

# LIKING LICHENS

Presenter: GARRY NEIL

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May 6, 2016





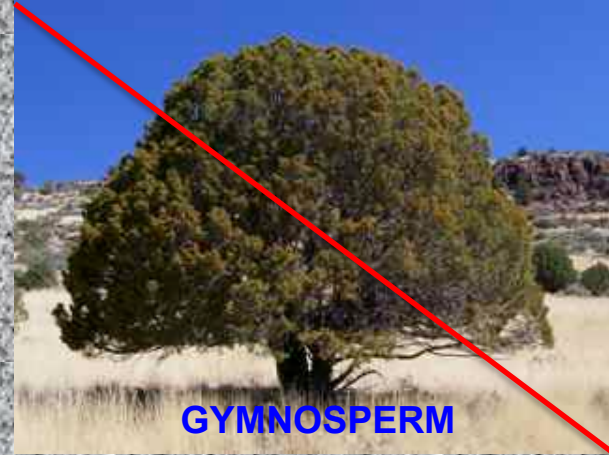
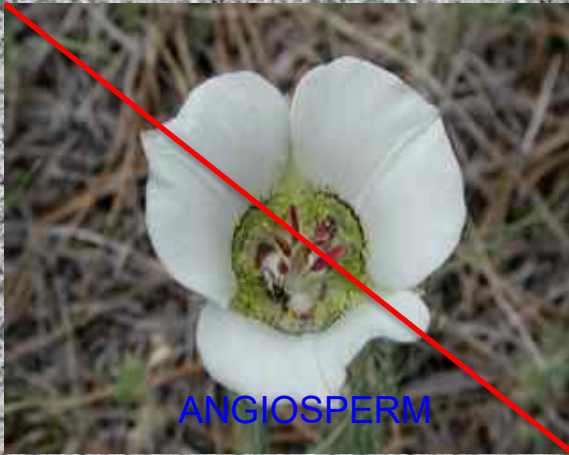


“Thought to be the first dry land plant. Lichens have a short growth periods immediately after a rain after which they wait out the dry spells. No climate is too rough for them. A rock is their home when they may live a thousand years.” (Sign at Joshua Tree National Park)

Photo: Nelda Skidmore



# WHAT LICHENS AREN'T



VASCULAR PLANTS

# WHAT LICHENS AREN'T



AND BY  
ITSELF IT  
ISN'T...



# WHAT ISN'T A LICHEN BY ITSELF?

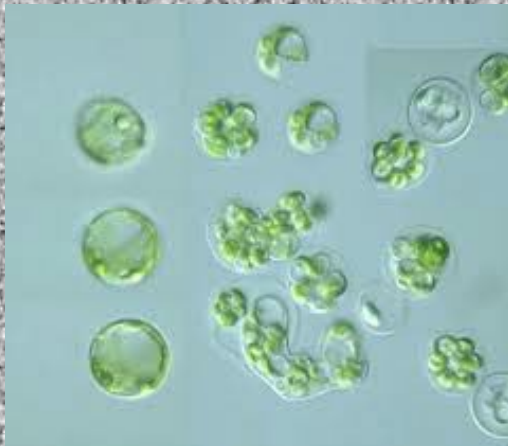


**CUP FUNGUS  
ASCOMYCETES**



**MUSHROOM  
BASIDIOMYCETES**

← **FUNGI** →



**GREEN ALGAE**



**CYANOBACTERIA**



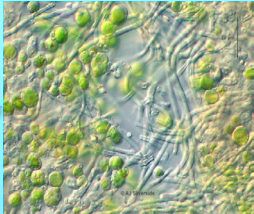
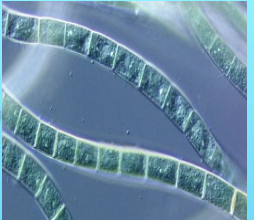
# SO WHAT EXACTLY IS A LICHEN?



- It is a symbiotic relationship i.e., “*Scratching each other’s back*”
- Lichens – majority of cases it is mutual relationship between one fungal species (**mycobiont**) and in the majority of cases only one green alga or cyanobacterium (**photobiont**).
- The photobiont contributes carbohydrates (through photosynthesis) to the mycobiont.
- The mycobiont provides surface area to capture mineral elements, protection from excess light and desiccation for the photobiont.



# LICHEN = FUNGUS?

- Lichens comprised of two or sometimes three biological Kingdoms
  - Always a fungus & either
    - Green Alga (**PROTISTA**) (Chlorophyta) 
    - Cyanobacterium (**MONERA**) (aka. Blue/Green Alga) 
    - Or, in some cases, both
    - Lichens are named after their fungal component
- Lichens are placed in the Kingdom **FUNGI**



# LICHENS – FOSSIL RECORD TO PRESENT

- Oldest certain fossil lichen is Early Devonian (about 400 MYA)\*
- As of March 2014 there were 5,393 total species in 704 genera, with an additional 46 subspecies, 56 varieties, and 2 forms recorded (cumulative checklist) for the Continental United States and Canada.\*\*
- As of 2010, 969 species of lichenized fungi had been presented for the state of Arizona – representing close to 20% of all species reported for the Continental US & Canada.\*\*\*

## Sources:

\*<http://www.ucmp.berkeley.edu/fungi/lichens/lichenfr.html>

\*\*<http://www.ndsu.edu/pubweb/~esslinge/chcklst/chcklst7.htm>

\*\*\*Bates, S., Barber, A., Nash III, T. 2010. A Revised Catalog of Arizona Lichens. CANOTIA 6(1): 26-43.



# MYCOBIONT

- The largest number of lichenized fungi are in the Class Ascomycetes (cup fungi)

(approx. 98% of lichenized fungi, & 42% of all known Ascomycetes)

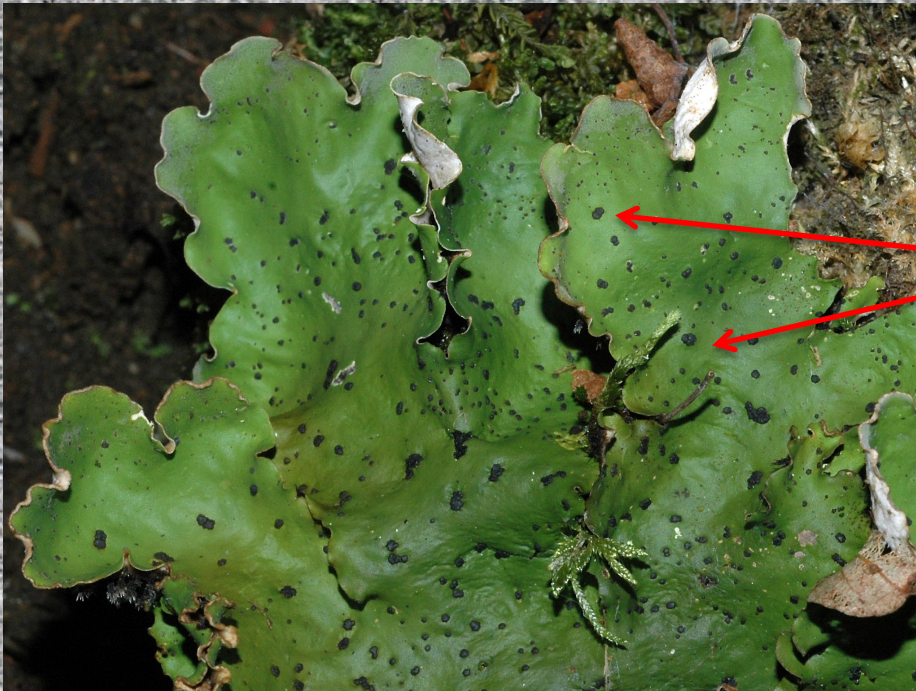


- With a low number being lichenized fungi in the Class Basidiomycetes (mushrooms)



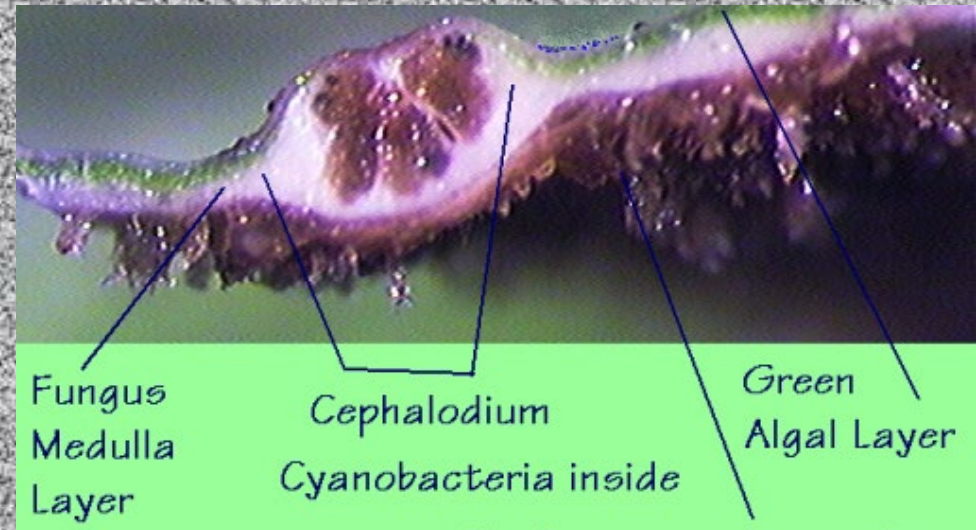


# TWO PHOTOBIONTS IN ONE SPECIES GREEN ALGA & CYANOBACTERIUM



cephalodia

Peltigera aphthosa  
*Common Freckle Pelt*





# BASIC FACTS

- Symbiotic organism
- 10% of lichen species play a significant role in Nitrogen Fixation ( $N_2 \rightarrow NH_3$ )
- Vast majority of lichens produce their own carbon source (autotrophic) and therefore are not parasitic
- Some mineral nutrients can be extracted from the substrate where the lichen is growing, but it does no harm to the living organism where it may live.



# SO WHO IS IN CHARGE?

- A species has the same lichen forming fungus and generally the same photobiont
- A specific photobiont can be associated with a large number of different lichen fungi
- Few photobionts have been identified to species
- It has been found that some lichen fungi can sometimes associate with a green alga and other times with a cyanobacterium
- Studies show that the fungus controls the appearance of the lichen but the photobiont does have a role in this transformation.

# LICHEN HABITAT

- Lichens can grow in habitats where neither partner could survive alone
- Green algal lichens can survive with the uptake of water vapor alone.
- Cyanobacteria lichens require liquid water
  - Therefore, cyanolichens are more commonly found in moist microhabitats



# PRIMARY PHOTOBIONT CYANOBACTERIA OR GREEN ALGA? (DRIED THALLI)

Lobaria  
pulmonaria  
Lungwort



Lobaria  
scrobiculata  
Textured  
Lungwort

# PRIMARY PHOTOBIONT CYANOBACTERIA OR GREEN ALGA? (WET THALLI)

Lobaria  
pulmonaria



Lobaria  
scrobiculata



# PRIMARY PHOTOBIONT?

## Peltigera neopolydactyla

(Carpet Pelt)



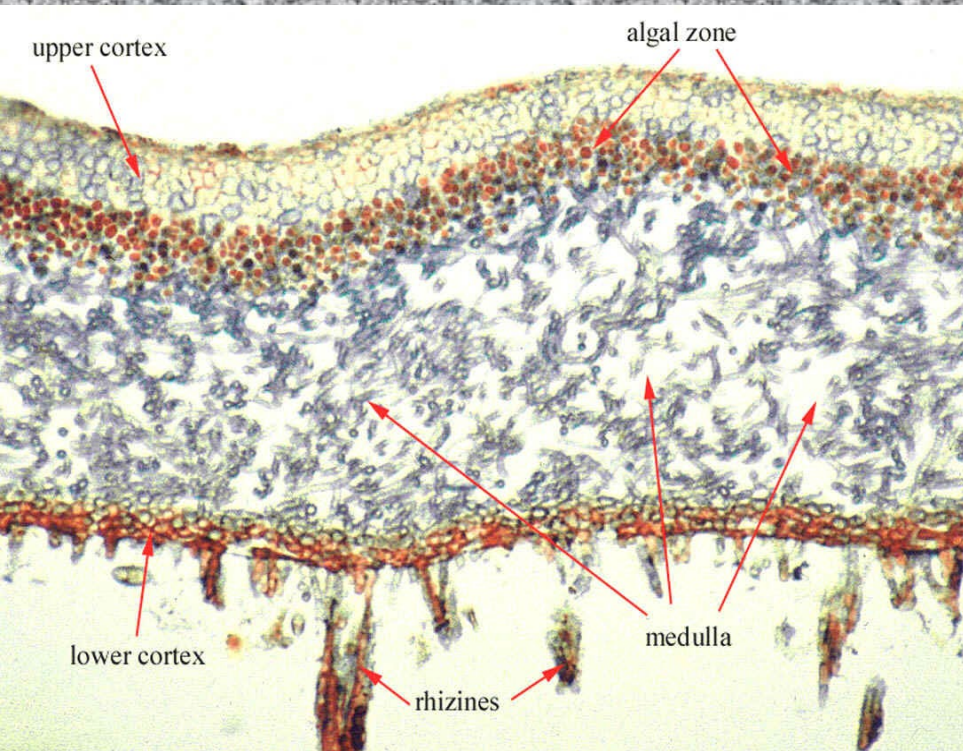
## Peltigera leucophlebia

(Ruffled Carpet Pelt)





# GENERAL STRUCTURE OF A LICHEN



- A typical lichen thallus (“body”) contains three main layers:
  - Upper Cortex
  - Algal Layer
  - Medulla
- With many containing an additional layer – Lower Cortex

(Image from MycoAlbum CD by George Barron see [www.mycographics.com](http://www.mycographics.com))



# LICHEN MORPHOLOGY

- Lichen body is called the thallus
- The morphology of the lichenized thallus is influenced by the photobiont and its direct contact with the mycobiont
- Divided into four growth forms
  - Crustose (crust)
  - Fruticose (shrubby)
  - Foliose (leafy)
  - Squamulose (small scales, often overlapping)

# CRUSTOSE LICHENS

- Usually entire thallus attached to a substrate (rock, bark, cement, etc.) – some sps. have free edges from substrate (squamulose)
- Some spp. have the thallus just beneath the rock surface with only fruiting body visible.
- Have a upper cortex, algal layer, and medulla
- No lower cortex
- Fungal hyphae (filaments) penetrate substrate





# SQUAMULOSE LICHENS



- Intermediate between foliose & crustose growth forms
- Composed of few to hundreds of small scales (1-15 mm) in diameter
- Attached to substrate along one edge like tiny shingles
- Each scale has basic morphology of a foliose lichen
- Because of their small size and stature, they are usually grouped with the crustose lichens

# FRUTICOSE LICHENS

- Shrubby
- Attached to substrate at a single pt.
- Enclosed by an outer cortex
- Thallus is radially symmetric (i.e. more or less round)
- Center of thallus hollow or filled with hyphae
- Exception: Genus *Cladonia*, thallus dimorphic – with primary flat thallus (squamule) and a secondary erect fruiting stalk (podetia) that is fruticose



Usnea sp





# Ramalina mensiesii

Lace Lichen, Fishnet





# Cladonia spp.



C. subulata



C. Chlorophaea



C. deformis



C. ochrochlora



C. cariosa



# FOLIOSE LICHENS

- Some of the largest of lichens
- Leaf-like
- Composed of lobes
- Loosely attached to their substrate usually by **Rhizines**
- Lobes have an upper and lower side



Lobaria Pulmonaria

rhizines

Peltigera canina



# COLORS OF LICHENS

- Absence special pigments – generally gray, greenish-gray or brown (if pigment melanin is present in or between cortical layers)
- When wet, cortex more transparent
- Number of brightly colored pigments can be deposited in the cortex e.g. acids (yellows), xanthonenes (brilliant yellows), anthraquinones (yellow, orange, red)



Letharia columbiana



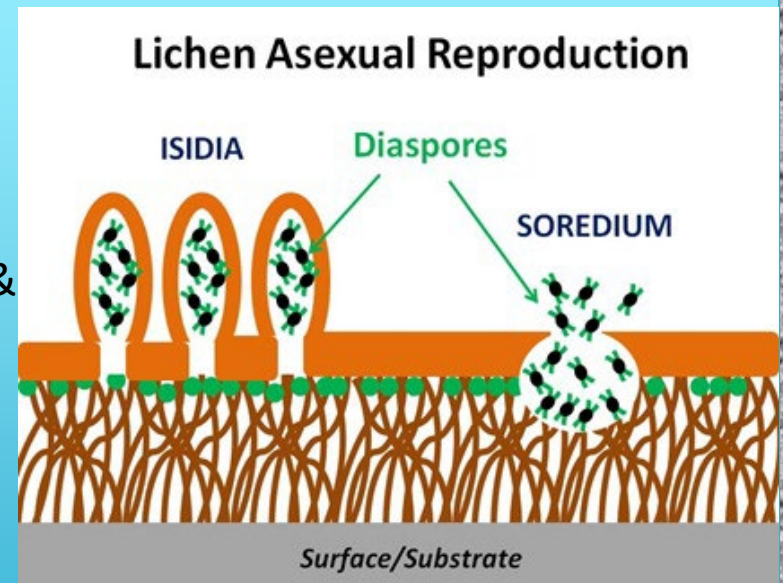
Caloplaca trachyphylla



# REPRODUCTION

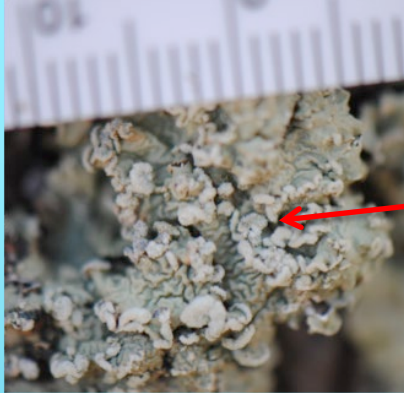
## 1. Lichens reproduce asexually

- Asexually
  - Fragmentation or propagules
  - **Isidia:** extension of cortex, algal, & medula tissue in the shape of a fingerlike growth
  - **Soredia:** originates in algal layer from a crack or pore in the lichen surface



<http://watchingtheworldwakeup.blogspot.com/2009/03/stuff-on-rocks-2-all-about-lichen.html>

# REPRODUCTION



**Soredia**



**Isidia**



**Propagules**



# REPRODUCTON

## 2. Lichens reproduce sexually (?)

- Sexually

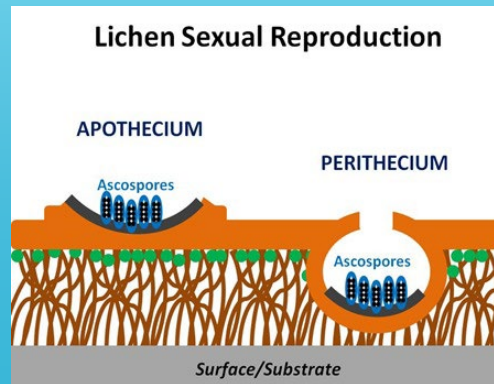
- Still somewhat a mystery

- Mycobiont can sexually and asexually produce spores (conidia), but the Photobiont (not known)

- Fungal sexual structures

- Apothecia

- Perithecia





# TYPES OF APOTHECIA



**Caloplaca flavorubescens**

Sulphur-firedot Lichen

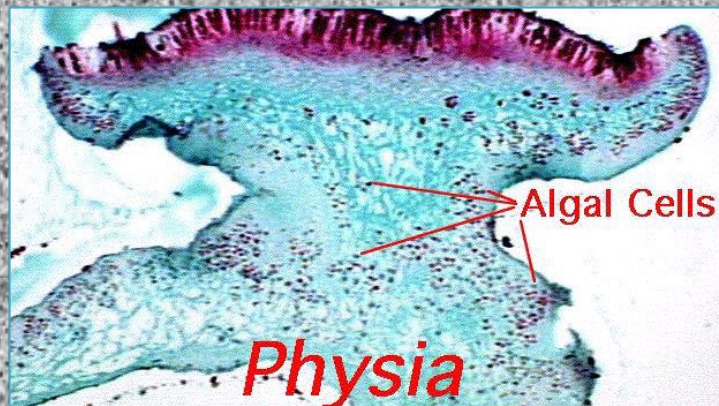
Disc shape apothecia



**Psora cerebriformis**

Brain Scale

Convex shape apothecia



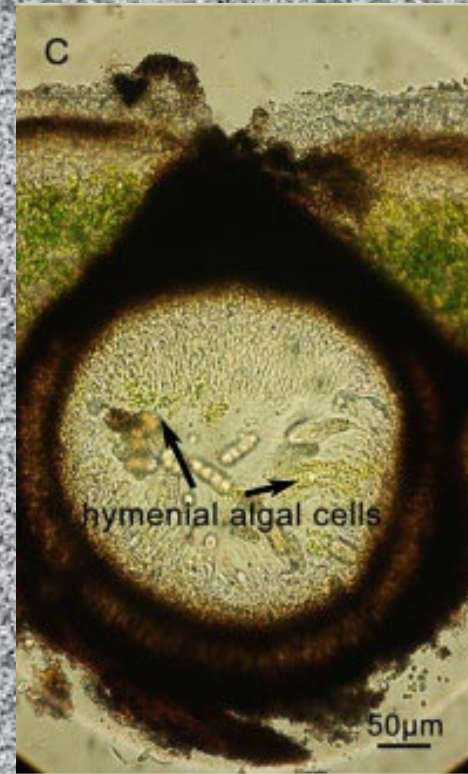


# PERITHECIA

PEAR SHAPED FRUITING BODIES



**Dermatocarpon miniatum**  
Common Stippleback



Cross Section of  
Perithecium\*

# LICHENS AS POLLUTION INDICATORS

- Air pollution effects lichens in various ways:
  - Reproduction potential
  - Reduction in photosynthesis, respiration, nitrogen fixation, changes in thallus structure and appearance
- Specific pollutants include:
  - Sulphur dioxide (pH)
  - Nitrogen fertilizers
  - Flourides
  - Metals
  - Ozone





# OTHER FACTS

- Growth (in general)
  - Crustose – 0.5 – 2 mm/yr
  - Foliose – 0.5 – 4 mm/yr
  - Fruiticose – 1.5 – 10 mm/yr; (Ramalina menziesii – increase their weight up to 1/3 a year)
- Green alga lichens obtain nitrogen from its substrate or from their water source or habitats rich in nitrogen (dung enriched areas)
- Dry lichens neither burn or generate energy, and are in a dormant state, as do mosses and liverworts (poikilohydry)
- Fragile rock carvings covered by lichens can be controlled by sprays containing copper salts or installing copper or zinc above the surface. Scrapping will damage the lichen-weathered surface.

# SAME ROCK – WHY THE DIFFERENCE?



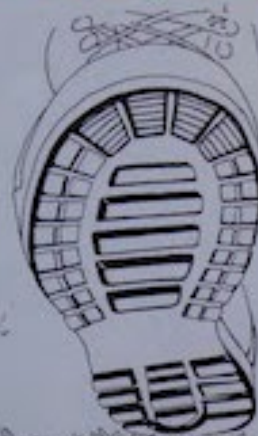


# BIOLOGICAL SURFACE CRUST - BSC

At first glance the desert topsoil  
looks like an old dry crust.  
**TAKE A CLOSER LOOK.**

## It's Alive!

That lumpy  
black crust  
is actually a  
living web of  
bacteria,  
moss, lichen,  
fungus and  
liverworts.



Microbiotic  
crust controls  
erosion, stores  
water, fertilizes  
soil and provides  
seed beds for  
all plants from  
wildflowers  
to trees.



**Don't bust the crust**

## Stay On The Trail

One footprint can crush  
a decade's worth of growth.



# BIOLOGICAL SURFACE CRUST

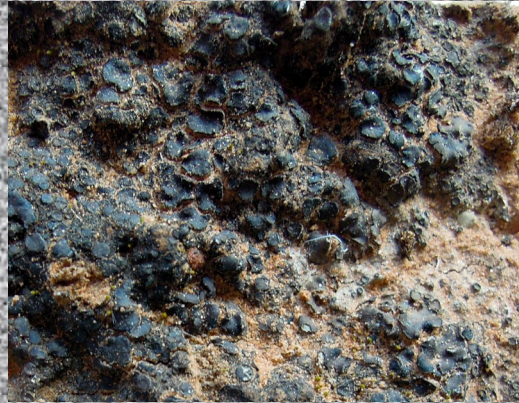
BSC – Intimate association between soil particles and cyanobacteria, algae, microfungi, lichens, mosses and liverworts which live within or on top of the uppermost millimeters of the soils.



- BSC found on almost all soil types
- Presence of these organisms increases soil stability as well as providing nutrients to the soil
- Most conspicuous development of BSCs occurs in hot, cool, and cold drylands
- In the Red Rock Area the morphology of the BSC is mainly **pinnacled** because of frost-heaving and has about 40% lichen-moss cover and can be up to 15 cm high



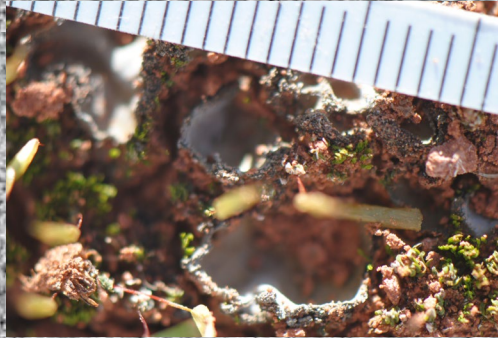
# SOME COMMON LICHENS FOUND ON BSC



Left to right: Cobblestone Lichen, Brown Stipplescale Lichen, Mealy Pixie cup, Rosette Pixie cup, Pebble Pixie cup, Cowpie Lichen



# SOME COMMON LICHENS FOUND ON BSC



Left to Right: Field Dog Lichen, Powdery Rock Olive, Ground Frost Lichen, Brain Scale, Brick Scale, Yellow Scale



# Usnea arizonica

Western bushy beard



- Fruticose lichen with a central, cartilagenous cord
- Green photobiont
- Main branches covered with perpendicular, spiny side branches
- W/O isidia or soredia
- Apothecia abundant at tip of branches with broad yellowish, puniose (powdery) disks with spiny margins
- Common on trees and most common western Usnea species

Source: Brodo, Sharnoff, & Shranoff, 2001

# Ramalina sinensis

Fan ramalina, burning bush



- Fruticose thallus – short and broad, fan shaped & undivided
- Green photobiont
- Apothecia on margins
- No soredia
- Strong longitudinal often reticulate ridges
- On twigs and branches of various trees and shrubs

Source: Brodo, Sharnoff & Sharnoff



# Xanthoria fallax

Hooded sunburst lichen



- Thallus foliose and tiny, but coalescing to cover large areas
- Tightly appressed at the base
- Soredia present, usually on the underside of lobe tips
- Apothecia uncommon
- Widespread usually on bark of broad leaved species
- Habitat is usually open to somewhat sheltered

Source: McCune & Geiser, 2009



# Umbilicaria deusta

Peppered Rock Tripes



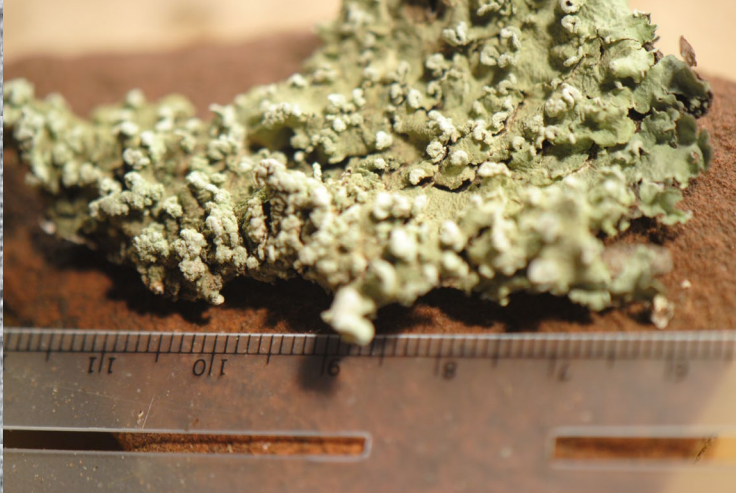
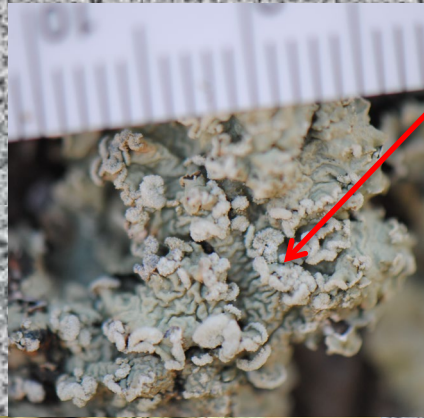
- Umbilicate foliose lichen
- Discrete, rounded thalli
- Attached by single holdfast
- Green photobiont
- Surface with black isidia
- On rock

Source: Brodo, Sharnoff & Sharnoff, 2001



# Flavopunctelia soledica

Powder-edged speckled greenshield



- Thallus lobes rounded
- Abundant gray soledia at the lobe margins
- Lower surface brown with light to dark brown rhizines
- Found on bark on various trees
- This particular specimen found on bark (NNE facing) of Pinus monophylla

SOURCE: Brodo, Sharnoff, & Sharnoff, 2001



# Shield Lichens

Most Common Lichens You Will See



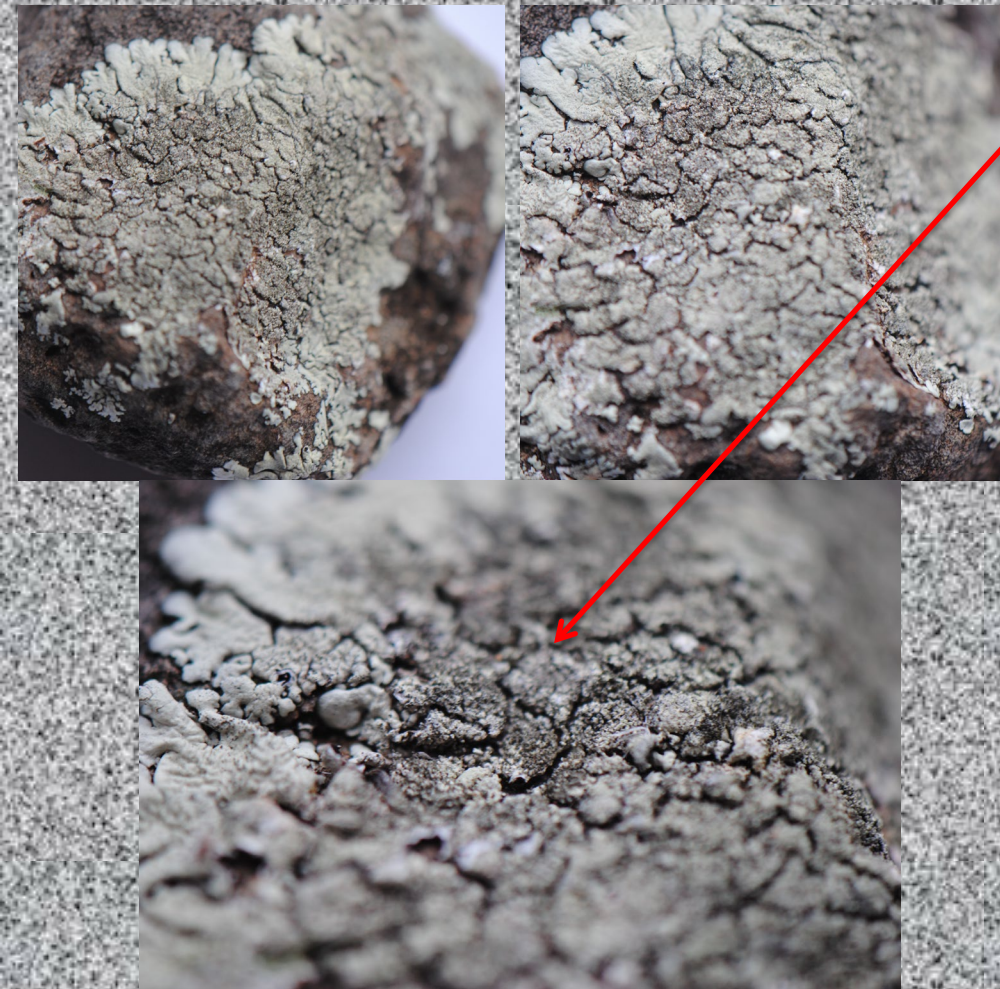


# Xanthoparmelia mexicana

Salted rock-shield

- Thallus closely attached to substrate
- Abundance of glabrose isidia
- Lower surface pale brown and gray at the margins; rhizines dark brown
- Apothecia and pycnidia rare
- On exposed rock, rarely on hard wood
- This particular specimen on basalt on top of Doe Mtn.

SOURCE: Brodo, Sharnoff, & Sharnoff, 2001





# Xanthoparmelia cumberlandia

Cumberland rockshield



- Foliose
- Thallus closely attached to rock and forming large patches
- Thallus lobe edges frequently black
- Lower surface brown with rhizines
- Apothecia and pycnidia common
- Photobiont green
- One of the most common rocksheilds

Source: Brodo, Sharnoff, & Sharnoff, 2001



# Xanthoparmelia psoromifera

## Shield Lichen



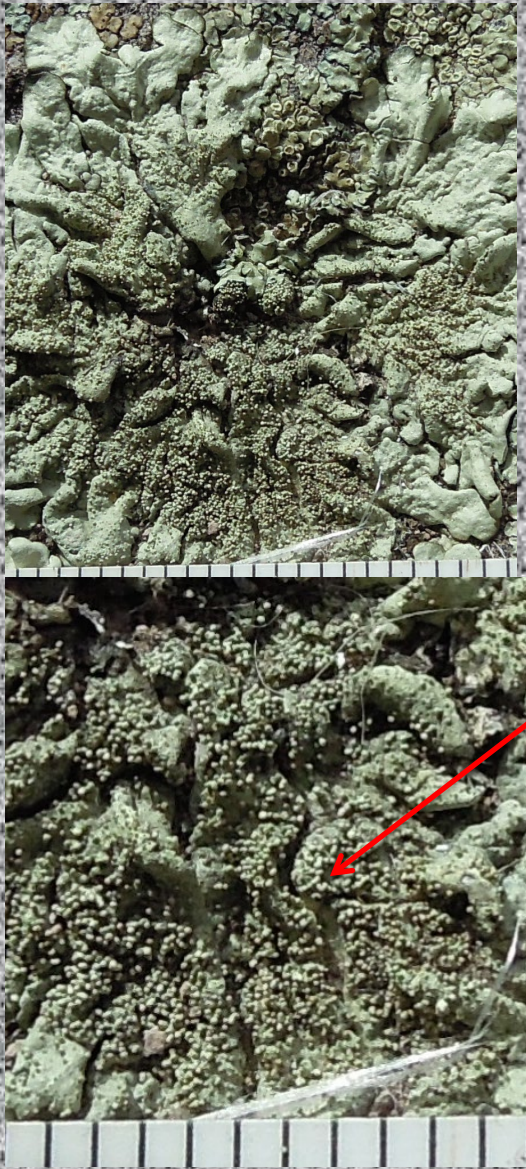
- Foliose, adnate to the rock surface
- Thallus 3 – 8 cm diam.
- Green photobiont
- No soredia or isidia; upper surface becoming rugose (rough) with age
- Lower surface pale brown with rhizines
- Apothecia common, dark brown
- Pycnidia common
- Open exposed habitats on acidic rocks

Source: Lichen Flora of the Greater Sonoran Desert Region, Vol. 2, 2004



# Xanthoparmelia lavicola

Salted Rock-Shield



- Foliose
- Green photobiont
- Circular patches up to 7 cm
- Round, flat to undulating lobes
- Loosely adnate to rock
- Brown lower cortex with rhizines
- Common name from the globular to cylinder isidia on the upper surface of the thallus
- Apothecia rare

Source: Brodo, Sharnoff, & Sharnoff, 2001



# Cladonia coniocraea

Common powderhorn



- Thallus gray-green
- Squamules rather large
- Podetia arising from the centers of the squamules
- Strongly tapered & usually unbranched
- Podetia with barely expanding cups
- Fine powdery sores almost to the base of the podetia
- Apothecia rare
- On soil or wood in shade

Source: Brodo, Sharnoff & Sarnoff, 2001



# Cladonia symphycarpa

Split-Peg Lichen

- Fruticose
- Primary thalli squamulose, gray-green, strapped shaped, curled up when dry showing white lower surface
- Podetia (stalks) rarely produced
- Green photobiont
- Common in open areas on thin or sandy soil, especially those rich in calcium (e.g. limestone)

Source: Brodo, Sharnoff & Sarnoff, 2001





# Lepraria lobificans

Fluffy dust lichen



- Sterile crustose (apothecia not present) consisting of nothing but a layer of soridea (leprose) – fluffy in appearance; green to gray in color
- Green photobiont
- Without well defined lobes
- Medulla – distinct (white)
- Found on shaded rock overhangs, bark, or moss
- Derives all moisture from the air

Source: Brodo, Sharnoff & Sharnoff, 2001

# Lepraria caesioalba

## Dust Lichen



- Sterile crustose (apothecia not present) consisting of nothing but a layer of soridea (leprose) – fluffy in appearance; whitish to bluish gray in color
- Green photobiont
- Without well defined lobes
- Medulla – distinct (white)
- Found on shaded rock overhangs, bark, or moss
- Derives all moisture from the air

Source: Brodo, Sharnoff & Sharnoff, 20001



# Lecanora muralis

## Stonewall Rim-Lichen



- Crustose Lichen becoming lobed in the margins
- Marginal lobes very flat and closely appressed to the substrate – 0.3 - 0.6 mm wide
- Apothecia yellow- to red-brown
- Found on all kinds of rock including cement and mortar, rock walls, and stone fences

Source: Brodo, Sharnoff, & Sharnoff 2001

# Peltigera rufescens

## Field Dog Lichen



- Thallus gray to brown when dry
- Heavily “powdered” (tomentum) on upper cortex
- Photobiont – cyanobacterium
- Lobes 5 – 115 mm across
- Strong upturned margins
- Lower surface with “veins” and rhizines
- Apothecia brown, saddle shape on upright lobes
- BSC Lichen

Source: Brodo, Sharnoff & Sharnoff, 2001



# Lichinella nigritella

Rock licorice



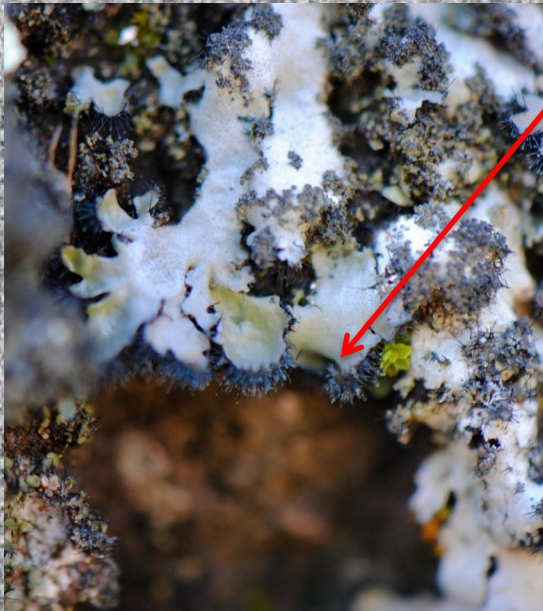
- Jelly, black, foliose lichen
- Cyanobacterium photobiont, mostly concentrated near lobe surface, leaving fungal medulla in the center
- Developing in crowded, frequently umbilicate clumps
- Moist habitats on various rocky substrates (granite and limestone)
- Very common in SW

Source: Brodo, Sharnoff & Sharnoff, 2001



# Phaeophyscia hispidula

Whiskered shadow lichen



- Foliose thallus pale greenish gray, lobes range from 1-4 mm wide
- Concave tips, white medulla
- Soredia on lobe surface
- Rhizines black, abundant, and long and unbranched
- Appearing as whiskers when views from above
- Apothecia uncommon
- Lower cortex black
- On bark, rock, and moss in moist habitats

Source: Brodo, Sharnoff, and Sharnoff, 2001



# Lecidea tessellata

Tile Lichen

- Crustose - aerolate
- Green Photobiont
- Thallus chalky white to blue-gray
- Apothecia black, sunken between the aeroles
- Usually on noncalcareous rock, but occasionally on other rock types (e.g. basalt)
- Very common in the Sedona region

Source: Brodo, Sharnoff, and Sharnoff, 2001



# Acarospora strigata

Soil Paint Lichen



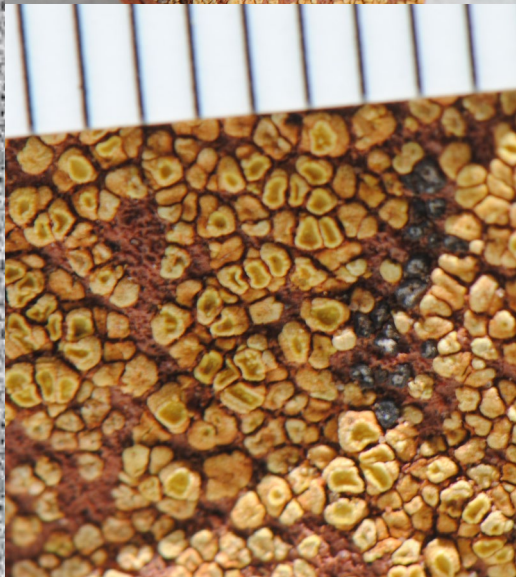
- Squamules usually pale gray; 0.5 – 1.5 mm in dia.
- Usually growing together to form a crust
- Fruiting bodies (apothecia) sunken in thallus; on to several in one thallus
- Found on rock in the Southwest; very common

Source: Brodo, Sharnoff, and Sharnoff, 2001



# Acarospora socialis

## Cobblestone Lichen



- Squamulose – overall about 10 cm wide; bleached-white to green yellow to various shades of yellow
- Green photobiont
- Found on sandstone, volcanic or granitic rock or vertical walls in all exposures
- Individual thalli 0.2 – 2.3 mm wide
- Apothecia immersed in the thallus, usually one/squamule
- Very common in AZ

Source: Lichen Flora of the Greater Sonoran Desert Region, Vol. 3, 2007

# Dermatocarpon americanum

## Stippleback Lichen



- Foliose, single lobed attached by a umbilicus
- Species is very “leathery” in texture
- Found on different types of rocks; often in seepages
- Upper cortex has multiple pores (perithecia)
- Photobiont is a green alga
- Widely distributed in AZ

Source: Lichen Flora of the Greater Sonoran Desert Region, Vol. 2, 2004



# REFERENCES USED FOR THIS PRESENTATION

Brodo, I., Sharnoff, S., and Sharnoff, S. 2001. Lichens of North America. Yale University Press, New Haven, Connecticut and London

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<http://lichenportal.org/portal/checklists/checklist.php?cl=1184&pid=100>

Lichen Flora of the Greater Sonoran Desert Region – collaborative study in a 3 volume published set that encompasses the entire state of Arizona.

McCune, B. and Geiser, L. 2009. Macrolichens of the Pacific Northwest. Second Edition. Oregon State University Press, Corvallis, Oregon.

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