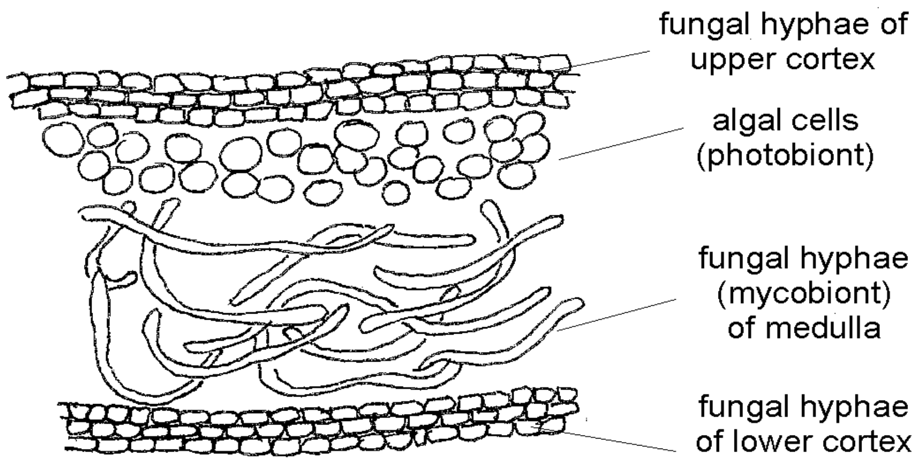
Lichen basics

When you look at a lichen you are not seeing one organism but at least two. You are seeing a structure (thallus) formed by the interaction of either a fungus with an alga or of a fungus with a cyanobacterium. The fungal partner is called the mycobiont. It is incapable of making food by photosynthesis so it gets its sugar derivatives from the algal (or cyanobacterial) partner called the photobiont.



A transverse section through the thallus of a lichen

The traditional approach considers lichens as mutualistic associations where both fungal and photobiont partners benefit. Together they are able to deal with ecological conditions that neither part would be able to handle on its own. Let's face it, would you ever expect to find algae, on their own, growing on the exposed, dry surfaces of rock? Yet protected within the fungal hyphae of their lichen partner they do manage to survive. The fungus absorbs and stores water in its hyphae and provides radiation protection to the algal cell. Similarly the fungal hyphae would not thrive unless they have a source of food and within lichens this is conveniently provided by the photobiont cells. This intimate association does not *seem* to be harming any of its partners.

A closer look at a lichen reveals that the photobiont cells become very leaky when they associate with fungi. The amount of sugars and sugar derivatives that leak out of the walls of photosynthetic algal cells into the fungal hyphae is so large that little food and energy is left for the algae. These are induced to refrain from sexual reproduction and to slow down their rate of growth and vegetative reproduction. These considerations have led to the idea of the photobiont being a captive of the mycobiont, rather than a partner. The fungal partner "enslaves" the photobiont to feed from the photobiont's photosynthesis. Hence the term "controlled parasitism" is sometimes used to describe the interaction within lichens.

The species of algae or cyanobacteria that form lichens are few and these are still capable of an independent existence. The same species of alga (or cyanobacteria) can form partnerships with different fungal species giving different lichens. The photobiont is not greatly changed by lichenisation and makes a trivial contribution to the thallus biomass, amounting to only about 10%.

Around 25% of the world's known fungal species are lichenised. The fungus of a lichen is usually incapable of independent existence under natural conditions. The fungus makes the major contribution (about 90%) to the thallus biomass. It requires an encounter with a specific algal partner to form a particular lichen. In doing so its appearance becomes radically altered. The scientific name given to a lichen e.g. *Verrucaria nigrescens* is actually that of the fungus it contains.

Lichens can survive very harsh conditions. Locally this means long months of exposure to the hot sun without water during which they will dehydrate. This interrupts photosynthesis and will slow down or arrest their growth but it still allows them to survive.

The substrates of lichens

It does help to note the substrate a lichen is growing on when attempting identification. Lichens of rocks, walls and stones are termed **saxicolous** e.g. the common *Verrucaria nigrescens* below:

Terricolous lichens grow on soil. There are some interesting soil lichens growing in the pockets of soil of the garigue of il-Majjistral e.g. *Fulgensia fulgens* (yellowish patches with radiating lobes) and *Cladonia foliacea f. convoluta* (bush-like thallus of ascending leafy squamules) shown in the photograph below.

Corticolous lichens prefer the bark of tree trunks and branches e.g. *Xanthoria parietina*, as in picture below.

Other substrates may be exploited by lichens e.g. some lichens are parasitic and grow on other lichens; some lichens grow on metal surfaces.

Lichen growth forms

The growth forms of lichens are based on the shape of the thallus, the arrangement of cortex, medulla, and algal layer within the thallus and the attachment of the thallus to substratum. The following forms are recognised:

Crustose lichens are attached to the substrate over their entire lower surface and have to be scraped off to be removed. They have no lobes or rhizines (rootlike attachments). Crustose thalli are often indistinct and may look like mere discolourations of the substrate. They are the more common form of lichen e.g. *Opegrapha calcarea* (see below left). Some crustose lichens e.g. *Caloplaca flavescens* form pleated edges towards the periphery (see below right). Such lichens are termed placoidioid (crustose-lobate)

In **squamulose** lichens e.g. *Psora decipiens* the thallus is composed of scale-like structures which may be partially free from the substrate.

Foliose lichens consist of flattened, leaf-like, often branched lobes which attach loosely to substrate from parts of their lower surface e.g. *Xanthoria parietina.*

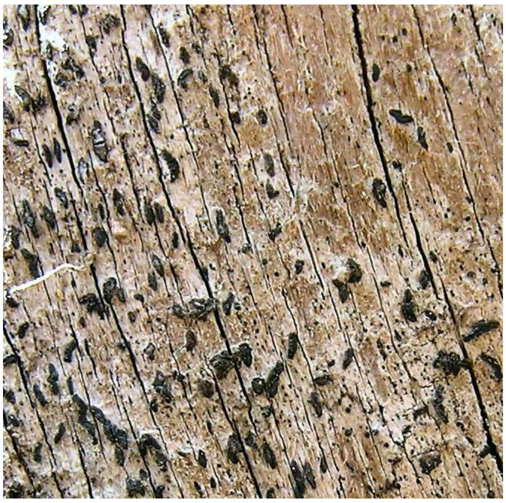
Fruticose lichens are bushy, strap-like, or hairlike in form and are attached to substrate at a single point or not at all e.g. *Roccella phycopsis* shown left.

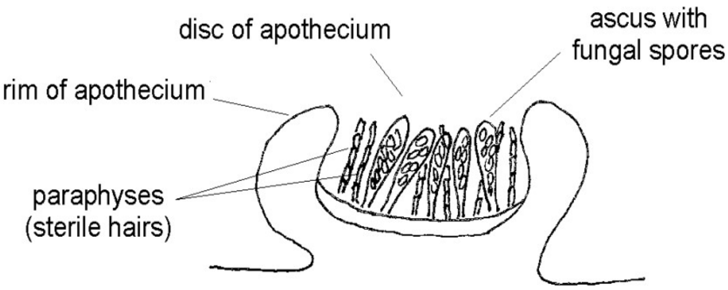
Reproduction in lichens

Lichens can reproduce both sexually and asexually but remember that only the fungal partner reproduces sexually. Most lichens reproduce sexually by the production of spores by the fungal partner but vegetative reproduction is also very common. Many species use both methods

The most commonly seen sexual reproduction structures of the fungal partners are **apothecia** and **perithecia**. Both structures produce fungal haploid spores. These spores must disperse and encounter the alga of the right species in order to grow into a lichen which would be given the scientific name of the fungus.

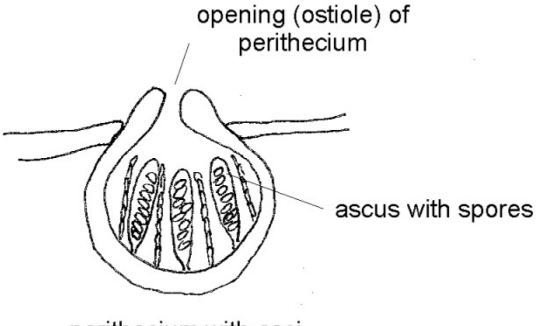
In many lichens apothecia resemble jam-tarts with a rim and an exposed disc. The disc consists of the tips of the sacs that hold the fungal spores. In lecanorine apothecia, the rim differs in colour from the disc e.g. the epiphytic *Lecanora horiza* (below left). In lecideine apothecia the rim and the disc are of the same colour (often black), which is different from the thallus colour. Apothecia are termed sessile if they protrude out of the thallus but lack a stalk. In many species apothecia are immersed within the thallus while in others they are held up on a stalk. Lirellae are elongate and at times branched apothecia e.g. *Opegrapha varia* (below right)





An apothecium in vertical section showing asci with spores

Perithecia are sexual reproductive organs in which the spore-producing region folds in, leaving an opening to the outside for spore dispersal e.g. *Pyrenula chlorospila*. Perithecia may be either totally immersed within thallus or may form small protrusions above the surface of thallus.



perithecium with asci and spores

Vegetative reproduction

Lichens can form vegetative propagules containing both algal and fungal components. These get dispersed by wind, rain and animals and can grow into a new lichen once they find the right substrate. Such propagules include soredia and isidia e.g. surface of *Xanthoria calcicola* covered with isidia shown below. With some lichens vegetative propagation takes place when a piece of the thallus is accidentally broken off.

Lichens as pollution monitors

A lichen absorbs most of its mineral nutrients from the air and rainfall. This is because unlike higher plants they lack a protective cuticle. Pollutants such as heavy metals, oxides of sulfur, radioactive elements, oxides of nitrogen and ammonium compounds accumulate inside their thalli. Sulfur dioxide (SO_2) is especially lethal to lichens because it lowers pH and deteriorates chlorophyll, which causes photosynthesis to cease. Lichens have been used to monitor the amount of pollutants in an environment. This is done by observing the condition of lichens as well as their chemical composition. *Xanthoria parietina* is tolerant of high levels of nitrogen especially ammonia and is common on trees and buildings near pig and cow farms. This lichen can be used as a monitor for nitrogen in the atmosphere.

Conclusion

Il-Majjistral is endowed with interesting communities of lichens. Whilst lichen identification is often tricky, lichen observation is an activity everybody can enjoy. Be ready to get as close as possible to the lichen. For ground lichens this may mean having to kneel down so it is worth carrying a piece of foam to cushion your knees from the rough ground. Note the substrate the lichen is growing on and observe the size, colour and growth form of the lichen. Observe also the size, shape and type of fruiting bodies. Use of a small X10 magnifying glass is highly recommended. A mere tenfold increase in magnification can present a new world of interesting features. **You do not have to end up with a scientific name in order to appreciate lichens!**

The following is a list of some of the lichens found at il-Majjistral Park. The words in brackets denote revised scientific epithets based on recent molecular studies.

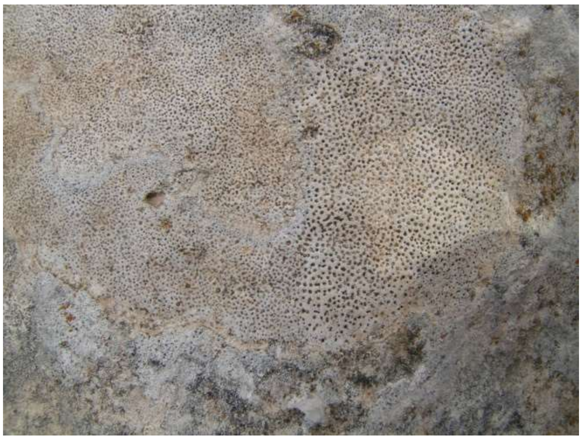
Sa: saxicolous Te: terricolous Co: corticolous
Cr: Crustose Fo: Foliose Fr: Fruticose S: Squamulose

1	*Aspicilia (Circinaria) calcarea*	Sa	Cr
2	*Bagliettoa parmigerella*	Sa	Cr
3	*Caloplaca (Variospora) aurantia*	Sa	Cr
4	*Caloplaca (Variospora) flavescens*	Sa	Cr
5	*Cladonia foliacea* f. *convoluta*	Te	Sq
6	*Cladonia pyxidata*	Te	Sq
7	*Cladonia rangiformis*	Te	Sq
8	*Clauzadea immersa*	Sa	Cr
9	*Collema (Enchylium) tenax*	Te	Fo
10	*Diploicia canescens*	Sa Co	Cr
11	*Diploschistes muscorum*	Te	Cr
12	*Diploschistes diacapsis*	Te	Cr
13	*Diplotomma alboatrum*	Sa	Cr
14	*Dirina massiliensis*	Sa	Cr
15	*Fulgensia (Gyalolechia) fulgens*	Te	Cr
16	*Lecania spadicea*	Sa	Cr
17	*Lecanora (Myriolecis) albescens*	Sa	Cr
18	*Lecidella stigmatea*	Sa	Cr
19	*Opegrapha (Arthonia) calcarea*	Sa	Cr
20	*Opegrapha variaeformis (Alyxoria variiformis)*	Sa	Cr
21	*Placidium (Clavascidium) lacinulatum*	Te	Sq
22	*Placidium (Clavascidium) semaforonense*	Te	Sq
23	*Placidium tenellum*	Te	Sq
24	*Psora decipiens*	Te	Sq
25	*Roccella phycopsis*	Sa	Fr
26	*Squamarina cartilaginea* var. *cartilaginea*	Sa Te	Sq
27	*Squamarina concrescens*	Sa	Sq
28	*Toninia aromatica*	Te	Sq
29	*Verrucaria nigrescens* f. *nigrescens*	Sa	Cr
30	*Xanthoria calcicola*	Sa	Fo

Updated August 2017 - Jennifer Fiorentino

<u>Pictures of different species of lichens - below</u>

Aspicilia calcarea



Bagliettoa parmigerella

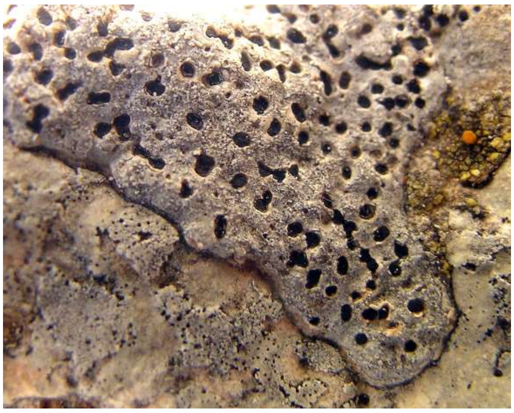
Caloplaca aurantia

Caloplaca flavescens

Cladonia foliacea f. convoluta

Cladonia pyxidata

Cladonia rangiformis



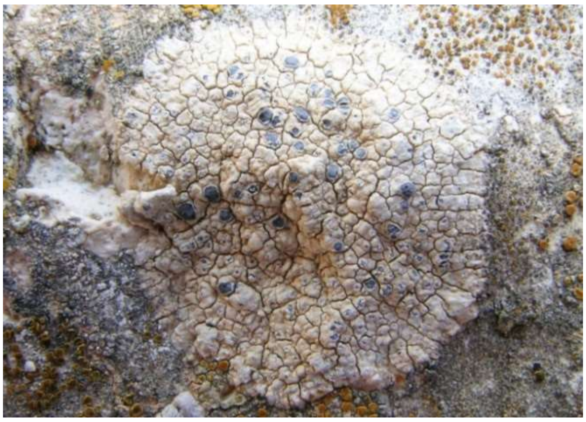
Clauzadea immersa

Collema tenax

Diploicia canescens

Diploschistes muscorum

Diploschistes diacapsis



Diplotomma alboatrum

Dirina massiliensis

Fulgensia fulgens

Lecania spadicea

Lecanora albescens

Lecidella stigmatea

Opegrapha calcarea

Opegrapha variaeformis

Placidium lacinulatum

Placidium semaforonens

Roccella phycopsis

Squamarina cartilaginea ssp cartilaginea

Squamarina concrescens

Toninia aromatica

Verrucaria nigrescens

Xanthoria calcicola

Placidium tenellum

Psora decipiens

Psora decipiens

Photos: Jennifer Fiorentino

Il-Majjistral Nature and History Park
Malta