters that overlap with most of the species in another genus. For this reason, and because there are many more foliose than fruticose lichens, we organized the section on foliose lichens into groups of species that share the same major morphological characters—for instance, color of the upper surface of the thallus when dry.

Unlike the larger fruticose and foliose lichens, crustose lichen genera are distinguished mostly by microscopic characters that cannot be seen in the field. Many completely unrelated genera look somewhat similar and share the same general outward appearance. There are also many more crustose lichens than foliose and fruticose lichens. For this reason, we used the same approach employed for foliose lichens and organized the crustose lichens into groups of species that share the same major morphological characters—for instance, thallus morphology and type of fruiting body.

Each section contains accounts of the species you are most likely to see in the Upland Southeast. Each species account includes the Latin name of the species, the common name of the species, a description of the ecology and distribution of the species in the region, a discussion of how to identify the species, and a comparison with similar species. At least one color photograph is included for each species. Although the accounts are focused on identification with a hand lens in the field, comparisons with similar species are occasionally supplemented with important contrasting characters in chemistry or microscopic morphology for those who wish to take identification a step further. Additionally, photographs are included for common look-alike species. Multiple common species that cannot be distinguished without detailed study in the lab are treated collectively in a single entry.

Begin your lichen adventure by using the dichotomous key below to navigate to the section where specific information and further identification keys are provided.

THE LICHEN ADVENTURE BEGINS

KEY TO SPECIES GROUPS

- 1 a. Thallus combining two different growth forms, with a crustose or foliose primary thallus that is accompanied by a secondary fruticose thallus **fruticose lichens (section I)**
- 1 b. Thallus of only one growth form, entirely crust-like, leafy, or shrubby **2**



Section I: dimorphic
(*Cladonia ochrochlora*, 2×).



Section I: fruticose (*Ramalina americana*, 1×, and *Usnea subgracilis*, ¾×).



- 2a. Thallus at least partly easily separated from the substrate, with lobes or branches, not resembling dust or paint 3
- 2b. Thallus entirely intimately attached to the substrate throughout, without lobes or branches, resembling dust or paint 6
- 3a. Thallus shrubby or otherwise highly three-dimensional, composed of branches that are uniform in color around the entire circumference **fruticose lichens (section I)**
- 3b. Thallus leaf-like, composed of lobes with two clearly differentiated surfaces that are not the same color 4
- 4a. Upper surface bright yellow or orange in color **brightly colored foliose lichens (section II)**
- 4b. Upper surface gray, blue gray, grass green, green yellow, brown, or black 5
- 5a. Upper surface green yellow, usnic acid present **green-yellow foliose lichens (section III)**
- 5b. Upper surface gray, blue gray, grass green, brown, or black, without usnic acid **gray to brown foliose lichens (section IV)**
- 6a. Upper surface bright yellow or orange in color **brightly colored crustose lichens (section II)**
- 6b. Upper surface gray, blue gray, grass green, green yellow, brown, or black **all other crustose lichens (section V)**



Section II: brightly colored foliose
(*Candelaria fibrosa*, 5×).

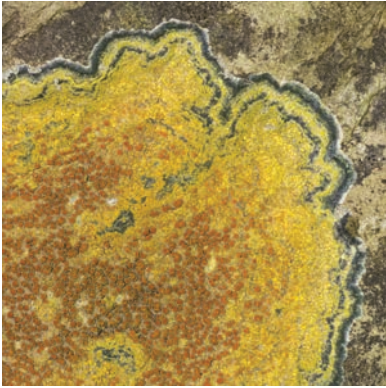


Section III: green-yellow foliose
(*Flavoparmelia caperata*, 2×).



Section IV: gray green (*Canoparmelia texana*, 2×) and brown foliose (*Umbilicaria mammulata*, ¾×).





Section II: brightly colored crustose
(*Caloplaca flavovirescens*, 1 ½×).



Section V: gray crustose
(*Buellia erubescens*, 3×).

SECTION I: FRUTICOSE LICHENS

Except for *Cladonia*, fruticose lichens are relatively rare throughout many areas of the Upland Southeast. You could get the impression that species of old man's beard (*Usnea*) are common if you visit parts of the Appalachians in North Carolina and Tennessee, but nothing could be further from the truth. The increased surface area of fruticose lichens, literally exposed on all sides, makes them especially susceptible to air pollution; coupled with their sensitivity to changes in climate and to large-scale disturbance, this means that many have been lost from areas where they once grew. This is particularly true of some of the largest and most conspicuous species.

The species accounts in this section are grouped by genus, rather than by color and reproductive mode, as they are for the foliose and crustose lichens. This is because there are comparatively few fruticose lichens, and each genus is distinct from all the others. Hence, each genus is easily recognized, and the species are most likely to be confused with each other, rather than with members of other genera. It is crucial to realize that, compared to foliose and crustose lichens, fruticose lichens are also extremely variable morphologically. Presumably, this is because they are more exposed to the harsh whims of the environment throughout their lives. Many people begin lichen identification with the conspicuous fruticose species they see around them, especially members of *Cladonia*. This inevitably results in frustration and disappointment, because the variability of these lichens makes interpreting the morphology difficult for someone who is just starting out. Also, in the case of *Cladonia*, the species often grow intermixed, and it takes experience to be able to recognize when two different species are growing side by side or, worse, intertwined. This is less of a problem for other fruticose lichens, although you must be careful to isolate the individual you want to identify from others that may be growing around it.

KEY TO FRUTICOSE LICHEN GENERA

- | | | |
|-----|---|-------------------------------------|
| 1a. | Thallus intensely orange or yellow; rare | 2 |
| 1b. | Thallus green yellow, gray, blue gray, brown, black, or some other color that is not intensely orange or yellow; common | 3 |
| 2a. | Apothecial margins covered with spiny projections | <i>Teloschistes chrysophthalmus</i> |
| 2b. | Apothecial margins smooth | <i>Teloschistes exilis</i> |



Teloschistes chrysophthalmus,
Outer Banks, NC, 2×.



Teloschistes exilis, Heggie's
Rock, GA, 1½×.

- 3a. Thallus clearly combining two types of growth forms (e.g., a crustose primary thallus with fruticose secondary thallus, or a squamulose primary thallus with fruticose secondary thallus) 4
- 3b. Thallus not combining two types of growth form, appearing to consist of only fruticose structures 10
- 4a. Primary thallus foliose, consisting of dispersed or aggregated scale-like squamules associated with the fruticose podetia **Cladonia (see genus for further key)**
- 4b. Primary thallus crustose, consisting either of a continuous paint-like crust or of irregularly aggregated island-like areoles, either way associated with fruticose structures of various types ... 5
- 5a. Growing on soil or humus 6
- 5b. Growing directly on rock 8
- 6a. Primary thallus blue gray; fruticose portion of thallus thorn-like, inflated, blue gray with conspicuously browned tips **Pycnothelia papillaria**
- 6b. Primary thallus white, brown, or greenish brown; fruticose portion mushroom-like, a distinctly stalked apothecium that is uniform in color 7
- 7a. Primary thallus white; fruticose portion bright pink or pink orange
..... **Dibaeis baeomyces (treated in crustose lichens, see section V)**
- 7b. Primary thallus brown or greenish brown; fruticose portion tan or brown
..... **Baeomyces rufus (treated in crustose lichens, see section V)**
- 8a. Primary thallus a gray to blue gray, lumpy, granular crust
..... **Stereocaulon (see genus for further key)**
- 8b. Primary thallus a brown or greenish brown, continuous, paint-like crust 9
- 9a. Fruticose portion a tan or brown, mushroom-like apothecium
..... **Baeomyces rufus (treated in crustose lichens, see section V)**
- 9b. Fruticose portion a black, pin-like apothecium *Pilophorus fibula*



Pilophorus fibula, Great Smoky Mountains, NC, 5×.

- 10a. Thallus hair-like, composed entirely of fine, narrow branches, overall appearing lax, wispy, or forming loose tangled clumps 11
- 10b. Thallus not hair-like, composed either of robust branches or flattened blades 15
- 11a. Thallus black or brown, not producing usnic acid 12
- 11b. Thallus greenish yellow, producing usnic acid 14
- 12a. Growing on rock, small, individual branches too fine to be easily resolved with naked eye 13
- 12b. Growing on bark or wood, large, branches easily seen with naked eye
***Bryoria* (see genus for further key)**
- 13a. Growing on dry rock faces protected from the rain ***Cystocoleus ebeneus***
- 13b. Growing on exposed rock faces and boulders, associated with water either directly in streams on periodically inundated rocks, or seepage faces of rock outcrops
Ephebe (see *Cystocoleus*)
- 14a. Branches with a central cord; common throughout the Upland Southeast
***Usnea* (see genus for further key)**
- 14b. Branches without a central cord; rare and found only in high-elevation spruce-fir forests
Alectoria fallacina (see *Usnea merrillii*)
- 15a. Thallus erect, growing distinctly and strongly vertically upward from the substrate; mostly on rocks, soil, humus, or wood, less frequently on the bark of living trees 16
- 15b. Thallus not distinctly erect, either dangling from the substrate or spreading perpendicularly outward; mostly on bark of living trees, less frequently on rocks and wood 17
- 16a. Thallus with multiple attachment points; branches hollow, not diverging from a single central base; outer surface rarely covered in a discontinuous patchwork of shingle-like squamules
***Cladonia* (see genus for further key)**
- 16b. Thallus at least superficially appearing to have a single attachment point; branches solid, appearing to diverge from a single central base; outer surface always covered in a patchwork of shingle-like structures ***Stereocaulon* (see genus for further key)**
- 17a. Branches flattened, without a central cord 18
- 17b. Branches round, with a central cord ***Usnea* (see genus for further key)**
- 18a. Thallus blue gray to gray, producing atranorin; lobes distinctly bicolored, with the upper surface blue gray to gray and the lower surface a mixture of white and purple black
***Pseudevernia* (treated in foliose lichens, see section IV)**
- 18b. Thallus greenish yellow, producing usnic acid; lobes uniform in color
***Ramalina* (see genus for further key)**



Bryoria nadvornikiana, Eagle Rocks, Great Smoky
 Mountains, TN, 1 ½×.

Bryoria

Characterized by their wispy, hair-like thalli that are various shades of brown, *Bryoria* grow on bark or wood; there are no other lichens like them in the Upland Southeast. The highest diversity occurs in the boreal forests and the Pacific Northwest, where the canopies of conifer trees can become so laden that they appear to consist entirely of masses of lichens. Species identification in this group is considered very difficult; thankfully, only a few species occur in the Upland Southeast, and most are both rare and not easily confused with one another. The only common species is *Bryoria furcellata*, which is treated here.

KEY TO UPLAND SOUTHEAST BRYORIA

- 1a. Common; at all elevations but mostly below 5,500 feet; soralia conspicuous, filled with spine-like brown isidia *Bryoria furcellata*
- 1b. Rare; only in high-elevation spruce-fir forests, above 5,500 feet; soralia inconspicuous or, if conspicuous, then lacking spine-like isidia 2
- 2a. Branches mostly uniform in color across the thallus 3
- 2b. Branches distinctly bicolored, a mixture of dark, almost black, branches that contrast strongly with those that are lighter brown in color 4
- 3a. Thallus pale, light brown to almost gray; usually with conspicuous soralia .. *Bryoria nadvornikiana*
- 3b. Thallus brown; soralia absent or inconspicuous *Bryoria americana*
- 4a. Thallus typically erect, short, shrubby; secondary branches diverging at right angles *Bryoria bicolor*
- 4b. Thallus typically lax, longer, and distinctly hair-like; secondary branches diverging at less than right angles *Bryoria tenuis*

Bryoria bicolor, Mount Le Conte,
 Great Smoky Mountains, TN, 2×.



***Bryoria furcellata* Ragged Ropes**

Ecology and distribution. A common and widespread species in temperate eastern North America, restricted mostly to middle and high elevations in the Upland Southeast. It is almost entirely restricted to conifers, especially pine and hemlock, and grows on the bark and branches of live trees, as well as wood of standing snags and fence posts. Occasionally, the species is found on hardwood trees, most frequently mountain laurel and sourwood.

Discussion. If you find a brown, tufted fruticose hair lichen, it is almost certainly *Bryoria furcellata*. A closer look at the branches should reveal the presence of soralia that are filled with a mixture of whitish soredia and spiny, brown isidia. All other *Bryoria* species in the Upland Southeast are restricted to the highest-elevation spruce-fir forests and, even then, are quite rare. Most of those other species have longer, subpendant or pendant thalli and soralia that lack spiny isidia. *Bryoria bicolor* is similar in having short, shrubby thalli, but as the name implies, it has distinctly two-toned thalli, where the main branches are a dark, shiny brown, almost black, and contrast strongly in color with the lighter brown color of the secondary branches. In *B. bicolor*, the secondary branches are also short and grow perpendicularly to the branches.



Bryoria furcellata, spinulose soralia, 10×.

Bryoria furcellata, Cataloochee Valley, Great Smoky Mountains, NC, 3×.



(continued...)

Page numbers in **bold** indicate the main entry for that genus or species, and those in *italics* indicate pages where an illustration is present.

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