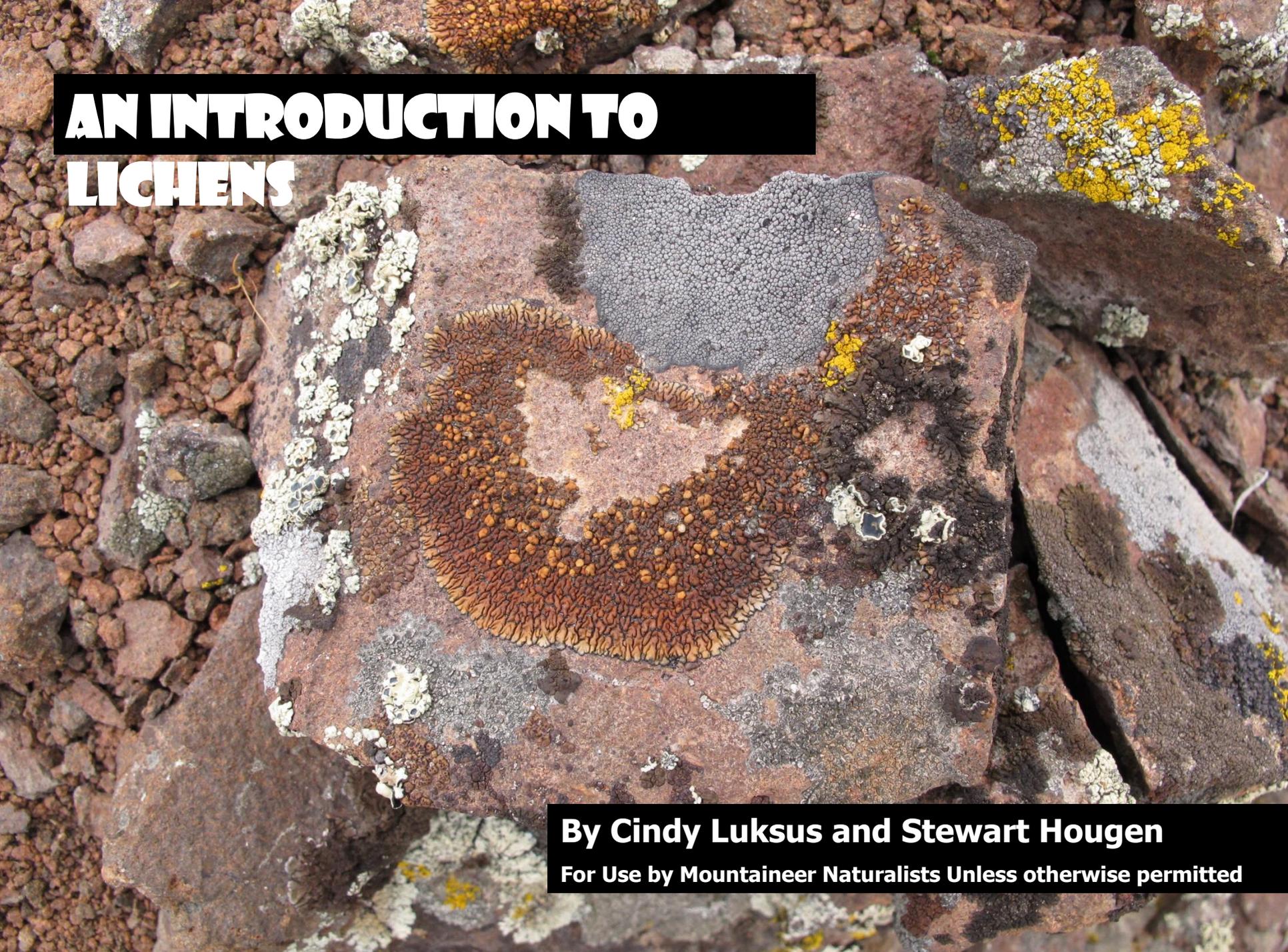


AN INTRODUCTION TO LICHENS



By Cindy Luksus and Stewart Hougen

For Use by Mountaineer Naturalists Unless otherwise permitted

Lichen Workshop Goals

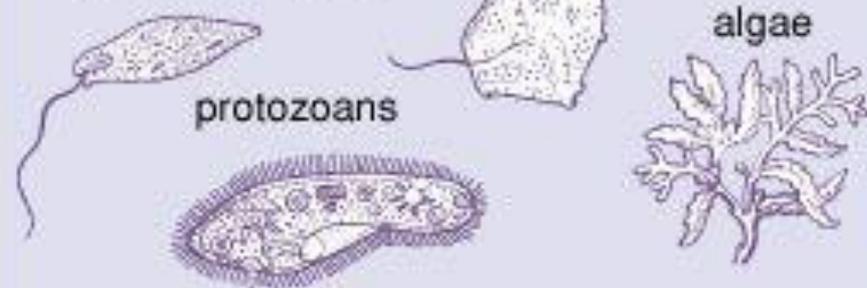
Interesting Stuff

- Basic biology & reproduction
- Evolution
- Importance & uses

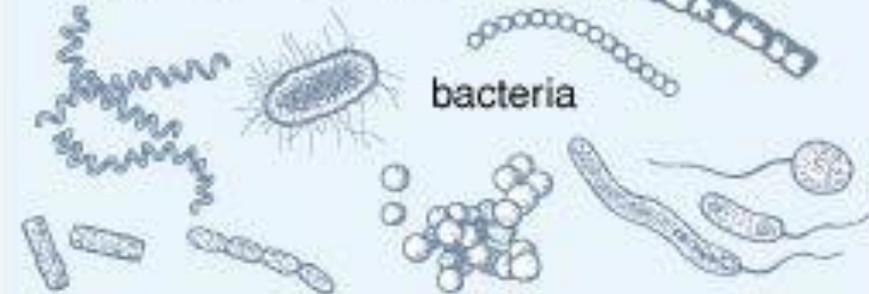
Basic form & ID



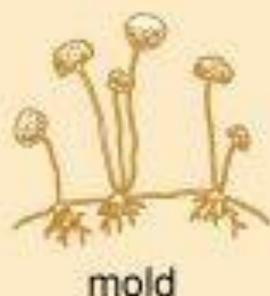
Kingdom of Protists



Kingdom of Monerans



Kingdom of Fungi



Kingdom of Plants



broad-leaved tree



conifer tree

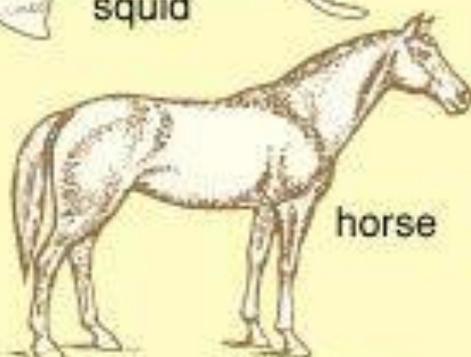
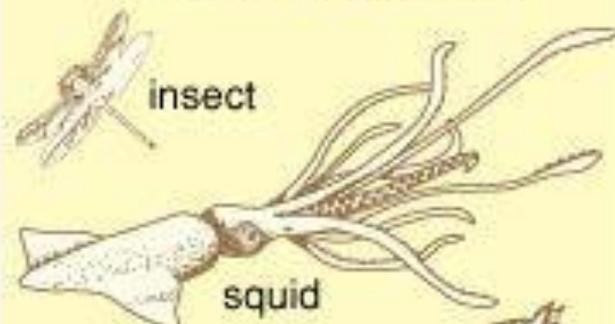


fern



moss

Kingdom of Animals



earthworm



sponge

What are Lichens?

- The fungus (Freddie Fungus) provides a cozy, sheltered environment and some nutrients to the algae (Amy Algae). The algae makes its food from sunlight (photosynthesis) and shares it with the fungus.
- They join in order to help each other survive (a **mutualistic** or **symbiotic** relationship).



<http://www.youtube.com/watch?v=LUyyR-HDUd0>

What are Lichens?

- Lichens are a combination of organisms belonging to 2 or 3 different biological kingdoms, and because of this, they present some challenges in classification



Fungi- in a lichen it is a shapeless blob



Algal "gunge"



**Cyanobacteria
"Blue Algae"**

- Lichens are named after their fungal partner. About one fifth of all known fungi are lichenized.
- There are approx 14,000 species of described lichens in all life zones. There are more than a 1000 in the PNW.
- The algae has its own name (40 different genera, approx 100 species, are photosynthetic partners). Some lichen photobionts are free living & widespread but most common one is not.

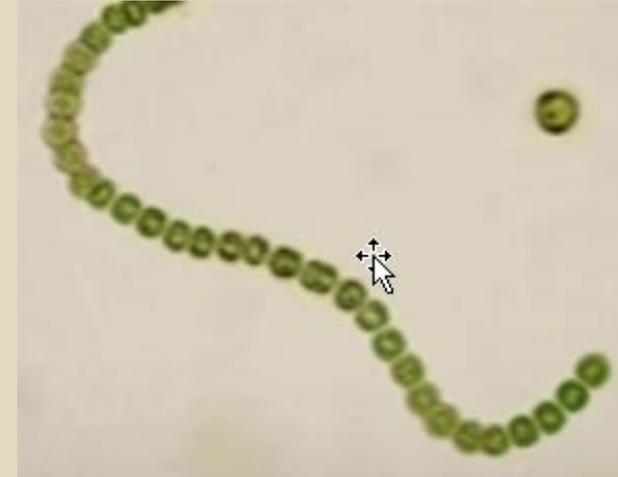
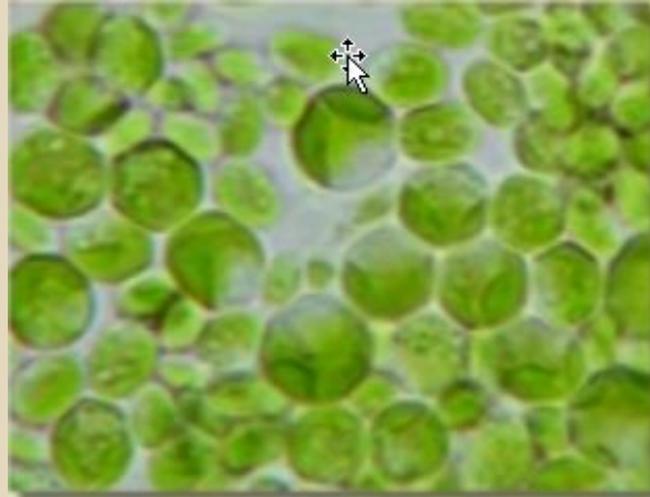
Mycobiont

Photobionts

Kingdom: Fungi
(A mushroom)

Kingdom: Plantae
(Single cell algae)

Kingdom: Monera
(Cyanobacteria)



Most common



Mycobiont

Photobionts

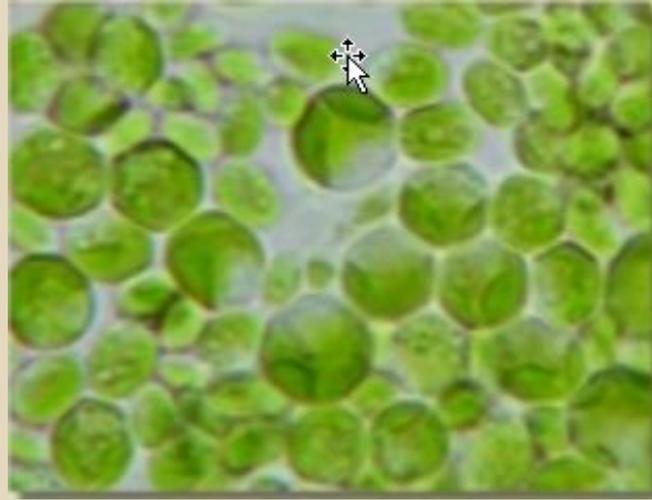
Kingdom: Fungi

(A mushroom)



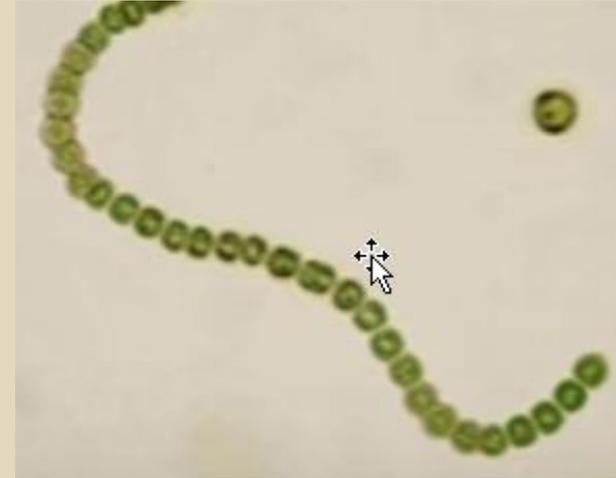
Kingdom: Plantae

(Single cell algae)



Kingdom: Monera

(Cyanobacteria)



Note dark color due to cyanobacteria

15% of time



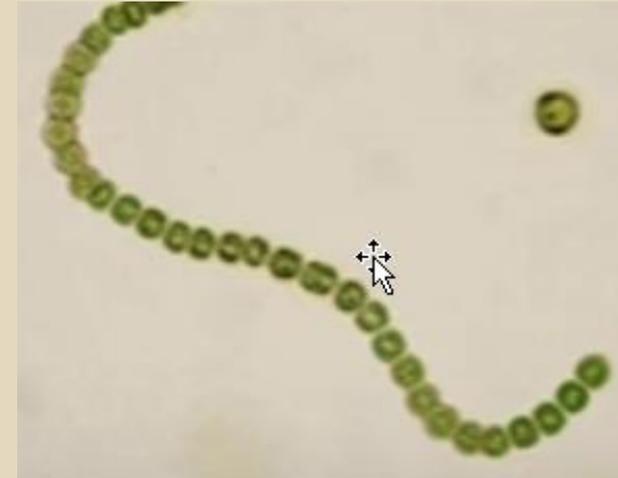
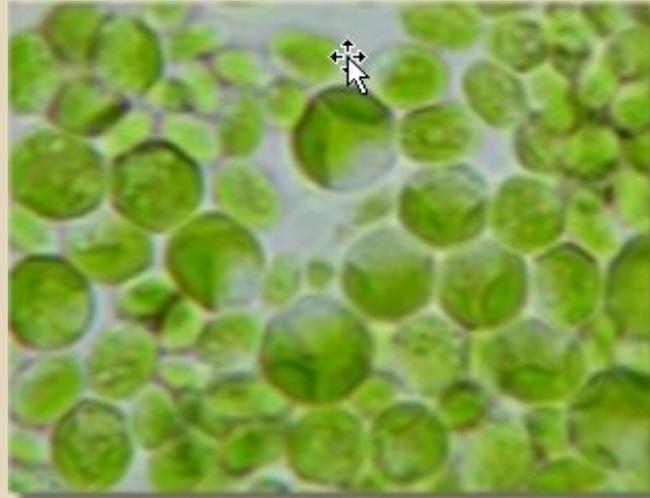
Mycobiont

Photobionts

Kingdom: Fungi
(A mushroom)

Kingdom: Plantae
(Single cell algae)

Kingdom: Monera
(Cyanobacteria)



Small number of lichens

???
Which
lichens



Yeast emerges as hidden third partner in lichen symbiosis

Recently researchers have uncovered an unexpected third partner embedded in the lichen cortex or "skin" -- **yeast**

These yeasts, single-celled fungi (different class of fungi from the usual lichen fungi) produce chemicals that help lichens ward off predators & repel microbes

What are Lichens?

- When a fungus (**mycobiont**), algae, and/or cyanobacteria (**photobionts**) join to form lichen it is called **lichenization**.

Fungal threads
wrapped around
alga

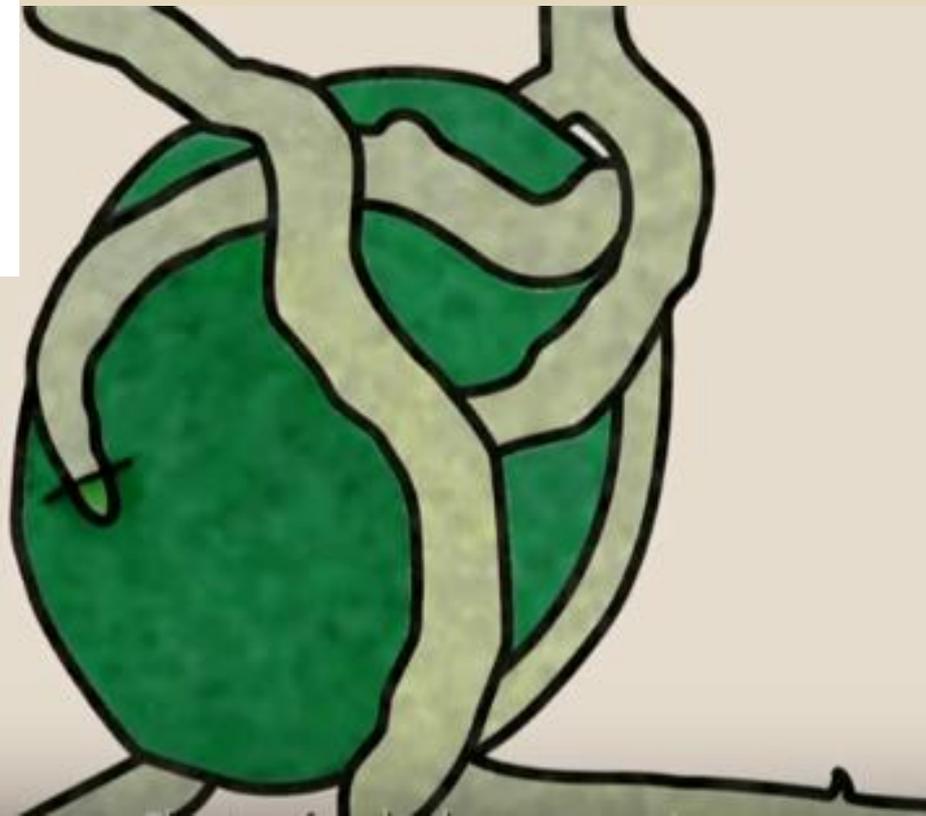
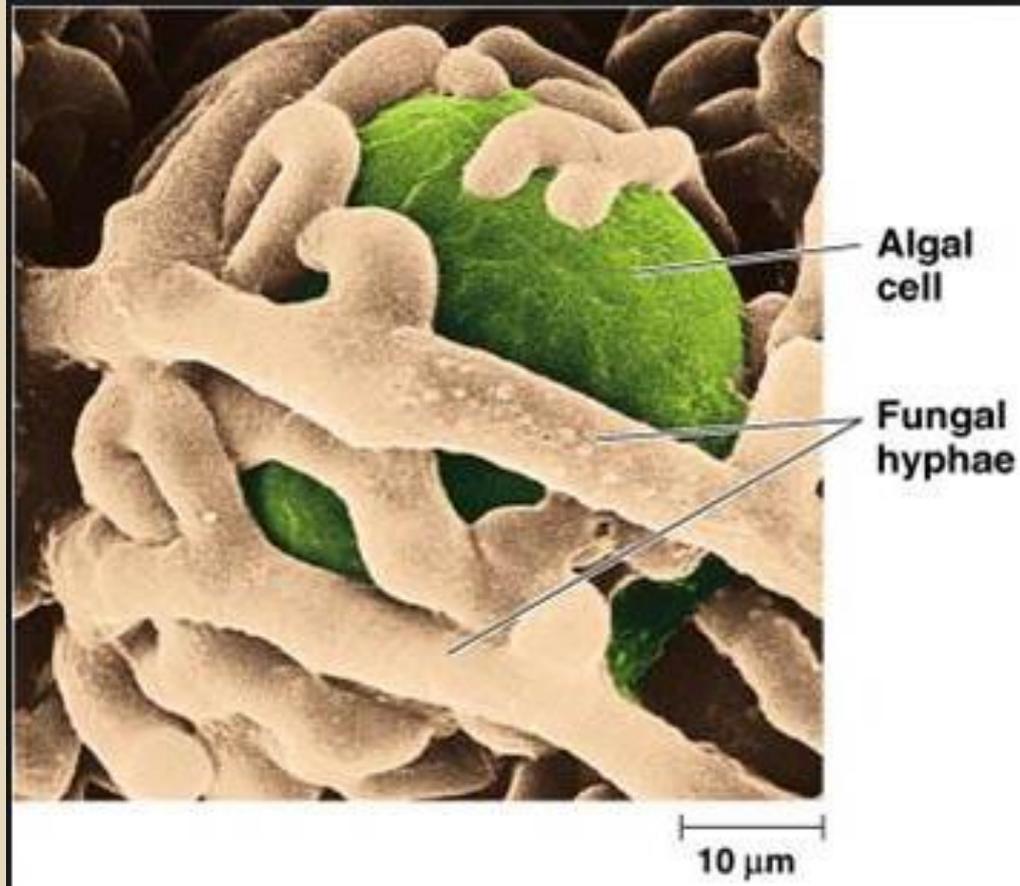


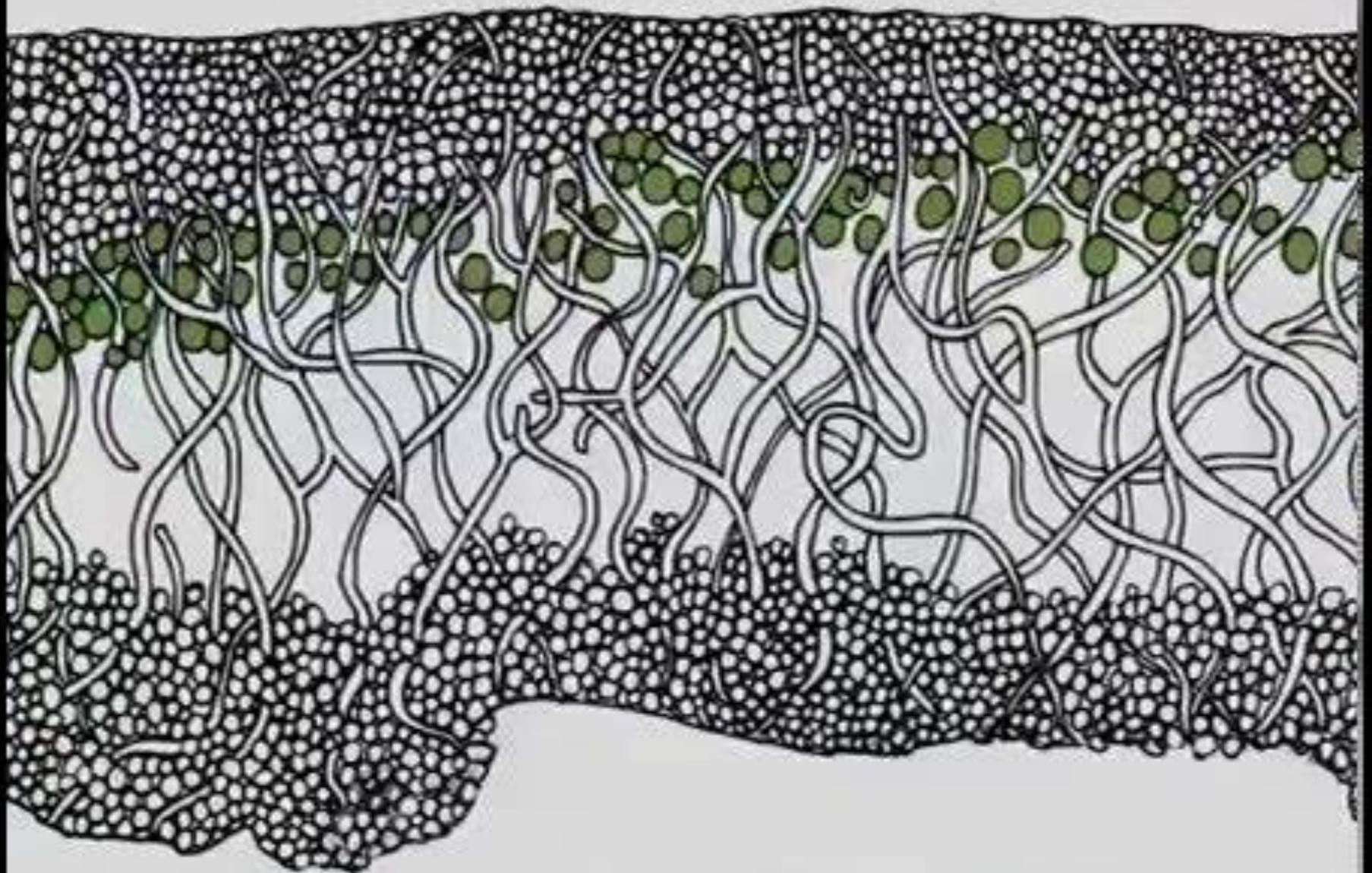
- The composite form is strongly altered in appearance, physiology, reproduction, and chemistry, compared to free-living fungi, algae, or bacteria.
- This allows lichen to live in some inhospitable places that neither of the partners could without the other. They can dry out completely when moisture is unavailable (*poikilohydry*), and their complex chemistry serve to reduce attacks by predators.
- They are usually slow growing (one to two centimeters a year), and can, in some cases, live a very long time.

Mycelia









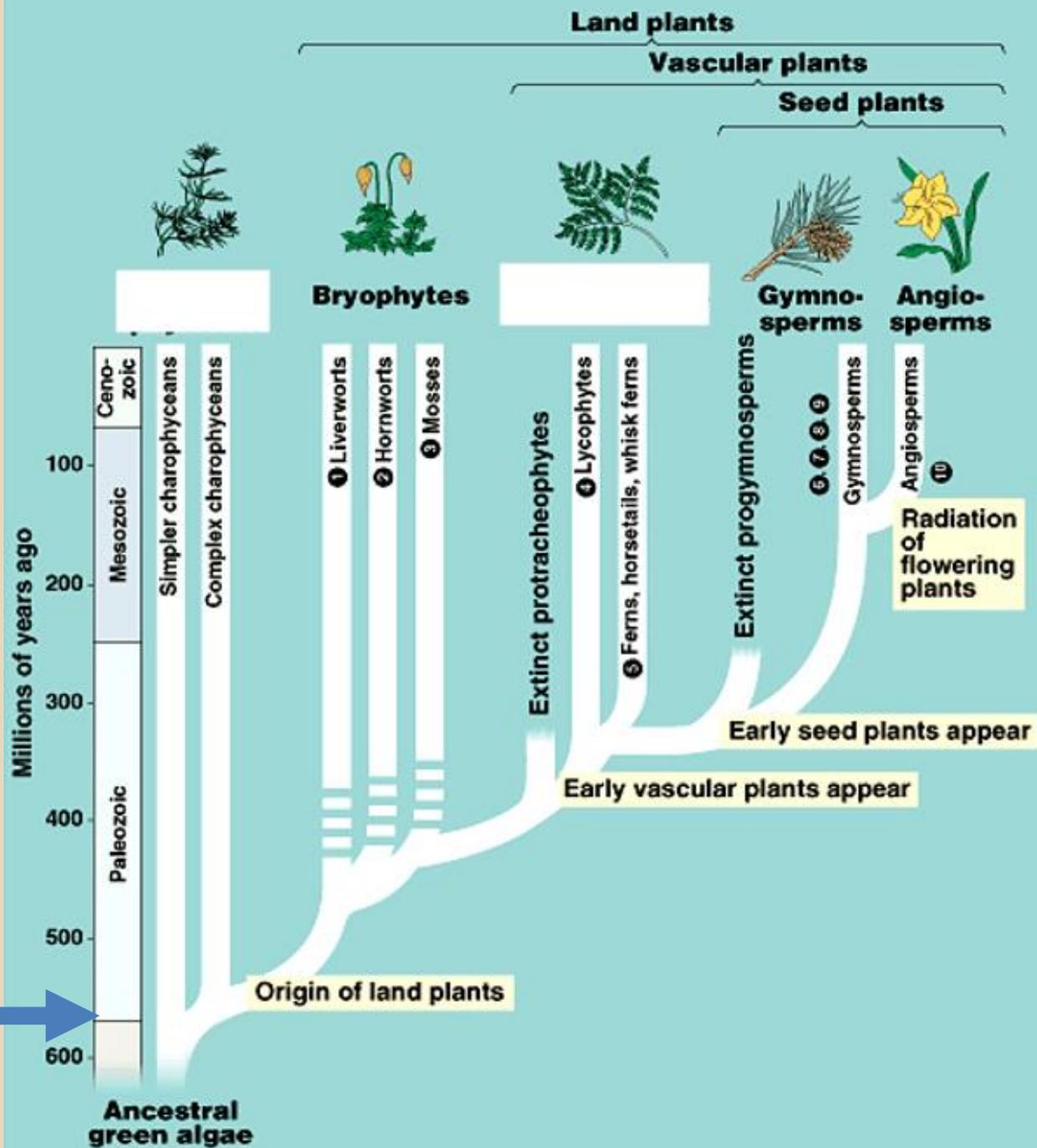
Together, the fungal hyphae and photosynthetic cells form a stable vegetative body or thallus.

Geologic History

Era	Period	Millions of years ago (mya)	Illustrations
CENOZOIC	Quaternary	(1.8 mya-present)	Illustration of a human and a gorilla.
	Tertiary	(65-1.8 mya)	Illustration of a gorilla and a meteor hitting the ground.
MESOZOIC	Cretaceous	(146-65 mya)	Illustration of a dinosaur, a flower, and a bird.
	Jurassic	(200-146 mya)	Illustration of a dinosaur and a bird.
	Triassic	(251-200 mya)	Illustration of a fly and a fern.
PALEOZOIC	Permian	(299-251 mya)	Illustration of the Earth.
	Carboniferous	(359-299 mya)	Illustration of a beetle.
	Devonian	(416-359 mya)	Illustration of a fern and a trilobite.
	Silurian	(444-416 mya)	Illustration of a fish and a spider.
	Ordovician	(488-444 mya)	Illustration of a landscape with water.
	Cambrian	(542-488 mya)	Illustration of a trilobite.
PRECAMBRIAN		(4570-542 mya)	Illustration of a cell with organelles.

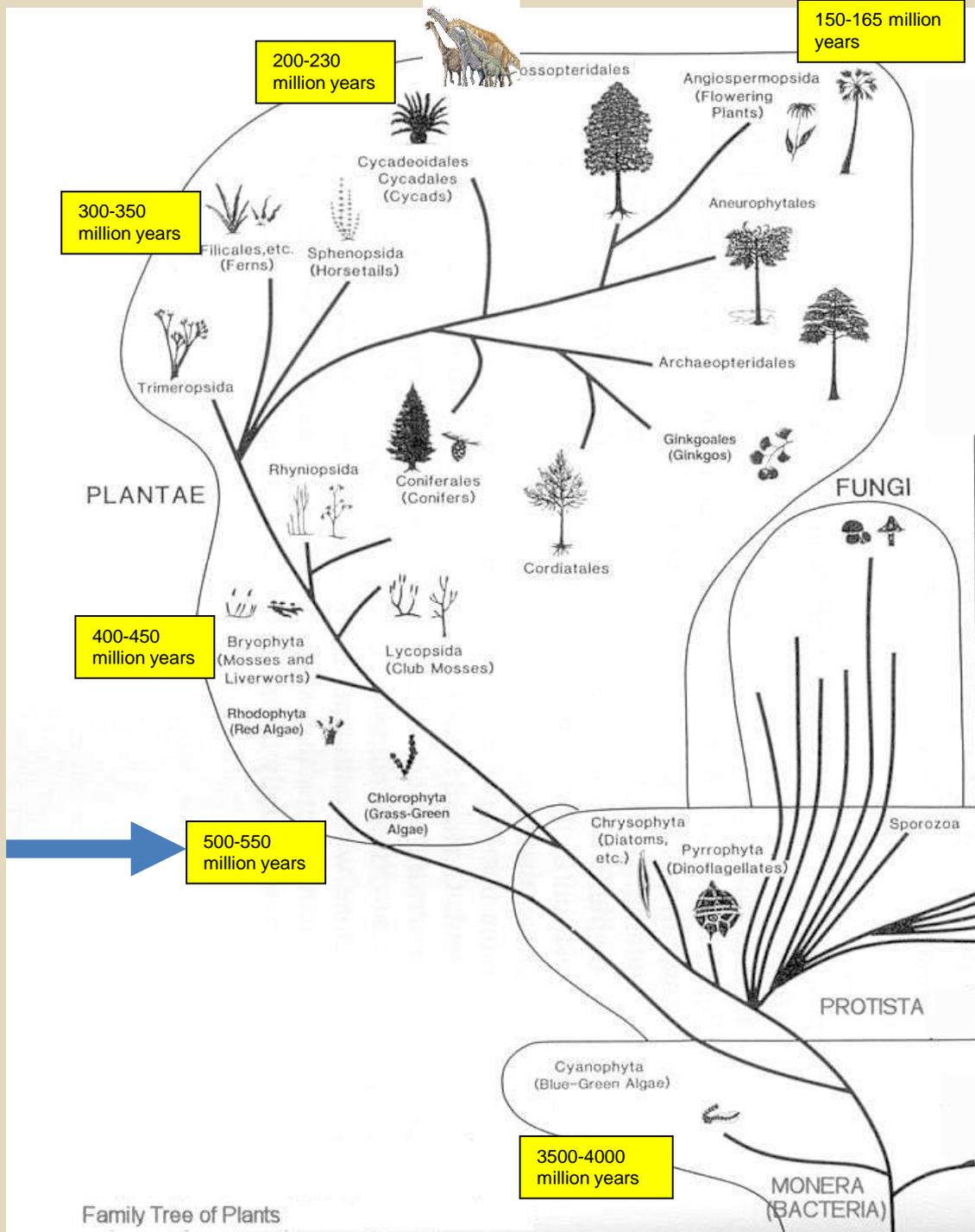


One called 'Pea Soup'

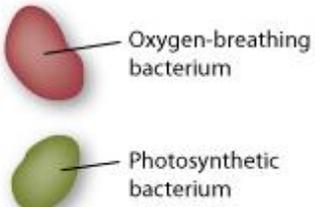


Lichen Evolution

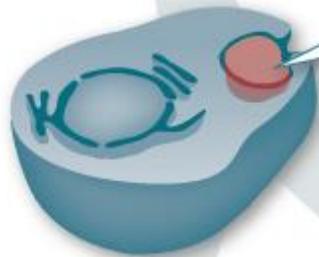
- Lichens are incredibly successful and ancient organisms that date back over 500 million years--- suggesting that a communal effort helped life make the ocean-to-land leap. Algae & fungi helped each other out.
- They are one of the pioneers of ecological succession. The first lichen lived on rock, dissolving minerals and photosynthesizing food.



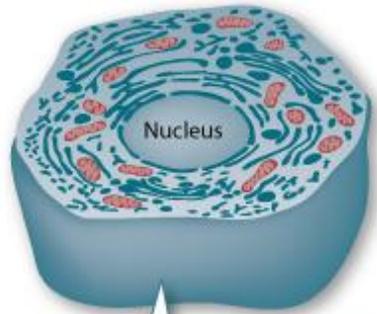
The young earth supported many types of bacteria.



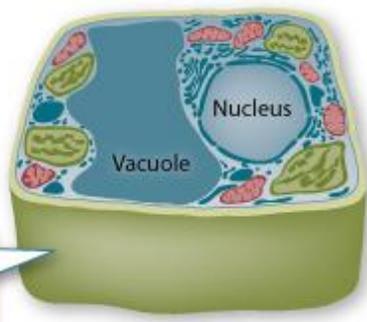
Most membrane-enclosed organelles, including the nucleus, ER and Golgi, probably originated from deep folds in the plasma membrane.



Mitochondria and chloroplasts originated as bacterial cells that came to live inside larger cells.



Modern animal and plant cells contain many organelles that serve as compartments for different cellular activities.



Basic Forms of Lichens

- **Foliose** (Leafy)
- **Fruticose** (Shrubby, branched, beard-like or strap-shaped)
- **Crustose** (Flaky or crust-like)



Rag Lichen
Parmelia

Beard Lichen
Usnea



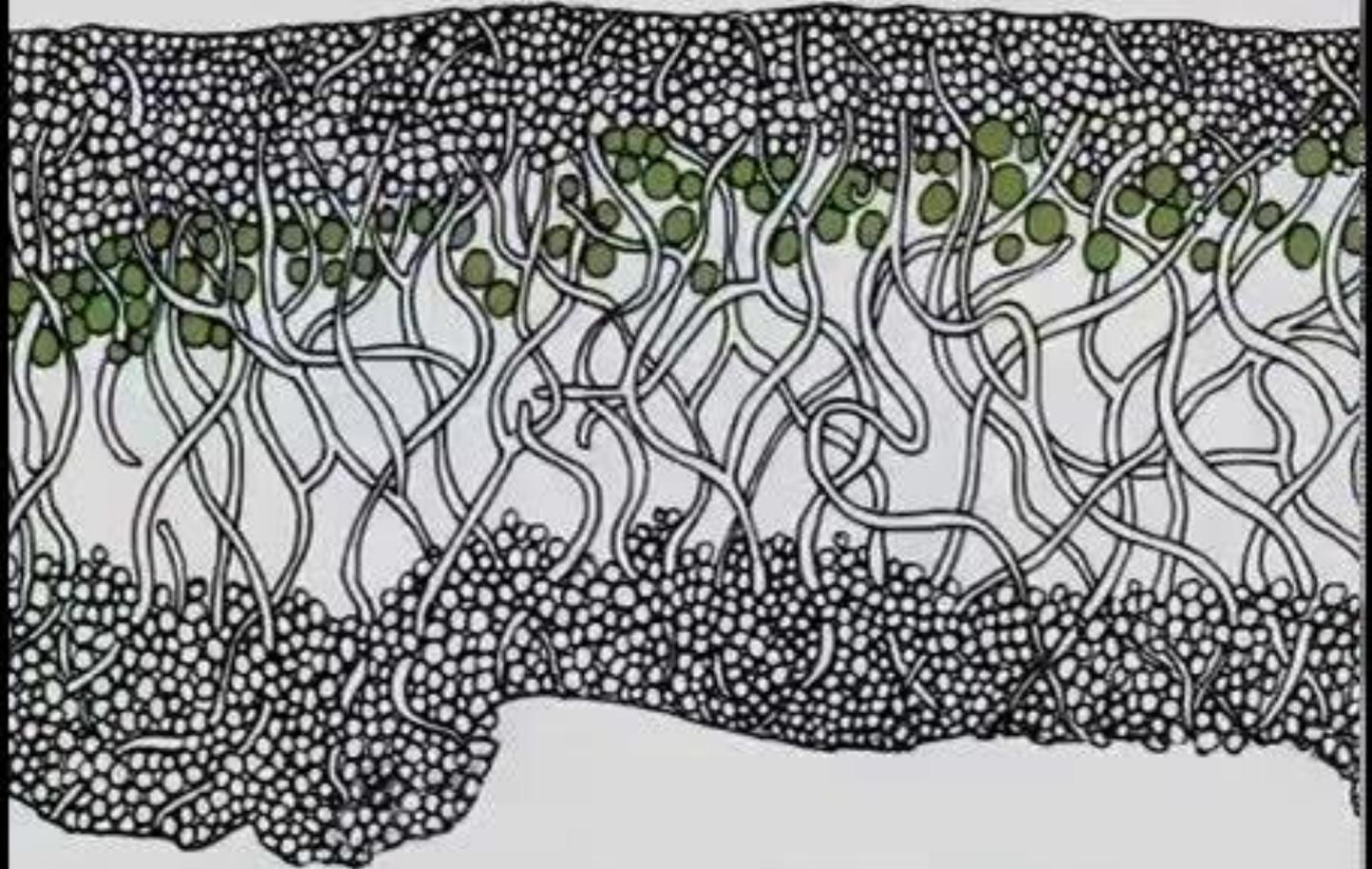
Dust Lichen
Leptaria

Structure of Lichens

Cortex
(protective layer)

Algae

Medulla
(fungal hyphae)



Together, the fungal hyphae and photosynthetic cells form a stable vegetative body or thallus.



Rhizines

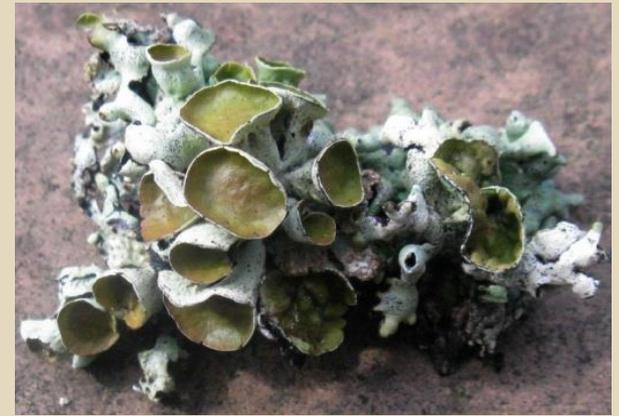
Root-like structures used for anchoring



Lichen Reproduction Structures

Sexual reproduction

- Apothecia – cup-like structures with fungal spores on upper surface. Poditia
- Fungus – spores – germinate – capture algae -- new individual.
- Some mystery still – mech. & rel. imp.



Asexual reproduction

- Soredia and Isidia – balls or finger-like projections of fungi and algae (photobiont)





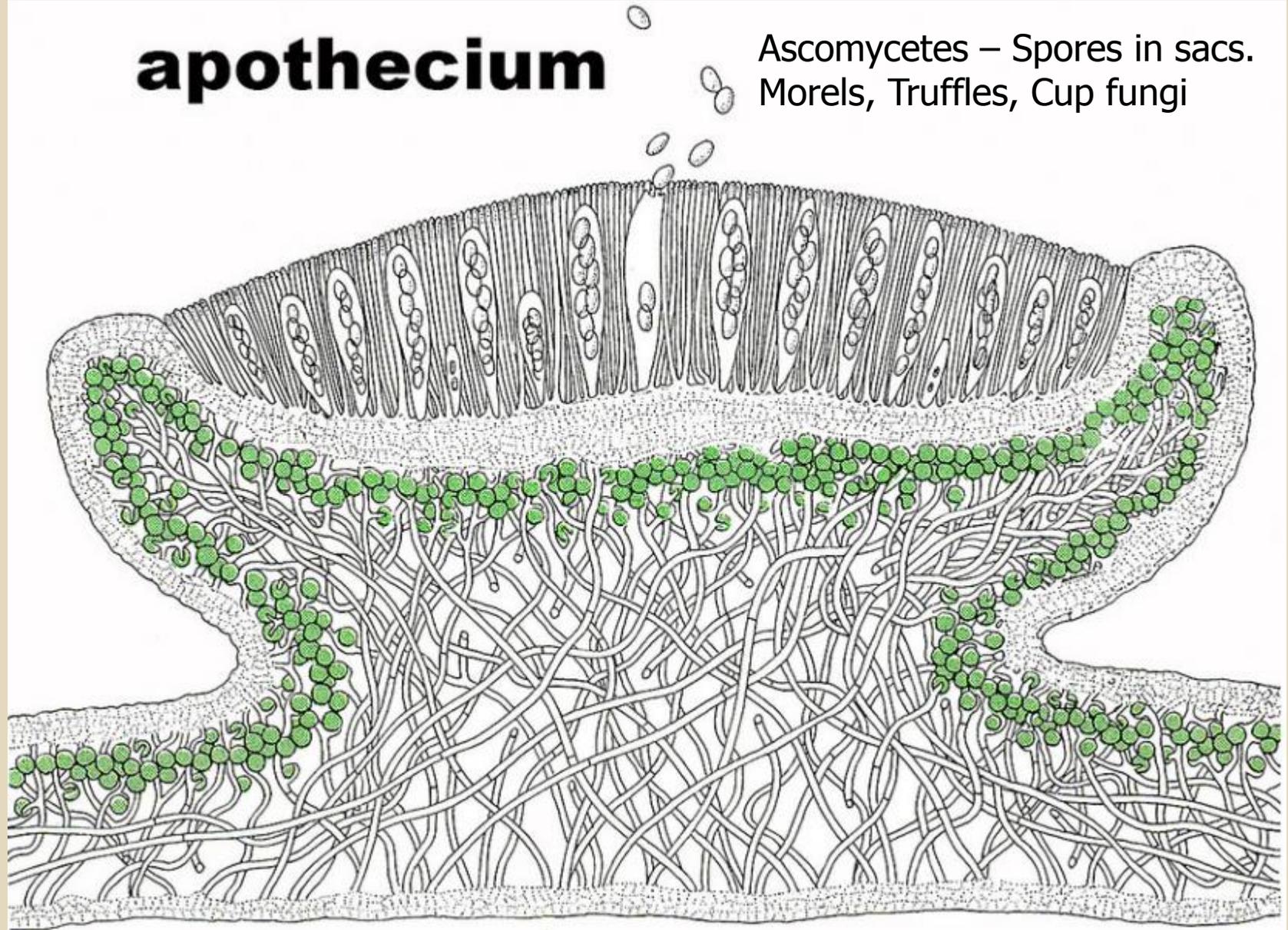
Apothecia

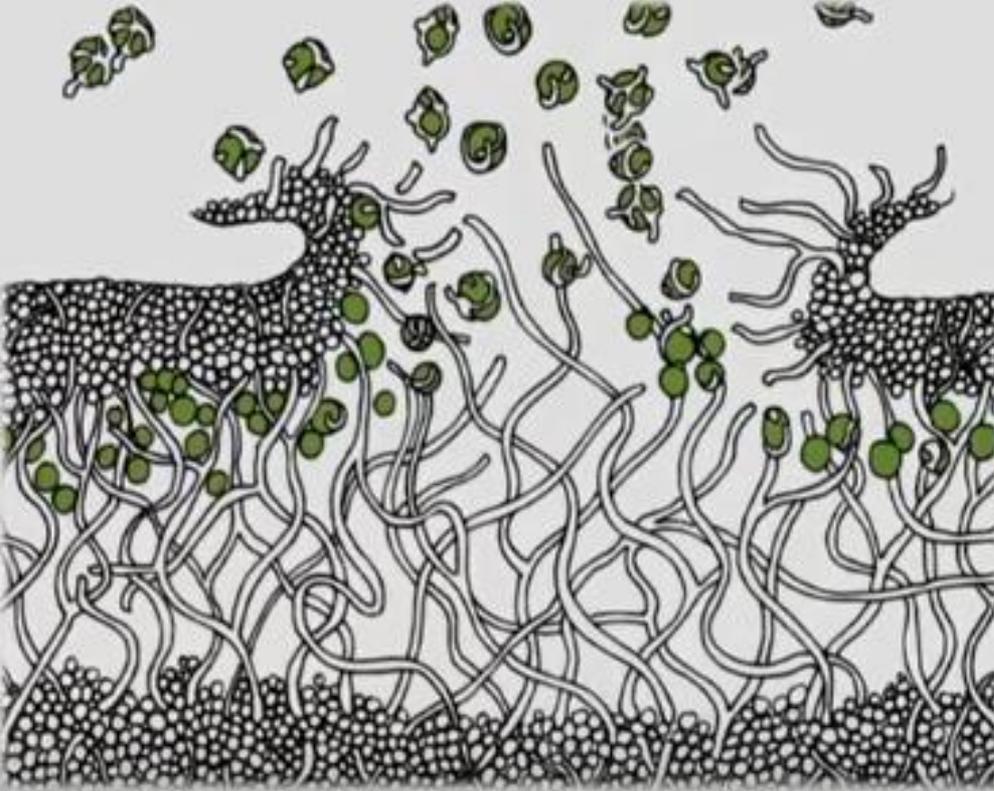
Sexual: Spores (think seeds) are produced in apothecia (a disk- or cup-shaped structure). However spores only contain the fungus component and have to find the algae component.



apothecium

Ascomycetes – Spores in sacs.
Morels, Truffles, Cup fungi



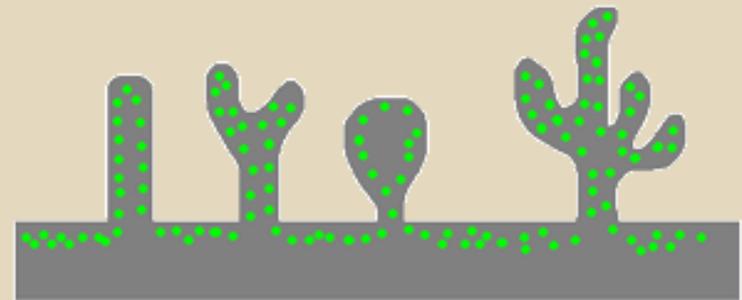


Soredia

Asexual: Sometimes there are openings here and there in the cortex (think “open sores”) and the inner “stuffing” of the lichen become exposed at the surface. These “stuffings” are little roundish packages made up of fungus & algae called soredia that look like clusters of tiny, powdery or granular balls. When released soredia can grow into new lichen.



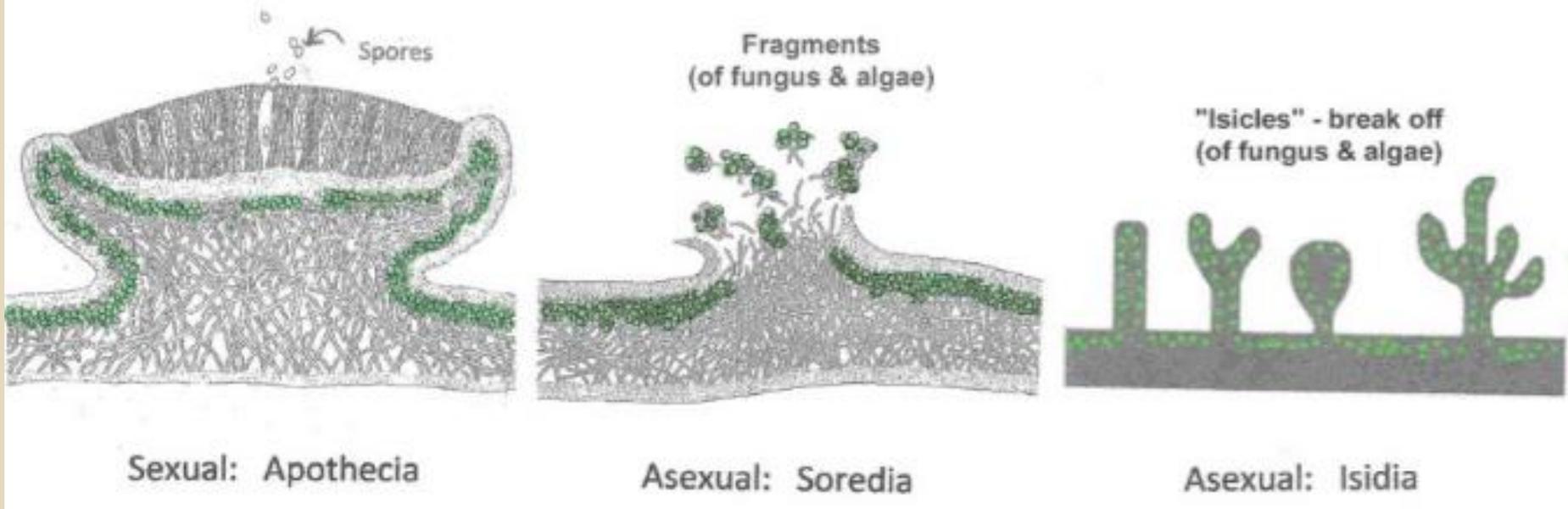
Isidia



Asexual: Isidia are wart like or “icicle-like” growths that contain both fungus and algae cells that can break off to start a new lichen just like soredia can.

Summary

Reproduction



Fragmentation: when pieces of lichen break off they may travel short distances by the wind or animals & they may establish new individuals. *Usnea* rely largely on this strategy.

Where are Lichens Found?

- Ground, glass, metal
- Tree bark and other wood
- Rocks
- Leaves
- Other lichens



They can be found in our forests, deserts, tundra, the highest mountains of the world, and rocks in Antarctica.

The ocean is the only biome on Earth not conducive to lichen growth and reproduction.



Lichen Characteristics

- Lichens are non-vascular. This makes them very dependent on the water and nutrients located directly on the surface or provided in the air.
- Many lichens show a marked preference to substrate---rock, bark of trees, wood, soil. They are very sensitive to the amount of nutrients available on any given growing site (calcium-loving, acid-loving, base-rich).
- They are not parasitic on what they attach themselves to (substrate)---except maybe other lichens.
- Lichens grow & disperse slowly compared to vascular plants.
- In PNW lichen diversity is high in coastal & riparian areas & in high rainfall, low- to mid-elevation forests.



Why are they important?

- **Excellent barometers of air quality**

Because they absorb pollutants along with water and air. They can become sickly and even die when pollutants (especially sulphur dioxide) are present. Lichen distribution data can be used to indicate pollution problems, and so are of great environmental management and ecological value.

1

- **Desert lichen crusts**

Fungi, cyanobacteria and moss reduce soil erosion by intercepting surface run-off and facilitating infiltration of water into hardpan soils. Soil stabilization.

- **Replenishes soil over bare rock and recharges the soil with nitrogen.**



air quality



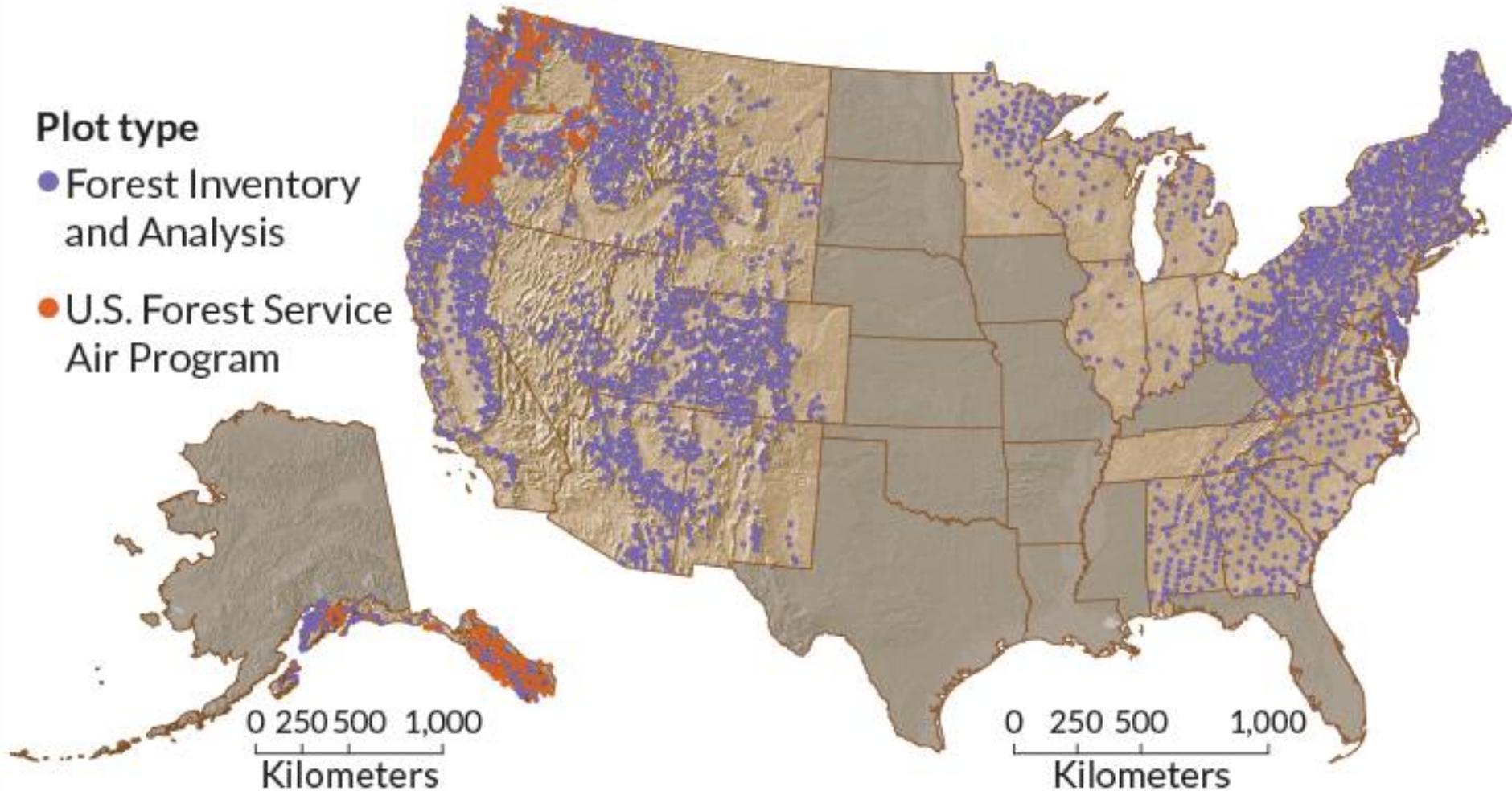
forest



city

A full picture

This map shows the national distribution of lichens based on data from more than 6,000 surveys by two monitoring programs of the U.S. Forest Service. It is one of many maps to be included in a new lichen atlas due out in 2017.



Why are they important?

- Birds use lichens to build their nests.
- Flying squirrels eat lichen, as do other mammals.



1

- Humans have used lichen to fix the scent in perfumes, in the fermentation of beer, for a wide variety of home remedies, bedding, diapers, dyes, and floral decorations, train setups.



Anna's Hummingbird



photo -
Dennis Paulson

In Summary

- Lichens are a combination of 2 to 3 different organisms (**Fungus, Alga, Cyanobacteria**) living in a mutualistically beneficial or symbiotic relationship.



- The alga lives embedded in the thallus of the lichen where it is protected by the fungus providing food thru photosynthesis through a process called lichenization. Lichens are classified based on their fungal component.
- They take on a variety of forms: **Foliose, Fruticose and Crustose**.
- Lichen use several reproductive strategies: **sexual** reproduction by way of spores containing only the fungal element and produced in parts like apothecia; **asexual** reproduction from roundish (soredia) or wart-like (isidia) packages of fungus and algae; or thru **fragmentation**. Learning some of this will help in identification.
- Lichen are excellent ecological indicators because they absorb water and nutrients directly from the air and substrate. They can be useful in soil stabilization and in **recharging the soil with nitrogen**.

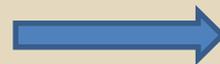
How to talk like a lichenologist:

Few lichens have common names that are in widespread use. Wolf lichen and reindeer lichen are two examples. But Ramalina doesn't even have a common name. So don't be afraid to use scientific names for lichen genera.

The Lichen Chart:

- The first page of the lichen chart shows 10 of the most common lichens in western Washington lowland forests.
- The second page shows 5 other common lichens of western & eastern Wa. It also shows 5 common crustose lichens.

10 common lichens



80%

Lichen ID --- presented in the same order as they are on the lichen chart

Lichen ID

Lichens on branch



Lichen Chart -- page 1

**Frog Pelt Lichen-
Peltigera**



**Large lobes
Large apothecia**

Freckle Pelt Lichen
Peltigera







Lung Lichen
Lobaria

Large lobes
Deeply indented



Shield or Waxpaper Lichen
Parmelia



Appressed small lobes





Rag Lichen
Platismatia

Loose large lobes



Tube Lichen Hypogymnia



Hollow tube-like lobes
"Dripped wax" look



A close-up photograph of a branch covered in lichen. The lichen has a complex, branching, antler-like structure that is light greenish-grey in color. The branch itself is dark brown and textured. The background is blurred, showing other branches and foliage.

Antler Lichen
Evernia

Strap-like
Divide regularly

By Richard Droker



Top
Gray-green



Bottom
White

Evernia



**Pixie Cups and British Soldiers -
Cladonia sp – Fruticose/Squamulose**

**Clusters of tiny basal
scales (spaumules)**

Clubs (podetia)

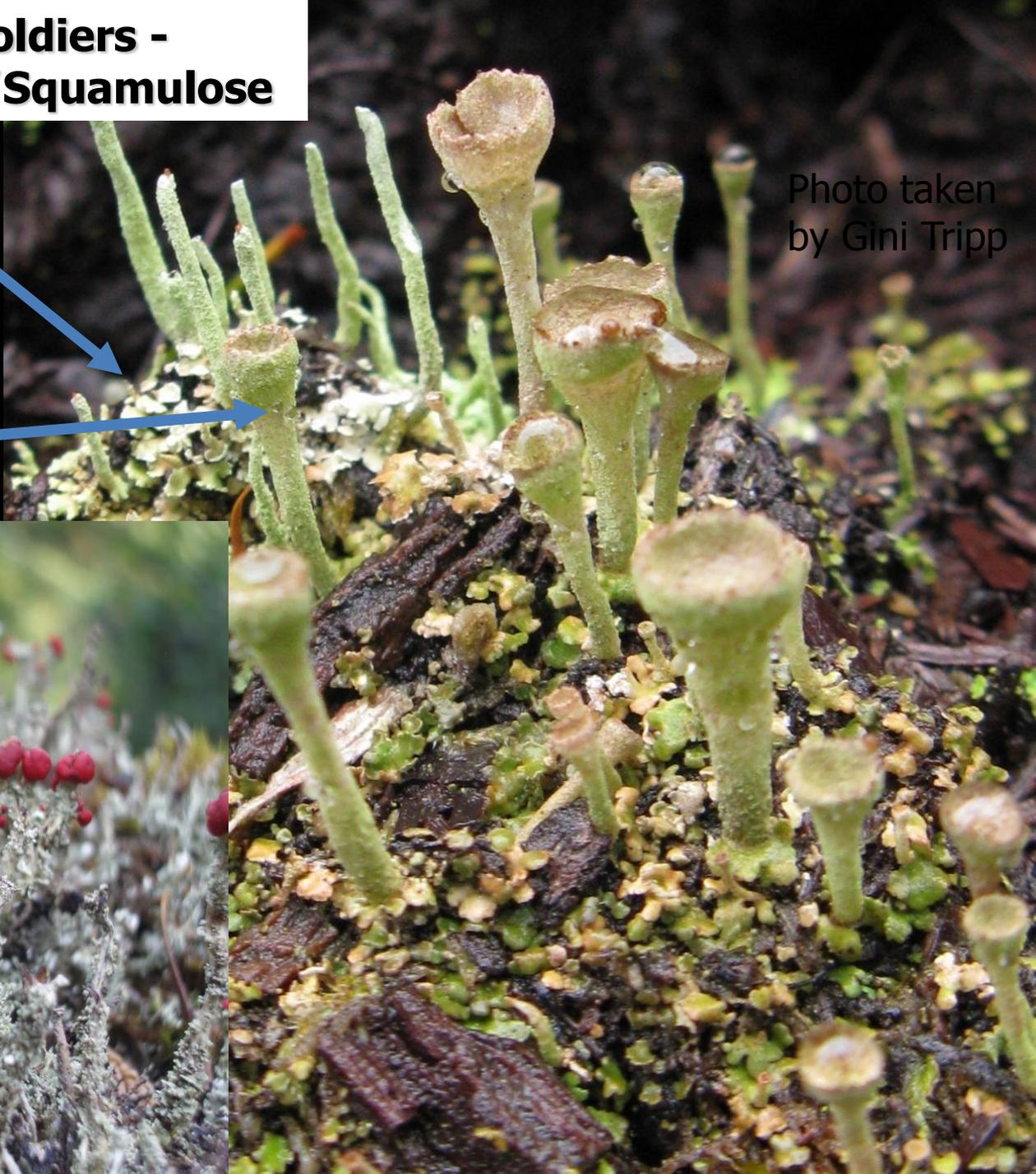


Photo taken
by Gini Tripp



Dragon Cladonia





Ramalina

Lobes divide (forks) unevenly



Fishnet Lichen
Ramalina menziesii





Beard Lichen
Usnea

Hairlike or long & pendulous
Central cord



Pendulous (no central cord)



**Witch's Hair – Alectoria sp.
- Fruticose**

Lichen Chart -- page 2



Horsehair Lichen
Bryoria

Long hanging threadlike
Blackish
E. Wa.



**Icelandic Lichen-
Cetraria**

**Narrow, slightly channeled lobes
Marginal soredia.**

Wolf Lichen
Letharia



Brilliant yellow green
Branched
E. Wa.



A close-up photograph of a tree branch covered in bright orange, sunburst-shaped lichen. The lichen consists of numerous small, overlapping, disc-shaped structures that give it a textured, cushion-like appearance. The background is dark and out of focus, showing other branches with similar lichen growth.

**Orange Sunburst Lichen -
Xanthoria**

Loose, disc-shaped 'pincushions'



Reindeer Lichen
Cladonia

On ground
Richly branched shrubby looking



Lichen Chart -- page 2
Crustose lichens

UPPER
CORTEX

ALGAL
LAYER

MEDULLA



A close-up photograph of a tree trunk. The bark is heavily covered with a grey, powdery lichen (Lepraria) that has a cracked, scale-like appearance. Interspersed among the lichen are patches of vibrant green moss. The background is slightly out of focus, showing more of the tree and some surrounding vegetation.

Dust Lichen
Lepraria

Powdery granules



Bark Barnacle
Thelotrema

Continuous smooth crust
Barnacle-like apothecia
Alder

Alai

Map Lichen

Rhizocarpon



Photo taken by
Gini Tripp

Bull's-eye Lichen –
Placopsis



Devil's Matchstick Pilophorus



Apothecia

Granular crust (pale greenish – grayish)



Fairy Barf

Helpful References

- *Macrolichens of the Pacific Northwest* by Bruce McCune and Linda Geiser, 2nd edition
- *Plants of the Pacific Northwest Coast* by Pojar & MacKinnon
- *Mosses, Lichens and Ferns of Northwest North America* by Dale Vitt, Janet Marsh and Robin Bovey
- *Lichens of North America* (2001) by Irwin Brodo, Sylvia Duran Sharnoff and Stephen Sharnoff
- University Washington Burke Museum Herbarium website.

Questions?

