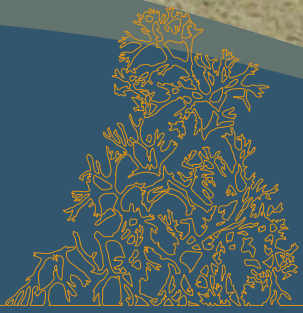
Plantlife

Heavy-metal lichens in Wales

A management guide



Introduction

They create spectacular living tapestries of colour, yet are found in places where most other life cannot survive. Meet the metallophyte lichens – part of a remarkable group of plants and fungi which live on rocks and soil that are rich in heavy metals.

In Britain over 80 species of lichen (and fungus that live on lichen) have been found on land containing one or more of the metals copper, zinc, iron and lead. This leaflet is a guide to their conservation in Wales. It is aimed at anyone who has an interest in such sites – explaining why many of the species they support are rare and special, and how best to look after them.

Cover: the survival of heavy-metal lichens and fungi rests largely on the conservation of man-made habitats such as former mine workings. Image by Ray Woods

A recipe for conservation

Our exploitation of metal-bearing rocks since the Bronze Age has been so extensive that today there are few natural outcrops rich in heavy metals. The survival of metallophyte lichens and fungi therefore rests largely on the conservation of man-made habitats. Deposits of lead, zinc, copper and iron lie scattered throughout upland Britain, with concentrations in south-west England, central Wales, the Pennines, and the Southern Uplands and Central Highlands of Scotland. However, some of the best examples of metal-rich habitat in Britain are found in the remains of metal mine workings in mid and North Wales.

The scarcity and vulnerability of metallophyte lichens and fungi in Wales is recognised by their listing in Section 42 of the Natural Environment and Rural Communities Act (2006) as being in need of special protection. Plantlife has also identified the Cambrian Mountains Orefield as being an Important Plant Area for the same reason. A few areas have statutory protection but the conservation of most sites is still dependent on the goodwill of owners and occupiers.

Known as coral lichen due its pale grey coral-like appearance, *Stereocaulon vesuvianum* is commoner in the uplands, especially on metal-rich rocks. Three varieties are now recognised

Lichens – the lowdown

Lichens are composite organisms made up of fungi and algae living in a mutually beneficial relationship. The body of a lichen is a species of fungus which houses one or more types of alga or cyanobacterium (occasionally both). Other specialised fungi (called lichenicolous fungi) have evolved to live on and parasitise lichens, creating still further diversity.

Some lichen and fungus species are more frequently found on metal-rich sites, though how they survive in such toxic environments is not fully understood. Some produce chemicals that neutralise the toxins, turning them into harmless insoluble compounds. In time the lichen can change colour, becoming orange where iron is present and green in copper-rich areas.

The unusual chemical methods they use to protect themselves may prove valuable to the human economy. Lichens have great potential to clear sites of toxic waste, for example. They are also useful for showing where there are metals in the rock or soil.

Lichens and fungi on metal-rich sites come in two sorts. Some species have only ever been found in metal-rich sites suggesting they have evolved to require the presence of such metals. Others grow elsewhere, such as mountain tops, but live also in metal-rich sites where the toxicity keeps competing species in check.

While some metallophyte lichens occur only on rock and are identifiable year-round, others are confined to soil or moss cushions and often can be identified only during winter and early spring when in fruit.

The coral lichen *Stereocaulon glareosum* lives on bare toxic soil that's low in nutrients. As this lichen ages it releases nitrogen compounds allowing other plants to colonise the ground

The tiny yellow spheres are the fruit bodies of a fungus of the genus *Thelocarpon* that has parasitised the grey lobes of the lichen *Baeomyces rufus*

With its orange-brown fruits, the lichen *Lecanora gisleriana* is confined to rocks rich in zinc or lead. Its colonies appear to take over the lobes of other metal-dependent lichens of the genus *Lecanora*

The orange crusts of the lichens *Acarospora sinopica* and *Rhizocarpon oederi* have taken up iron from the rock on which they grow and rendered it insoluble so as not to cause them harm

The minute stalked rose-pink fruits of *Dibaeis baeomyces* are distinctive, although when absent the species appears as a whitish-grey crust dusted with rounded vegetative propagules called schizidia that provide an alternative means of reproduction

With its red fruits crowning wide cups, *Cladonia diversa* is a conspicuous and common lichen of acid environments. It was once used to treat wounds owing to the usnic acid it contains having antibiotic properties

How important is a site?

Assessing the importance of sites is not easy and needs expertise. Diversity of species is one measure. Any site with a significant number of the lichen species listed at the end of this leaflet warrants protection and active conservation. The presence of other metallophytes – certain mosses, liverworts, ferns and flowering plants – can also increase the conservation value of sites. Natural rock outcrops or soils supporting metallophyte species are so rare that they are considered to be of greatest importance.

Ystumtuen Mine, Ceredigion. These tips are an important habitat for lichens on both soil and rock. The foreground is grey with the coral lichen *Stereocaulon*

Metal-rich habitats

Natural rock outcrops and screes where mineral veins reach the surface. Because of our extensive mining over millennia only fragments of such habitat remain.

Semi-stable river gravels rich in lead and zinc. These might once have occurred naturally but are now largely the product of recent mining.

The remains of metal-mine workings including buildings and equipment. Well-lit rock around the tops of shafts and the entrances to tunnels (adits) can also support species of metallophyte lichen (see page 8). Metal-mine spoil heaps can be particularly important (left), especially if undisturbed or made of large rock containing heavy metals.

Paths, tracks and railway lines. Mine spoil has been used to surface paths, forest tracks, railway lines and even graves as its toxicity keeps weeds at bay. For example the Fan lead mines near Llanidloes, Powys, provided material for the Cambrian Railway and the Central Wales Railway. More than 40 years after the latter's closure the metal-rich ballast is still remarkably weed-free, providing excellent habitat for metallophytes on the Radnorshire Wildlife Trust's nature reserve at Gilfach Farm near Rhayader, Powys.

Slag tips at metal smelting sites. Although rare, the lower Swansea Valley and the Mendips provide notable examples. In addition there are many, mostly small, ancient sites. Restoration of the once extensive toxic tips in the lower Swansea Valley has now left only small areas for metallophyte lichens. Metal-rich furnace slag however turns up in some very odd places, such as Victorian garden rockeries, and can support notable lichen communities.

Other habitats include building materials containing heavy metals and where stonework, soil or moss has been soaked by run-off from metal structures such as copper window grills, lightning conductors, galvanised wire fencing, electricity pylons and corrugated iron sheeting.

Cwm Ystwyth Mine, Ceredigion (above): the remains of buildings and other structures can provide suitable micro-habitats. Opencast workings such as at Frongoch, Ceredigion (right) create new areas of metal-rich rock that lichens can colonise

Management and threats – top tips

Gravel banks beside the Afon Ystwyth, Ceredigion

River gravels

The lichens of metal-rich river gravels throughout Wales are increasingly threatened by the colonisation of woody plant species and a decline in the natural renewal of gravel banks. This appears to be due to the man-made stabilisation of river channels in recent decades. The possible causes include the increased use of block stone revetments to contain river erosion, a reduction in the number of extreme flooding events and a reduction in grazing by both domestic stock and rabbits that formerly kept scrub and tree growth in check. It is advisable to find solutions to erosion problems that ensure gravel deposition is not affected and grazing encouraged.

Archaeological digs

Small, remote trial mining sites can damage lichen communities. Before every dig, it is advisable to carry out a detailed lichen survey to work out which areas to leave undisturbed. Where conflicts are unavoidable it's vital that a lichen expert (lichenologist) is consulted to advise on best practice. Temporarily moving lichens with their substrates to safe ground should be considered a last resort and is only feasible where the lichen interest is highly localised. The lichens must be returned to their original and exact position as quickly as possible. Such action, however, is highly specialised, may require licensing and success cannot be guaranteed.

Likewise, we advise that remedial work after digs should follow an assessment of the lichen interest and plans should be made to minimise damage.

Spoil tips

The best tips for lichens are those with large, undisturbed, metal-rich rocks in sunny positions. Small, remote trial mining sites where the recovery of metal-rich rocks was uneconomic can be more important than their size would suggest. The tips of finely ground, sludge-like particles are generally of less interest unless colonised by mosses and liverworts receiving lime-rich water.

Tips should be kept free of shading trees and shrubs wherever possible, but with disturbance kept to a minimum. Feeding livestock on, or close to tips can lead to dung accumulating which can kill lichens. Fencing may be needed to control off-road vehicle access and to reduce the risk of the removal of the tip material for hardcore. In grazed sites such fencing should not impede grazing stock.

Rock outcrops, open cuts, shafts and tunnel entrances (adits)

Lichens generally require well-illuminated conditions. If such sites have to be fenced off for safety reasons and cannot continue to be grazed, increasing levels of shade from developing vegetation may become a threat. Regular clearance of shrubs and trees is advised. The gating or fencing of tunnel entrances should be done so as not to significantly reduce light levels at the entrance. For example, gates can sometimes be placed well inside the adit.

Disused shafts, wheel pits and open cuts can be dumping grounds for rubbish. If possible, barrier fencing to reduce fly-tipping should be sited to allow grazing stock unhindered access.

Close cooperation between builders and lichenologists has led to the sensitive restoration of this chimney at Cwmsymlog Mine, Ceredigion

Old buildings

Disused buildings can support a great range of metallophyte lichens. However, the theft of stone and collapse of neglected structures can greatly diminish the importance of a site. Before attempting building restoration,it's best to have a lichen survey so that work can be planned to minimise damage to the lichens.

Other threats

There have been a number of proposals for major wind power stations around mine sites. Such development, with a high demand for hardcore, raises the risk of removal of tips and disused buildings from unprotected mine sites. Environmental impact assessment and careful planning can do much to avoid damage. Where groundworks are to be undertaken, the presence on site of a lichenologist is highly advisable.

In some cases metallophyte lichens have been damaged or destroyed by:

- **Coniferous afforestation**, including leaf fall, shading and colonisation from adjacent plantations.
- **Reuse of old mines.** Where mines, on being considered brownfield sites, are put to other uses such as timber processing.
- **Off-roading,** car rallying and motorcycle scrambling.
- **Remediation schemes** aimed at reducing the area of contaminated land and the impact of heavy-metal rich run-off on rivers and streams.

Greater awareness, careful planning and appropriate advice could have reduced the damage to these rare and special organisms.

Lichens associated with metal-rich rocks and soils in Wales

Any site with more than three of the following species should be considered as a candidate metallophyte lichen site for the purposes of Section 42 of the Natural Environment and Rural Communities Act (2006). This species group is classed as being of principal importance to Wales. Also indicated is the Welsh Lichen Red Data List (*A Lichen Red Data List for Wales,* Woods 2010) threat status and where significant the percentage of the British population that occurs in Wales.

Acarospora sinopica LC	*Rhizocarpon cinereovirens* NT, NR, 55%
Baeomyces placophyllus LC	*Rhizocarpon furfurosum* NT, NS, 56%
Belonia incarnata NT, NS	*Rhizocarpon oederi* LC
Epilichen scabrosus NE	*Sarcosagium campestre* s.l.*
Gyalidea subscutellaris NT, NR, 92%	*Steinia geophana* LC, NS, 34%
Gyalideopsis crenulata DD, NR, E, 100%	*Sterocaulon condensatum* NT, NS, 27%
Lecanora epanora LC	*Sterocaulon dactylophyllum* LC
Lecanora gisleriana VU, NR, 60%	*Stereocaulon delisei* VU, NS, IR, 21%, S42
Lecanora handelii NT, NS, 37%	*Stereocaulon glareosum* VU, NR, 50%
Lecanora subaurea NT, NS	*Stereocaulon leucophaeopsis* NT, NS
Placopsis lambii LC, 37%	*Stereocaulon nanodes* LC, NS
Placynthiella hyporhoda VU, NR	*Sterocaulon pileatum* LC
Polyblastia agraria LC, NS, IR, 40%	*Stereocaulon symphycheilum* VU, NR, 25%, S42
Psilolechia leprosa LC	*Vezdaea* spp. ¥

Key

* The *var. campestre* is LC while the *var. macrosporum* is NT
¥ All *spp.* are LC except for *V. acicularis* which is NT
LC Least Concern
NT Near Threatened
VU Vulnerable
NR Nationally Rare
NS Nationally Scarce
E Endemic (occurs nowhere else in the world)
IR International Responsibility
NE Not Evaluated
% Proportion of British Population in Wales where significant
S42 Also listed individually in Section 42 of NERC Act, 2006

Further reading

Woods, RG (2010) ***A Lichen Red Data List for Wales***. Plantlife.

Dobson, FS (2011) ***Lichens: An Illustrated Guide to the British and Irish Species (6th edition)***. Richmond Publishing.

Fletcher, A (ed.) (2001) ***Lichen Habitat Management***. British Lichen Society and Countryside Council for Wales.

Gilbert, O (2000) ***New Naturalist Lichens***. HarperCollins.

Purvis, W (2000) ***Lichens***. The Natural History Museum.

Purvis, OW and Halls, C (1996) ***A Review of Lichens of Metalliferous Rocks.*** Lichenologist 28:571-601.

More information

The British Lichen Society
www.thebls.org.uk

British Lichens
This website has photos of many metallophyte lichens.
www.britishlichens.co.uk

Lichens of Wales
The website for Welsh lichenologists and all interested in lichens.
www.wales-lichens.org.uk

The Welsh Mines Society
www.welshmines.org

Advice

Plantlife Cymru (see overleaf for details).

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Plantlife Cymru
Speaking up for Wales's wild plants

Plantlife Cymru speaks up for Wales's wild plants. We work to protect wild plants and fungi, and keep the colour in our countryside. Wild plants play a vital role in everyone's lives, cleaning our air and water, and feeding and sheltering insects, birds and animals. They are also critical in the fight against climate change.

Plantlife Cymru manages nature reserves, influences policy and legislation, and runs events to help people celebrate wild plants and fungi. We also work with others to promote wild plant conservation for the benefit of all.

Patron: HRH The Prince of Wales.

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