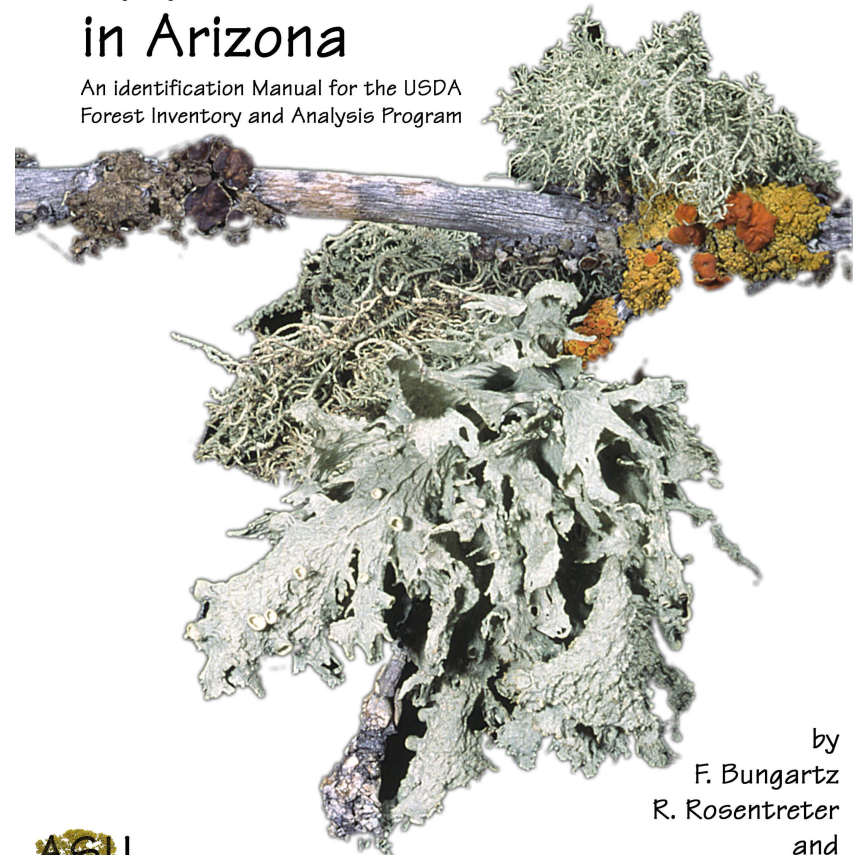


Field Guide to Common Epiphytic Macrolichens in Arizona

An Identification Manual for the USDA
Forest Inventory and Analysis Program



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For further information or copies of this field guide write to one of the authors:

Frank Bungartz
Arizona State University
Lichen Herbarium,
PO Box 87 1601
Tempe, AZ 85287, USA
frank.bungartz@asu.edu

Dr. Roger Rosentreter
Bureau of Land Management
Division of Resources
1387 S. Vinnell Way
Boise, ID 83709, USA

roger_rosentreter@blm.gov

by
F. Bungartz
R. Rosentreter
and
T. H. Nash III

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INTRODUCTION

This guide deals with the more common genera and species of epiphytic macrolichens known from Arizona and to some extent throughout the arid Southwest. It is intended as a quick field reference and not a comprehensive guide to the entire flora. More extensive treatments are now available but these do not fill the need for a small, portable field-guide (see **Literature**).

The guide is a result from several training sessions conducted for the USDA Forest Service Inventory and Analysis (FIA) Program in Tucson, Arizona over the past two years. Because of the arid climate the epiphytic macrolichen flora in the southwestern US may be less diverse than in other regions but it is also characterized by a different range of species which is not represented in other field guides. Although the result of the FIA Program this guide will also be helpful to other naturalists interested to learn more about lichens and their identification.

Epiphytic macrolichens are one important focus of the FIA Program carried out nationwide by the USDA Forest Service according to a standardized methodology. Specimens of epiphytic macrolichens are collected by forestry staff in the field, assigned abundance ratings and later identified by a specialist in the laboratory.

Training forestry personnel is crucial to maintain a successful "capture rate". The monitoring concept assumes that well trained staff will find at least 65% of all macrolichen species which an experienced lichenologist would find in the same plot.

This guide does not replace the training, but helps the forestry personnel to distinguish lichens in the field. It provides keys and illustrated descriptions to the common genera and species.

Our knowledge of lichen distribution is still unsatisfactory and some apparently rare species have therefore also been included in this guide. The FIA Program will eventually not only provide data about the ecological status of forests throughout the US, it will also provide a considerable amount of data on lichen distribution. Future revisions of this guide may then include species which we have yet rarely observed in Arizona.

Why use lichens as forest health monitors?

Lichens are organisms which are very sensitive to environmental change. As a result lichens are ideal monitor organisms for bio-indication of forest health. There are two major reasons for this phenomenon: (1) Lichens grow extremely slowly, (2) they accumulate the majority of their nutrients from the air and (3) they lack a waxy cuticle on the surface which protects them from air pollutants.

As a result of the slow growth of lichens, old growth forests are often associated not only with bigger, more ancient lichen specimens but they often support a range of specifically adapted species which indicate environmental continuity of these forests. Young, less mature forests usually support quite a different lichen flora. Lichens are thus excellent monitors for forest disturbance.

The accumulation of air-borne nutrients over their entire surface makes lichens particularly susceptible to air pollution. The distribution of rare species often correlates with less polluted areas and the disappearance of these species from forests may well serve as a warning sign. Once lichens start disappearing from a forest, rising pollution levels may soon affect other plants and animals and the ecological balance of the whole system. Pollutant tolerant lichen species will accumulate high levels of air-borne contaminants and are therefore also valuable as monitoring organisms. Finally, transplant experiments in concert with fumigation studies have helped to establish sensitivities to specific air pollutants.

The rather recent phenomenon of increasing nutrient levels in many ecosystems can also be monitored closely with lichens. Lichens will often react more quickly than vascular plants to changing

nutrient regimes. Some species naturally occur in extremely nutrient-enriched habitats and are good indicators of locally elevated levels within the forest system.

Regional studies of the lichen flora will help to establish long term scientific monitoring of forest systems in particular environments. The arid flora of the southwestern US is not only characterized by a different suite of species but it has been somewhat neglected because of less biodiversity of epiphytic macrolichens. The extension of the FIA with lichens to this area will improve our knowledge about these species.

What is a lichen?

Although lichens do actually look like single organisms they are indeed two separate organisms growing very tightly together (Fig. 1): a fungus (mycobiont), which provides the dominant, overall structure of the lichen, and a population of algal cells (photobiont) which live inside the structure provided by the fungus and using light to photosynthesize just like all green plants.

The mycobiont is most generally an ascomycete, a fungus which reproduces by forming spores inside sac-like structures. Ascomycetes are often small, inconspicuous fungi like many molds. Only very few lichens belong to the basidiomycetes, the fungi which we often observe as typical mushrooms. All fungi form threads of cells, the hyphae. These hyphae can be closely aggregated to form a fruiting body or a lichen or they can penetrate their substrate as single strands of cells like in a bread-mold.

The photobionts are microscopically small and are either green algae or blue-green algae (cyanobacteria). Some lichens actually have two different photobionts, both green algae and cyanobacteria.

The tight association of these very different organisms is generally called a symbiosis. It is not yet well established if this relationship is mutual for both partners or beneficial only to the fungus. Cell division of the photobionts is strongly controlled by the fungus and sexual reproduction is usually suppressed. Some lichenologists therefore regard this symbiosis as a highly regulated parasitism of the algae by a fungus. Other scientists postulate a beneficial microenvironment for the algae, leading to a wider distribution and greater abundance of the algae, and therefore claim that the lichen symbiosis is a mutualistic association.

In any case scientist did not recognize this close association until the middle of the 19th century. Only microscopically the two organisms can clearly be distinguished.

Generally three different growth types can be distinguished among lichens: crustose, foliose and fruticose lichens.

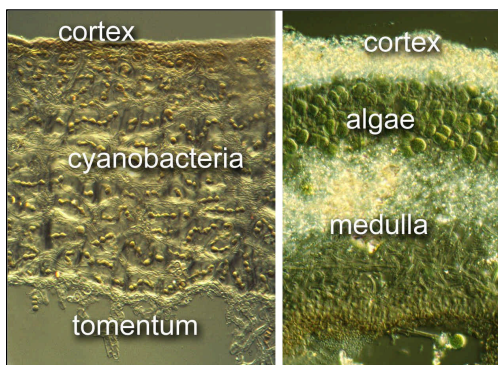


Fig. 1: Cross section through a lichen with cyanobacteria as photobiont (left) and green algae (right).

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For further information or copies of this field guide write to one of the authors:

Frank Bungartz
Arizona State University
Lichen Herbarium,
PO Box 87 1601
Tempe, AZ 85287, USA

frank.bungartz@asu.edu

Dr. Roger Rosentreter
Bureau of Land Management
Division of Resources
1387 S. Vinnell Way
Boise, ID 83709, USA

roger_rosentreter@blm.gov

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LITERATURE

Read more about the biology of lichens:

One of the best introductions for beginners is...

PURVIS, O.W. (2000): Lichens. - Smithsonian Institution Press. 112 pp.

This is a brief introduction to the general biology of lichens. The different chapters explain what lichens are, what they look like, where they grow, about their physiology, ecology and their influence on the substrate as well as ethnobotany of lichens. The book is very colorful, easy to read but nevertheless accurate.

A more scientific treatment is...

NASH (ed.) (1996): Lichen Biology. Cambridge University Press. 302 pp.

This book is one of the best textbooks on lichenology. The chapters cover many different aspects of lichen biology and have been written by experts in particular fields. However, if you are not well versed with the scientific background you might find it difficult to read.

If you are seriously interested in lichen identification:

BRODO, I.M., SHARNOFF, S.D. & SHARNOFF, S. (2001): Lichens of North America. - Yale University Press. 795 pp.

This is a marvelously illustrated book with some of the best photographs available. It provides a good introduction to lichens which focuses a little more on identification than the Purvis book.

The Lichens of North America covers all of Canada and the continental USA but not Mexico. Even a large "bible" like this wonderful book cannot completely cover all lichens growing within this vast area. The book will allow you to identify many common species and genera but not necessarily the more difficult taxa.

NASH III, T.H., RYAN, B.D., GRIES, C. AND BUNGARTZ, F. (eds.) (2002): Lichen Flora of the Greater Sonoran Desert Region. Volume 1. - Lichens Unlimited. Arizona State University, Tempe. 532 pp.

This book is not so nicely illustrated as the North American Flora but the goal is to provide a complete treatment of all species found in the American Southwest including large parts of Northeast Mexico. The Sonoran Flora has an extensive introduction which is helpful to learn much of the terminology used for lichen identification. It is only available directly from the ASU lichen herbarium at <http://ces.asu.edu/ASUlichens/Sonoran/Flora.html>.

An excellent reference to publications regarding lichen identification is provided at:

<http://www.huh.harvard.edu/collections/lichens/guide/index.html>

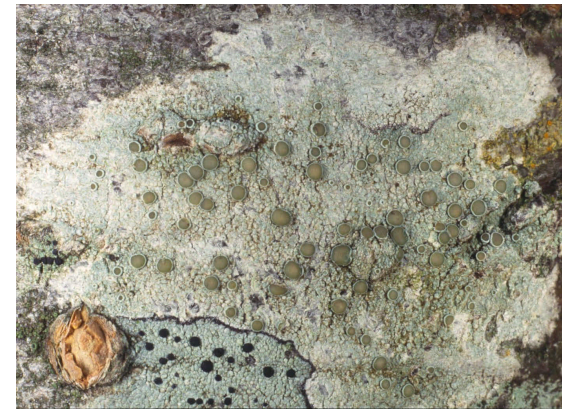


Fig. 2. The crustose lichen *Lecanora*.

Crustose lichens (Fig. 2) grow very closely attached to the substrate, they cannot be removed from this substrate without damage. Lichenologists therefore usually collect them together with the piece of bark, rock or soil on which they grow. Crustose lichens are often inconspicuous and frequently difficult to identify. Nevertheless, some crustose lichens can grow to quite some considerable size and are larger than some foliose or fruticose species. Approximately a third of all lichens is crustose.

Foliose lichens

(Fig. 3) have a distinct upper and lower side. The lower side may grow close to the substrate and is often tightly attached with special holdfasts like rhizines or hapteres. Nevertheless, foliose lichens can usually be de-Tuckertached from the substrate much more easily and often without damage than crustose lichens. Some foliose lichens have very narrow lobes and look a little similar to the fruticose lichens. A few foliose lichens are large and can reach more than 30 cm (12 inches) in diameter. However, most foliose lichens are smaller and some are inconspicuously minute, less than a few millimeters.



Fig. 3. The foliose lichen *Hypotrachyna*.

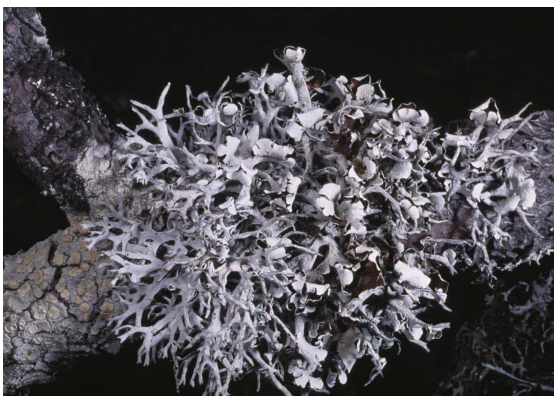


Fig.4: The fruticose lichen *Pseudevernia*.

Fruticose lichens

(Fig. 4) can be pendant, i.e. hanging down and appearing beard-like or they grow erect and appear shrub-like. They have distinct branches which may be sometimes a little flattened but a distinct upper and lower side can usually not be distinguished. In the Pacific Northwest the lichen species *Usnea longissima* can reach up to several meters in length, but most fruticose lichens are less than a few centimeters.

For convenience many lichenologists distinguish **macro-** and **microlichens**, large and small ones. These categories are not very distinct. Crustose lichens are most generally regarded to be microlichens whereas foliose and fruticose species as macrolichens. The FIA Program only records macrolichens. Even though the macrolichens constitute only a minority of the entire lichen flora, they are more easily observed and collected in the field. Most microlichens also require microscopic examination in order to be identified. For simplicity this guide therefore only discusses macrolichens and the reader is referred to other important guidebooks for further reference on microlichens (see **Literature**).

What does a lichen look like?

The body of a lichen is called the **thallus**. Lichen thalli often grow closely adjoined and the thallus lobes of foliose lichens or the branches of fruticose lichens can intermingle. For identification it is important to distinguish separate thalli from one another. Color, the width of the lobes or the branches and several structures on the thallus surface help to distinguish different species.

Colors, Lichen Substance & Spot Tests

One of the most important characters to distinguish lichens is their **color**. Unlike mosses or liverworts, lichens are very rarely plain green. Many species are bright yellow, orange, pale lime-yellow, brown, olive or black. Dark olive or black lichens usually have cyanobacteria as photobionts. When wetted these lichens often swell enormously and become rather gelatinous. Most other lichens have green algae as photobionts which contribute little to the color of the lichen. Instead these lichens produce a variety of characteristic pigments. The pigments are usually present especially on the upper surface and the color is more pronounced in the sun. It has therefore been argued that many pigments provide sunscreen to the lichen.

The pigments are part of the so-called lichen substances, a range of secondary metabolites which are unique to lichens and never (or very rarely) produced by other organisms. The chemistry of these pigments provides important diagnostic information for lichen identification.

A flask-shaped structure which produces spores not inside a walled structure but by budding-off from the tip of a lichen hypha. Pycnidia are often deeply immersed in the lichen thallus and only visible as a small blackened pore.

rhizine (rhizines):

A root-like holdfast on the lower side of a foliose lichen thallus.

soralium (soralia):

A distinctly confined area on a lichen thallus where soredia are produced.

soredium (soredia):

A fine, powdery, or “fluffy” aggregate of fungal hyphae with a few algal cells not covered by a cortex (compare with isidium). Soredia are asexual propagules which form a fine to coarse powder. Soredia are usually formed from soralia, i.e. distinctly delimited areas where the cortex of the lichen ruptures.

spermatium (spermatia):

A male sex cell.

spore (spores):

A general term for a reproductive structure. Spores may be produced asexually or by sexual means.

symbiosis (symbioses):

A more or less permanent and close association of two different organisms. In a strict sense only mutualistic associations are often regarded as symbioses but broader definitions include parasitism.

thalline margin:

A margin of a fruiting body which is not formed by the fruiting body itself but by the surrounding lichen thallus.

thallus (thalli):

The main body of a lichen. The term is derived from the opposite of a cornus which refers to the highly organized body of vascular plants. Vascular plants are always organized in leaf, stem and root. Lichens are not structured like this and consequently form a thallus, not a cornus. Algae or bryophytes also form a thallus.

tomentum:

A felt-like mat covering the lower side of a foliose thallus.

umbilicate:

A single, central holdfast of some foliose lichens.

vascular plants:

Vascular plants have a highly developed vascular system to transport sugars and water throughout the plants. Only ferns and flowering plants have such an elaborate system. Bryophytes and algae are non-vascular plants. Lichens cannot be considered plants because their major partner is a fungus.

mutualism:

A symbiosis which benefits both partners. There is some evidence that the lichen symbiosis may be mutualistic to the algae which are dominated by the fungus. The microenvironment provided by the fungus seems to be less hostile than the unsheltered terrestrial environment and many alga cells are thus more widely distributed within the lichen symbiosis than in the free-living state.

mycobiont (mycobionts):

The fungal partner of a lichen symbiosis.

parasitism:

A symbiosis where one partner negatively affects the other partner (host). Not all parasites kill their hosts, some only weaken the host by depleting it of resources. The lichen symbiosis may be a highly evolved form of parasitism where the lichen fungus totally controls the algal partner.

perithecium (perithecia):

The flask-shaped fruiting body of a lichen which produces fungal spores. Perithecia are often deeply immersed in the thallus and sometimes only visible by a small pore. Unless examined microscopically they often look similar to pycnidia. However, no lichen has both apothecia and perithecia. Therefore, if apothecia are present on a thallus, small, blackened pores which can also be observed must be pycnidia.

photobiont (photobionts):

The photosynthetic partner in a lichen symbiosis, either a population of green algae or cyanobacteria.

photobiont layer (photobiont layers):

A confined zone of photobiont cells, usually just below the cortex of a lichen and above the medulla. Many gelatinous lichens do not show a strict zonation into cortex, photobiont layer and medulla.

photosynthesis:

Photosynthesis is a process by which algae and plants convert inorganic carbon (CO₂) and water (H₂O) into organic carbon (sugar, carbohydrates) using light energy. All life on earth depends on this process. Algae, like all plants, are capable of photosynthesis. They are therefore energy independent from other organisms whereas animals and fungi need to feed on other organisms.

propagule (propagules):

Any device by which any organism distributes itself.

proper margin:

A margin of a fruiting body which is essentially formed by the fruiting body itself and not the surrounding lichen thallus.

pruina:

A fine grainy or crystalline powder on the surface of some lichen thalli. The structure varies from a powder sugar to a castor sugar appearance. Pruina is usually white and not to be confused with more "fluffy", pale green to bluish green soredia.

pseudocyphellium (pseudocyphellae):

A white speckle on the thallus surface where medullar hyphae reach the thallus surface and break through the cortex.

pycnidium (pycnidia):

Spot tests give some general information about the chemistry of these pigments. The most common substances being used are: **potassium hydroxide** (10% KOH in water; commonly referred to as "K"), **calcium hypochlorite** (available as stable solution in household bleach; commonly referred to as "C") and *p*-phenylenediamine (freshly dissolved crystals in ethanol or Steiner's solution: 1g crystals with 10 g sodium sulfite in 100 ml water and 5 ml liquid dishwashing detergent; commonly referred to as "P").

WARNING: Whenever using spot test chemicals apply them safely and use minor amounts of reagents! Discard tested material and do not store it with your specimens! Spot tests with rather toxic chemicals like "P" should not routinely be carried out in the field.

There is quite a range of colors present in lichens but the most important ones are yellow, gray, brown and black:

YELLOW:

Three different kinds of yellow lichen substances can generally be distinguished, **lemon yellow**, **orange yellow** and **lime green yellowish**.

The lemon yellow color of many lichens is the result of substances derived from pulvinic acid, like calycin. These substances do not react with KOH. Only rarely lemon yellow lichens show a weak red spot test reaction. In some lichens the lemon yellow color can be particularly bright, almost fluorescent; in the desert the crustose lichen *Acarospora* often paints whole cliffs a bright yellow.

Orange yellow lichens can be very deeply colored and almost red. They are then easy to distinguish from lemon yellow lichens. However, some shaded forms may be rather light orange. The substances responsible for the orange yellow color are anthraquinones (like parietin) which give a very strong, deep purple reaction with KOH. These orange lichens are not closely related to the lemon yellow species. Although they may look similar it is quite important to notice the different colors to recognize different species.

Lime green lichens have a faint yellowish tinge which among lichenologists is often described as typical lichen-yellow. The color is more accurately described as yellowish green. It is caused by usnic acid, a very common lichen substance which does not react considerably with KOH but gives a dull brownish spot test. These lime green lichens are very rarely confused with the other yellow species.

GRAY:

Different shades of gray are quite important in lichen identification. Many species are bright gray, almost white and somewhat gleaming. This is due to the pigment atranorin which gives a KOH yellow spot test reaction. When wet, these species hardly change color but remain whitish gray for some time before they eventually become more greenish.

Other grayish lichens lack this pigment and therefore appear rather dull, dark gray or sometimes brownish or greenish gray. When wetted they soon become darker and eventually turn olive gray.

BROWN:

The third most common color is brown. These brownish pigments typically show no indicative spot test reactions but it is important to distinguish if the brown color is truly a pigment or a result of the dark photobiont in the lichen thallus. Lichens with a brownish pigmented cortex have a white medulla and green algae inside. They can be quite dark brown, almost blackened, or olive and rather greenish brown. Lichens with cyanobacteria may also appear brown but they don't have a white medulla and usually turn pitch-black when wetted.

BLACK:

Lichens with cyanobacteria are often a very deep brown or deep olive green to almost entirely black. The color of these lichens becomes even darker when wetted and they then often appear almost entirely black. The dark color of the lichen is not caused by any pigments produced by the fungus but it is the color of the photosynthetic partner, the cyanobacteria. Because of the mucilage of the cyanobacteria, these lichens often swell considerably when wet and assume a ± gelatinous structure.

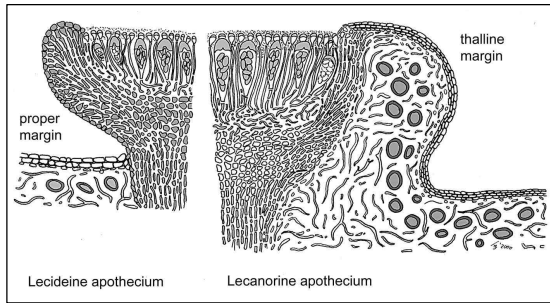


Fig. 5. The apothecium.

layer in the fruiting body where fungal spores are produced. These spores are microscopically small. The margin can appear similar in structure and color to the thallus or to the disc. If it is similar to the thallus it can also be called a thalline margin and the whole apothecium is referred to as lecanorine (named after the lichen *Lecanora*). In lecideine apothecia (named after the lichen *Lecidea*) the margin appears strongly blackened and rather similar to the disc. Biatrorine apothecia (named after the lichen *Biatroa*) have a margin similar to the disc but not strongly blackened.

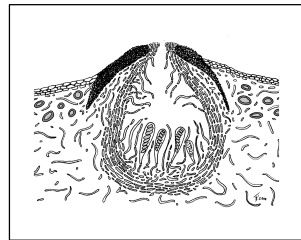


Fig. 6. The perithecium.

Some lichens also produce flask-shaped fruiting bodies called **perithecia** (Fig. 6). Usually only the opening of the "flask" protrudes through the thallus surface and perithecia are therefore much less conspicuous than the broad discs of apothecia.

From the outside perithecia look very similar to structures called **pycnidia** (Fig.7). These pycnidia also form spores but not enclosed in sac-like structures. These spores (= conidia) are often believed to be the male spermatia of the lichens, but some can also germinate and form a new lichen.

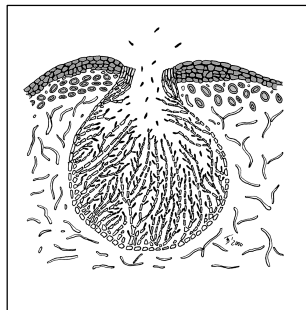


Fig. 7. The pycnidium.

Fruitingbodies

Many lichens reproduce by forming fruiting bodies called **apothecia** (Fig. 5). They are bowl- or disc-shaped structures which the lichen fungus forms on the thallus surface, i.e. on the branches or lobes.

Two important parts of an apothecium can be distinguished: the margin and the disc. The margin of an apothecium forms a ring around the disc of the apothecium. The disc is the

gelatinous:

Jelly-like in structure. Many but not all cyanolichens are gelatinous when wet.

green alga (green algae):

Green algae are plants which predominantly live in marine or fresh water. Some small, often single-celled or simple multicellular green algae also live terrestrial or as photosynthetic partners of lichen symbioses.

hair (hairs):

A fine filamentous structure on the upper or lower surface of a lichen thallus.

hypha (hyphae):

A fine thread (or filament) of fungal cells. All fungi apart from yeasts grow as hyphae.

isidium (isidia):

Asexual reproductive propagule of a lichen which is covered by a cortex. Isidia may have quite different, diagnostic shapes. Some are cylindrical and slender, some are more granular and button-like, some inflated and swollen, some branched, some scale like etc.

lecanorine:

Lecanorine refers to a fruiting body with a thalline margin.

lecideine:

Lecideine refers to a fruiting body with a margin of a similar color of the disc, strongly blackened and carbonized inside.

lichen (lichens):

A symbiosis of a fungus with a population of photosynthesizing cells (cyanobacteria or green algae) where the fungus usually provides the dominant structure inhabited by the algae.

lobe (lobes):

Foliose lichens are usually divided into flattened, finger-like subdivisions called lobes.

macrolichen (macrolichens):

Large, conspicuous lichens. All foliose and fruticose lichens are often regarded as macrolichens even though some crustose lichens may become rather large and some fruticose or foliose lichens are minute.

macula (maculae).

A white (uncolored) spot or line on the thallus surface where the cortex of the lichen remains intact.

medulla:

The inner, central part of a lichen which usually appears white and cottony throughout. In some species this layer can, however, be rather dense (like the central strand of *Usnea*) or even be colored (like the medulla of *Phaeophyscia endococcinoides*).

microlichen (microlichens):

Small, inconspicuous lichens. All crustose lichens are often regarded as microlichens even though some become rather large. A microscope is usually necessary to identify these small lichens.

conidium (conidia):

A spore which is not produced inside a sac-like structure but budding-off from the tip of a lichen hypha. Small conidia are often believed to function as spermatia. Larger ones have been observed to germinate.

cortex (cortices):

A distinct layer of densely conglutinated hyphae on the surface of a thallus. Foliose lichens often have an upper and a lower cortex.

crustose:

Growth form of a lichen which is attached to the substrate directly with its lower surface.

cyanobacterium (cyanobacteria):

Bacteria which photosynthesize similar to green plants and algae. Cyanobacteria are frequently deep brown to black or blue green in color and are also referred to as Blue Green Algae. In a strict sense cyanobacteria are true bacteria with a cell structure quite different from any other algae. They are nevertheless often treated as algae since they have a similar ecology.

cyanolichen (cyanolichens):

A lichen with a cyanobacterium as photobiont.

cyphellium (cyphellae):

An elaborate pore structure on the lower side of lichen thalli belonging to the genus *Sticta*. Cyphellae are most easily recognized as distinctly rounded, well delimited pores.

foliose:

Growth form of a lichen which has an upper and a lower cortex and predominantly grows in two dimensions, leaf-like. Foliose lichens are usually attached to the substrate with special holdfasts like rhizines. Umbilicate lichens are foliose lichens which are attached by a single, central holdfast, the umbilicus.

fruticose:

Growth form of a lichen which has a shrub- or beard-like appearance. Fruticose lichens are distinctly three dimensional. Their branches may be somewhat flattened but have no distinct upper and lower side.

fruiting body (fruiting bodies):

General term for the sexual reproductive structure of a lichen which produces spores. The fruiting bodies of ascomycete lichens are apothecia or perithecia. Only basidiomycete lichens form little mushroom-like fruiting structures.

fungus (fungi):

Fungi are neither animals nor plants but a kingdom of their own. Like plants they grow stationary but they are unable to photosynthesize. Their cells have cell walls and usually grow in long filaments or threads called hyphae. Only yeasts are single celled fungi which do not form hyphae. Like animals fungi have to feed on organic material which plants produce. Many fungi form symbioses with other organisms. They either parasitize on these other organisms or live in a mutualistic relationship.

Soredia & Isidia

Not all lichens form fruiting bodies. The sexual reproduction of the fungus with spores may indeed be quite inefficient because every germinating spore will have to find suitable algae before a lichen can successfully be established.

Much more effective is the asexual reproduction with lichen propagules called soredia or isidia.

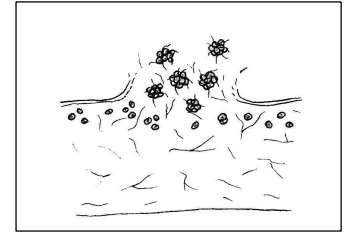


Fig. 8: Soredia.

Soredia (Fig. 8) are simply loose, mealy packets of fungal hyphae closely woven around algal cells. Where soredia are produced the smooth cortex on the surface of a lichen breaks apart and the powdery mass of soredia are extruded. This powder easily sticks to animals or is blown around as a fine dust and thus aids in the distribution of both the fungus and the algae.

Isidia (Fig. 9) are

more elaborate than soredia, they are much coarser and appear as granules, cylindrical structures, scales or they are even branched. Unlike the powdery mass of soredia, isidia are always covered by an intact lichen cortex. The are, in fact, miniature lichens on the surface of a mature lichen thallus. If they break off, they will form a new lichen wherever they happen to be distributed.

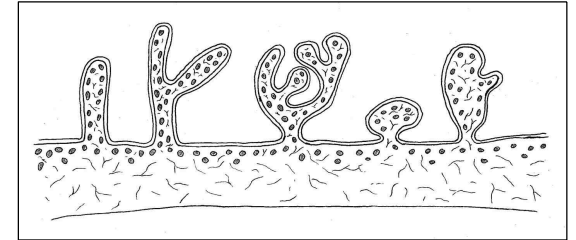


Fig. 9: Isidia.

Usually soredia and isidia are quite distinct, diagnostic structures. A good way to distinguish these two important structures is to observe the thallus closely with a good hand-lens. If the cortex appears intact and the whole structure is rather coarse, the lichen produces isidia. If the surface looks damaged and eroded with an undifferentiated, fluffy, cottony or powdery mass, the lichen reproduces asexually with soredia.

Attachment structures, cilia, hairs etc.

Fruticose lichens usually grow from a single, basal holdfast. Very few foliose lichens are attached only by a single holdfast, the umbilicus. More frequently the foliose lichens are attached with several holdfasts. Common structures are root-like protrusions on the lower side called rhizines. Less often other parts of the lower thallus surface directly grow attached to the substrate.

Rhizines grow downwards like roots but can be confused with cilia. Cilia are long lashes which do not grow on the lower side and they do not act as attachment organs. Cilia grow from the lobe margins, and are stout and often darkened.

Much finer hairs can sometimes be observed on the surface of a lichen. Hairs are usually colorless, they can be very small and covering the entire surface of the thallus like a felt, or larger and irregularly dispersed. On the lower side many lichens form a felt of hairs called tomentum.

The Surface

The surface of lichens can be either smooth or roughened and often appears covered with powder called pruina. Pruina is usually the result of some cortical cells becoming eroded and/or the formation of fine to coarse crystals which cover the entire thallus or parts of it. These crystals look similar to salt-crystals. They are opaque and inconspicuous when moist. Some pruina may have a distinct color when dry, but most pruina appears as a white powder. Even coarsely crystalline pruina is much finer than the mealy lichen propagules called soredia.

The surface of many macrolichens is usually protected by a dense layer of fungal hyphae called the cortex. This cortex somewhat reduces evaporation but hinders CO₂ diffusion into the thallus. Algae need CO₂ for photosynthesis and in some lichens the cortex is therefore perforated by relatively simple holes called pseudocyphellae. Pseudocyphellae appear like white speckles on the surface of the lichen where the cortex is broken and hyphae from the medulla break through the algal layer. Maculae are less conspicuous white dots where the thallus cortex remains intact. Very distinct, round pores can be found on the lower side of the lichen *Sticta*, these pores are called cyphellae. The regular and distinct cyphellae are much more prominent than the irregular, indistinct pseudocyphellae.

Shapes and Structures

Many other shapes and structures can be observed among lichens. The branching pattern of fruticose lichens is often important; some growing erect, some hanging down. Foliose lichens can have large and broadly flattened lobes or narrow, sometimes inflated and hollow or channeled lobes. Comparing growth form and appearance will help a lot in distinguishing different species. Observe closely, get a feeling for the "look of a lichen". Notice subtle differences in color and appearance.

How to collect lichens

For the purpose of confirming the lichen species it is almost always necessary to collect them and bring them back to the laboratory where they can be studied with a dissecting or compound microscope and where their typical chemistry may be analyzed.

Nevertheless many lichens can be distinguished in the field. If you know what to look for some lichens can even be identified with considerable confidence. This guide is meant to provide help for field identification but it does not replace your eyes and an open mind. You should ask yourself some intelligent questions before you rush off trying to collect as many specimens as possible.

Where do lichens typically grow?

Lichens are typically small and apart from places like the Arctic tundra they do not usually dominate entire landscapes. They have adopted a survival strategy considerably different from vascular plants. They can completely dry out without dying-off. During periods of extensive drought lichen simply lie dormant whereas vascular plants need to store water to survive in arid environments. Some vascular plants like cacti have become very effective in storing water but even they will die if their storage isn't replenished.

Lichens can survive extremely long droughts. Therefore they are able to inhabit habitats rarely colonized by vascular plants: poor and barren soils, rock surfaces, the bark of trees or wooden stumps. In these habitats they are rarely challenged. Nevertheless even lichens need some humidity from rain or

GLOSSARY OF TERMS

If applicable the plural of the terms is given in parentheses.

alga (algae):

Algae is a very general term for simple, photosynthesizing organisms. Most algae live in water, either marine or in fresh water. Some small, often single-celled or simple multicellular algae also live on terrestrially or as photosynthetic partners of lichen symbioses.

algal layer (algal layers):

see photobiont layer.

apothecium (apothecia):

The disk shaped fruiting body of a lichen which produces fungal spores. Apothecia are usually quite conspicuous, button-like structures on the thallus surface.

ascomycete (ascomycetes):

Fungi which produce spores inside microscopic, sac-like structures (= sac-fungi).

basidiomycete (basidiomycetes):

Fungi which produce spores inside microscopic, fingerlike protrusions; often forming elaborate fruiting bodies (mushrooms).

biatorine:

biatorine refers to a fruiting body with a margin of a similar color of the disc, not blackened or carbonized inside.

blue-green alga (blue green algae):

See cyanobacterium.

branch (branches):

Parts of a fruticose lichen thallus which are round in cross-section and either growing erect or hanging downwards.

bryophyte (bryophytes):

Mosses, liverworts and hornworts are bryophytes. They are true green plants and have nothing in common with lichens, which are fungi. Because of their small size and their ecology they are nevertheless frequently confused with lichens. Bryophytes often grow in similar habitats as lichens even though they generally prefer slightly more humid environments. Bryophytes are usually vividly bright to olive green. They do not produce colorful substances which are so common to many lichens. Mosses are rarely confused with lichens because they often look like miniature plants. Some liverworts have a thallus which may look quite similar to some foliose lichens but otherwise they have nothing in common with lichens. Liverworts are true plants with tissues and cells similar to other bryophytes.

cilium (cilia):

Long lashes growing from lobe margins of a foliose lichen.

Xanthoria montana L. Lindblom
Southwestern sunburst lichen



© P. Bougartz, ASI, Lisbon, Hebrides

Characterization:

Xanthoria montana is a small rosette-forming foliose lichen with small lobes but rather large fruiting bodies. It has no soredia or isidia.

Distinguish from:

In the American Southwest *Xanthoria montana* is much more common than the very similar *X. hasseana*. Both species can only be identified with confidence if the spores are compared. *X. montana* has a narrow and *X. hasseana* a wide spore septum.

X. montana is often slightly darker in color and has shorter rhizines than *X. hasseana*.

Collection notes:

Collect enough material. Although the species is small it usually grows quite abundant where it occurs. If abundant material is collected the rarer counterpart *X. hasseana* may occasionally be found as well.

Spot test reactions:

P- , K+ purple (always!), KC-, C-.

Habitat & ecology:

On broad-leaved trees from mid-elevations upwards.

Abundance: Common.

dewfall. In the desert they will therefore live in sheltered, N-facing habitats. On desert trees they often grow close to the ground or on the lower side of branches.

What to look for?

The standardized method of the FIA Program requires that only lichens growing on trees above knee height (0.5 m) shall be collected. That does not mean you are not allowed to look somewhere else! Look around! A species growing below knee height on one trunk may be found higher up on a different tree. Check for different habitats! Look at different trees! Hard-barked trees support a different flora from soft-bark ones. Conifers are different from deciduous trees. Shaded trees inside a forest are more sheltered than exposed trees on the forest perimeter or growing isolated in larger, more open parts of the forest. Because you will rarely be able to reach into the canopy you want to examine recently fallen branches. Old branches which have been lying on the forest floor for prolonged time will not have healthy canopy lichens growing on them. These lichens are usually the first parts of the litter to decompose and the damaged, decaying lichens should not be collected. However, recently fallen branches may still support a well developed flora of canopy lichens which should be collected.

Look from a distance to get an idea about different habitats but also examine separate habitats closely with your hand-lens. Big, colorful species are easy to spot; dark, minute lichens can be very inconspicuous. You may only discover these species if you screen for them closely using your hand-lens!

Which parts to collect?

Although foliose and fruticose lichens can often be removed from their substrate without damage to the thallus, they are often much better supported with the piece of bark. Use a stout knife and be careful not just to collect lichen fragments.

Small specimens can usually be collected by cutting away a large enough piece of bark below them. It is important to collect well developed thalli. If you have a choice, collect specimens with better developed fruiting bodies or other important diagnostic structures.

If the whole specimen is too large to be removed entirely, make sure you get all the characteristic parts. Lichens usually grow in circular patterns; marginal lobes are often quite different in structure than the central part of the thallus. Therefore always collect parts from the center and the margin!

Collection gear

A good hand-lens (min 10x) is a must. Without it you will never recognize minute differences or even find some species. A stout knife or even a wood chisel will be necessary to remove a specimen from a tree. Always carry enough paper packets for collection and make sure you clearly label each packet. Specimens without sufficient data are worthless!!!

Some wrapping tissue (e.g. a roll of toilet paper) will help to protect brittle specimens. A little spray bottle with water can be very helpful to wet brittle specimens before collecting. Especially gelatinous lichens will easily break when dry but are rather flexible when wet.

If you decide to carry chemicals make sure they are in unbreakable containers. Architectural drawing pens like "Rapidograph" can easily be filled with spot test chemicals and are quite safe for application. Nevertheless: be very careful whenever you use these chemicals! Especially P should not be used routinely in the field!

Estimate abundance ratings

Lichens are quite variable organisms; they often look similar but still belong to different species. Observe very closely with your hand-lens before you decide to assign abundance ratings. It will always be possible to combine abundance ratings from lichens which you considered different but actually belong to

the same species. On the other hand it will not be possible to differentiate between several different species which you collected in one packet with a single abundance rating assigned to all of them. Several lichen species often grow very closely together. If they cannot conveniently be separated always make sure that you indicate exactly on the packet which one of the lichens your abundance ratings refer to, e.g. write some information on the packet like: "the light green one, not the deep brown specimen".

Abundance codes used by the field crews

- 1 = rare (less than 3 specimens seen during the survey)
- 2 = occasional (4 – 10 specimens seen during the survey)
- 3 = common (more than 10 specimens seen; this is the most common abundance rating!)
- 4 = abundant (more than half of the branches and tree trunks are inhabited by this species; this abundance estimate should only be given to the most common species)

How to store and mail specimens

Lichens can be very easily stored as long as they are kept dry. When wet they will very soon start to rot and the damage will be irreversible. It is therefore necessary to keep the material which you collected for identification dry. In Arizona this will usually not be a problem. You will rarely be confronted with a bad weather situation where you collected damp or even wet specimens. However, some specimens can be very brittle when they are dry. Sometimes it may help to wet these specimens in the field to avoid collecting only specimen fragments. It also helps to wrap these brittle specimens in some tissue paper before you place them into specimen packets. **NEVER STORE SPECIMENS IN PLASTIC BAGS, ALWAYS USE PAPER!!!** Even specimens which you consider to be completely dried out may have some remaining water inside and eventually rot inside the plastic bag.

Make sure that you wrap specimens packets tightly and use protective stuffing for transport and shipping. Remember: if your material is well preserved and intact it can easily be identified; once specimens are heavily damaged, they become worthless!

Xanthoria fallax (Hepp) Arnold Hooded sunburst lichen



Characterization:

Xanthoria fallax is a very small lichen with tiny, hooded lobes and long, orange rhizines. These lobes have "budding" soredia-like granules (= blastidia) along the margins.

Distinguish from:

Xanthoria fallax is the most common species in Arizona and probably the entire Southwest. It can easily be confused with other small lobed "sorediate" species. The mode of forming soredia-like granules (= blastidia) in cupped hoods from the edge of the lobe margins is diagnostic.

Be careful to distinguish the orange color of the species from the yellow of the sorediate *Candelaria concolor*. Shaded species may fool you! *Candelaria concolor* generally develops much finer lobes which are not hooded.

Collection notes:

Collect enough material. Although the species is small it usually grows quite abundant where it occurs. If abundant material is collected the other rarer "sorediate" species may occasionally be found as well.

Spot test reactions:

P- , K+ purple (always!), KC-, C-.

Habitat & ecology:

In almost any habitat which is somewhat nutrient enriched, even at low and rather dry elevations (with *Hyperphyscia adglutinata* the only species common in mesquite forests and desert scrub).

Abundance: Very common, the most abundant one of the "sorediate" species.

Xanthoria

Sunburst lichens

Sunburst lichens really do have the color of the sun bursting from the horizon at dawn. This color is the anthraquinone parietin which can also be found in much lesser amounts in rhubarb. Shaded forms can nevertheless be much more yellow than orange or even appear yellow with a strong greenish color cast.

- 1 Thallus with soredia, very rarely with fruiting bodies; frequent, especially on slightly nutrient-enriched bark..... Hooded sunburst lichen; *Xanthoria fallax* (Hepp) Arnold
[Note: other sorediate species occur but are rather rare and difficult to distinguish from *X. fallax*]
Thallus without soredia, almost always with large fruiting bodies2
- 2 Spores with a thick septum; species **very rare** in Arizona
..... Poplar sunburst lichen; *Xanthoria hasseana* Räsänen
- Spores with a thin septum; species common in Arizona
..... Montane sunburst lichen; *Xanthoria montana* L. Lindblom

KEY TO THE COMMON EPIPHYTIC MACROLICHENS OF ARIZONA

This key is intended to be used only as a supplement to field work. It will often be impossible to key out every specimen in the field and this key may only provide some general guidance about which characters are important to distinguish different species.

A good hand-lens (at least 10x) is necessary to observe small features of the lichen thallus. Many diagnostic characters will otherwise be overlooked and different species not be distinguished. Use your eyes to screen for different habitats first, then use the hand-lens to look and observe more closely.

The terminology is briefly explained in the introduction and short definitions are also given in a glossary. Unfamiliar terms are also explained in the key, but it is nevertheless recommended that you familiarize yourself with at least some of the general terms used to describe structures of lichens.

Some genera and species are difficult to distinguish without further microscopic or chemical examination. Spot tests can be very helpful and whenever these tests are diagnostic, characteristic reactions have been included in this key. Microscopic characters which cannot be observed without dissection have only been included where they provide a better distinction than macroscopic characters which may still be observed with a hand-lens.

Collection notes:

Whenever in doubt, collect material that looks different in separate packets and assign separate abundance ratings to these specimens!

behind the species name in this key indicates that a detailed species description with illustration is provided

- 1 Thallus foliose, i.e. leaf like; lobes with a distinct upper and lower side, growing mostly in one plane, closely or loosely attached to the bark **I. Foliose Lichen Key**
Thallus fruticose, i.e. shrub-, bush- or beard-like; branches sometimes flattened but without a distinct upper and lower side, growing erect or loosely hanging downwards, usually only attached to the bark by a single holdfast **II. Fruticose Lichen Key**

I. Key to the Common Foliose Lichens of Arizona

- 1 Thallus dark black, gray to olive brown, always with cyanobacteria (blue green algae) as photobiont (**foliosecyanolichens**) **2**
Thallus not black, sometimes brownish or even dark brown but always with green algae as photobiont [green color visible if you scratch and damage the thallus surface] **10**
- 2(1) Thallus swelling and gelatinous when wet; common lichens (**gelatinouscyanolichens**) **3**
Thallus not gelatinous when wet; **rare** lichens (only the minutely foliose cyanolichen *Koerberia biformis* is rather common), only found in moist, sheltered habitats **4**
- 3(2) Thallus dull black, gray-black, brownish black, sometimes with a felt of white hairs (= tomentum) below [microscope: delimited by a single celled cortical layer]
..... Jellyskin lichens; *Leptogium*

- Thallus vivid black, not gray or brown, never with a white tomentum on the lower side [microscope: thallus not layered and not delimited by a single celled cortical layer] Jelly lichens; *Collema*
- 4(2) Lower side with a felt of dark hairs (= black tomentum) and white, distinctly delimited, round pores (= cyphellae); very rare, in very humid microhabitats Moon lichens, crater lichens; *Sticta*
Lower side with or without a tomentum and never with distinctly delimited pores (= cyphellae); but irregular white speckles (pseudocyphellae) or spots (= maculae) may be present on the upper surface.....5
- 5(4) Main thallus developed on a non-lichenized dark gray to black web of fungal hyphae (= hypothallus); the main thallus is usually different in color and the hypothallus distinct especially around the edges6
Thallus without a hypothallus9
- 6(5) Thallus with isidia along the lobe margins or the entire thallus divided into minute lobes; thallus color gray to greenish gray [microscope: photobiont *Nostoc*, a blue cyanobacterium forming chains of uniformly globose, 3-7 µm cells interspersed with larger, colorless cells (= heterocysts)]7
Thallus with most isidia central on the surface, not along the lobe margins; thallus color dark gray to bluish gray, **rare**, at mid-elevations [microscope: photobiont *Scytonema*, a filamentous cyanobacterium with individual cells which are not uniformly globose and broader than 5 µm; the filaments often appearing as a stack of ± flattened cells, like a string of coins; rarely with false branches, difficult to observe within the lichen] Salted shell lichen;
..... *Coccocarpia palmicola* (Spreng.) Arv. & D. J. Gallow
- 7(8) Thallus composed of small squamules or tiny lobes; thallus forming small rosettes8
Thallus composed of very small squamules which are closely attached to the substrate and the lichen thus appears to be crustose; thallus not forming distinct rosettes but irregular in outline Brown shingle lichens, mouse lichens; *Fuscopannaria*
- 8(7) Fruiting bodies (if present) with a conspicuous margin which has the same color and surface structure as the surrounding thallus; thallus P+ orange, (thalline margin; lecanorine) Shingle lichens, mouse lichens; *Pannaria*
Fruiting bodies (if present) with an inconspicuous margin which has the same color and surface structure as the disc; thallus P-, (proper margin; lecideine) Shingle lichens; *Parmeliella microphylla* (Sw.) Müll. Arg.
- 9(5) Thallus lobes narrow (< 4 mm), very inconspicuous, dark olive, relatively common on oaks (but often overlooked due to its small size) Tiny olive lichens; *Koerberia bififormis* A. Massal.
Thallus lobes large (> 4 mm), conspicuous, gray to brown, rarely olive-brown; rather rare and usually growing on mosses over rock, but also present at tree bases, rarely further up on a tree trunk .. Kidney lichens; *Nephroma*
- 10(1)Thallus bright yellow to orange 11
Thallus color different 13
- 11(10)Thallus orange, K+ purple (sunburst color: anthraquinones) Sunburst lichens; *Xanthoria*
Thallus yellow, not K+ purple (usually K-, rarely K+ faintly reddish) [candleflame or lemon color: calycin] 12

Usnea arizonica Moytko
Western bushy beard



© P. Burgener, ASU Herbarium

Characterization:

Usnea arizonica grows erect in a tufted bush. It is frequently fertile with large, pale yellow, disk-shaped fruiting bodies with fibrils along the disk margin. The thallus has no isidia or soredia but is often densely covered with long fibrils.

Distinguish from:

Most other *Usnea* species are not as abundantly fertile but in young thalli fruiting bodies are often not yet developed. The branches of the thallus of *U. arizonica* are rounded and not pitted. The most common species of *Usnea* in Arizona appears to be *Usnea hirta*, which, however, is not fertile and has pitted branches densely covered in isidia, not fibrils.

Collection notes:

Because many species of *Usnea* may look rather similar it is important to collect well developed specimens and place them in separate packets with separate abundance ratings.

Habitat & ecology:

On bark of trees, often on branches and twigs.

Abundance: Moderately common.

Spot test reactions:

P+ yellow, K+ yellow turning reddish or occasionally P-, K-.

Usnea

Beard lichens

The genus *Usnea* is called beard lichens because many species look like long, pale hair. They all have a faint yellow green color because of usnic acid. The genus can easily be distinguished from other fruticose lichens because of the central strand (Carefully pull apart the branches: the outer layers of the thallus rip apart and the central strand becomes visible).

In general the genus *Usnea* is rather difficult to identify without chemical analysis of the secondary metabolites. Thin-layer chromatography is often necessary to distinguish the species with confidence.

- 1** Main branches rounded in cross section (= terete) but appearing somewhat irregular and pitted (= foveate) **2**
Main branches rounded in cross section (= terete) but not pitted.....**3**
- 2(1)** Thallus long, slender, hanging downwards; often only the main branches ± pitted (= foveate); rarely fertile; without spiny isidia; a very rare species, growing on conifers at high elevations (only known from the South of Arizona; Santa Catalina Mountains)
..... Pitted beard lichen; *Usnea cavernosa* Tuck.
Thallus short, stout, rather indistinctly pitted; usually not fertile; densely covered with spiny isidia; a common species, especially on conifers
..... Bristly beard lichen, shaggy beard lichen; *Usnea hirta* (L.) W. A. Weber
- 3(1)** Apothecia common, abundant; thallus usually shrubby and ± erect; without soredia; a species fairly common, growing on oaks at higher elevations
..... Western bushy beard; *Usnea arizonica* Motyka
Apothecia extremely rare; thallus usually ± elongated, hanging; usually with soredia**4**
- 4(3)** Thallus long and slender, main branches hanging downwards; with short isidia and/or soredia; thallus usually blackened at the base; an infrequent to locally common species, especially growing on conifers, at mid- to higher elevations
..... Fishbone beard lichen; *Usnea filipendula* (Ach.) Stirt.
Thallus tufted, main branches ± irregularly erect; without isidia but with excavated, fine-powdery soredia; thallus blackened at the base; an infrequent to rare species, growing especially on conifers, at higher elevations
..... Lustrous beard lichen; *Usnea glabrata* (Ach.) Vain.

- 12(11)**Thallus of bright lemon yellow, large straps, almost fruticose in appearance; rare, on conifers; often with large, brown fruiting bodies
..... Brown-eyed wolf lichen; *Letharia columbiana* (Nutt.) J. W. Thomson
Thallus of minute golden yellow lobes, distinctly foliose to subfruticose; some species with small yellow fruiting bodies Candleflame lichens, lemon lichens; *Candelaria*
[Note: Because of the erect growth habit *Letharia* is often considered to be a fruticose lichen, it nevertheless has distinctly flattened branches with an upper and lower surface. The fine lobes of *Candelaria* may also grow somewhat erect and especially *C. concolor* could be interpreted to be fruticose. Both *Letharia* and *Candelaria* therefore also key out at # 5, Fruticose Key]
- 13(10)**Thallus lobes mostly over 2 mm wide; disc of the fruiting body (if present) brown to nut-brown, rarely blackish brown (Attention: both *Hypogymnia* and *Imshaugia* key out here even though they have rather small lobes but pale brown to brown fruiting bodies and non-septate spores) [microscope: spores (if present) colorless, non-septate] (**parmeliodlichens**) **14**
Thallus lobes usually less than 2 mm wide, rarely larger (e.g., some species of *Heterodermia*); disc of the fruiting body (if present) dark brown to black [microscope: spores brown, one-septate] (**physcioid lichens**) **28**
- 14(13)** Thallus yellow-green, always with a yellowish tinge (a color like *Usnea*, i.e. with usnic acid) **15**
Thallus color different, never with a yellow-green tinge (gray, whitish gray, dark gray, brown, greenish brown, olive brown etc.) **17**
- 15(14)** Upper cortex smooth throughout, thallus surface intact, not marked with white speckles (= pseudocyphellae), but sometimes with white dots (= maculae); medulla C- or rarely C+ red (if gyrophoric acid present) **16**
Upper cortex with tiny, round, white speckles of broken thallus surface (= pseudocyphellae) [Attention: *Flavopunctelia soredica* has only very poorly developed speckles]; medulla always C+ red (with lecanoric acid) Speckled greenshield lichens; *Flavopunctelia*
- 16(15)** Usually growing on bark; lobes often ± matt, large and spreading [chemistry: hyphal cell walls with isolichenin; microscopy: spores relatively large, ellipsoidal, 14-20 x 7-10 µm]; in Arizona usually at higher elevations in woodlands
..... Greenshield lichens; *Flavoparmelia*
Usually growing on rock (but in dry woodlands also rarely found on bark and wood, especially on fallen branches or at the tree base, very rarely further up the tree trunk); lobes often ± shiny and relatively narrow [chemistry: hyphal cell walls with lichenin; microscopy: spores comparatively small, ellipsoidal, 6-10 x 4-6 µm]; very common desert species [the species are difficult to distinguish and their chemistry often needs to be analyzed; different species are therefore not distinguished in this key]
..... Rock-shield lichens; *Xanthoparmelia*
- 17(14)** Thallus dark brown, K- or K+ yellow (with or without atranorin) **18**
Thallus gray, whitish gray, pale ivory, K+ yellow (with atranorin) **19**
- 18(17)** Thallus brown to olive green; lobes flattened and ± closely appressed to the substrate; speckled with black dots (= pycnidia) across the entire thallus surface, more common at higher elevations, especially on *Quercus gambelii*, sometimes also growing on rock
..... Camouflage lichens; *Melanelia*
Thallus brown to greenish brown; lobes usually not flattened and not closely appressed to the substrate; not speckled with black dots across the entire surface, black dots (= pycnidia) confined to the tip of swollen marginal protrusions; lobe margins often turned upwards; usually growing on conifers and wood
..... Wrinkle lichens, ruffle lichens; *Tuckermannopsis*

- 19⁽¹⁷⁾ Thallus with loose, narrow and strap-shaped lobes [appearing fruticose, also keys out at # 6, Fruticose Lichens], upper side gray, lower side channeled (= caniculate) and vivid black (at least at the base) Western antler lichen, *Pseudevernia intensa* (Nyl.) Hale & W. L. Culb.
Thallus lobes not narrow and strap-shaped, growing more closely attached..... **20**
- 20⁽¹⁹⁾ Medulla pale orange-yellow (at least in part, necessary to scratch the thallus surface to view the medulla!); **very rare** species.....
.....Powdery axil-bristle lichen; *Myelochroa aurulenta* (Tuck.) Elix & Hale
Medulla white; common species **21**
- 21⁽²⁰⁾ Upper surface with speckles or cracks where medullary hyphae are pushing through the thallus cortex (= pseudocyphellae) **22**
Upper surface mostly intact, but sometimes spotted with white dots or lines which may break to form fissures, medullary hyphae not pushing through the thallus surface (= maculae)..... **23**
- 22⁽²¹⁾ Speckles forming white dots (= punctiform pseudocyphellae); species infrequent to common
..... Speckled shield lichens, speckled back lichens; *Punctelia*
Speckles forming white lines (= linear pseudocyphellae), lines sometimes branched and net-like (reticulate); lobes often smaller than in *Punctelia*; species infrequent, only at higher elevations, growing on conifers and *Quercus gambelii*
.....Hammered shield lichen; *Parmelia sulcata* Taylor
- 23⁽²¹⁾ Upper surface with a very distinct net-like (= reticulate) pattern of white lines, thallus surface often breaking into deep fissures along these lines; lobe margins always lined with dark “lashes” (= cilia); species relatively common on rocks, rarely growing on trees
..... Cracked ruffle lichen; *Rimelia reticulata* (Taylor) Hale & Fletcher
Upper surface without any white spots or fissures; lobe margin with or without “lashes” (= cilia), usually growing on bark or wood **24**
- 24⁽²³⁾ Thallus lobes swollen, inflated, hollow inside, without rhizines, often sorediate; a **rare** species of upper elevations, growing on conifers.....
..... Powdered tube lichen; *Hypogymnia bitteri* (Lynge) Ahti
Thallus lobes solid, with rhizines **25**
- 25⁽²⁴⁾ Lower side of the thallus densely covered with distinctly forked (dichotomous), black rhizines; rhizines frequently protruding from the margin and thus visible from above; the lobe tips have square, almost truncated shape and the lobe angles form rounded “loops”; common species on oaks with hard bark (e.g. on *Quercus hypoleucoides*)..... Loop lichens; *Hypotrachyna*
Lower side of the thallus with simple rhizines (rarely sparsely branched but not distinctly and regularly forked); lobe tips rounded and lobe angles incised (as if cut with scissors) **26**
- 26⁽²⁵⁾ Thallus lobes without “lashes” (= cilia); lobes ± elongated but not much overlapping; closely appressed; rhizines simple; common species on conifers and hardwood
..... Starburst lichens; *Imshaugia*
Thallus lobes seamed with long lashes (= cilia) along the margin; lobes not elongated and frequently overlapping; growing appressed or loosely **27**
- 27⁽²⁶⁾ Thallus lobes broad (8-20 mm wide); lower surface with a pale brown marginal zone without rhizines (> 1 mm wide); growing “ruffled” and not closely appressed; isidia cylindrical, not lobe-like, without “lashes” (= cilia); medulla K-; [chemistry: cell walls with isolichenan]; moderately common to

Tuckermannopsis fendleri (Nyl.) Hale
Dwarf wrinkle-lichen



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Characterization:

Tuckermannopsis fendleri is an often abundantly fertile species with strongly dissected margins along the fruiting bodies as well as the thallus lobe margins.

Distinguish from:

Tuckermannopsis weberi looks very similar but has a C+ red medulla. *Melanelia* species are much more flattened with broader and less dissected lobes.

Collection notes:

The dark thalli are easily overlooked because they do not stand out against the color of the bark.

Habitat & ecology:

On bark of conifers (especially Pinus), rarely oaks. Often on branches and twigs.

Spot test reactions:

No reactions.

Abundance: Rare (but often overlooked because of the dark color).

Sticta

Moon lichens, crater lichens

Sticta is a genus of large cyanolichens with a felt of black hairs (= black tomentum) on the lower side. They are called crater lichens because of the white, distinctly delimited, round pores (= cyphellae) on the lower side. These pores look like white craters within the surrounding felt of black hairs (= tomentum).

The species of this genus are rather rare because they need quite humid, sheltered habitats.

- Thallus with isidia mostly on the thallus surface, rarely along cracks of the upper side..... Peppered moon lichen, *Sticta fuliginosa* (Hoffm.) Ach.
- Thallus with isidia along the margins of the thallus lobes, not on the surface..... Weigel's moon lichen, *Sticta weigelii* (Ach.) Vain. (= *S. beauvoisii*)

Tuckermannopsis

Wrinkle-lichens, Ruffle lichens

Ruffle lichens are dark brown to olive brown, foliose lichens with strongly wrinkled and often deeply dissected lobes. Many species in the genus have an almost fruticose (shrubby) appearance but they are truly foliose because their lobes have a distinct upper and a lower side. The genus is closely related to *Melanelia* and the most characteristic distinction of the two genera is the location of pycnidia on the thallus. Pycnidia are very tiny, spore producing, urn-shaped structures which look like black dots. In *Melanelia* these black dots are sprinkled all over the thallus surface but in *Tuckermannopsis* the black dots are confined to marginal protrusions.

- 1 Thallus with fruiting bodies, not isidiate but frequently with wart-like protrusions along the margins (= pycnidia) 2
Thallus without fruiting bodies, densely covered by isidia.....
..... Coral-edged wrinkle-lichen; *Tuckermannopsis coralligera* (W. A. Weber) W. A. Weber
- 2 Medulla C- (fatty acids only); infrequent Dwarf wrinkle-lichen; *Tuckermannopsis fendleri* (Nyl.) Hale
Medulla C+ red (olivetric acid); relatively common, on conifers and wood
..... Weber's wrinkle-lichen; *Cetraria* (= "*Tuckermannopsis*") *weberi* Essl.

rare, growing on bark and among mosses over rock
..... Salted ruffle lichen; *Parnotrema crinitum* (Ach.) M. Choisy
Thallus lobes narrow (0.5 – 2 mm wide) lower surface without a distinct marginal zone, lobes growing ± closely appressed; isidia ± flattened and lobe-like, with protruding "lashes" (= cilia); medulla K+ yellow; [chemistry: cell walls without isolichenan], rare, usually growing on bark
..... Hairy-spined shield lichen; *Parmelinopsis horrescens* (Taylor) Elix & Hale

28⁽¹³⁾ Thallus usually very tightly appressed to the substratum; upper surface ± ridged and lobes depressed (concave), often with large white patches, fruiting bodies (if present) with an inconspicuous margin which has the same color and surface structure as the disc (proper margin; lecidine) or rarely with a thin thalline margin which soon disappears; species infrequent, mostly subtropical and only found in southern Arizona
..... Buttoned rosette lichens; *Pyxine*

Thallus closely appressed to rather loose; upper surface not ridged and lobes convex, lobes often powdered with pruina but not forming distinct patches; fruiting bodies (if present) with a conspicuous margin which has the same color and surface structure as the surrounding thallus (thalline margin; lecanorine), margin not becoming excluded; common species throughout Arizona 29

29⁽²⁸⁾ Thallus very small, composed of very small lobes or scales (squamulose to foliose), lobes with few or no rhizines; forming inconspicuously small thalli which are difficult to remove from their substrate 30

Thallus distinctly foliose, forming conspicuous small thalli with a distinct lower surface and therefore more readily detached from the substrate..... 31

30⁽²⁹⁾ Thallus indistinctly foliose with small lobes, growing closely appressed and usually difficult to remove from the substrate; lower side darkened, with sparse, very short rhizines or entirely without rhizines; particularly common at low elevations, on mesquite (*Prosopis*)
..... Grainy shadow-crust lichen; *Hyperphyscia adglutinata* (Flörke) H. Mayrhofer & Poelt

Thallus entirely composed of small scales (= squamulose), growing loosely to closely appressed; lower side pale, white or similar in color as the upper surface; usually mot common at lower elevations, on various substrate
..... various squamulose lichens (e.g., *Cladonia*, *Hypocenomyce*, *Normandina*)
[Note: specimens need not to be collected for the FIA Program]

31⁽²⁹⁾ Thallus light gray; thallus color mostly unchanged when wet, thallus surface K+ yellow (atranorin) 32

Thallus dark gray to brown; thallus becoming dark when wet, thallus surface K- (atranorin absent from the cortex, but some species react K+ yellow in the medulla) 33

32⁽³¹⁾ Thalli moderately large in size, often over 3 cm in diameter; some species without a lower cortex and therefore looking "cottony" (only visible with a good hand-lens!) [microscopy: upper cortex with hyphae running parallel to the surface (= prosoplectenchymatous)]
..... Fringe lichens; *Heterodermia*

Thalli relatively small in size, usually less than 3 cm in diameter; all species have a smooth lower cortex (only visible with a good hand-lens!) [microscopy: upper cortex with a cellular structure (= paraplectenchymatous)]
..... Rosette lichens; *Physcia*

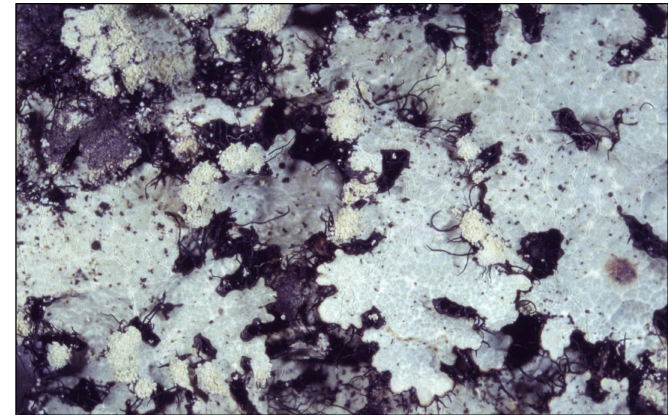
33⁽³¹⁾ Upper surface matt, not distinctly powdered with coarse pruina; rhizines simple to sparsely branched
..... Shadow lichens; *Phaeophyscia*

Upper surface strongly powdered with a distinct crystalline, coarse pruina (especially at the lobe tips); rhizines often strongly branched (like a bottlebrush), rarely unbranched..... Frost lichens; *Physconia*

II. Key to the Common Fruticose Lichens of Arizona

- 1 Main thallus branches rounded in cross section (= terete), hanging downwards or growing in irregular bushy tufts.....2
 Main thallus branches flattened, often strap-shaped, broadened and somewhat similar to the lobes of foliose lichens, but predominantly growing erect, (Note: Compare to # 15 & 25, Foliose Lichen Key)4
- 2(1) Thallus with basal squamules and erect cup-shaped or pin-shaped stalks which bear the fruiting bodies at the tip (= podetia)Cladonia lichens, pixie-cup lichens; *Cladonia*
 Thallus not differentiated into basal squamules and erect stalks3
- 3(2) Thallus yellow-green, with a tough central strand of densely interwoven hyphae (Test: Gently pull apart a branch and the central strand becomes visible); on conifers and hardwoods, moderate to high elevationsBushy beard lichens; *Usnea*
 Thallus brown, without a central strand (Test: Even gently pulling apart the branches will break them); on conifers, at high elevations..... Horsehair lichens, maidenhair; *Bryoria*
- 4(1) Thallus bright yellow to golden yellow or greenish yellow5
 Thallus not yellow, gray or brown, without any yellow tinge7
- 5(4) Thallus bright yellow to golden yellow6
 Thallus greenish yellow (color like *Usnea*, i.e. with usnic acid)
Ramalina lichens, shrub lichens; *Ramalina*
- 6(5) Thallus of large (> 5 mm wide), bright yellow, strap-shaped lobes; species rare, on conifers at higher elevations Brown-eyed wolf lichen; *Letharia columbiana* (Nutt.) J. W. Thomson
 Thallus of minute (< 5 mm wide) golden yellow to lemon yellow lobes; species common, on a variety of trees, often on nutrient enriched bark Candleflame lichens, lemon lichens, *Candelaria*
 [Note: Both genera also key out at # 15, Foliose Lichen Key]
- 7(4) Thallus upper side brown; lobes ± broadened and ± flattened, predominantly spreading horizontally and thus growing foliose, but some species also growing more erect and appearing almost fruticose [Note: keys also out at # 23, Foliose Lichen Key] Wrinkle lichens, ruffle lichens; *Tuckermannopsis*
 Thallus upper side pale gray to ivory; lobes thin and strap-shaped, growing erect giving the thallus a distinct fruticose appearance; lower side of the lobes distinctly channeled (= canaliculate), vivid black (at least at the base), on conifers (especially *Pinus strobiformis*), at upper elevations
 Western antler lichen; *Pseudevernia intensa* (Nyl.) Hale & W. L. Culb.
 [Note: *Pseudevernia* has strap-shaped lobes with a distinct upper and lower surface. It grows rather loose and the thallus therefore appears more like a fruticose than a foliose lichen, it also keys out at # 25, Foliose Lichen Key]

Rimelia reticulata (L.) Nyl.
 Cracked ruffle lichens



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Characterization:

The cracked ruffle lichen *Rimelia reticulata* (Taylor) Hale & Fletcher is easily recognized by the fine cracks which form a distinct network on the upper surface of the lichen. The lichen has rather large lobes with marginal soralia and long, black cilia.

Distinguish from:

In the Southwest this lichen cannot easily be confused with similar species. Similarly sized species of *Parmotrema* have a smooth, not "cracked" surface and are rather rare. *Parmelinopsis horrescens* also has a smooth surface and much smaller lobes.

Collection notes:

Collect enough material for identification, not just small fragments.

Habitat & ecology:

On bark of broad-leaved trees; from mid-elevations upwards .

Spot test reactions:

Cortex K+ yellow, UV-; medulla P+ orange, K+red, KC-, C-.

Abundance:

Rare to moderately common.

Rimelia

Cracked ruffle lichens

Cracked ruffle lichens are medium-sized to large lichens with a network of white lines on the thallus surface (reticulate maculae). These white lines easily break and develop into a characteristically cracked surface. Cracked ruffle lichens have large lobes which are not very closely attached but appear "ruffled". The thallus lobes almost always bear long, black cilia.

The cracked ruffle lichen *Rimelia reticulata* is a relatively rare to locally common lichen on bark in Arizona.

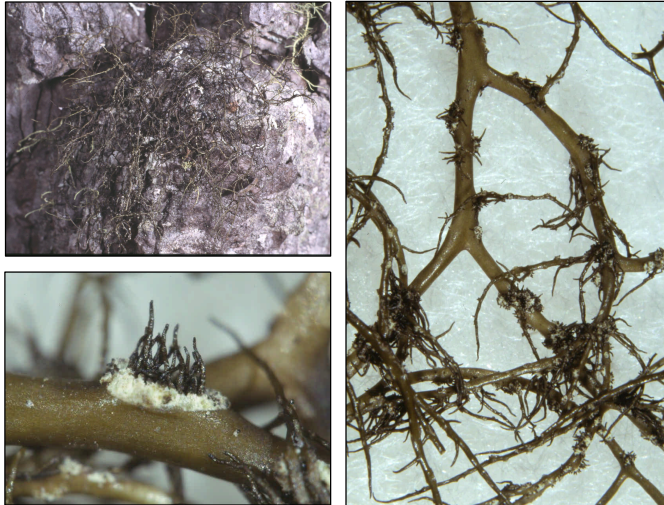
Bryoria

Horsehair lichens, maidenhair

The fruticose thallus of all horsehair lichens resembles the dark brown mane of a horse. A less charming name is maidenhair.

- Thallus growing in irregular, ± erect tufts with divergent side branches; soralia with isidiate spines Burred horsehair; *Bryoria furcellata* (Fr.) Brodo & D. Hawksw.
- Thallus forming tufts of slender, hanging branches; soralia without spines Pale footed horsehair; *Bryoria fuscescens* (Gyeln.) Brodo & D. Hawksw.

Bryoria furcellata (Fr.) Brodo & D. Hawksw.
Burred horsehair lichen



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Characterization:

B. furcellata forms irregular tufts with divergent, short side branches. The cortex is dark brown, shiny and soredia arise from fissures. This species is most easily recognized by the short spiny isidia which grow from within the soredia.

Distinguish from:

In the American Southwest *Bryoria furcellata* is often confused with the more common *Bryoria fuscescens*. However, it can easily be distinguished from that species because *Bryoria furcellata* is the only species with spiny isidia growing out of the soralia.

Collection notes:

Collect specimens attached to the substrate. Do not just rip off!

Spot test reactions:

Cortex & medulla PD+ red, K-, KC- and C-.

Habitat & ecology:

On bark of conifers in open woodlands at mid- and high elevations.

Abundance: Rare.

Ramalina sinensis Jatta
Fan ramalina,
burning brush



Characterization:

Ramalinasinensis has rather short and broad, fan-shaped branches which are irregularly dissected. The species therefore has an almost a foliose appearance. Specimens are usually abundantly fertile along the margins of the lobes.

Distinguish from:

R. sinensis is the most common fertile *Ramalina* on bark in the American Southwest. Other fertile species which have been reported from Arizona are *R. americana* and *R. celsa*. The branches of *R. americana* are rather narrow and much more regularly divided. *R. celsa* has long, strap-shaped branches with fruiting bodies directly on the flattened surface of the branches, not on the margins. These "straps" branch very infrequently and only from the tips. Both *R. americana* and *R. celsa* are very rare throughout Arizona.

Collection notes:

If possible collect entire specimens of mature thalli.

Spot test reactions:

All reactions negative (only KC+ pale brownish yellow; usnic acid).

Habitat & ecology:

On bark of broad-leaved trees or conifers, often on branches or twigs; at higher elevations.

Abundance: Moderately common to rare.

Ramalina

Ramalina lichens, Shrub lichens

Species of the genus *Ramalina* are greenish yellow fruticose lichens usually with a ± erect, bushy thallus. Unlike *Usnea* they usually have more flattened branches and never have a central cord.

- 1 Thallus with fruiting bodies, without soredia2
 Thallus without fruiting bodies, usually with soredia4
- 2(1) Fruiting bodies on the surface of long flattened, strap-shaped branches, very rarely found in Arizona .
 Palmetto lichen; *Ramalina celsatris* (Sprengel) Krog & Swinscow
 Fruiting bodies along the edge of the shorter flattened branches 3
- 3(2) Branches broadly flattened, fan-shaped, irregularly dissected; moderately common at higher altitudes .
 Fan ramalina, burning brush; *Ramalina sinensis* Jatta
 Branches narrowly flattened, ± regularly branching; very rarely found in Arizona.....
 Sinewed ramalina; *Ramalina americana* Hale
- 4(1) Soredia in inflated, hooded extensions on the tips of the branches
 Hooded ramalina; *Ramalina obtusata* (Arnold) Bitter
 Soredia different.....5
- 5(4) Thallus of flexible, finely dissected, narrowly flattened branches, soredia forming from slits along the
 margins Dotted ramalina; *Ramalina farinacea* (L.) Ach.
 Thallus of stiff, irregular, moderately broadened branches; soredia forming on the lower surface and
 along torn branch tips Chalky ramalina; *Ramalina pollinaria* (Westr.) Ach.

Bryoria fuscescens (Gyeln.) Brodo & D. Hawksw.
 Pale-footed horsehair lichen



Characterization:

B. fuscescens forms tufts of slender and thin branches hanging downwards. The cortex of the lichen is pale to dark brown, shiny and soredia arise from fissures.

Distinguish from:

In the American Southwest *Bryoria fuscescens* is the most common *Bryoria* species. It can easily be distinguished from *Bryoria furcellata* because it does not have spiny isidia growing out of the soralia.

Collection notes:

Collect specimens attached to the substrate. Do not just rip off!

Spot test reactions:

Cortex & medulla usually P-, rarely P+ red; soralia P+ red; otherwise K-, KC- and C-.

Habitat & ecology:

On bark of conifers at mid- and high elevations.

Abundance:

Infrequent.

Candelaria

Candleflame lichens, lemon lichens

All candleflame lichens are lemon yellow or strong yellow like the flame of a candle or egg yolk. This color is caused by the pigment calycin (a pulvinic acid derivate), a distinctly different color from the deep orange of the sunburst lichens (*Xanthoria*). The color does not react strongly purple with K but sometimes a faint reddish reaction can be observed.

Candleflame lichens are small, foliose lichens with very small lobes [0.3-0.5 (0.7) mm broad].

- 1 Thallus with soredia; lobes growing somewhat erect and overlapping; rarely forming fruiting bodies. 2 Thallus without soredia; lobes flattened and growing mostly prostrate; often with fruiting bodies Fringed candleflame lichen; *Candelaria fibrosa* (Fr.) Müll. Arg.
- 2 Soredia forming on the lower side of the lobes; lower side without a cortex (cottony); rarely with fruiting bodies Pacific candleflame lichen; *Candelaria "pacifica"* Westberg ined. Soredia budding along the lobe margins and on the thallus surface; lower side with a smooth cortex; almost never with fruiting bodies Rainy candleflame lichen; *Candelaria concolor* (Dicks.) Stein.

Pyxine petricola Nyl.

Common buttoned rosette lichen



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Characterization:

Pyxine petricola is the only species in the American Southwest without soredia. It is usually richly fertile with black button-like apothecia.

Distinguish from:

Young apothecia may have a thin white margin and the species could therefore easily be mistaken for fertile *Physcia* species like *P. aipolia* or *P. stellaris*. Mature fruiting bodies are, however, black throughout. The thallus lobes in *Pyxine* also grow more closely appressed and appear depressed (concave) near the lobe tips (see picture). *Physcia* species have convex lobes which are usually less closely attached. The thallus of *P. petricola* reacts K- (not yellow as the thallus of a *Physcia*).

Collection notes:

If possible collect entire specimens of mature thalli.

Spot test reactions:

No reactions.

Habitat & ecology:

On bark of broad-leaved trees, often on branches or twigs; from low to high elevations.

Abundance: Rare (mostly tropical to subtropical; in the US confined to the Southwest).

Pyxine

Buttoned rosette lichens

Buttoned rosette lichens look very similar to the rosette lichens of the genus *Physcia* but they usually grow much more closely attached to their substrate. Although *Pyxine* species have a similar whitish ivory color to *Physcia* species, they often do not have the gray cortical pigment atranorin and thus frequently react K- instead of K+ yellow (though some species have atranorin and therefore do react K+ yellow).

Physcia species have fruiting bodies distinctly surrounded by a thick, permanent margin. This margin has the same color as the thallus whereas the disk of the fruiting body is black, sometimes covered by white pruina. In most *Pyxine* species the fruiting bodies are black throughout. A margin formed by the thallus is only rarely present in young fruiting bodies. With maturity this thin, whitish rim usually becomes excluded and the disc swells. The common name of the lichen derives from older fruiting bodies which look like black, convex buttons. Also characteristic for this genus are large whitish patches on the surface of the often slightly depressed thallus lobes. Some species have a distinctly colored medulla whereas *Physcia* species always have a white medulla.

Microscopically *Pyxine* can easily be distinguished from *Physcia* because of a bluish-black pigment in the apothecium which strongly reacts K+ purple.

The genus is largely tropical to subtropical and only a few species can be found in southern Arizona.

1 Thallus with soredia; rarely also with fruiting bodies; K- or K+ yellow; medulla white throughout or upper part with a yellowish to pale orange pigment; **rare** [species difficult to distinguish without thallus chemistry or fruiting bodies] 2

Thallus always without soredia; usually with black fruiting bodies; K-; medulla white; usually growing at lower elevations (the most common *Pyxine* species in Arizona) Common buttoned rosette lichen; *Pyxine petricola* Nyl.

2(1) Thallus K- and UV+ yellow (lichexanthone present), fruiting bodies rarely present, with a thin margin which has the same color and surface structure as the surrounding thallus (thalline margin; lecanorine); medulla white throughout; in moist habitats in the South of Arizona Peppered buttoned rosette lichen; *Pyxine cocoëns* Müll. Arg.

Thallus K+ yellow (atranorin present) or K- (if atranorin in very low concentrations), UV-, fruiting bodies rarely present, with an inconspicuous margin which has the same color and surface structure as the disc (proper margin; lecideine); upper part of the medulla with a yellowish to pale orange pigment; in moist habitats in the South of Arizona Mustard lichen; *Pyxine soredata* (Ach.) Mont.

Candelaria concolor (Dicks.) Stein.

Grainy candleflame lichen, lemon lichen



Characterization:

C. concolor has small, somewhat erect lobes with granular soredia along the lobe margins which form by budding (= blastidia).

Distinguish from:

C. concolor is only very rarely fertile and always sorediate. The soredia form by budding along the lobe margins or on the thallus surface. The species can thus be distinguished from *C. pacifica* where soredia form from the lower side.

Collection notes:

Collect enough material for identification.

Spot test reactions:

Cortex & medulla PD-, K- (or pale rosé, never purple!), KC- and C-.

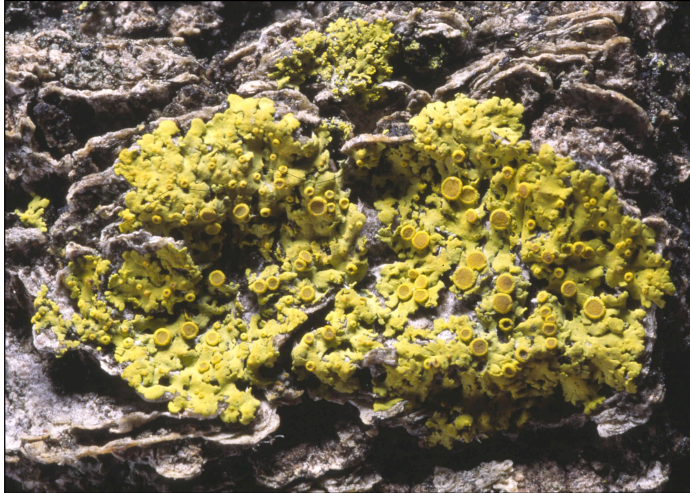
The pigment calycin has a distinctly different chemistry from other more orange yellow pigments (anthraquinones) which are typical for the orange lichen *Xanthoria*. All candleflame lichens therefore never react K+ purple. They are usually K- (very rarely pale rose).

Habitat & ecology:

On sunny, often slightly nutrient-enriched bark.

Abundance: Common.

Candelaria fibrosa (Fr.) Müll. Arg.
Fringed candleflame lichen



© J. Burgaz, ANI Lichen Herbarium

Characterization:

C. fibrosa is easily recognized because it never forms soredia and it is usually abundantly fertile.

Distinguish from:

Candelaria fibrosa is the only species of the genus which is never sorediate. Another species, *C. pacifica*, is also usually fertile but develops soredia on the lower side of the thallus lobes. *C. concolor* is another species with soredia which is rarely fertile, but the soredia are formed on the lobe surface.

Collection notes:

Collect enough material for identification. If present, be sure to collect fertile material!

Spot test reactions:

Cortex & medulla PD-, K- (or pale rose, never purple!), KC- and C-.

The pigment calycin has a distinctly different chemistry from other more orange yellow pigments (anthraquinones) which are typical for the orange lichen *Xanthoria*. All candleflame lichens therefore never react K+ purple. They are usually K- (very rarely pale rose).

Habitat & ecology:

On sunny, often slightly nutrient-enriched bark.

Abundance: Common.

Punctelia hypoleucites (Nyl.) Krog
Southwestern speckled shield lichen



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Characterization:

Punctelia hypoleucites has bowl-shaped fruiting bodies but lacks soredia or isidia.

Distinguish from:

Both *Punctelia subrudecta* (medulla C+ red) and *P. bolliana* (medulla C-) are sorediate species.

Collection notes:

Collect both parts from the margin and the center of the thallus!

Habitat & ecology:

On bark and wood of hardwoods.

Abundance: Common.

Spot test reactions:

Cortex K+ yellow; medulla P-, K-, KC+ red, C+ red.

Punctelia

Speckled shield lichen

Speckled shield lichens are large foliose lichens with a bluish-gray thallus and conspicuous white speckles where the cortex of the thallus is broken (= pseudocyphellae). The Latin name "*Punctelia*" refers to these speckles.

- 1 Soredia absent, 2
Soredia present, medulla C+ red; infrequent, usually at higher elevations, on conifers (e.g., on Douglas fir) Powdered speckled shield lichen; *Punctelia subrudecta* (Nyl.) Krog
- 2(1) Central part of the thallus usually not covered with small lobes; with conspicuous white speckles (= pseudocyphellae); medulla C+ red; common on oaks at intermediate elevations (the most common *Punctelia* in Arizona) Southwestern speckled shield lichen; *Punctelia hypoleucites* (Nyl.) Krog
- Central parts of the thallus often covered with small lobes; speckles (= pseudocyphellae) sometimes less conspicuous; medulla C-; **very rare** (may be present in northeastern Arizona) Eastern speckled shield lichen; *Punctelia bolliana* (Müll. Arg.) Krog

Cladonia

Cladonia lichens, reindeer lichens, soldier lichens, pixie-cup lichens, powderhorns, peg lichens

All *Cladonia* species have a primary thallus made of small scales (= squamules) and a secondary thallus which can be cup- or horn-shaped or shrub-like. Most *Cladonia* species grow on soil between mosses, on old logs or wood and on tree bases. They are only rarely found further up on a tree trunk.

- 1 Most stalks (= podetia) cup-shaped, rarely pointed at the tip, base of the stalks (= podetia) smooth along at least ¼ of their length (with a cortex) 2
Most stalks (= podetia) horn-shaped and pointed at the tip, very rarely bearing cups; base of the stalks (= podetia) usually mealy and with a thin, indistinct cortex, on soil and tree bases, in humid situations also growing on the tree trunk Mealy pixie-cup; *Cladonia coniocraea* (Flörke) Spreng.
- 2(1) Stalks (= podetia) with very narrow, slender cups, these cups as wide or only slightly wider than the stalks, on soil and tree bases, in humid situations also growing on the tree trunk Smooth-footed powderhorn; *Cladonia ochrochlora* Flörke
- Stalks (= podetia) with broad, wide open cups 3
- 3(2) Stalks (= podetia) with very irregular cups which are strongly covered with scales (= squamules); frequently with brown fruiting bodies along the rim of the cups; probably restricted to soil but one of the more common species Split peg lichen, split peg soldiers; *Cladonia cariosa* (Ach.) Spreng.
- Stalks (= podetia) with regular cups, not covered with scales (= squamules); more rarely with well developed fruits along the rim of the cups 4
- 4(3) Cups gradually tapering at the base, stalks (= podetia) K+ yellow; usually growing on exposed, thin soil, very rarely on wood debris Pixie-cup lichen; *Cladonia humilis* (With.) J.R. Laundon
- Cups funnel-shaped with a narrow base and a broad rim; stalks (= podetia) K- (faint brownish) 5
- 5(5) Stalks (= podetia) covered with corticate granules; mostly on soil and tree bases, very rarely further up the tree trunk Pebbled pixie-cup; *Cladonia pyxidata* (L.) Hoffm.
- Stalks (= podetia) covered with true powdery soredia (i.e. without a cortex); mostly on soil and tree bases, very rarely further up the tree trunk Mealy pixie-cup; *Cladonia chlorophaea* (Flörke ex Sommerf.) Spreng.

Cladonia ochrochlora Flörke
Smooth-footed powderhorn



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Characterization:

Cladonia ochrochlora has a basal thallus composed of tiny squamules from which erect horn-like stalks (= podetia) grow upwards. The tips of these “horns” bear tiny cups which are rarely only slightly wider than the entire stalk. The upper parts of the stalks are covered with dense farinose soredia, the lower part usually has a smooth cortex.

Distinguish from:

Cladonia ochrochlora is very easily confused with *Cladonia coniocraea*. The diagnostic difference of the two species are the tiny cups at the tip of the stalks of *C. ochrochlora*. *C. coniocraea* never forms these cups but the stalks are pointed at the tip. *C. ochrochlora* usually is more distinctly corticate at the base. However, these differences are not always very distinct and some authors therefore regard *C. ochrochlora* as a form of *C. coniocraea*.

Collection notes:

Do not collect squamules without stalks or cups.

Spot test reactions:

PD+ red, K- (or brownish), KC- and C-.

Habitat & ecology:

Mostly on the base of tree trunks, logs and decaying wood.

Abundance: Common.

Pseudevernia intensa (Nyl.) Hale & W. L. Culb.
Western antler lichen



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Characterization:

Pseudevernia intensa is often fertile with large, chocolate brown fruiting bodies. It has no soredia or isidia.

Distinguish from:

In the Southwest this lichen cannot easily be confused with other epiphytic lichens. The isidiate species *P. consocians* does not reach the Southwestern US but can be found in Mexico.

Spot test reactions:

Cortex P- (or pale yellow), K+ yellow, KC-, C-; medulla P-, K-, KC+ pink, C+ pink.

Habitat & ecology:

At higher elevations especially on conifers.

Abundance: Rare to moderately common.

Collection notes:

Collect entire specimens.

Pseudevernia

Antler lichen

The antler lichens appear to be fruticose lichens but are actually foliose with thin, strongly branched lobes with a distinctly ivory white upper and a channeled, black lower side.

The western antler lichen *Pseudevernia intensa* is the only species found in the Southwestern United States.

Cladonia pyxidata (L.) Hoffm. Pebbled pixie-cup



© T. Burgner, ASU Herbarium

Characterization:

Cladonia pyxidata has a basal thallus composed of tiny squamules from which cup-shaped stalks (= podetia) emerge. These cups are trumpet-shaped and entirely covered in coarse, corticate granules. In mature specimens brown fruiting bodies can be found on the margins of the cups.

Distinguish from:

Cladonia pyxidata is easily confused with other cup-shaped *Cladonia* species. The most distinct character are the corticate granules which are much coarser than the soredia typical for other cup-shaped *Cladonia* species.

Collection notes:

Do not collect squamules without cups.

Spot test reactions:

PD+ red, K- (or brownish), KC- and C-.

Habitat & ecology:

Mostly on the base of tree trunks, logs and decaying wood.

Abundance: Common.

Collema

Jelly lichens

All jelly lichens have the cyanobacterium *Nostoc* as photobiont. They are dark olive, becoming vivid black when wet. Dry specimens are shriveled up and fragile. When wetted these lichens swell and assume a jelly-like consistency.

Like most cyanolichens, jelly lichens can be easily overlooked because of their dark, blackish to deep olive color. They require slightly more humid habitats than most green algal lichens.

- 1 Thallus with isidia (small globular or cylindrical outgrowths) 2
Thallus without isidia; probably common, but often overlooked because of its small size
..... Bark jelly lichen; *Collema conglomeratum* Hoffm.
- 2(1) Isidia cylindrical, slender; on oaks, especially soft-barked ones (the most common species of *Collema* in Arizona) Blistered jelly lichen; *Collema furfuraceum* (Arnold) Du Rietz
Isidia globose, short (probably more common in California than in Arizona)
..... Blistered jelly lichen *Collema nigrescens* (Huds.) DC.

[Note: both species are very similar and can easily be confused]

Physconia elegantula Essl. Elegant frost lichen



Characterization:

Physconia elegantula is a small brownish, isidiate lichen powdered with coarse pruina. Most conspicuous are the fruiting bodies which bear a crown of branched isidia (see small photo).

Distinguish from:

The branched isidiate fruiting bodies are very distinctive and this lichen can hardly be confused with other species.

Collection notes:

Collect enough material for identification, not just small fragments.

Spot test reactions:

No reactions.



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Habitat & ecology:

On bark of broad-leaved trees, often on branches or twigs; from mid-elevations upwards.

Abundance: Infrequent.

Physconia detera (Nyl.) Poelt
Bottlebrush frost lichen



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Characterization:

Physconia detera is a small brownish gray lichen with strongly branched rhizines (like a bottlebrush). Most characteristic are the coarse brownish soredia extending along the lobe margins.

Distinguish from:

The soredia which form all along the lobe margin are very characteristic. The more common *Physconia perisidiosa* has lip-shaped soredia only at the tips of the lobes.

Collection notes:

Collect enough material for identification, not just small fragments.

Spot test reactions:

No reactions.

Habitat & ecology:

On bark of broad-leaved trees, often on branches or twigs.

Abundance: Rare (In the Southwestern US *Physconia perisidiosa*, a similar species, is much more common than *P. detera*).

Collema nigrescens (Huds.) DC.
Blistered jelly-lichen



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Characterization:

Collema nigrescens is one of the largest jelly lichens. It is characterized by knob-like, globular isidia and is usually also fertile (see picture).

Distinguish from:

Collema furfuraceum is very similar but has cylindrical isidia.

Collection notes:

Be careful to collect intact specimens. Dry thalli are brittle. If necessary wet the thallus before collecting.

Spot test reactions:

No reactions.

Habitat & ecology:

Usually on bark in humid and sheltered situations, in Arizona only from mid-elevations upwards. Frequently growing with mosses.

Abundance: Common.

Flavoparmelia

Greenshield lichens

Greenshield lichens (*Flavoparmelia*) can be distinguished from speckled greenshield lichens (*Flavopunctelia*) because they have no conspicuous white speckles on the thallus surface and a distinctly different chemistry. However, *Flavopunctelia soredica*, the sorediate speckled greenshield, usually has very poorly developed speckles and is not easily recognized. It has distinct crescent shaped soralia at the tip of the lobes. The greenshield *Flavoparmelia caperata* never has speckles and the soredia develop all along the lobe margins, not forming distinct crescent shaped soralia.

In Arizona Greenshield lichens without speckles are not very commonly encountered growing on trees. In Arizona *F. caperata* is quite rare. *F. baltimorensis* usually grows on rocks, only very rarely on trees.

- Soredia granular, warty, medulla C- (or C+ red, if gyrophoric acid present, reaction usually stronger if tested with KC); common on rocks, occasionally at the bases of oak tree, very rarely further up the tree trunk Rock greenshield; *Flavoparmelia baltimorensis* (Gyeln. & Förriss) Hale
- Soredia fine (farinose), medulla C-; usually on bark, relatively rare in Arizona (common along the Californian coast) Common greenshield; *Flavoparmelia caperata* (L.) Hale

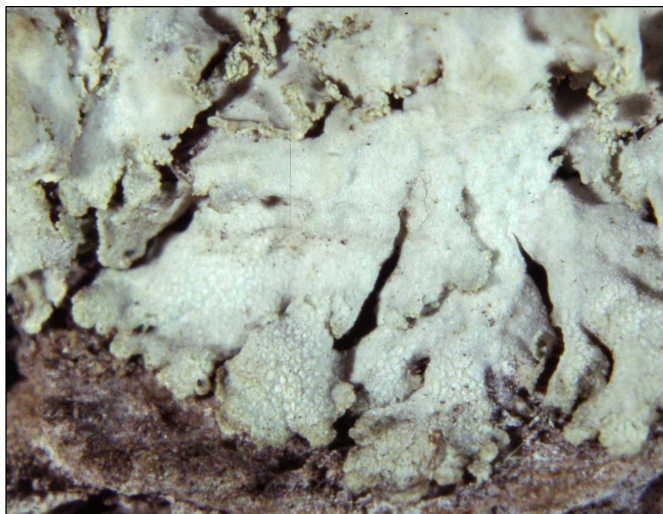
Physconia

Frost lichens

Frost lichens are small foliose lichens. They look “frosted” because they are characteristically covered by a coarse crystalline pruina which is usually best developed around the lobe margins and can easily be observed if the lichen is dry. Beneath the pruina the thallus usually appears pale brownish. It considerably changes color when wet and becomes dark green. Most frost lichens have finely branched rhizines which resemble a bottlebrush. *Physconia* species may sometimes be confused with species in the genus *Phaeophyscia* but these lichens have simple to sparsely branched rhizines and they are usually much darker gray (not brownish) and not covered by a coarse, crystalline pruina.

- 1 Thallus with isidia, often also with fruiting bodies which have a “crown” of branched isidia
..... Elegant frost lichen; *Physconia elegantula* Essl.
Thallus with soredia..... **2**
- 2(1) Soredia forming all along the margin of the lobes, rare
..... Bottlebrush frost lichen; *Physconia detera* (Nyl.) Poelt
Soredia forming lip-shaped soralia at the lobe tips, infrequent to moderately common
..... Crescent frost lichen; *Physconia perisidiosa* (Ach.) Bory

Physcia dimidiata (L.) Nyl.
Sugar rosette lichen



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Characterization:

Physcia dimidiata is a small whitish-gray, foliose lichen with granular soredia along the margins of the lobes. It is densely covered with a coarse, white pruina.

Distinguish from:

Physcia dimidiata is easily distinguished by its coarse crystalline pruina from *P. tribacia* which has smooth shiny lobes not covered with pruina (best observed when the thallus is dry). Both *P. dimidiata* and *P. tribacia* have a K- medulla. *P. poncinsii* which has a K+ yellow medulla, is much rarer and is usually powdered by a much finer pruina.

Collection notes:

Collect enough material for identification, not just small fragments.

Spot test reactions:

Cortex K+ yellow; medulla P-, K-, KC-, C-.

Habitat & ecology:

On bark of broad-leaved trees, often on branches or twigs, also on rock, from low and mid elevations to the upper montane.

Abundance: Common (the most common sorediate *Physcia* species in Arizona).

Flavopunctelia

Speckled greenshield lichens

All speckled greenshield lichens are large lichens which grow rather rapidly. The thallus is often more than 10 cm and the lobes can be wider than 1 cm. Speckled greenshield lichens are typically yellow green (usnic acid) and characteristically spotted with white speckles. These speckles are formed where the cortex of the lichen ruptures (= pseudocyphellae). The speckles are quite distinct in most of the species and the genus can thus easily be distinguished from "unspeckled" greenshield lichens which belong to the genus *Flavoparmelia*.

Only *Flavopunctelia soredica*, has very poorly developed white speckles and can be easily confused with species in the genus *Flavoparmelia*.

- 1 Thallus sorediate; almost never forming fruiting bodies 2
Thallus not sorediate; usually with fruiting bodies 3
- 2(1) Soredia mostly developing along the lobe margins, white speckles (= pseudocyphellae) weakly developed; usually growing on bark (especially on *Quercus emoryii*), growing from mid-elevation to lower forest transition zones, frequently misidentified as *F. flaventior* (this is the most common sorediate *Flavopunctelia* in Arizona) Powder-edged speckled greenshield; ***Flavopunctelia soredica*** (Nyl.) Hale
Soredia predominantly laminal, speckles (= pseudocyphellae) well developed; in Arizona mostly growing on rock, rarely found on bark; in coastal regions (e.g., California) also frequently found on bark Speckled greenshield; ***Flavopunctelia flaventior*** (Stirt.) Hale
- 3(1) Lower surface black towards the center; thallus lobes 1.5 - 3 mm wide; usually growing on oak, less often on conifers (one of the most common macrolichens in Arizona) Blackened bottom speckled greenshield; ***Flavopunctelia praesignis*** (Nyl.) Hale
Lower surface pale tan throughout; thallus lobes 2 - 5 mm wide; on hard-barked oaks, infrequent Darrow's speckled greenshield, ***Flavopunctelia darrowi*** (J. W. Thomson) Hale

Flavopunctelia darrowi (J. W. Thomson) Hale
Darrow's speckled greenshield



Characterization:

Flavopuncteliadarrowi is a large, yellow-green foliose lichen. It is usually fertile and has a pale brown underside throughout (see photo).

Distinguish from:

The only other *Flavopunctelia* with fruiting bodies in the American Southwest is *F. praesignis* but this species has a strong black underside (which, however, can be pale brown along the margins).

Collection notes:

Make sure you collect both characteristic parts of the margin and the center of this large lichen thallus.

Habitat & ecology:

On bark of oaks and conifers; from mid-elevations upwards.

Spot test reactions:

medulla PD-, K-, KC+ red, C+ red, cortex KC+ yellowish (usnic acid).

Abundance: Common.

Physcia biziana (L.) Nyl.
Frosted rosette lichen



Characterization:

Physciabiziana is a non-sorediate, non-isidiate, often richly fertile species. The fruiting bodies have very dark brown, almost black disks which are usually abundantly pruinose. The thallus is usually strongly pruinose (frosted).

Distinguish from:

The thallus medulla of both *Physcia stellaris* and *P. biziana* reacts K- (attention: all *Physcia* have a K+ yellow cortex and testing needs to be carefully applied only to the medulla, not the upper cortex!). *P. biziana*, however, is densely covered by pruina whereas *P. stellaris* is not pruinose. Specimens of *P. biziana* with little pruina are usually more coarsely powdered than *P. atpolia* which can also be distinguished by a K+ yellow medulla.

Collection notes:

Collect enough material for identification, not just small fragments.

Habitat & ecology:

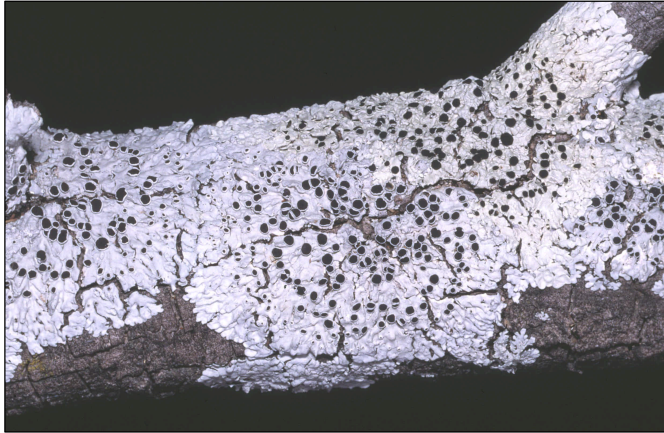
On bark of broad-leaved trees, often on branches or twigs.

Spot test reactions:

Cortex K+ yellow; medulla P-, K-, KC-, C-.

Abundance: Moderately common.

Physcia aipolia (Ehrh. ex Humb.) Fűrnr.
Hoary rosette lichen



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Characterization:

Physcia aipolia is a non-sorediate, non-isidiate, often richly fertile species. The fruiting bodies have very dark brown, almost black disks which are often (but not always) densely pruinose. The thallus can be finely pruinose or appears rather smooth but it always has some white spots (maculae).

Distinguish from:

The thallus medulla of *Physcia aipolia* reacts K+ yellow which sets it apart from both *Physcia stellaris* and *P. biziana* which have a K- medulla (attention: all *Physcia* have a K+ yellow cortex and testing needs to be carefully applied only to the medulla!). *P. stellaris* has no white spots and is usually less pruinose than *P. aipolia*. *P. biziana* is usually densely covered by a very coarse (almost crystalline) pruina. Even in specimens with little pruina *P. biziana* is much more coarsely powdered than both *P. stellaris* or *P. aipolia*.

Collection notes:

Collect enough material for identification, not just small fragments.

Spot test reactions:

Cortex and medulla K+ yellow, KC-, C- (atranorin).

Habitat & ecology:

On bark of broad-leaved trees, often on branches or twigs.

Abundance: Moderately common.

Flavopunctelia flaventior (Stirt.) Hale
Speckled greenshield



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Characterization:

Flavopunctelia flaventior is a large foliose yellow-green lichen. It is sorediate on the surface of the thallus lobes. (Note: The strong green color of the photograph is typical for a specimen which is wet; dry specimens are pale yellow-green. Compare with the pictures of other species in this genus!).

Distinguish from:

The only other *Flavopunctelia* with soredia is *Flavopunctelia soredica* which, however, has crescent shaped soredia at the lobe tips and only rarely on the surface of the thallus. *F. flaventior* usually has conspicuous white speckles (pseudocypellae) whereas in *F. soredica* these speckles are usually very weakly developed.

Collection notes:

Make sure you collect both parts of the margin and the center of the large lichen thallus.

Spot test reactions:

medulla P-, K-, KC+ red, C+ red, cortex KC+ yellowish (usnic acid).

Habitat & ecology:

On bark of oaks and conifers; from mid-elevations upwards.

Abundance:

Common.

Flavopunctelia praesignis (Nyl.) Hale
Black bottom speckled greenshield



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Characterization:

Flavopunctelia praesignis is a large, yellow-green foliose lichen. It is usually fertile, never sorediate and has a strong black underside (which may be pale brown only along the margins of the thallus).

Distinguish from:

The only other *Flavopunctelia* with fruiting bodies in the American Southwest is *F. darrowi* but this species has a pale brown underside throughout.

Collection notes:

Make sure you collect both parts of the margin and the center of the large lichen thallus.

Spot test reactions:

Medulla PD-, K-, KC+ red, C+ red, cortex KC+ yellowish (usnic acid)

Habitat & ecology:

On bark of conifers and oaks; from mid-elevations upwards.

Abundance: Common.

Physcia adscendens (Fr.) H. Olivier
Hooded rosette lichen



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Characterization:

Physcia adscendens is a small foliose lichen with narrow, somewhat erect growing lobes. It therefore almost looks like a minutely fruticose lichen. The lobes have helmet-shaped soralia ("hoods") at the tips and long pale brown to brown cilia.

Distinguish from:

In the Southwest this lichen can only be confused with *Physcia tenellula* which is much smaller and has crescent shaped soralia at the lobe tips. *Physcia tenellula*, however, is a coastal species known only from few localities in California and Baja California.

Collection notes:

Make sure you collect well developed specimens.

Habitat & ecology:

On bark, especially small branches and twigs, especially in somewhat nutrient enriched locations; from mid-elevations upwards.

Spot test reactions:

Medulla P-, K-, KC-, C-, cortex P+ yellow, K+ yellow, KC-, C-.

Abundance: Common.

Physcia

Rosette lichens

Lichens in the genus *Physcia* are much smaller than the parmelioid lichens. *Physcia* and *Heterodermia* both have a bright white or ivory white surface and become only slightly more greenish when wet. The pale gray pigment of the thallus surface (atranorin) reacts always K+ yellow. Both genera can easily be distinguished microscopically because of a structurally different cortex. In the field these two genera can easily be confused. Because of the different cortex *Physcia* species often appear a little less shiny than *Heterodermia* species. However, both genera can be densely pruinose. *Physcia* species generally have a smooth lower cortex whereas some *Heterodermia* species are missing a lower cortex and therefore have a cottony underside.

- 1 Thallus without soredia, usually with fruiting bodies; infrequent, at higher elevations2
Thallus with soredia, usually sterile4
- 2(1) Upper side usually very densely powdered with a coarse, crystalline pruina (rarely poorly developed), lobes rounded, sometimes with a brownish tinge; in Arizona the most common species, growing on bark, from low to high elevations
..... Frosted rosette lichen; *Physcia biziana* (A. Massal.) Zahlbr.
Upper side not powdered or very weakly powdered with a fine pruina, lobes ± truncated, pale ivory (never brownish)3
- 3(2) Medulla K+ yellow (with atranorin); lobe surface ± dull, finely powdered or not powdered; an infrequent species, usually growing on *Quercus gambelii*
..... Hoary rosette lichen; *Physcia aipolia* (Ehrh. ex Humb.) Fűrnr.
Medulla K- (without atranorin), lobe surface usually shiny, not powdered (very rarely with a fine pruina); an infrequent species, growing on a variety of substrates
..... Star rosette lichen; *Physcia stellaris* (L.) Nyl.
- 4(1) Lobes narrow, strongly dissected, growing almost minutely fruticose; lobe tips with helmet-shaped (“hooded”) soralia and long “lashes” (=cilia); often growing on small branches and twigs, especially in nutrient-rich situations
..... Hooded rosette lichen; *Physcia ascendens* (Fr.) H. Olivier
Lobes wider, not strongly dissected and growing horizontally (distinctly foliose); lobe tips without helmet-shaped (“hooded”) soralia or “lashes” (=cilia); growing on a variety of bark substrates5
- 5(4) Upper side not powdered or very weakly powdered with a fine pruina6
Upper side powdered with a coarse, crystalline pruina; in Arizona the most common *Physcia* species with soredia
..... Sugar rosette lichen; *Physcia dimidiata* (Arnold) Nyl.
- 6(5) Medulla K- (without atranorin); soredia along the margin of the lobes, not excavated; lobe surface shiny, not powdered; infrequent to rare
..... Fringed rosette lichen; *Physcia tribacia* (Ach.) Nyl.
Medulla K+ yellow (with atranorin); soredia on the thallus surface, in crater-like excavations; lobe surface ±dull, finely powdered or not powdered; rare
..... Powdered rosette lichen; *Physcia poncinsii* Hue

Flavopunctelia soredica (Nyl.) Hale

Powder-edged speckled greenshield



© F. Burgartz, ASU Lichen Herbarium

Characterization:

As the name suggests *Flavopunctelia soredica* is sorediate. The soredia are typically formed crescent-shaped along the lobe margins. Speckled greenshield lichens are typically speckled by white spots (pseudocypellae) but in *F. soredica* these spots are usually very weakly developed.

Distinguish from:

The only other sorediate *Flavopunctelia* in the American Southwest is *F. flaventior* but this species usually has more conspicuous white speckles and the soredia form mostly on the thallus surface.

Flavopunctelia soredica which typically develops only few or almost no white spots can easily be confused with *Flavoparmelia caperata* or *Flavoparmelia soredians*. However, the thallus medulla of these two species does not react with C and a C+ red reaction of the medulla is diagnostic for the genus *Flavopunctelia*.

Collection notes:

Make sure you collect both parts of the margin and the center of the large lichen thallus.

Spot test reactions:

Medulla PD-, K-, KC+ red, C+ red, cortex KC+ yellowish (usnic acid).

Habitat & ecology:

On bark of oaks and conifers; from mid-elevations upwards.

Abundance: Common. (In the dry forest areas of the Southwest *F. soredica* is much more common than *F. flaventior*).

Fuscopannaria

Brown shingle lichens

Brown shingle lichens look like clay shingles of an old fashioned roof. They are composed of very small squamules which are closely attached to the substrate. The lichen thus appears to be almost crustose. It does not usually form distinct rosettes but the thallus is irregular in outline.

In Arizona *Fuscopannaria* species are relatively rare and always restricted to sheltered, humid forests, often on shaded, steep and N-exposed slopes.

- Thallus thick (up to 0.5 mm), often forming dense cushions of closely overlapping shingles; rare in Arizona, usually growing on tree bases and rocks, rarely encountered further up the tree trunk Californian shingle lichen; *Fuscopannaria californica* (Tuck.) P.M. Jorg.
- Thallus thinner, mostly forming expanding crusts of loosely overlapping shingles; frequent in Arizona, but usually growing on rocks Rock shingle lichen; *Fuscopannaria leucophaea* (Vahl) P. M. Jorg.

Phaeophyscia hispidula (Ach.) Essl.

Whiskered shadow lichen



Characterization:

Phaeophyscia hispidula is the largest of these rather small lichens. It has lobes up to 6 mm broad and can form irregular thallus patches of more than 6 cm. The species is usually coarsely sorediate with pale greenish soralia. The lobe margins are densely lined by a black fringe of "whiskers", i.e. a dense mat of unbranched black rhizines extending all across the lower surface right to the edge of the lobes.

Distinguish from:

Because of its relatively large size and the conspicuous "whiskers" this species is usually easily recognized and rarely confused with other lichens. *Hyperphyscia adglutinata* is much smaller, has almost no rhizines and is very closely attached to the substrate. *Phaeophyscia cernohorskyi* and *P. hirsuta* are both much smaller and characterized by hyaline hairs on the thallus surface.

Collection notes:

Collect enough material for identification, not just small fragments.

Spot test reactions:

No reactions.

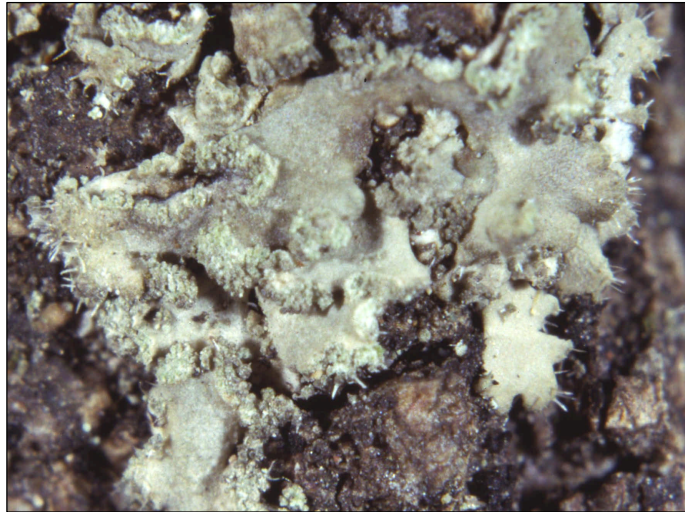
Habitat & ecology:

On tree bark and rocks.

Abundance:

Abundant.

Phaeophyscia hirsuta (Mereschk.) Moberg
Hairy shadow lichen



© F. Rauscher, ANU, Canberra, Australia

Characterization:

Phaeophyscia hirsuta is very small pale gray to dark gray or grayish brown lichen with a densely pruinose surface and and fine, colorless, almost transparent hairs. It forms granular soredia at the tips of the thallus lobes.

Distinguish from:

The species can easily be confused with *Phaeophyscia cernohorskyi* which also has stiff, almost transparent hairs all over the thallus surface but develops soredia all along the lobe margins. *Hyperphyscia adglutinata* does not have hairs. It is much smaller and grows more closely attached.

Collection notes:

Make sure you collect well developed specimens with soredia.

Spot test reactions:

No reactions.

Habitat & ecology:

On bark from mid-elevations upwards.

Abundance: Common.

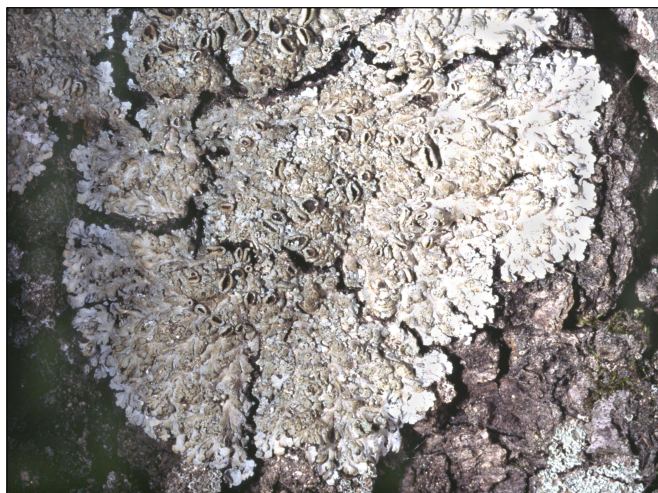
Heterodermia

Fringe lichens

Lichens in the genus *Heterodermia* are relatively small. They usually have a bright white or ivory white surface and become only slightly more greenish when wet. The pale gray pigment of the thallus surface (atranorin) reacts always K+ yellow. The only other genus which is also pale whitish and K+ yellow is *Physcia*. Both genera can easily be distinguished microscopically but are often confused in the field (refer to the genus description of *Physcia*).

- 1 Lobes without a lower cortex (hand-lens: cottony lower side); without soredia; fruiting bodies with a conspicuously lobed margin; infrequent Cupped fringe lichen; *Heterodermia hypoleuca* (Muhl.) Trevisan
Lobes with a lower cortex (hand-lens: smooth lower side); with or without soredia; with or without fruiting bodies; common 2
- 2(1) Thallus with soredia, almost never with fruiting bodies 3
Thallus without soredia, usually with fruiting bodies; fruiting bodies rarely with a ± lobed margin; in Arizona the most common *Heterodermia* on oaks (previously often misidentified as *H. diademata*), less common on rocks Southwestern cupped fringe lichen; *Heterodermia rugulosa* (Kurok.) Wetmore
- 3(2) Soralia mostly at the lobe tips, medulla K+ yellow, not turning red (without salazinic or norstictic acid); common to relatively rare Powdered fringe lichen, powdered centipede; *Heterodermia speciosa* (Wulfen) Trevis.
Soralia mostly along the margins, medulla K+ yellow, turning red (with salazinic or norstictic acid); more common on rock, but rarely also on tree bases Powdered fringe lichen, powdered centipede; *Heterodermia pseudospeciosa* (Kurok.) W. L. Culb.

Heterodermia hypoleuca (Muhl.) Trevis.
Cupped fringe lichen



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Characterization:

Heterodermia hypoleuca is often abundantly fertile with fruiting bodies which typically have a crenate margin (i.e. the margin looks like rounded teeth). The species forms no soredia. The surface is often finely powdered and ivory to pale beige below this pruina. The lower surface does not have a cortex and therefore appears cottony. The medulla is always bright white.

Distinguish from:

In the Southwest the species may easily be confused with *H. rugulosa* which, however, has a smooth lower cortex and a yellow, K+ purple pigment in the medulla.

Collection notes:

Collect enough material for identification, not just small fragments.

Spot test reactions:

medulla PD- (or pale yellow), K+ yellow, KC- or KC+ yellow-orange, C-. **Abundance:** Common.

Habitat & ecology:

Mostly on bark of broad-leaved trees.

Abundance: Common.

Phaeophyscia endococcinodes (Poelt) Essl.
Orange-marrow lichen



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Characterization:

Phaeophyscia endococcinodes is easily recognized by its bright orange medulla (see photo).

Distinguish from:

The only other *Phaeophyscia* with an orange medulla is *Phaeophyscia edococcina*. The two species can only be distinguished microscopically. *P. endococcinodes* has thick-walled spores with rounded to elongate lumina and *P. edococcina* has thin-walled spores with angular to rounded lumina.

Collection notes:

Collect enough material for identification, not just small fragments.

Spot test reactions:

no reactions.

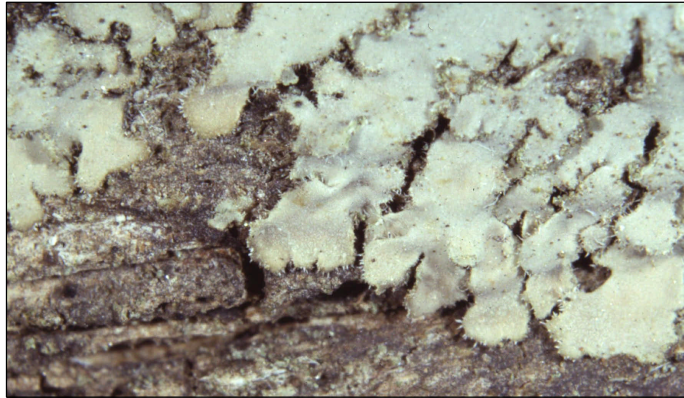
Habitat & ecology:

On oaks and other broad leaved trees.

Abundance: Moderately common to rare.

Phaeophyscia cernohorskyi (Nädv.) Essl.

Hairy shadow lichen



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Characterization:

Phaeophyscia cernohorskyi is very small pale gray to dark gray or grayish-brown lichen with a densely pruinose surface and fine, colorless, almost transparent hairs. It is granular-sorediate along the lobe margins.

Distinguish from:

The species can easily be confused with *Phaeophyscia hirsuta* which also has stiff, almost transparent hairs all over the thallus surface but develops soredia on its lobe-tips, not on the margins. *Hyperphyscia adglutinata* does not have hairs. It is much smaller and grows more closely attached.

Collection notes:

Make sure you collect well developed specimens with soredia.

Spot test reactions:

No reactions.

Habitat & ecology:

On bark from mid-elevations upwards.

Abundance: Common.

Heterodermiarugulosa (Kurok.) Wetmore

Southwestern cupped fringe lichen



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Characterization:

Heterodermia rugulosa is usually abundantly fertile (the picture shows a sterile specimen). The margin of the fruiting body is usually entire and only rarely develops a few lobes. The species forms no soredia. The surface is usually strongly powdered and ivory to pale beige below the pruina. The lower surface has a smooth cortex. The generally white medulla is characterized by conspicuous yellow spots which react K+ purple.

Distinguish from:

In the Southwest the species may easily be confused with *H. hypoleuca* which, however, has a cottony lower surface without a smooth cortex and the white medulla lacks the yellow pigment typical in *H. rugulosa*.

Collection notes:

Collect enough material for identification, not just small fragments.

Spot test reactions:

medulla PD- (or pale yellow), K+ yellow, KC- or KC+ yellow-orange, C-.

Habitat & ecology:

Mostly on bark of broad-leaved trees.

Abundance: The most common

Heterodermia species in Arizona.

Heterodermia speciosa (Wulfen) Trevis.
Powdered fringe lichen, powdered centipede



Characterization:

Heterodermiaspeciosa has lobe tips with cilia and crescent-shaped soralia. It is usually not bright white but slightly beige or grayish and sometimes pruinose. The thallus lobes are growing rather irregular and do not form distinct rosettes. The thallus lobes are flattened and have a lower cortex and are therefore smooth below. Several lichen thalli often grow into each other and the outline thus becomes even more irregular.

Distinguish from:

This species can very easily be confused with *H.pseudospeciosa* which has different thallus reactions (P+ strong yellow, K+ red), less flattened lobes and is generally smaller.

Collection notes:

Collect enough material for identification, not just small fragments.

Spot test reactions:

medulla P- (or pale yellow), K+ yellow, KC+ yellow, C-.

Habitat & ecology:

Mostly on bark of broad-leaved trees.

Abundance: Common.

Phaeophyscia

Shadow lichens

Like most other lichens in the *Physciaceae*, shadow lichens are fairly small lichens. They can generally be distinguished from *Physcia* and *Heterodermia* because they are much darker. Their cortex does not contain the bright gray pigment atranorin and therefore is K-. When wetted the thallus of even light gray *Phaeophyscia* species becomes much darker than any *Physcia* or *Heterodermia*. Another similar genus is *Physconia*. Most *Physconia* species are covered with coarse pruina and have bottle-brush rhizines. *Phaeophyscia* has little and finer pruina and simple or moderately branched rhizines.

- 1 Medulla conspicuously red or orange (with skyrin); relatively common, on rocks, occasionally on tree bases, rarely further up on the tree trunk [the two species can only be reliably distinguished microscopically] 2
Medulla not orange (without skyrin) 3
- 2(1) Spores with rounded to elongate lumina and relatively thick walls.....
..... Common orange-marrow lichen; *Phaeophysciaendococcinodes* (Poelt) Essl.
Spores with angular to somewhat rounded lumina (generally broader than long), relatively thin walls .
.....Western orange-marrow lichen; *Phaeophysciaendococcina* (Körb.) Moberg
- 3(1) Thallus lobes large, mostly 2-4(-5.5) mm wide, without transparent hairs on the surface; the most common *Phaeophyscia* species in Arizona and the largest one; very common on rocks, occasional on trees (soft-barked oaks)
..... Whiskered shadow lichen; *Phaeophysciahispidula* (Ach.) Essl.
Thallus lobes small, usually less than 1.5 mm wide, with transparent hairs on the surface.....
..... 4
- 4(3) Soredia developing only at the lobe tips; common, on bark, at lower to mid-elevations.....
..... Hairy shadow lichen; *Phaeophysciahirsuta* (Mereschk.) Moberg
Soredia developing all along the lobe margins; infrequent to common from mid-elevations upwards...
Hairy shadow lichen; *Phaeophysciacernohorskyi* (Nädv.) Essl.

Parmotrema crinitum (Ach.) M. Choisy
Salted ruffle lichen



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Characterization:

Parmotrema crinitum has 4 - 12 mm wide, often deeply dissected lobes with long black cilia. The thallus is strongly "salted" with cylindrical to branched isidia, especially towards the center.

Distinguish from:

Species of the genus *Parmotrema* are quite rare in the Southwest. More commonly encountered on bark is *Rimelia reticulata* which is similar in size but has a conspicuously cracked surface and is sorediate rather than isidiate.

Collection notes:

Collect enough material for identification, not just small fragments.

Spot test reactions:

Cortex, K+ yellow (atranorin); medulla P+ orange, K+ yellow, KC-, C-.

Habitat & ecology:

On a variety of substrates, mostly on bark of broad leaved trees, rarely on conifers, but often also on rock. Not at low elevations.

Abundance: Rare.

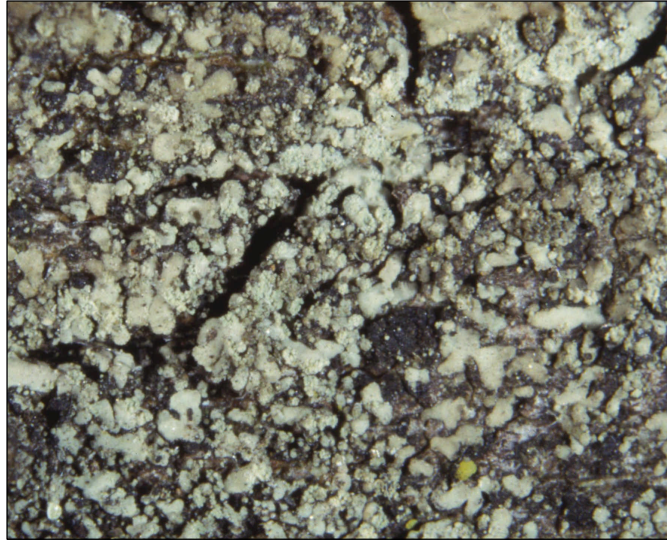
Hyperphyscia

Shadow-crust lichens

The name "shadow-crust lichens" emphasizes that the tiny lobes of this shade-gray lichen grow very closely attached to the bark. Nevertheless *Hyperphyscia* species are foliose and therefore commonly regarded as macrolichens.

The grainy shadow-crust lichen *Hyperphyscia adglutinata* is the only species commonly found on bark in the Southwest (see species description).

Hyperphyscia adglutinata (Flörke) H. Mayrhofer & Poelt
Grainy shadow-crust lichen



© F. Burgartz, ASU Lichen Herbarium

Characterization:

Hyperphyscia adglutinata is a very minutely lobed lichen which grows closely attached to its substrate. It initially forms distinct rosettes but these rosettes soon merge and the tiny lobes then grow in irregular patches. The lichen has granular (grainy) soredia which form along the margins and the tips of the lobes.

Distinguish from:

Hyperphyscia adglutinata is the smallest grayish lichen. It may be confused with *Phaeophyscia cernohorskyi* or *Phaeophyscia hirsuta* which have slightly larger lobes and hairs on the surface of their lobes. *Hyperphyscia* grows much more closely attached to the substrate than either of the *Phaeophyscia* species.

Collection notes:

This tiny lichen is easily overlooked make sure you use your hand-lens to find it.

Spot test reactions:

All spot tests negative.

Habitat & ecology:

On bark. Often the only lichen in lowland mesquite (*Prosopis*) forests, especially abundant along desert washes and streams. However, the species also grows in other forests where it is frequently overlooked because of its tiny size.

Abundance: Common to very common (but often overlooked).

Nephroma

Kidney Lichens

Kidney lichens are large, dark brown lichens (looking somewhat similar to the lobes of a kidney). In Arizona they are quite rare and often only found in forests at higher altitudes because they need sheltered, moist habitats.

- Thallus with soredia..... Fringed kidney lichen; *Nephroma helveticum* Ach.
- Thallus without soredia..... Powdery kidney lichen; *Nephroma parile* (Ach.) Ach.

Pannaria

Shingle lichens, mouse lichens

Shingle lichens or mouse lichens of the genus *Pannaria* form small, distinct rosettes of shingle-like overlapping lobes. The thallus reacts P+ orange and the fruiting bodies (if present) have a conspicuous margin which has the same color and surface structure as the surrounding thallus (thalline margin; lecanorine fruiting bodies).

In Arizona *Pannaria* species are rather rare and confined to sheltered and somewhat humid forests.

- Thallus with mostly simple, coralloid isidia; most common *Pannaria*, more frequent on rocks than tree bases Coral-rimmed shingle lichen; *Pannaria tavaresii* P. M. Jørg.
- Thallus with “wooly”, soredia-like, decorticated lobules Mealy-rimmed shingle lichen; *Pannaria conoplea* (Ach.) Bory

Parmotrema

Ruffle lichens

Unlike many other large foliose lichens ruffle lichens are not flattened and closely attached to the substrate. Instead they have large, ruffled lobe margins with conspicuous, long black cilia.

Parmotrema crinitum is a relatively rare lichen in Arizona. It usually grows at higher elevations.

Melanelia subolivacea (Nyl.) Essl.

Brown-eyed camouflage lichen



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Characterization:

Melanelia subolivacea is a brown to olive-brown medium-sized foliose lichen with flat to bowl-shaped fruiting bodies.

Distinguish from:

Melaneliamultispora which occurs in California looks identical but has asci with 12 - 32 spores. *M. subolivacea* has only 8 spores per ascus.

Narrow lobed specimens may be confused with *Tuckermannopsis* but all *Melanelia* species have laminal pycnidia, i.e. small black dots on the thallus surface. *Tuckermannopsis* has marginal pycnidia, i.e. small black dots in swollen protrusions along the lobe margins (often difficult to see).

The margin of the fruiting bodies and the thallus surface of *Melanelia subolivacea* are usually smooth but some specimens can have abundant papillae. These specimens look similar to *Melanelia exasperata*, a species occurring in the American Northeast but absent from the Southwest.

Collection notes:

Make sure you collect thalli with fruiting bodies.

Spot test reactions:

No reactions.

Habitat & ecology:

On bark from mid-elevations upwards.

Abundance: Common.

Hypotrachyna

Loop lichens

The name "loop lichens" comes from the appearance of these foliose lichens which have angular lobes with rounded lobe axils ("loops"). Dichotomously forked rhizines are another important character to recognize this genus. The chemistry of *Hypotrachyna* is quite diverse and different species contain a variety of different substances.

The smooth loop lichen *Hypotrachyna pulvinata* is a very common species in Arizona. The other species growing on bark are relatively rare and not keyed out here.

Hypotrachyna pulvinata (Fée) Hale
Smooth loop lichen



© F. Bungartz, ANU Library Herbarium

Characterization:

Hypotrachyna pulvinata is most easily recognized by its smooth, faint-bluish gray lobes without isidia and soredia. It is usually richly fertile with bowl-shaped, chocolate brown fruiting bodies and characteristically forked rhizines (dichotomously branched).

Distinguish from:

The species is quite distinctive and rarely confused with other lichens. *Imshaugia placorodia* looks similar but it has short, unbranched rhizines and is generally much smaller (more the size of a *Physcia*) than *Hypotrachyna pulvinata*.

Collection notes:

Collect enough material for identification, not just small fragments.

Spot test reactions:

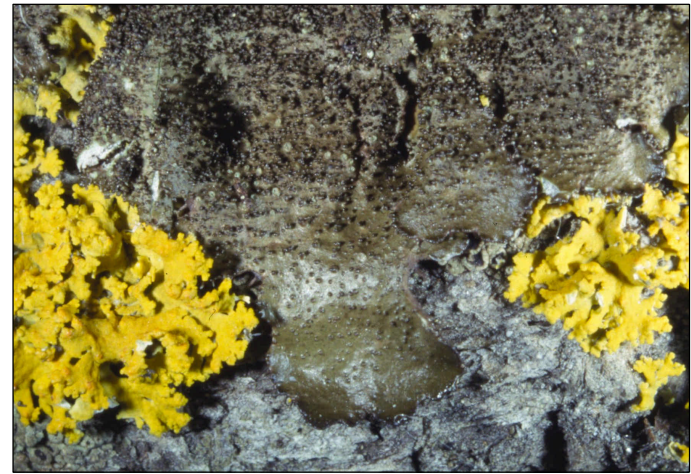
Cortex K+ yellow (atranorin), KC-; medulla P-, K-, KC+ pink, C+ pink.

Habitat & ecology:

On oaks with hard bark, from mid-elevations upwards.

Abundance: Common to very common.

Melanelia elegantula (Zahlbr.) Essl.
Elegant camouflage lichen



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Characterization:

Melanelia elegantula is a brown to olive-brown medium-sized foliose lichen. It is densely covered with cylindrical isidia. (In this picture the brown *Melanelia elegantula* is shown growing together with the yellow thalli of a *Candelaria*).

Distinguish from:

This species can easily be confused with the rare *Melanelia exasperatula* which has broader, spatula-shaped isidia.

Collection notes:

Make sure you collect specimens with well developed isidia.

Spot test reactions:

No reactions.

Habitat & ecology:

On bark from mid-elevations upwards.

Abundance: Infrequent (but easily overlooked).

Melanelia

Camouflage lichens, coffee lichens

Camouflage lichens are dark brown to olive brown, medium-sized, foliose lichens.

Melanelia is closely related to *Tuckermannopsis*, another brown to olive-brown macrolichen genus frequently growing on trees. The most characteristic distinction of the two genera is the location of the pycnidia on the thallus. Pycnidia are very tiny, spore producing, urn-shaped structures which look like black dots. In *Melanelia* these black dots are sprinkled all over the thallus surface but in *Tuckermannopsis* the black dots are confined to marginal protrusions. Species of *Tuckermannopsis* usually have more narrow, erect lobes and sometimes grow somewhat fruticose.

Because of their camouflage color *Melanelia* species are easily overlooked even though they are larger than many other small lobed but pale white or grayish lichens.

In Arizona the two most common species growing on bark are:

- Thallus isidiate, fruiting bodies rare; relatively common to infrequent, at mid- to high elevations, on oaks and conifers Elegant camouflage lichen; *Melanelia elegantula* (Zahlbr.) Essl.
- Thallus not isidiate, fruiting bodies common; common (but overlooked), on oaks and conifers, at mid- to high elevations Brown-eyed camouflage lichen; *Melanelia subolivacea* (Nyl.) Essl.

Imshaugia

Starburst lichens

All starburst lichens are relatively small, pale gray to ivory white, foliose lichens. They are “parmelioid” lichens, i.e. they are small foliose lichens with non-septate, colorless spores. Because of their small lobes (ca. 1 - 2 mm wide) they resemble the rosette lichens (*Physcia*) or the fringe lichens (*Heterodermia*) which are “physcioid” lichens, i.e. they have septate, dark brown spores. Fruiting bodies of rosette and fringe lichens have dark brown to blackish discs but *Imshaugia* has pale brown to nut brown disc. One species (*Imshaugia aleurites*) is isidiate.

- Thallus isidiate, fruiting bodies rare; relatively common, at mid-elevations, on pines & other conifers
Salted starburst lichen; *Imshaugia aleurites* (Ach.) S. F. L. Mey.
- Thallus not isidiate, fruiting bodies common; rare, on pines, at high elevations
..... American starburst lichen; *Imshaugia placorodia* (Ach.) S. F. L. Mey.

Imshaugia aleurites (Ach.) S.F.L. Mey.
Salted starburst lichen



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Characterization:
Imshaugia aleurites is a pale ivory to grayish white lichen with small lobes densely covered in cylindrical isidia. Well developed specimens also have fruiting bodies.

Distinguish from:
Imshaugia aleurites looks similar to *Physcia* or *Heterodermia* but species of those genera which occur in the Southwest have no isidia.

Collection notes:
Make sure you collect a well-developed specimen and not just fragments.

Spot test reactions:
P+ orange, K+ deep yellow, KC-, C-.

Habitat & ecology:
On bark of conifers, from mid-elevations upwards.

Abundance: Common.

Leptogium rugosum Sierk
Rough bearded jellyskin



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Characterization:
Leptogium rugosum is a rather large-lobed species with a white felt on the lower side (note the photograph!). It is usually richly fertile (i.e. with fruiting bodies).

Distinguish from:
The only other common *Leptogium* species with white a tomentum on the lower surface is *L. pseudofurfuraceum*. This species, however, is not fertile but densely covered with isidia.

Collection notes:
Dry specimens are brittle. Make the specimens wet to prevent the collection of only fragments.

Spot test reactions:
No reactions.

Habitat & ecology:
On a variety of bark, especially oaks.

Abundance: Common.

Leptogium

Jellyskin lichens

Jellyskin lichens *Leptogium* are often difficult to distinguish from the jelly lichens *Collema*. Both groups have the cyanobacterium *Nostoc* as photobiont, they are brittle when dry and flexible, of jelly-like consistency and swollen when wet. Unlike *Collema*, all *Leptogium* species have a “skin”, i.e. a cortex of cells only distinguishable with a microscope. Because of this “skin” dry *Leptogium* species appear often less shiny and a little bit dull compared to *Collema*. Dry specimens are often brownish rather than olive. Some *Leptogium* species have a hairy, white felt (= tomentum) on the lower side and are thus easily distinguished from *Collema*.

Jellyskin lichens, like most cyanolichens, can easily be overlooked because of their dark color. They require more humid habitats than most green algal lichens.

- 1 Thallus with a felt of white hairs on the lower side (= tomentum) [Section *Mallotium*]2
Thallus without a white tomentum on the lower side3
- 2(1) Thallus with isidia, without fruiting bodies, common (probably the most common *Leptogium* on bark, previously often called *L. furfuraceum* in the US).....
.....Dimpled jellyskin; *Leptogium pseudofurfuraceum* P. M. Jørg.
Thallus without isidia, often with brown fruiting bodies; infrequent to common, on oaks with soft bark Rough bearded jellyskin; *Leptogium rugosum* Sierk
- 3(1) Thallus with isidia.....4
Thallus without isidia but very minutely lobed, lobes growing ± erect and giving the thallus an almost fruticose appearance; an infrequent species, usually growing on tree bases and among mosses over rocks, rarely found further up on a tree trunk Tattered jellyskin; *Leptogium lichenoides* (L.) Zahlbr.
- 4(3) Thallus surface distinctly wrinkled5
Thallus surface smooth6
- 5(4) Thallus usually brownish, of radiating, irregularly overlapping lobes which appear to merge into each other, individual lobes often more than 3 mm wide; a relatively common species growing mainly on oaks Stretched jellyskin; *Leptogium millegranum* Sierk
Thallus usually lead gray, with distinctly separate lobes, individual lobes rarely more than 5 mm wide; a relatively common species on rocks which only occasionally grows on tree basesSouthwestern ruffled jellyskin; *Leptogium arseni* Sierk
- 6(4) Isidia forming small, flattened scales, never cylindrical; one of the most common *Leptogium* species in Arizona but usually growing on rock..... Scaled blue jellyskin; *Leptogium denticulatum* Tuck.
Isidia not forming flattened scales, distinctly cylindrical, rarely ± swollen; in Arizona relatively rare, mostly growing on oaks
.....Blue jellyskin, blue oilskin; *Leptogium cyanescens* (Rabenh.) Körb.

Imshaugia placorodia (Ach.) S.F.L. Mey.
American starburst lichen



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Characterization:

Imshaugiaplacorodia is a small, pale ivory to grayish white lichen with relatively large, brown to pale brown fruiting bodies.

Distinguish from:

Imshaugia placorodia may look similar to fertile *Physcia* or *Heterodermia* species but it has fruiting bodies with pale brown to brown and not dark brown or blackish discs.

Collection notes:

Make sure you collect a well-developed specimen and not just fragments.

Spot test reactions:

P+ orange, K+ deep yellow, KC-, C-.

Habitat & ecology:

On bark of conifers from mid-elevations upwards.

Abundance: Infrequent.

Koerberia

Olive tiny-lobed lichens

Koerberia is a very small foliose lichen with tiny lobes. It is dark olive-green because of the presence of the cyanobacterium *Scytonema* in the thallus.

The olive tiny-lobed lichen *Koerberia biformis* is the only species in the Southwest found on bark (see species description). This very small lichen with a dark olive color can be very easily overlooked and is probably much more common than collections suggest.

Koerberia biformis A. Massal.

Olive tiny-lobed lichen



© J. Burgaz, ASU Lichen Herbarium

Characterization:

Koerberia is a very tiny, foliose lichen with a dark olive-green thallus (for comparison: the photograph shows also a bright green moss and some large lobes from a *Leptogium* species). The dark color of the lichen comes from the filiform cyanobacterium *Scytonema* but unlike the other, much larger cyanolichens *Leptogium* or *Collema*, *Koerberia* does not swell much when wet. *Koerberia biformis* is densely isidiate and frequently fertile with small, brown and strongly convex fruiting bodies.

Distinguish from:

The very minute foliose lichen can easily be overlooked, but once recognized it is not easily confused with other epiphytic lichens.

Collection notes:

Collect enough material for identification, not just small fragments.

Spot test reactions:

No reactions.

Habitat & ecology:

On oaks.

Abundance:

Common.