Life of Lichen

Pinellas County Natural Resources

Introduction

Pinellas County is home to a vast diversity of an amazing group of organisms called Lichens. What are these organisms? They are neither a plant, nor an animal, but they are living, "breathing", reproducing complex organisms; the result of a seemingly impossible relationship.

In high-school biology, you may have heard the saying: "Freddie **Fungus** and Alice **Algae** took a LICHEN for each other" but it is a bit more complicated than that. Lichens are composed of several organisms from three different Kingdoms of living things: Fungi, Plants and Bacteria.

The association of these separate organisms is often referred to as a symbiotic relationship, defined as two or more organisms living in a mutually beneficial arrangement. An example would be the clownfish that lives amongst the tentacles of a sea anemone. The brightly colored clownfish acts as a lure that draws other fish into the deadly tentacles. The clown fish's immunity to the anemone's toxin allows it a safe place to live and scraps of food. The anemone gets the advantage of a live-in fish lure.

Lichens are a bit different. It is believed that the algal component of a lichen can survive outside of the relationship, while the fungal component cannot. Therefore, rather than a mutually beneficial relationship, there are signs that the fungus is actually parasitizing (taking nutrients away from the host) the algae.

Fig. 1 Tree trunk with many lichen species

Lichen Biology

1. Fungi

Fig. 3 Typical cup fungus or Ascomycete

The fungal component, or **mycobiont**, provides the structure of the lichen and feeds off the sugars produced by the algae/bacteria component, the **photobiont**(s). The most common fungus present in lichen associations belong to the group of Cup Fungi or **Ascomycetes**. These produce cup-shaped structures (**ascocarps,** see Fig. 3 and 4) which contain spore-producing cells. When spores are released they grow into the next generation of cup fungi. The capacity of this group of fungus to express this cup-shaped structure is maintained in lichen associations and one can often find lichen with these

Fig. 2 Jester Lichen (*Cladonia leporina*)

Fig. 4 Well-developed ascocarps

Fig. 5 Trebouxia sp. an algae often found in lichen associations

Lichen Reproduction

Lichen reproduce primarily asexually; by creating microscopic bundles (**soredia**) of all components that make up the lichen species and releasing them into the air. If these soredia find a suitable habitat to grow, they will begin the process of creating the body (**thallus)** of the lichen in the same arrangement as the parent lichen.

Fig. 6 The white areas of this "script" lichen are releasing soredia

growths; an expression of one type of lichen reproduction (see Fig. 4). For a long time, scientists studying lichen associations could not understand how the same combinations of myco– and phyto- bionts could lead to entirely different lichen organisms. Recently an additional element has been discovered to exist within this arrangement: **yeast.** Yeast is a single-celled fungus that belongs to a different group than the Ascomycetes. The acceptance that this additional "biont" plays a part has solved the mystery. This realization may also explain why lichen cannot be "created" in the lab by combining known fungal/algal components.

2. Plants

As for the phytobionts, we will examine the algae first. One Genus often assimilated into a lichen association is *Trebouxia* spp. This single-celled algae is in the Chlorophyta or Green Algae group of the Plant Kingdom. *Trebouxia* can exist as a free-living algae, found on the surface of the soil, on tree trunks and fence posts. Another green algae, *Trentepohlia* spp**.** is another algae often found in lichen associations. This Genus is also terrestrial, found in the same habitats as *Trebouxia*, though in the Tropics, is found growing on the surface of plant leaves. Despite being a member of the Green Algae, *Trentepohlia* has other pigments besides chlorophyll that often give it an orange or yellow appearance.

3. Bacteria

Another of the phytobiont groups is the **cyanobacteria** formerly known as the blue-green algae. These are true bacteria, neither plant nor fungus. *Nostoc* spp. is a representative often found in lichen associations. *Nostoc* is a photosynthetic bacteria that exists as a chain of bead-like cells, including special cells called heterocysts that have the capacity to "fix" atmospheric Nitrogen into a form that is available to the photosynthetic cells. Free-living *Nostoc* spp can be found on the surface of the soil as a gelatinous green mass, often after a rain. *Nostoc* spp may also exist as aquatic gelatinous masses in slow-moving water.

Fungus Depends on the Phytobiont(s) for Survival

The evolution of lichens has resulted in the inability of the fungal species in a lichen association to exist as a free-living organism. Even under perfect laboratory conditions, the fungus when isolated out of a lichen cannot survive for an extended period of time. The algae and bacteria, however can and do exist as free-living organisms.

The Structure (Thallus) of a Lichen

The basic structure of a lichen is like that of the popular peanut butter cup candy. A layer of phytobionts (the peanut butter) is held within a matrix of fungal fibers or hyphae (the chocolate). This allows the phytobionts access to sunlight as well as protection from drying out. The protective role of the fungus has allowed lichens to inhabit extreme environmental conditions. Lichen can be found living on rock surfaces in harsh climates that would prove lethal to the photobionts on their own.

Lichen Diversity

There is no global list of known lichen species, but estimates vary from 13,000 to 30,000 different lichen species. The various growth forms are described as: **Crustose, Foliose and Fruticose**.

1. **Crustose** lichens are lichens that exist as if painted onto the surface they grow on. It is nearly impossible to pry the organism from the surface. Examples of crustose lichens include the very colorful "Baton Rouge" lichen, *Cryptothecia rubrocincta (*also referred to as *Herpothallon rubrocinctum*) Fig. 7. This lichen exists throughout the Southeast US and appears as deep-pink circular masses on the trunks of trees. Another interesting group of crustose lichen are called the Script Lichen. These are also like paint on the surfaces where they grow. The body or thallus of these lichen are marked with "scribbles" of areas of reproductive structures. These are found on smooth-barked trees (like red maple, *Acer rubrum*) often in flooded forests in the Southeast.
2. **Foliose** lichens are "leafy" with thalli that can be flicked up and off the surface where they grow. A large Genus of foliose lichens are the Shield Lichens, or *Parmelia* spp. Fig. 8. These large and easily-observed species can be found in a variety of habitats. Their abundance has led to their being used to monitor lichen growth rates as well as air quality. Different species of lichen have different tolerances to air pollutants.
3. **Fruticose** lichens are "shrubby" and stand proud of the substrate they grow on. Terrestrial examples include the Deer Moss (*Cladonia* spp.) Fig. 9 and Jester Lichen (*Cladonia leporina*) Fig. 2. These two are locally abundant in Oak Hammocks and Pine Flatwoods; though they are not fire-adapted and colonies may be totally lost following a wildfire. Another fruticose type lichen is most often found growing on the trunks and branches of trees. This one is called *Usnea* spp. Usnea means "beard" in Latin, and these multi-filamentous lichens may appear as little beards hanging from the branches, especially after a rain.

Fig. 7 Crustose Baton Rouge (*Cryptothecia rubrocincta*)

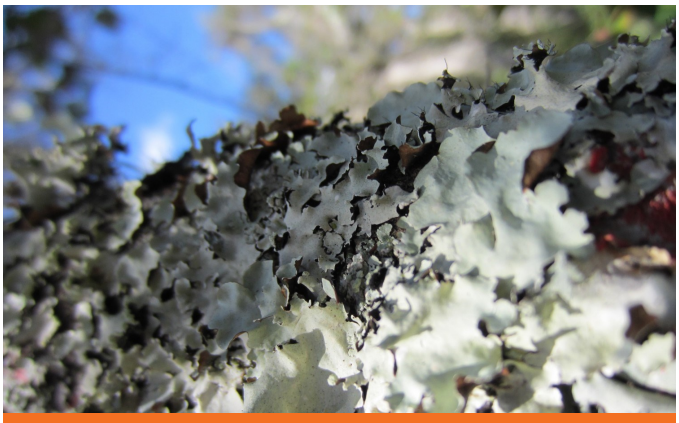

Fig. 8 Foliose Shield Lichen (*Parmelia* sp.)

Fig. 9 Fruticose, terrestrial, Deer Moss (*Cladonia* sp.)

British Soldiers

A charming fruticose lichen called British Soldiers or Matchstick Lichen is *Cladonia* sp. During its reproductive phase this stick-like lichen bears masses of reproductive structures on the tips that are bright red, like a British Soldier's red hat.

Lichen Medicine?

Lichens are a fascinating group of communal organisms. With their ability to synthesize complex compounds for survival/self-defense, science is exploring medicinal possibilities using lichen[1]. There is much more to learn about lichen, their ecological role(s), economic importance and traditional uses around the world.

Glossary

Algae - a large group of photosynthetic organisms that possess chlorophylls a and b and store food as starch

Ascomycetes - a Phylum of Fungus that reproduces via ascospores produced in asci in cup-shaped ascocarps

Cyanobacteria - photosynthetic bacteria that possess chlorophyll a and accessory pigments

Fungus (plural: Fungi) - the Kingdom of organisms either single-celled or forming bodies called mycelium composed of tubular strands of hyphae. Fungi reproduce by spores and secrete "digestive" enzymes and re-absorb nutrients. Those in lichenized relationships parasitize their captive algae/bacteria for nutrition

Mycobiont - in lichen, the fungal component. Provides structure and can absorb rainwater to benefit all components

Photobiont - in lichen, the organism(s) that provide the fungal "host" with the sugars that are the by-products of their photosynthetic activity. Can be algae or bacteria or both

Soredia - microscopic, airborne bits of the parent lichen that contain all necessary components to grow a new lichen if they land on a suitable substrate and begin to grow

Thallus - the "body" of a lichen with fungal hyphae filaments surrounding a layer of photosynthetic organisms

Yeast - a single-celled fungus that exists in a variety of habitats, either individually or in chains. These do not form hyphae and reproduce by budding

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[1] Rancović, Branislav (ed.) 2015. Lichen Secondary Metabolites: Bioactive Properties and Pharmaceutical Potential. Springer, New York, NY.