Tree Lungwort

(*Lobaria pulmonaria*)

This large and distinctive lichen is a composite organism containing 3 different species and is an indicator of ancient forests.

Worldwide distribution

Tree lungwort is a widely-distributed species, occurring in much of the northern part of the northern hemisphere. Its range encompasses central, northern and western Europe (including the UK and Ireland), Russia, China, Tibet, India and Iran, and it also occurs in the epiphyte-rich laurel forests of Madeira and the Canary Islands, off the northwest coast of Africa. In North America it is distributed along the west coast from Alaska to central California, and in the east from Newfoundland south through the Appalachian Mountains and in the Great Lakes region. Tree lungwort has also been recorded in the cloud forests of Costa Rica.

Tree lungwort on the trunk of a goat willow (Salix capraea) *in Glen Affric.*

Within its range in North America, tree lungwort is considered an indicator species of old growth forests, where it is often abundant. In various European countries, however, such as Switzerland, it is classified as threatened or endangered, because of habitat loss and the reduction of its range due to the effects of airborne pollutants, especially sulphur dioxide.

Distribution in Scotland

In Scotland, tree lungwort grows mainly in the western half of the country, where the wetter climate provides the higher levels of moisture that it needs to thrive. It occurs throughout the western part of the mainland, from Caithness to Argyll, and on Orkney, Lewis, Harris, Skye and other isles in the Inner Hebrides. It has also been recorded on St. Kilda. Elsewhere in the country, tree lungwort occurs more sparsely at sites in Ayrshire, Galloway, the Borders, Perthshire, Strathspey and Moray. In Glen Affric it occurs in the gorge of the Affric River and in woodland on sheltered north-facing slopes.

South of the border, tree lungwort has been greatly reduced in range since the 19th century because of atmospheric pollution and is now restricted mainly to a few sites in the Lake District, Wales and the southwest of England.

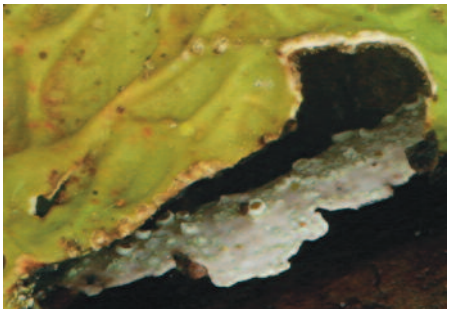
Physical characteristics

Tree lungwort is a foliose, or leaf-like, lichen in the Lobariaceae family. It is one of the largest lichens, and its thallus (as the body of a lichen is known) has a distinctive, lobed growth form. It is bright green in colour on the upper side when it is wet, but this turns more olive-brown in dry conditions, while the underside is a pale creamy white colour. The surface of the thallus consists of a series of ridges and hollows, and it is this that has given rise to the common name of 'lungwort' and the specific epithet, 'pulmonaria'. In centuries gone by, under the 'Doctrine of Signatures', as formulated by herbalists in the Renaissance era, the use of plants was thought to be indicated by their physical form, and this lichen was used for treating respiratory problems because of its resemblance to the structure of a lung.

Detail of the lobed thallus of tree lungwort, showing the convoluted surface of ridges and hollows.

The lobes of tree lungwort are from 8 – 30 mm wide, up to 180 mm long and may branch two or three times, giving the thallus a complex and characteristically fractal shape. Lichens are generally very slow in their growth, but tree lungwort is one of the fastest species, growing at up to 4 mm per year, so that large specimens may be up to 50 years old.

As a lichen, tree lungwort is a composite organism, containing both a fungal partner, or mycobiont, and an algal partner, or photobiont. The fungus, which gives the lichen its scientific name, provides the rigid physical structure and anchorage for the composite organism, and the algal partner, which in the case of tree lungwort is *Dictyochloropsis reticulata*, provides the ability to gain energy from the sun through photosynthesis. This partnership between fungus and alga is a mutualistic symbiosis, in which both partners benefit from the presence of the other. The algal partner gains the ability to thrive out of water, through being protected from desiccation, or drying out, by the physical structure of the fungus, while the fungal partner, which cannot harvest the sun's energy directly itself, gains access to the nutrients that the alga produces through photosynthesis.



Here, the green upper side and the whitish-coloured underside of the thallus can both be seen. The wart-like structures visible on the underside are a separate fungus growing on the lungwort, most likely Nanostictis christiansenii.

Detail of the thallus of tree lungwort, showing the apothecia. These brown discs are the reproductive structures that release the fungal spores.

Tree lungwort is one of the lichens that consists of a three-way, or tripartite, partnership – in addition to the fungus and alga, it also contains a cyanobacterium (*Nostoc sp.*). Cyanobacteria were formerly known as blue-green algae, but have recently been shown to be types of bacteria, unrelated to algae. The cyanobacterial partner, or symbiont, in tree lungwort gains energy from the sun through photosynthesis, and is also able to absorb nitrogen from the atmosphere and 'fix' it into the thallus of the lichen. The cyanobacteria occur inside small structures called cephalodia that are distributed within the thallus. The algal partner in tree lungwort exists underneath the cortex or upper layer of the lichen, and above the medulla, which is a loosely arranged layer of fungal hyphae. It is the algal partner that gives tree lungwort its bright green colour when wet, as it requires moisture for photosynthesis to take place.

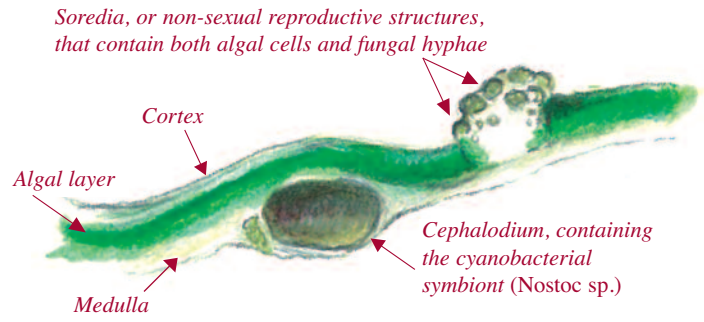


Illustration showing a section through the thallus, or body, of tree lungwort.

Reproduction in lichens occurs, in principle at least, through both sexual and asexual means, although the latter is considered to be the more common and successful of the two methods. It is only the fungal partner that can reproduce sexually, through the production of spores, so for a new lichen to develop by this method, a spore must germinate in a site where its algal partner occurs separately, which is relatively rare. In tree lungwort, fungal spores are produced in fruiting bodies called apothecia. These are reddish-brown in colour and occur infrequently on the upper surface of the thallus.

Asexual or vegetative reproduction takes place in lichens through the production of tiny structures called isidia and soredia, which contain both algal cells and fungal hyphae. In tree lungwort, these occur along the ridges on the upper side of the thallus. The isidia and soredia break off at their base and are dispersed by wind and rain. If they reach a suitable substrate, such as the bark of a tree or a rock surface, they will then grow on to form a new lichen. In Scotland tree lungwort occurs on trees such as rowan (*Sorbus aucuparia*), hazel (*Corylus avellana*), aspen (*Populus tremula*) and willows (*Salix spp.*).

Like most arboreal lichens, tree lungwort is an epiphyte, meaning that it will use a tree for support, without taking any nutrients from it. Instead it derives its nutrients from the sun, through photosynthesis, from organic material that accumulates where it is growing, and from the air, through the ability of its cyanobacterial partner to absorb nitrogen from the atmosphere. It is this latter characteristic that renders tree lungwort susceptible to airborne pollution, and has led to its disappearance from large parts of its former range in England and elsewhere in Europe.

Ecological relationships of tree lungwort

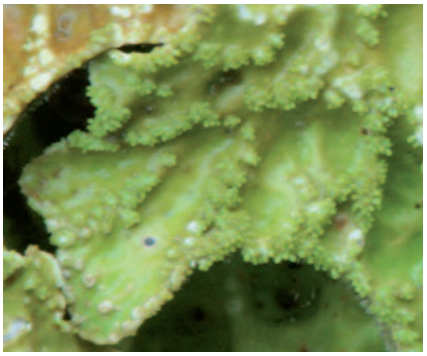
Despite its relatively small size and, in Europe at least, its comparative scarcity, tree lungwort is nonetheless an important component of the forest ecosystems where it occurs. It is treated as an indicator of old growth forests in North America, and, especially in the Pacific Northwest region, it is common and abundant. It is likely that it was similarly so in Europe before our forests were heavily modified by humans, and, in Scotland at least, reduced to such a small fraction of their original extent.

Because of the ability of its cyanobacterial symbiont to fix atmospheric nitrogen, tree lungwort makes a significant contribution of nitrogen to the forest ecosystem, when fallen thalli decompose in the litter layer. A closely-related species, *Lobaria oregana,* has been recorded as occurring at densities of over 1 tonne per hectare in the Pacific Northwest forests of North America, and as adding over 15 kg. of nitrogen per hectare to the soil each year. The decline of tree lungwort in European forests therefore represents a significant loss of a natural source of nutrients.

Fallen lungwort amongst leaves near Badger Falls in Glen Affric. When the lichen decomposes, the nitrogen it absorbed from the air will become available as a nutrient for other plants.

Tree lungwort is eaten by a range of organisms, including molluscs, such as snails and the European black slug (*Arion ater*), and caribou or reindeer (*Rangifer rangifer*). In the northeast of North America it is apparently a favourite food of moose (*Alces alces*), and this is likely to have been the case in Scotland too before moose were extirpated about 1,000 years ago.

A range of other fungi are associated with tree lungwort, including parasites such as *Dactylospora lobariella* and a brain fungus (*Tremella lobariacearum*) that grow on the thallus. One study in the western Pyrenees recorded 21 species of parasitic fungi growing on tree lungwort. *Plectocarpon lichenum* is a fungus that forms galls resembling apothecia on the thalli of tree lungwort, and is host specific, meaning that it occurs on tree lungwort and nowhere else. Another fungus (*Endophragmiella hughesii*) contributes to the decay of fallen pieces of lungwort thalli.



Close up of tree lungwort, showing the isidia and soredia on the ridges of the thallus.

Humans have long utilised tree lungwort, not only as a treatment for lung diseases, but also as a source of natural dyes and, in India, for treating eczema and haemorrhages, while in Siberia it was used as a flavour for beer.

Text and photographs by Alan Watson Featherstone. Illustrations by Caragh McAuley.
Printed with vegetable oil-based inks on recycled paper made from 80% post-consumer waste by Big Sky, Findhorn.

TREES FOR LIFE