



OPAL **Air** Survey

Workbook and recording sheets

Please read the workbook before starting the survey

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What is air pollution?

Air pollution is often associated with the deposit of black particles seen on windows, leaves and buildings in urban areas. However, much of the air pollution in Britain today is largely invisible and so more difficult to detect, although you may be able to smell the pollutants from car exhausts, farmyards and heavy industry. In this survey we are interested in pollutants containing nitrogen. These include ammonia and oxides of nitrogen (nitric oxide and nitrogen dioxide). Although nitrogen is essential for the growth of all living organisms, too much nitrogen can cause problems. Ammonia and oxides of nitrogen can stimulate the growth of some plants and fungi but stop others from developing, thereby changing the natural world around us.

In this survey we will be looking for lichens that are known to grow particularly well when they are close to sources of ammonia, as well as lichens that do not like excessive nitrogen in any form. We will also be looking for a fungus, commonly known as tar spot and found on sycamore trees, that we believe is sensitive to air pollution including nitrogen dioxide.

Nitrogen dioxide can cause harm to human health and vegetation. It is one of several pollutants measured regularly at over 130 sites across the UK. We know from these results that the chemical composition of the air has changed considerably over recent decades. Policies to reduce air pollutants and the availability of 'clean technology' have led to a sharp reduction in levels of some pollutants such as sulphur dioxide, although there has been much less impact on nitrogen-containing pollutants.

You can read more about air quality where you live by reading the Air Quality Strategy for England, Wales and Northern Ireland and by visiting the website www.airquality.co.uk.

Why does air pollution occur?

The burning of fossil fuels associated with industrial processes and transport produces large amounts of oxides of nitrogen and microscopic particles. Large urban areas and places close to busy roads have the highest concentrations of nitrogen dioxide (see Map 1 on the fold-out chart). These levels are not generally sufficient to cause harmful effects to most people.

The highest ammonia concentrations are found in the countryside (see Map 2 on the fold-out chart). Ammonia is particularly associated with agriculture. Levels of ammonia may be high in areas of arable farming, where fertilisers are used to improve the growth of crops, and in areas of livestock farming, where ammonia is released in animal wastes.

Bioindicators of air quality

Biological indicators (or 'bioindicators') are species whose presence or performance is sensitive to changes in environmental conditions, and which can therefore be used as indicators of air quality. Lichens and fungi are well known for their sensitivity to air pollution, which is why they are being used in the **OPAL Air Survey**.



OPAL (Open Air Laboratories) is an exciting initiative which has received a grant from The Big Lottery Fund. It is encouraging people to get in touch with nature by enabling them to explore and study their local environments. Through partnerships nation-wide, OPAL is running free, fun projects which anyone can get involved with.

From playing fields and window boxes to backyards or beaches, all spaces are different and all are important. The five year programme will bring scientists and the public closer together, allowing environmental issues to be explored which have both local and global relevance. OPAL aims to inspire a new generation of nature-lovers by encouraging people to spend more time outdoors understanding the world around them.



The OPAL Air Survey

OPAL is running activities that will help us learn a lot more about the way that the natural environment is affected by air pollution. As well as a research centre where plants are exposed to pollution (<http://www3.imperial.ac.uk/opalairecentre>), OPAL is organising this national Air Survey. By getting involved you can find out about the impact of air pollution in your local area and help build up a national picture of the distribution and abundance of lichens and fungi that can be affected by pollution.

The **OPAL Air Survey** has two parts:

- **Activity 1** uses lichens on trees
- **Activity 2** uses a fungus (*Rhytisma*) that causes tar spot on sycamore leaves

In **Activity 1**, lichens growing on tree trunks and twigs are used as bioindicators of nitrogen pollution. Record which are present and which are not. Look out for green and orange algae as well as insects, as these may also be responding to pollution.

In **Activity 2**, a fungus which grows on sycamore leaves is used as another bioindicator of air pollution. Help to map the distribution of tar spot and relate this to differences in air quality across the country.

Full instructions for carrying out both activities can be found in the accompanying fold-out chart. This workbook contains the recording sheets and further background information. Additional copies of the chart and workbook can be downloaded from www.OPALexploreNature.org.

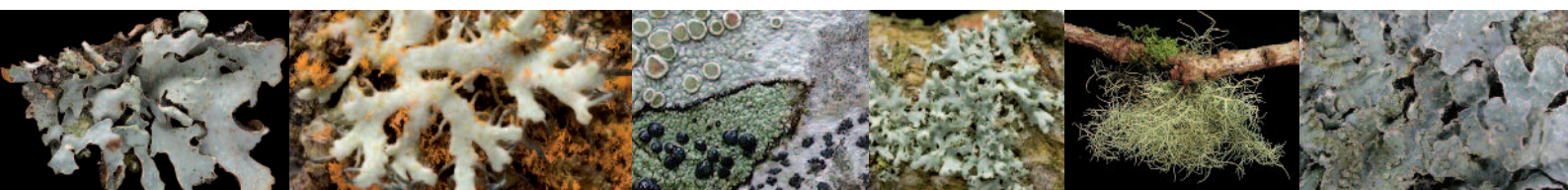


Health and safety

We don't advise you to work on your own. Take a responsible friend who can help with your survey, and in case things go wrong. Make sure that you know what to do in an emergency. Ensure that you have performed a risk assessment where applicable.

Be aware and avoid hazards around trees such as roots, low-hanging branches and falling branches. Cover any cuts or open wounds before starting the activity. Take special care when working around trees to avoid getting twigs in the eye.

Do not damage any tree, its twigs or branches. Be careful not to disturb other plants and local wildlife. Ensure that you have permission from the land-owner to survey lichens and trees on their land. This survey is designed for use in England. Check local conditions if you intend to use it elsewhere.





Activity 1: Lichens on trees

What are lichens?

Lichens are made up of two or more different organisms living together, a fungus and an alga. The fungus provides the body (thallus) in which the algal partner can live, protected from damaging conditions such as high levels of light (ultraviolet radiation) and lack of water (drought). The algal partner provides the essential carbohydrates (food for the fungus) from carbon dioxide and water, with the aid of sunlight. This close, interdependent relationship is referred to as a symbiosis.

What do lichens look like?

Unlike mosses (photograph a) and flowering plants, lichens do not have green leaves or a stem. They may be pale or bright coloured and commonly occur in three forms.



1. Leafy lichens (photograph b) have leaf-like lobes closely or loosely attached to the bark from the lower surface



2. Bushy lichens (photograph c) are branched and shrub-like, attached to the bark at the base



3. Crusty lichens (photograph d) are closely attached as if painted on the bark

In this survey we are only using leafy and bushy lichens. Look out for algae (photographs e and f) that may cover the surface of trunks and twigs in more polluted areas.

Where to find lichens

Lichens will grow on almost any surface including trees, rocks, earth and artificial surfaces such as concrete and tarmac. In this survey we are looking for lichens on trees. Lichens grow best in light and where they are not competing directly with tall grass, shrubs or climbing plants.

Why lichens?

Lichens that are highly sensitive to air quality have been used to detect sources of pollution. In the past, when the air in many places was highly polluted by sulphur dioxide, few lichens could survive, creating lichen deserts around many industrial and urban areas. Lichens are now returning to British towns and cities, and they can still provide a great deal of information about air quality.

Further information

Lichens: An Illustrated Guide to the British and Irish Species. Dobson (2005).

Lichens on Twigs. Wolseley, James & Alexander (2003). Field Studies Council.

Online key to lichens: www.nhm.ac.uk/jdsml/nature-online/lichen-id-guide

British Lichen Society website: www.thebls.org.uk

Additional photographs of lichens at www.OPALexploreNature.org and at www.iSpot.org.uk



(a) Moss



(b) Leafy lichen



(c) Bushy lichen



(d) Crusty lichens



(e) Green algae



(f) Orange algae





Activity 2: **Tar spot of sycamore**

The parasitic fungus *Rhytisma acerinum* causes the appearance of black spots known as 'tar spot' on sycamore leaves. Research suggests that the fungus does not thrive where pollution levels are high, so it could be a useful bioindicator. The fungus spends the winter in infected leaf litter on the ground. In the spring, it produces spores which are transported to newly emerging leaves by the wind and by small insects. The presence of large amounts of infected leaf litter under a tree makes it more likely that new leaves will become infected. Although the spots might be considered unsightly, the fungus is not thought to have a large effect on the vigour of infected trees. Since the fungus is affected by air pollutants such as sulphur dioxide and oxides of nitrogen we expect to find fewer spots on leaves in polluted areas.

Results

Activity 1: Lichens on trees. Lichens are sensitive to local variations in the amounts of nitrogen-containing pollutants in the air and illustrate what conditions are like in your local area.

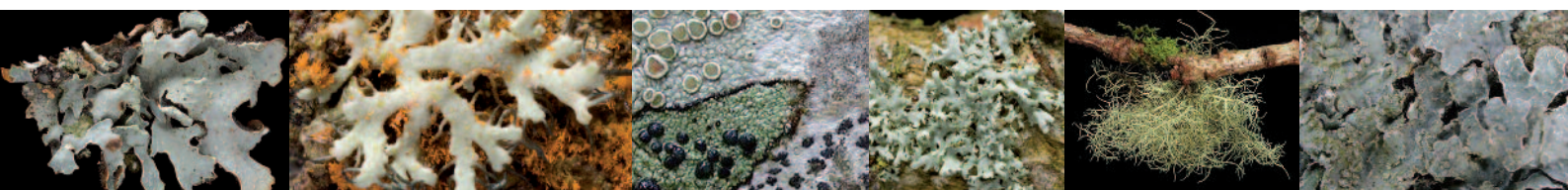
- Clean air sites will have more nitrogen-sensitive species (like *Usnea* and *Evernia*)
- Sites with high levels of nitrogen will have lots of nitrogen-loving species (like *Xanthoria* and *Phycia*)
- If nitrogen-sensitive and nitrogen-loving lichens are growing together, the air quality is probably changing

How is the air quality changing? If you have found lichens on the twigs as well as the trunks then:

- If the twigs support more nitrogen-sensitive species than the trunk, the air quality may be improving
- If the twigs support more nitrogen-loving species than the trunk, the air quality may be deteriorating
- If the twigs are covered in algae, and there are no lichens, the algae are probably preventing the establishment of lichens, indicating high levels of nitrogen pollution

Why is there a difference between trunks and twigs? Trunks have a much older bark surface than twigs, and may have been affected by higher levels of air pollution (for example sulphur dioxide) in the past. However, as twigs grow they produce some new bark surface every year, so the lichens that you find on twigs are more likely to reflect recent levels of air pollution. This survey will help us to gain a better understanding of the impacts of air pollution today.

Activity 2: Tar spot of sycamore. High numbers of spots may indicate relatively clean air. However, while few spots may suggest relatively polluted air, it may also indicate an absence of fungal spores to infect newly emerging leaves.





Activity 1: Results

Date of survey _____



✓ Please tick the appropriate boxes

- How did you participate in the survey today?
- Have you carried out a field survey before?
- Could you identify a lichen before you did the survey?
- Are you interested in air quality where you live?

A Site characteristics

5. Record the location of your site (postcode / OS map reference / GPS reading) and site name

6. Which of these best describes your site?

☐

Street

☐

Playing field / park

☐

Garden

☐

Farmland

☐

Churchyard

☐

Wasteland

☐

Woodland edge

7. Can you see any of the following from any of the trees that you are sampling?

☐

Busy road

☐

Sewage treatment works

☐

Industry / factory

☐

Building site or quarry

☐

Farmland / manure heap

☐

Playing field / park

☐

None of these

B Tree characteristics

Tree 1	Tree 2	Tree 3	Tree 4
Species: _____	Species: _____	Species: _____	Species: _____
Trunk girth: _____ cm	Trunk girth: _____ cm	Trunk girth: _____ cm	Trunk girth: _____ cm

C Record indicator lichens on the trunk

	Amount of each indicator lichen on the trunk of each tree (0, 1, 2 or 3)				
	Example	Tree 1	Tree 2	Tree 3	Tree 4
Nitrogen-sensitive					
1. <i>Usnea</i>	0				
2. <i>Evernia</i>	0				
3. <i>Hypogymnia</i>	1				
Intermediate					
4. <i>Melanelixia</i>	1				
5. <i>Flavoparmelia</i>	2				
6. <i>Parmelia</i>	1				
Nitrogen-loving					
7. Leafy <i>Xanthoria</i>	2				
8. Cushion <i>Xanthoria</i>	1				
9. <i>Physcia</i>	3				
How many other types of lichen?	4				
Type(s) of algae (✓ tick)					
Green	☐	Green ☐	Green ☐	Green ☐	Green ☐
Orange	☒	Orange ☐	Orange ☐	Orange ☐	Orange ☐
None	☐	None ☐	None ☐	None ☐	None ☐



1

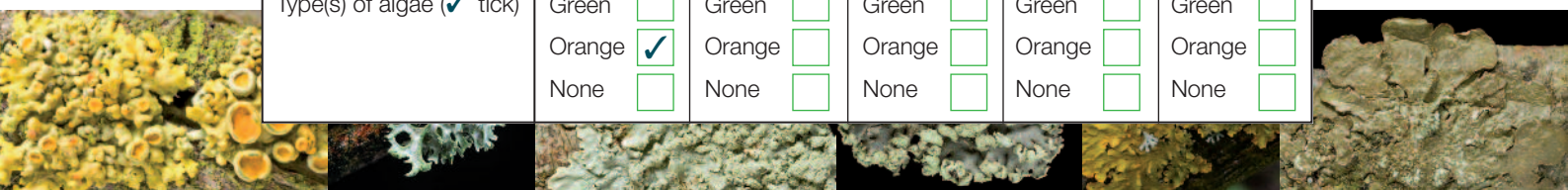


2



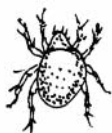
3

Amount of each indicator lichen (0, 1, 2 or 3)

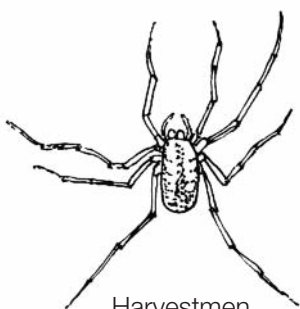




Spiders



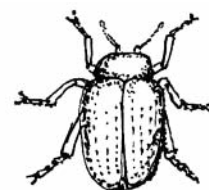
Mites



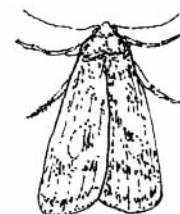
Harvestmen

Use this table to record if you have seen any insects or other small animals on the trunk or twigs of each tree. Record 0 if nothing is present.

	Number of each animal seen				
	Example	Tree 1	Tree 2	Tree 3	Tree 4
Spiders	0				
Mites	2				
Harvestmen	1				
Beetles / ladybirds	0				
Moths	0				
Snails / slugs	2				
Shieldbugs	0				
Other (please specify below)	0				
Tree 1 _____	Tree 2 _____				
Tree 3 _____	Tree 4 _____				



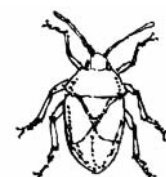
Beetles / ladybirds



Moths



Snails / slugs



Shieldbugs

D Record lichens on twigs

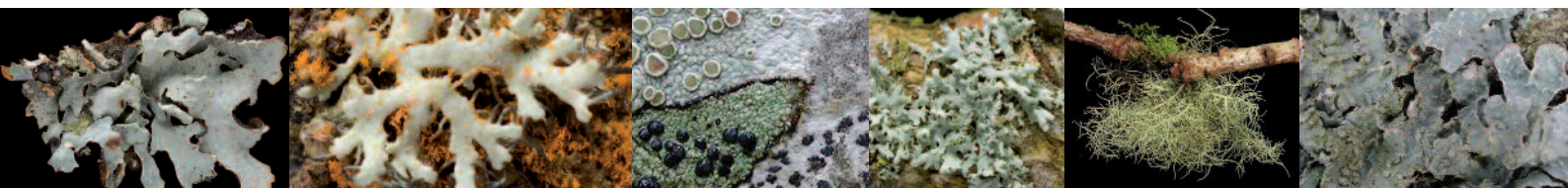
Only look for indicator lichens on twigs if it is safe to do so. Leave the columns blank in the table for any of the trees where you could not reach the twigs safely.

☐ Tick this box if you could not reach the twigs for any of your trees

	Indicator lichen on the twigs of each tree (✓ if present, 0 if not present) Leave the columns blank for the trees where you could not reach the twigs safely				
	Example	Tree 1	Tree 2	Tree 3	Tree 4
Nitrogen-sensitive					
1. <i>Usnea</i>	0				
2. <i>Evernia</i>	0				
3. <i>Hypogymnia</i>	✓				
Intermediate					
4. <i>Melanelixia</i>	✓				
5. <i>Flavoparmelia</i>	0				
6. <i>Parmelia</i>	0				
Nitrogen-loving					
7. Leafy <i>Xanthoria</i>	✓				
8. Cushion <i>Xanthoria</i>	✓				
9. <i>Physcia</i>	✓				
How many other types of lichen?	4				
Type(s) of algae (✓ tick)	Green ☐ Orange ☒ None ☐	Green ☐ Orange ☐ None ☐	Green ☐ Orange ☐ None ☐	Green ☐ Orange ☐ None ☐	Green ☐ Orange ☐ None ☐

E Complete your survey

Upload your results to the OPAL website www.OPALexploreNature.org





Activity 2: Results

Date of survey _____



A Site characteristics

1. Record the location of your site (postcode / OS map reference / GPS reading) and site name

2. Which of these best describes your site?

☐

Street

☐

Playing field /
park

☐

Garden

☐

Farmland

☐

Churchyard

☐

Wasteland

☐

Woodland
edge

3. Can you see any of the following from your site?

☐

Busy
road

☐

Sewage
treatment works

☐

Industry /
factory

☐

Building site
or quarry

☐

Farmland /
manure heap

☐

Playing field /
park

☐

None of
these

B Tree characteristics

Tree 1	Tree 2	Tree 3	Tree 4
Trunk girth: _____ cm	Trunk girth: _____ cm	Trunk girth: _____ cm	Trunk girth: _____ cm
Fallen leaves*: _____	Fallen leaves*: _____	Fallen leaves*: _____	Fallen leaves*: _____

* 0 = no fallen leaves 1 = a small amount of fallen leaves 2 = lots of fallen leaves

C Record leaf information

	Tree 1		Tree 2		Tree 3		Tree 4	
Leaf number	Number of tar spots*	Leaf width cm**	Number of tar spots*	Leaf width cm**	Number of tar spots*	Leaf width cm**	Number of tar spots*	Leaf width cm**
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

*Count all tar spots on the leaf, including partial and incomplete spots **Remember to measure the leaf width at the widest point

D Complete your survey

Upload your results to the OPAL website www.OPALexploreNature.org

Or post your completed workbook to: Freepost RSCH-CKYJ-HYYC, OPAL, Centre for Environmental Policy, Imperial College London, London SW7 2AZ

If you would like OPAL to send you the final results at the end of the survey, please include your postal address and/or e-mail address

This pack has been developed by Sally Power¹, Pat Wolseley^{2,3}, Barbara Hilton³, Linda Davies^{1,3}, Nigel Bell¹, Nathan Callaghan¹, Emma Green¹, Rebecca Farley⁴, Simon Norman⁴

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¹ Imperial College London. ² Natural History Museum. ³ British Lichen Society.

⁴ Field Studies Council.

