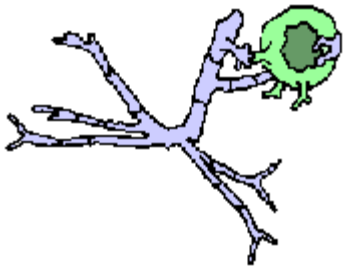
Cladonia

By Cæcilie Gervin

Picture from: www.ece.ubc.ca/%7Eianc/VNHS2008_Day6/

Lichens in general



- A lichen is a **composite organism** that consists of a **fungus** (the mycobiont) that grows symbiotically with an **algae** (the photobiont). This relationship between the fungus and the algae is called **symbiosis**.
- The algae is **photosynthetic**, produces sugar and other carbohydrates which both the fungus and the algae itself use for nutrition. The fungus, on the other hand protects the photobiont within its tissue against the sun so that the algae does not dry out.
- The **lichen fungus** is usually in the class of **Ascomycetes**
- Lichen fungi usually associate with **green algae** or **cyanobacteria**
- There are close to 14,000 species of lichens in the world; very diverse in size, form and color.
- Lichens are geographically distributed all over the world. They are found from the poles to the tropics, from the intertidal zones to the peaks of mountains, and on every kind of surface e.g. soil, rocks, tree bark and even on the backs of some living insects!

Source: Lichens of North America, Brodo et al. Picture from: Oregon State University, http://ocid.nacse.org/lichenland/LichenLite/index.php

The lichen association

However, the relationship between the fungus and the algae is not as harmonious and mutually beneficial as believed earlier. There are few if any lichens in which the algae are not invaded and killed to some extent by the fungus. However, of course, the photobiont (the algae) are able to reproduce faster than they are destroyed – otherwise it would not be very beneficial for the fungus.

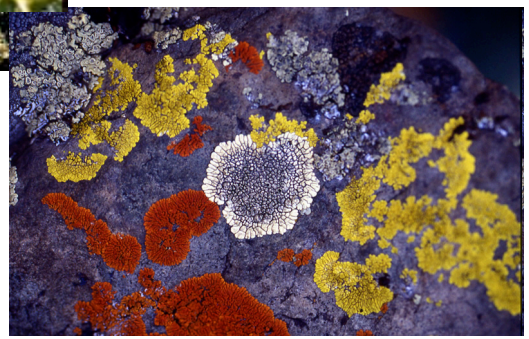
Source: Lichens of North America, Brodo et al

Different types of lichens

Fruticose: Lichen thallus is stalked, pendent, or shrubby.

Foliose: Lichen thallus is flat and "leafy"

Crustose: Lichen thallus is generally in contact with the substratum



Source: Lichens of North America, Brodo et al. Pictures from www.nature-diary.co.uk/2007-05-26.htm, bcbiodiversity.homestead.com/foliosrag.html and www.fs.fed.us/.../biology/growthforms.shtml

Nomenclature:

The scientific names of the lichens consist of two elements: the name of the **genus** (in italics, beginning with a capital letter) followed by the species designation or **"epithet"** (in italics, written entirely in lowercase) E.g. *Cladonia pleurota*.

The name given to a lichen is actually the name of its fungal component. E.g. *Cladonia borealis* is the name of the fungus of the lichen.

Source: Lichens of North America, Brodo et al

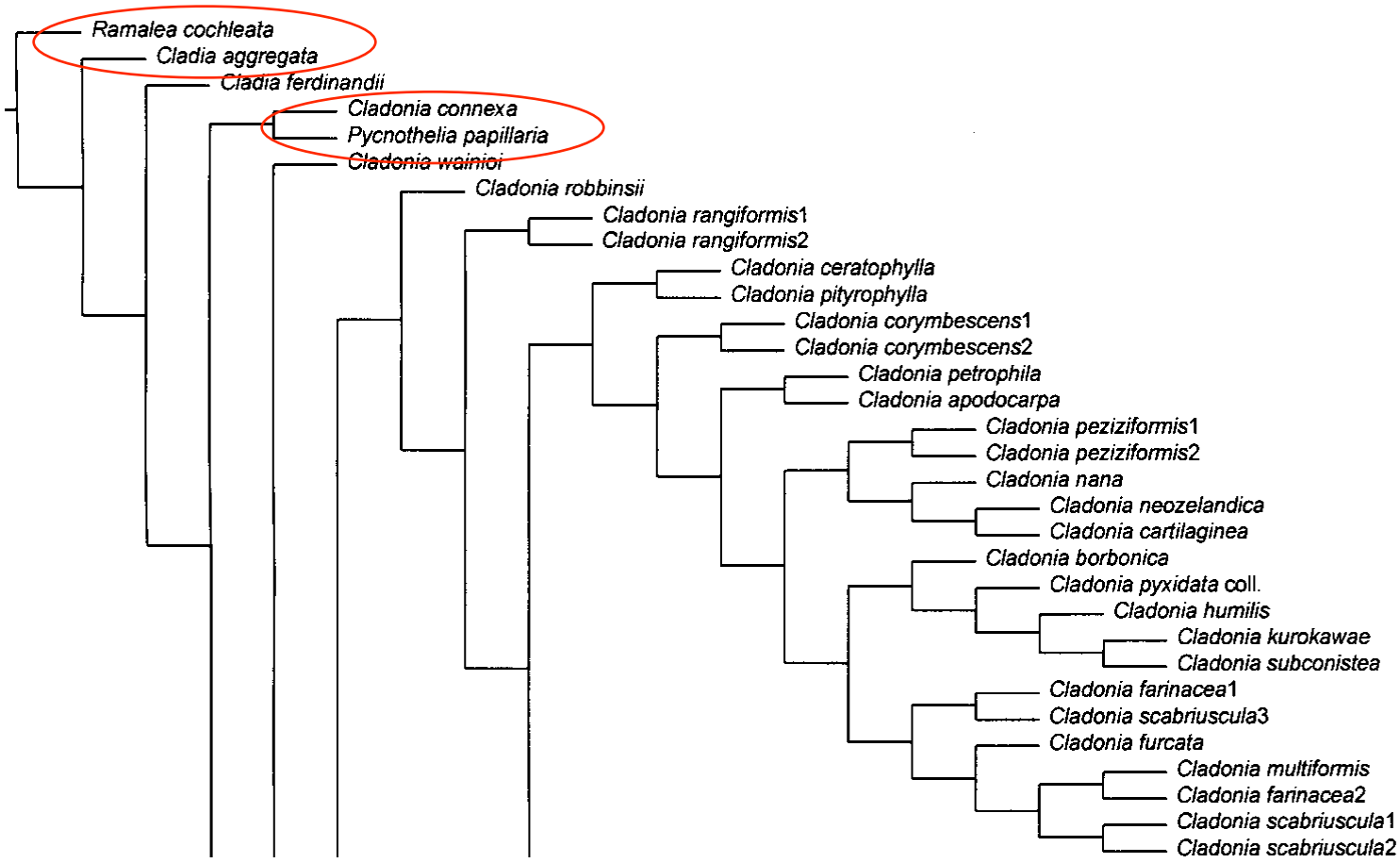
The Evolution of the Genus Cladonia

- The classification of each lichen is determined almost entirely by the **genetic information** contained in the fungus, which, in most cases, determines the lichen's structure.

- Analyses based on genetic information of the genus *Cladonia* were carried out by Soili Stenroos et al (2002). This was done to resolve the **phylogeny** of *Cladonia* as a step toward establishing taxonomy for the group.

- The results suggested that *Cladonia* (including *Cladina*) is a **monophyletic group**, except for *Cladonia connexa*, which remains outside and joins with *Pycnothelia papillaria* in a sister-group. Representatives of the genus *Cladia* and *Ramalea* were suggested to be more distantly related to Cladonia.

Source: Lichens of North America, Brodo et al and article: "Phylogeny of the Genus *Cladonia* s. lat. (Cladoniaceae, Ascomycetes) Inferred from Molecular, Morphological, and Chemical Data", Stenroos et al



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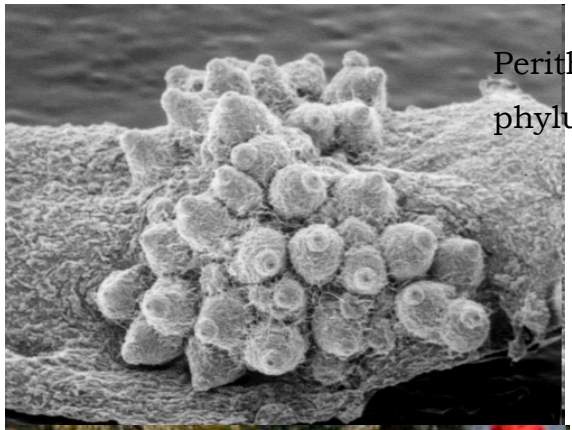
Morphological characteristics of a lichen:

The **thallus** is the plant body of the lichen

The **podetia** is the stalk with the fruiting bodies

Source: Lichens of North America, Brodo et al and Answers.com. Pictures from: biology.uwsp.edu/courses/botlab/Lab21a.htmRemove frame and www.nature-diary.co.uk/2007-05-26.htm

Morphological Characters of a Lichen - Continued



Perithecia of the red bread mold of the phylum Ascomyceta, Neurospora crassa

Apothecia of Cladonia lichen

Their fruiting bodies are called **ascomata** (singular: ascoma). The ascomata are usually one of 2 basic types: **apothecia** or **perithecia**. Apothecia are basically disk- or cup shaped structures. Perithecia are flask-shaped structures. The fruiting bodies are used in their **sexual reproduction**.

Cladonia has apothecia

Source: Lichens of North America, Brodo et al. Pictures from: plantbio.berkeley.edu/.../research_overview.html and www.nature-diary.co.uk/2007-05-26.htm

Morphological Characters of a Lichen - Continued

Some lichen have **squamules**. That is small, loosely attached thallus lobes

Soredia (singular: soredium) are tiny balls that contain algae and fungal cells that escape from the parent lichen and grow into a new lichen thallus = **asexual reproduction**

Source: "Lichens of the National Forests in Alaska", booklet by USDA and Answers.com.
Pictures from: www.treknature.com/gallery/photo180936.htm and www.biology.ed.ac.uk/.../microbes/lichen.htm

Morphological characters of the Genus Cladonia

- The **podetia** often end in a cup-like structure; they can be covered with **squamules or soredia**, or they can be quite **smooth**
- Apothecia can be found at the top of the podetia and are **brown** or **bright red** (or in few cases, yellowish beige)

Cup-like structure

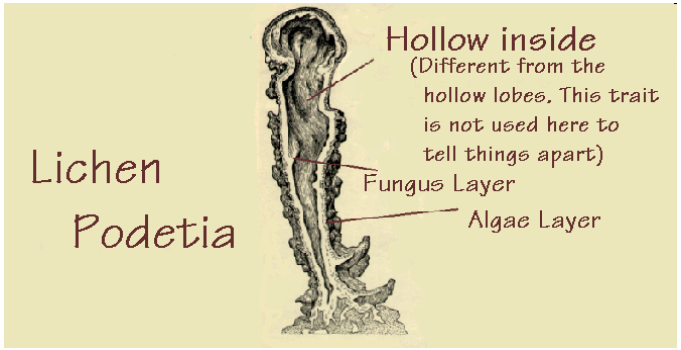
Squamules on podetia and apothecia bright red

Source: Lichens of North America, Brodo et al

Morphological characters of the Genus Cladonia

- The species in the genus are **fruticose lichens** (i.e. lichen thallus is stalked, pendent, or shrubby
- Development begins with a **primary thallus that are made of squamules**. Later, the podetia will evolve.
- The **podetia is always hollow**

The hollow stalks distinguish *Cladonia* from other fruticose lichens of comparable size, color and habit and the squamulose primary thallus distinguishes it from *Cladina* and *Dactylina*, which also produce hollow stalks



Source: Lichens of North America, Brodo et al. Picture from: ocid.nacse.org/lichenland/html/podetia.html

Morphological characters of the Genus Cladonia - Continued

- The **photobiont** is a green algae (either *Trebouxia* or *Pseudotrebouxia*)

Trebouxia

- They are found on soil, peat, wood, bark, or rock, often mixed with mosses

Source: Lichens of North America, Brodo et al. Picture from: www-biol.paisley.ac.uk/.../Trebouxia.html

Cladonia borealis and pleurota

Distribution of Cladonia borealis in North America

Source: Lichens of North America, Brodo et al.

Comparison of Cladonia borealis and pleurota

Cladonia borealis:

- Their thallus is pale yellowish green
- Primary squamules with lobes free from each other
- Podetia is with goblet-shaped cups
- Podetia do not have cups covered with granular soredia
- Apothecia, which are bright red, is found on the cup margins
- Contains barbatic acid (chemistry: PD-, K-, KC+ gold)
- They grow in arctic alpine, on soil or rocks in full sun

Cladonia pleurota:

- Their thallus is white to pale yellowish green
- Primary squamules with lobes clustered together
- Podetia is with goblet-shaped cups
- Podetia have cups covered with granular soredia
- Apothecia, which are bright red, is found on the cup margins
- Contains zeorin acid (chemistry: PD-, K-, KC+ gold)
- They grow on old wood, especially of conifers, less frequently on bark

Source: Lichens of North America, Brodo et al

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Cladonia borealis without soredia

Cladonia pleurota with soredia

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Taxonomic key:

A. Podetia has broad cups covered with granular soredia, squamules on podetia clustered together, they grow in arctic alpine, on soil or rocks .....*Cladonia pleurota*

A. Podetia does not have cups covered with granular soredia, squamules on podetia with lobes free from each other, they grow on old wood, especially of conifers, less frequently on bark.....*Cladonia borealis*