

Lichens and air pollution

Lichens as a measure of air pollution due to sulfur dioxide

Lichens are mutualistic associations of a fungus and an alga. They are very sensitive to sulfur dioxide pollution in the air. After industrialisation, many lichen species became extinct in large areas (e.g. beard moss *Usnea articulata*). This is mainly due to sulfur dioxide pollution, but loss of habitat can also lead to reductions in some species. During the early and mid-twentieth century, air pollution levels in many MEDCs* were much greater than they are today. However, the air quality is declining today in many LEDCs**.

Lichens are widely used as bio-indicators. If air is very badly polluted, there may be no lichens present, just green algae. If the air is clean, lichens become abundant. A few lichen species can tolerate quite high levels of pollution and may be found on pavements, walls and tree bark in urban areas. The most sensitive lichens are shrubby and leafy, whereas the most pollution-tolerant lichens are crusty in appearance. Since industrialisation, many of the shrubby and leafy lichens such as *Ramalina*, *Usnea* and *Lobaria* species have declined in their range.

Some species of lichens have become more widely distributed as they are more tolerant of acid conditions; examples include *Bryoria*, *Parmeliopsis*, *Pseudevernia* and *Rinodina*.

Zonation of lichens

A lichen zone pattern which corresponds to the mean levels of sulfur dioxide experienced may be observed in large towns and cities, or around industrial complexes. Particular species of lichen present on tree bark can indicate the typical sulfur dioxide levels found in that area:

- No lichens present: the air quality is very poor (**zone 1**)
- Only crusty lichens present: the air quality is poor (**zone 3**)
- Leafy lichens present: the air quality is moderate to good (**zone 6**)
- Rare species present: the air quality is very clean (**zone 10**).

The table on the next page details zonation of lichens in increasing levels of sulfur dioxide pollution.

Sulfur dioxide air quality and lichen zones: the *Hawksworth & Rose zone scale* for the estimation of mean winter sulfur dioxide levels in England and Wales, using lichens growing on acidic and non-nutrient-enriched tree bark.

Zone	Moderately acid bark	Mean winter SO ₂ / µg m ⁻³
1	Only algae present, confined to base: <i>Desmococcus viridis</i> .	>170
2	Algae extend up the trunk: <i>Lecanora conizaeoides</i> present but confined to base.	about 150
3	<i>Lecanora conizaeoides</i> extends up the trunk; <i>Lepraria incana</i> becomes frequent on the base.	about 125
4	<i>Hypogymnia physodes</i> and/or <i>Parmelia saxatilis</i> or <i>P. sulcata</i> appear on the base but do not extend up the trunk; <i>Hypocenomyce scalaris</i> , <i>Lecanora expallens</i> and <i>Chaenotheca ferruginea</i> often present.	about 70
5	<i>Hypogymnia physodes</i> or <i>Parmelia saxatilis</i> extend up the trunk to 2.5m or more; <i>Parmelia glabratula</i> , <i>P. subrudecta</i> , <i>Parmeliopsis ambigua</i> and <i>Lecanora chlorotera</i> appear; <i>Calicium viride</i> , <i>Chrysothrix candelaris</i> and <i>Pertusaria amara</i> may occur; <i>Ramalina farinacea</i> and <i>Evernia prunastrii</i> present but largely confined to the base; <i>Platismatia glauca</i> may be present on horizontal branches.	about 60
6	<i>Parmelia caperata</i> present at least on the base; rich in species of <i>Pertusaria</i> (e.g. <i>P. albescens</i> , <i>P. hymenea</i>) and <i>Parmelia</i> (e.g. <i>P. revoluta</i> (except in NE), <i>P. tiliacea</i> , <i>P. exasperatula</i> (in N)); <i>Graphis elegans</i> appearing; <i>Pseudevernia furfuracea</i> and <i>Bryoria fuscescens</i> present in upland areas.	about 50
7	<i>Parmelia caperata</i> , <i>P. revoluta</i> (except in NE), <i>P. tiliacea</i> , <i>P. exasperatula</i> (in N) extend up the trunk; <i>Usnea subfloridana</i> , <i>Pertusaria hemisphaerica</i> , <i>Rinodina roboris</i> (in S) and <i>Arthonia impolita</i> (in E) appear.	about 40
8	<i>Usnea ceratina</i> , <i>Parmelia perlata</i> or <i>P. reticulata</i> (S and W) appear; <i>Rinodina roboris</i> extends up the trunk (in S); and <i>Usnea rubiginosa</i> (in S) usually present.	about 35
9	<i>Lobaria pulmonaria</i> , <i>L. amplissima</i> , <i>Pachyphiale cornea</i> , <i>Dimerella lutea</i> , or <i>Usnea florida</i> present; if these are absent, crustose flora well developed with often more than 25 species on larger well-lit trees.	under 30
10	<i>Lobaria amplissima</i> , <i>L. scrobiculata</i> , <i>Sticta limbata</i> , <i>Pannaria</i> spp., <i>Usnea articulata</i> , <i>U. filipendula</i> or <i>Teloschistes flavicans</i> present to locally abundant.	'pure'

