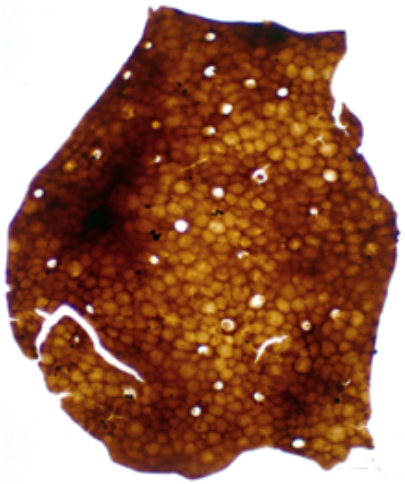
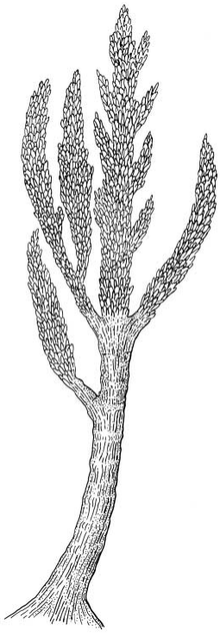
Ancient Tiri Part 10: Adventures in "Deep Time". The Lichens.

For visitors, lichens are one of the most eye-catching features on Tiri. Appearing bright and conspicuous as you ascend the steep road towards the Wharf Dam, they form colourful yellow splashes on the greywacke rocks flanking the track. Further up the tracks they grace the tree trunks and branches of our trees with an intricate veil of life – tiny ecosystems in their own right.



A fossil nematophyte. *Wikimedia*

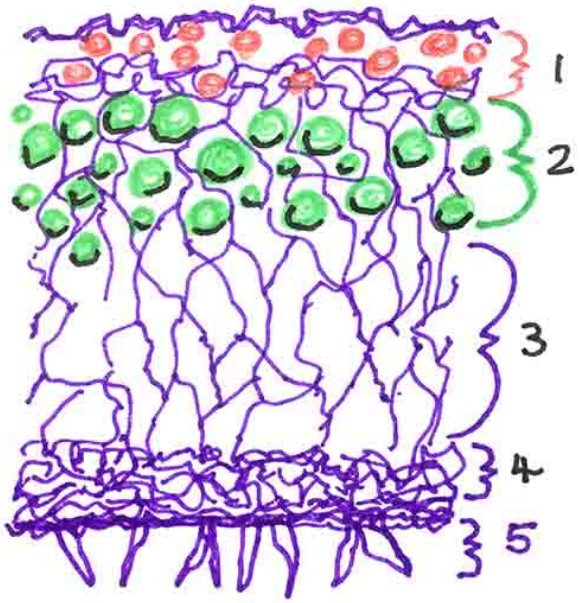


Protaxites

Lichens are the result of *mutualistic* partnerships between several different species of *fungus* (called the *Phycobiont*) and *photosynthetic algae* (the *Photobiont*) living together for mutual benefit (Mutualism). These partnerships evolved very soon after the appearance of the first fungi. The oldest certain fossil lichen is Early Devonian (about 400 million years old) from the Rhynie Chert, near Aberdeen, Scotland. At about this time, there were several very strange plant-like organisms living on land, including the mat-like nematophytes, crust-like spongiophytes, and the huge, tree-like *Prototaxites* (which was originally described as a fossil conifer trunk). Under the microscope, these can be seen to be made up of intertwining fungus filaments, and some palaeontologists have proposed that these fossils are actually unusual lichens. Spongiophytes may plausibly be lichens, but others think the microscopic filaments that make up nematophytes and *Prototaxites* lack the typical branching patterns of fungal hyphae. They suggest they probably represent isolated offshoots of an algal lineage, "unsuccessful experiments" in colonizing the land, which left no descendants. We may never know for sure.

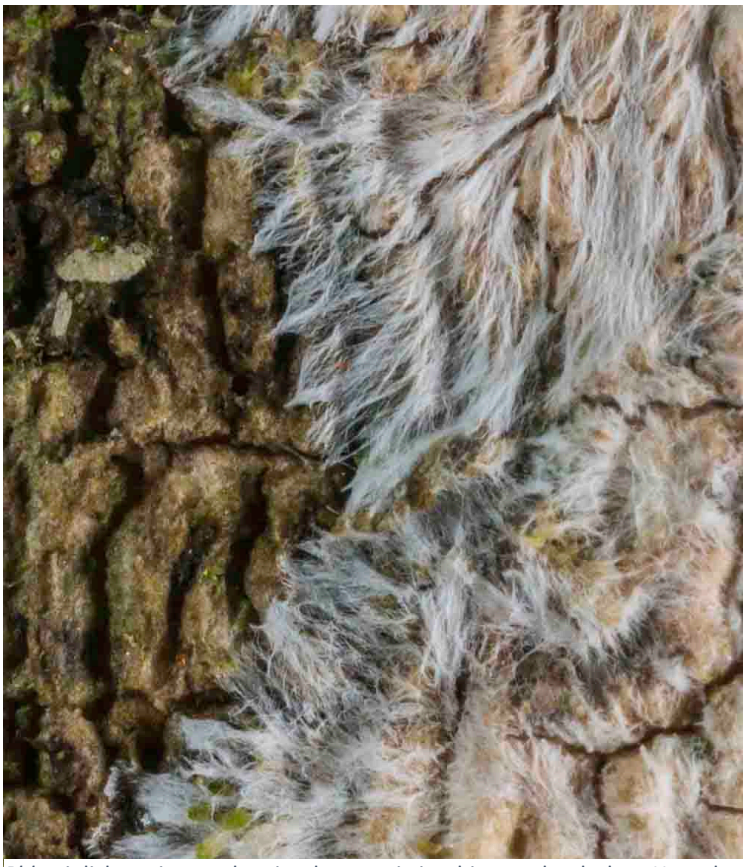
35% of all known lichens worldwide are made with just *two species* of fungus. Most of the fungus species involved are capable of living *independent lives* as saprophytes feeding off dead wood and the like. The photobionts too are capable of living independently outside the lichen partnership.

Algae are not the only mutualistic partners involved. In some lichens *cyanobacteria* (blue-green "algae") occur instead of green



algae, and often *yeasts* (single celled fungi) are found in certain lichen species.

The main flattened part of the body of the lichen is called the *thallus*, and is composed of a tangled fungal mat with a *tough dense* top "Rind" (or *cortex*) often impregnated with yeasts (1), which impose a characteristic *colour and shape* to the lichen. These special pigments shield the photobionts from excessive damaging UV light. Below this protective layer lies the *spongy upper medulla* (= middle) where photosynthetic algae/cyanobacteria are located (2). Spaces in the medulla below allow *gas exchange* (3), and below this is found the lower cortex (4) with hair like *Rhizines* (5) which *anchor the lichen* to the substrate.



Phlyctis lichen gives mahoe its characteristic white trunk splashes. Here the photo shows the fungus component at the edge of the lichen. J.S.

Lichens occur in 3 main thallus forms:

1. 

2. 

3. 

1. *Crustose* = a *flattened, encrusting* thallus with no free edges.
2. *Foliose* = *leaf like*, flattened with *free curling edges, Xanthoparmelia* or *Heterodermia sp*?
3. *Fruticose* = *branched* with a freely hanging thallus resembling tiny *tree branches*. *Usnea*.

Physcia adscendens has green algae as photobionts. Dark coloured *Leptogeum* and *Collema* have cyanobacterial photobionts. *J.S.*

Lichens that partner with green algae often have a grey or grey/green appearance when dry (and a more vivid green colour when wet). Lichens partnering with cyanobacteria are often black or a dark greenish brown in colour when dry (and have a black, gelatinous rubbery appearance when wet).
Lichens are superb *survivors in extreme environmental conditions*. Not only are they amongst the longest living organisms known, they also have the ability to shut down their metabolic processes almost completely during dry spells, reviving again within minutes when rain wets them. Tiri is a very dry island, and our lichens spend a good part of the year in suspended animation, "coming to life again" when wet conditions allow.
Despite their toughness lichens are very *vulnerable to air pollution* (foliose and fruticose forms especially) in the form of sulphur dioxide and nitrogen oxides which are responsible for acid rain. Their presence or absence in a particular place can *indicate air quality* – a feature used by environmental scientists.

Lichens are often the first species to colonise *bare rock* (called *pioneer* organisms). They secrete acids which dissolve and *erode the rock* beneath them releasing grit particles and minerals which combine with organic matter to form soil in which other plants can take root and establish themselves, driving an important ecological process called *primary succession* where bare ground/rock slowly develops into scrub then forest.

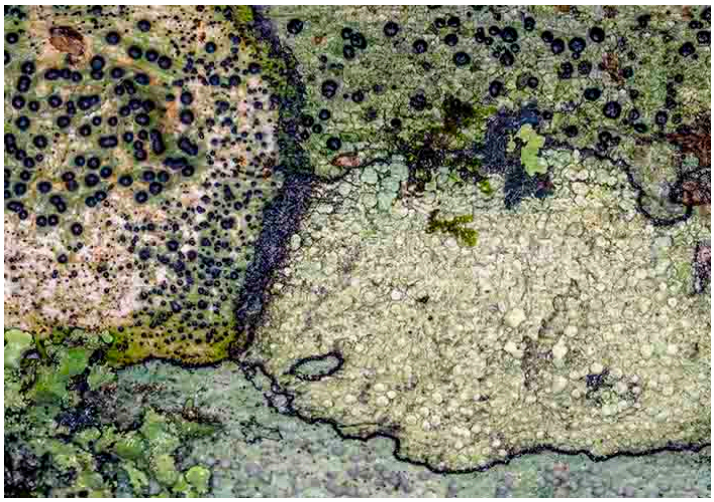
Here *Xanthoparmelia* lichen has formed soil particles from solid rock, allowing grasses and other plants to root and grow. J.S.

Reproduction in lichens involves the fungus partner and can be sexual or asexual. The commonest asexual reproductive structures seen on the tops of many lichens are the round knobbly objects call apothecae. Strictly speaking these are the *fungal* reproductive structures, the photobionts are “taken along for the ride” when these structures disperse to form *new lichen colonies*.
Sometimes delicate fuzzy areas are seen on the thallus called phyllidia (see *Leptogeum* above), fragments of which can easily break off in wind or rain to grow elsewhere asexually where conditions permit. Most lichens easily fragment when brittle when dry, and each tiny piece has the potential to form a new lichen.

It is often said that lichens do no serious harm to trees when they use them for support. This is not strictly true because although they are merely epiphytes and are not harming the tree as parasites would, they do have a considerable effect on the *wind resistance properties* of a trees twigs and branches. They could seriously reduce a trees ability to survive gale force winds. Trees go to considerable lengths to ensure that lichens and other epiphytes *do not grow* on them. They do this by *regularly shedding the outer layers of bark* on their twigs, getting rid of developing lichens as they do so. A sickly weak tree cannot do this efficiently and will often have masses of lichens festooning its branches. Look out for this as you climb Coronary Hill on the way back to the Visitor Centre. On the right you will see several shrubby Karo trees. Some are plainly struggling in the poor soil conditions there, and are smothered in fruticose lichens. A short distance further up the hill you can see healthier Karo specimens almost devoid of lichen cover.

In the same way, you will often find fallen dead twigs on the tracks covered in lichens. Examination reveals these have usually been dead for some time allowing the lichens to grow on them unhindered before eventually snapping off in the wind and falling to the ground. Living healthy twigs show *markedly less* lichen growth.

Crustose lichens probably do damage to trees by *blocking breathing pores called lenticels* in branches and trunks. Again, trees already weakened by environmental stress are probably most at risk as they will have a reduced ability to *slough off bark flakes* to clear their surfaces. The photos below show the same section of mahoe trunk covered with crustose lichens. They were taken five years apart, and reveal no effective attempt by the tree to slough them off. The tree itself is sickly and in decline. The pictures also show interspecific competition between the different lichen species on this branch. A black “no-man’s-land” delineates the boundary between the opposing crustose species, probably caused by the production of *defensive chemicals*. This is rather like corals “fighting” on a reef for space, as they attack and digest each other’s soft tissues at the boundary where they meet. Foliose lichens may initially grow over them but this success short lived and before long they are repelled and fall away.
It rather nicely Illustrates the “slow-motion” nature of lichen growth and interactions. Are these *really* “war zones” or *peaceful boundaries*?



A good key to identify the foliose lichens of NZ can be found at:
http://nzpcn.org.nz/publications/NZ_FOLIOSE_LICHEN_KEY_low_res_April_2011.pdf

In our next issue of Ancient Tiri we shall look at the clubmosses and the animal life that roamed amongst them.

John Sibley 2019