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lichenary

Buzău, România

The official Lichen identification guide

Preface

Welcome to the quiet, yet vibrant, world of lichens.

Lichenary is not just a project, but an invitation: to look up from the screen, approach the bark of a tree, and literally see what nature is telling us. Every splash of color, every growth form, or texture hides a story about air purity, about pollution, and about the delicate balance of our ecosystem.

About this guide

"The Official Lichen Identification Guide" offers you a simple and intuitive way to recognize the most common species, to learn what they can tell us about the environment, and how we can use these observations to collectively build a living map of air quality.

The guide combines science with the joy of discovery. It is created for students and pupils, as well as for anyone who loves nature and wants to contribute to collective knowledge.

Our wishes

We wish for every person who uses this guide to feel the same awe we feel when discovering a new lichen.
We wish for this project to be a bridge between science and soul, between data and emotions, between humans and the environment.
We wish that, years from now, looking back at what we achieved, we can say that we contributed — even if just a little — to a cleaner, more careful, more vibrant world.

Acknowledgements

Thank you to everyone who observed, photographed, and submitted data about lichens, to those who believed in the idea that "small observations can change the world." Special thanks also to all our extraordinary volunteers who offered their time to make this guide possible. Thank you to nature — for its patience, for its discrete colors, for the lesson of silence.

Enjoy! The Lichenary Team

Table of Contents

How to take a good photo of a lichen

Clear photos are very important for the correct identification of lichens. Follow these simple steps using only your phone's camera and, optionally, a magnifying glass:

Step 1: Get physically close, avoid digital zoom

Digital zoom reduces image quality. Get close enough to the lichen so that it occupies the majority of the frame.

Step 2: Stabilize your phone

Hold the phone firmly with both hands or rest it on a stable surface to avoid shaking and blurry pictures.

Step 3: Use natural light

Photograph in diffused natural light, avoiding the flash which can create unwanted reflections or shadows.

Step 4: Capture all important details

Photograph the entire structure of the lichen, including the edge and, if possible, the underside. Use the magnifying glass for fine details, but without touching the lichen

Step 5: Choose a good composition

Activate the grid on the screen and place the lichen at an interesting point in the frame. Also include contextual elements, such as bark or rock.

What to avoid:

- Digital zoom
- Photographing in poor light
- Using the flash
- Touching the lichen with the magnifying glass
- Photographing only a part of the lichen

➔ Additional tips:

- Clean the camera lens before taking pictures
- Note the date and location of the photograph

With a well-taken photograph, you help protect and understand nature!

How to upload your observation

To submit your observation of the photographed lichen, follow these simple steps:

Step 1: Log in or create an account

1. Access the project's official website.

2. Log into your account.

3.If you don't have an account, create one and wait for an administrator to activate your account.

Step 2: Access the dashboard

- After logging in, enter the dashboard.

Step 3: Upload the observation

- Click the „Upload a Lichen Observation button.

Step 4: Complete the form

1. Upload the photo taken.

2. Enter the date and time when you took the photo.

3. Write the approximate location (for example: "Jean Paul Street, Paris, France" or "Herăstrău Park, Bucharest, Romania").

4. Enter the exact coordinates of the location (latitude and longitude):

- For the northern hemisphere, latitude is written with a plus sign (+), and for the southern hemisphere with a minus sign (-)!
- For the eastern hemisphere, longitude is written with a plus sign (+), and for the western hemisphere with a minus sign (-)!
- The values must be entered in the following way: 46.018193, instead of 46°1'5.49''. Also, the decimals must be delimited with a dot(.) and not a comma(,).

5. You can find the coordinates using the Google Maps app on your phone.

Step 5: Identify the lichen species

- Use the identification guide to select the correct species, based on the photos and the information provided there. The guide is available on the website, in the resources and necessary materials section.

Step 6: Note the pollution score

- On each species page in the guide you will also find the pollution score. Enter this score in the form.

Step 7: Submit the observation

- Click the "Upload" button to submit your observation.

Step 8: View your observations

- You can see all observations made on the "View Your Observations" page in the dashboard.

Glossary

Term	Definition
Lichen	Symbiotic organism resulting from the association between a fungus (mycobiont) and a green alga or a cyanobacterium (photobiont). Although it looks like a plant, the lichen is a unique biological entity that does not traditionally fall into the plant kingdom.
Thallus	The body structure of a lichen, often mistaken for a leaf or a patch on bark. It is the visible part and can have various shapes, colors, and textures specific to each species.
Foliose lichen	A lichen with a relatively flat, leaf-like thallus. It is attached to the substrate by rhizines, but its edges are generally free and can be easily detached.
Fruticose lichen	A lichen with a three-dimensional, branched thallus in the form of a tuft, beard, or hair-like strands. It can grow vertically or hanging and is easy to recognize in the field.
Crustose lichen	A lichen with a thallus completely attached to the substrate, often with a crust-like or paint-like appearance. It cannot be removed without damaging both the thallus and the substrate.
Squamulose lichen	A lichen with a thallus made of small, overlapping scales or plates. This type is common in species of the genus *Cladonia*.
Podetium (plural: podetia)	A vertical projection originating from the basal thallus (especially in *Cladonia*), shaped like a cup, horn, or trumpet. It is an important feature for species identification.
Lobes	Extensions of the thallus in foliose lichens, which can be wide, narrow, smooth, or toothed. Their shape, size, and orientation are key identification traits.
Soralia	Specialized areas of the thallus where soredia form. They appear as powdery or granular spots on the lichen surface and are involved in vegetative reproduction.
Soredia	Microscopic structures consisting of a fragment of fungal hyphae and algal cells. They serve as reproductive units, enabling efficient vegetative propagation.
Isidia	Small formations, usually cylindrical or horn-like, that appear on the thallus surface. They can detach

	and form new individuals, contributing to vegetative reproduction.
Apothecia	Sexual reproductive structures of the fungal component of lichens, typically disc-shaped and colored brown, black, or red. They produce fungal spores.
Pruina	A fine, powdery layer with a bluish, whitish, or opaque appearance, present on the thallus or apothecia. It is an important diagnostic feature in some species.
Rhizines	Thin, root-like structures on the underside of the thallus that anchor the lichen to the substrate. They do not absorb water but serve only for attachment.
Central axis	An internal, usually elastic and whitish strand present in the branches of fruticose lichens (e.g., *Usnea*). Visible when a branch is broken.
Sept (septate)	In biology, refers to the presence of dividing walls within spores or other cellular structures. The number and position of septa help in taxon identification.
Cortex	The outer protective layer of the thallus, made of compact hyphae. It may cover one or both surfaces of the thallus and acts as a barrier against water loss.

Bioindicator	An organism whose presence, absence, or abundance provides information about environmental quality. Lichens are excellent bioindicators of air quality due to their sensitivity to pollutants.
Eutrophicati-on	Excessive enrichment of the environment with nutrients, especially nitrogen, from atmospheric pollution or agriculture. It favors tolerant species and reduces sensitive ones.
VOC (Volatile Organic Compounds)	Organic substances that easily evaporate into the atmosphere, originating from petroleum products, solvents, detergents, etc. They negatively affect sensitive lichens.
SO_2 (Sulfur dioxide)	An atmospheric pollutant primarily produced by the burning of fossil fuels. Extremely harmful to sensitive lichens, especially crustose and foliose species.
NO_x (Nitrogen oxides)	A group of gaseous compounds resulting from combustion processes (traffic, industry). They affect photosynthesis and favor nitrophilous lichens.
NH_3 (Ammonia)	A gaseous compound mainly from agricultural activities (animal waste, fertilizers). Contributes to eutrophication and

	influences lichen community composition.
Heavy metals	Toxic chemical elements (e.g., lead, mercury, cadmium) that can be absorbed from the atmosphere and deposited in the lichen thallus, negatively affecting growth and reproduction.
Oligotroph	Refers to a nutrient-poor environment, especially low in nitrogen compounds. Sensitive and specialized lichens prefer these conditions and disappear from eutrophicated habitats.

Xanthoria parietina

Teloschistaceae

Thallus Typology

Foliose thallus, well-developed, often radially lobed, with lobes large and flattened. It is attached to the substrate by rhizines, with the margin slightly raised.

Morphological Description

- ➔ Thallus yellow-golden to bright orange, especially in areas exposed to light.
- ➔ The color intensifies when wet.
- ➔ The surface is smooth or slightly rough, often covered with apothecia.
- ➔ The marginal lobes are rounded, raised, sometimes slightly crenate.
- ➔ The thallus may have a faintly whitish margin, without soredia.
- ➔ The apothecia are almost always present as round, flattened discs, orange or reddish-orange in color.
- ➔ The margins are slightly raised.

Habitat

- ➔ On tree bark (especially in well-lit areas), on walls, stones, and other siliceous or calcareous substrates.
- ➔ Prefers urban areas.
- ➔ It is widespread from sea level to low and mid-mountain regions.
- ➔ It shows tolerance to different substrate types and anthropogenic conditions.

Easily Observable Features

- ➔ The thallus is bright yellow, orange with golden tones.
- ➔ Pruinose coating is usually absent.
- ➔ Apothecia are very common, circular, and orange.
- ➔ Lobes are large, rounded, well-defined, and slightly overlapping.

Ecological Tolerance

- Dehydration – high tolerance. Can completely lose water and rapidly regulate photosynthesis after rehydration.
- Sulfur dioxide (SO_2) – moderate to high tolerance. The species is also present in urban areas.
- Nitrogen oxides (NO_x) – high tolerance. Prefers habitats with slight eutrophication.
- Other nitrogen compounds (NH_3, nitrates) – high tolerance. Grows well in areas with agricultural influence.
- Heavy metals (Cu, Cr, Cd, Pb, Hg, etc.) – moderate tolerance. Can accumulate some heavy metals but does not persist in areas with high concentrations.
- Volatile organic compounds (VOCs) – relatively high tolerance, but affected under excessive exposure.

Sensitivity

- Dehydration – low sensitivity.
- Sulfur dioxide (SO_2) – low to moderate sensitivity.
- Nitrogen oxides (NO_x) – low sensitivity.
- Heavy metals (Cu, Cr, Cd, Pb, Hg, etc.) – moderate sensitivity.
- Volatile organic compounds (VOCs) – moderate sensitivity.

Pollution Score: 10

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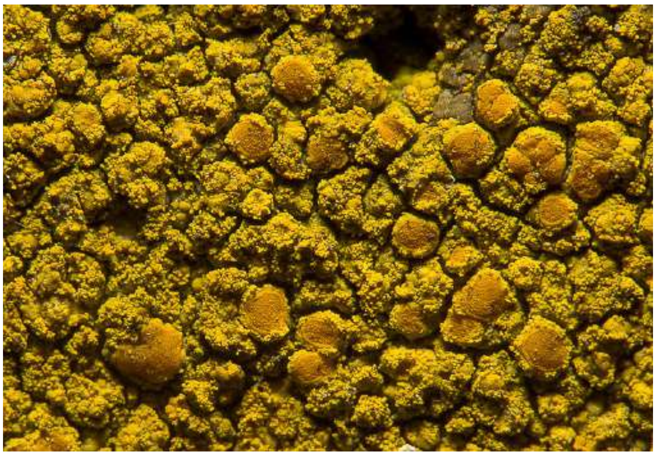
Caloplaca citrina

Teloschistaceae



Thallus Typology

It is tightly attached to the substrate, appearing crust-like, as a film spread over the surface. It has no rhizines (attachment threads) or raised structures like those of a foliose or fruticose thallus. It may have circular apothecia, orange or reddish in color.

Morphological Description

- → Crustose thallus, bright yellow or yellow-green, attached to the substrate.
- → Surface granular, with visible soredia.
- → Apothecia: small, orange, sometimes absent.
- → Lobes are absent. No lobed margins or distinct prominences present.

Habitat

- → Most commonly on calcareous or alkaline surfaces exposed to light, such as walls, roofs, stones, concrete, and mortar.
- → It can also occur on tree bark, especially in urban or semi-urban areas.

Easily Observable Features

- → Bright yellow or sulfur yellow in its active and hydrated state.
- → Matte yellow or pale yellow when dry or aged.
- → Color is uniform across the entire crustose thallus surface.
- → Surface is smooth or slightly granular, without a powdery appearance.
- → Pruina is absent or extremely minimal, undetectable to the naked eye.

Ecological Tolerance

- Dehydration – very high; tolerates dry periods and intense sun exposure well.
- Sulfur dioxide (SO_2) – high; can survive in industrial areas polluted with SO_2.
- Heavy metals (Pb, Zn, Cd, Cu) – moderate; resistant to some metals like Pb and Cu, but high toxicity of metals such as Cd or Hg affects it.
- Nitrogen oxides (NO_x) – moderate; tolerates moderate levels, but very high concentrations can be harmful.
- Ammonia (NH_3) and other nitrogen compounds – high; occurs in agricultural areas with intensive fertilization.
- Volatile organic compounds (VOCs) – variable; tolerates moderate urban concentrations, but highly reactive organic compounds can affect it.

Sensitivity

- Dehydration – slightly sensitive; tolerates dry periods well.
- Growth and reproduction decrease under extreme stress conditions.
- May be replaced by other species in highly modified or hostile environments.

Pollution Score: 9

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Polycauliona candelaria

Teloschistaceae

Thallus Typology

Foliose or fruticose, relatively small in size, shaped like cushions approximately 3 cm in diameter. It may have a spiny appearance and grows in small clusters resembling shrubs, occasionally showing granules on the thallus.

Morphological Description

- It has an orange color, but can also take yellow shades, hence the name “Candelaria.”
- The lobes are very thin.
- The surface may be spiny or slightly smooth.
- The thallus can have a surface with small visible granules, and the lobes are covered with fine grains (called soredia) that aid in reproduction.
- The lower surface is crustose, whitish, sometimes with a yellowish tint.
- Apothecia are rare, brown in color with smooth margins.

Habitat

- On tree bark, as well as other wooden surfaces.
- In areas with high sun exposure (walls, stones, even coastal zones).
- On rocks and other nutrient-rich surfaces.

Easily Observable Features

- Bright orange, sometimes orange with slightly yellowish tones.
- Can become pale under deteriorating conditions.
- Granules (soredia) develop at the margins and tips of the lobes, appearing smooth.

- The lower surface is whitish with simple, sparse white rhizines.

Ecological Tolerance

- Dehydration – very high; tolerates dry periods and intense sun exposure well.
- Sulfur dioxide (SO_2) – high; can survive in industrial areas polluted with SO_2.
- Heavy metals (Pb, Zn, Cd, Cu) – moderate tolerance; may cause discoloration and drying.
- Nitrogen oxides (NO_x) – moderate tolerance.
- Ammonia (NH_3) and other nitrogen compounds – moderate to high tolerance; especially present in nutrient-rich areas.
- Volatile organic compounds (VOCs) – low to moderate tolerance; can alter membrane permeability, causing thallus damage.

Sensitivity

- Dehydration – The thallus can dry out, becoming fragile.
- Deterioration may lead to a loss of the bright orange color.

Pollution Score: 8

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Candelaria concolor

Candelariaceae

Thallus Typology

Foliose, small in size, in the form of rounded cushions with a diameter under 1 cm. It may appear individually, fragmented, or as coarser granules, sometimes with a slightly tufted appearance.

Morphological Description

- Color varies from yellow-green to bright yellow.
- Lobes are thin, flat, with toothed margins.
- The surface of the thallus may be slightly wavy.
- The thallus may have a surface with small visible granules or be covered with fine grains (called soredia) that aid in lichen reproduction.
- The lower surface is whitish, matte, with sparse white rhizines.
- Apothecia are rare, very small, yellow in color with rough margins.

Habitat

- On the bark of deciduous trees (e.g., Maple, Willow, Elm).
- In open, well-lit areas (parks, roadsides, hedgerows).
- On wooden fences and sometimes on nutrient-rich rocks or walls.

Easily Observable Features

- Color is yellow-green to bright yellow, not orange (unlike Xanthoria). It may become pale under deteriorating conditions.
- No pruina (fine whitish coating) is visible.
- Apothecia appear rarely and are very small. They are yellow with rough

margins and may be absent in deteriorated specimens.

- Granules (soredia) develop at the edges and tips of the lobes, giving the lichen a fringed appearance, almost never smooth.
- The lower surface is whitish and matte, with sparse simple white rhizines.

Ecological Tolerance

- Sulfur dioxide (SO_2) – low tolerance; the species is sensitive to high concentrations, showing thallus discoloration and reduced vitality in heavily polluted environments.
- Nitrogen oxides (NO_x) – moderate tolerance; can persist in environments with moderate NO_x levels, but high exposure affects thallus structure and physiology.
- Ammonia (NH_3) and other nitrogen compounds – moderate to high tolerance; frequently occurs in eutrophicated habitats with elevated nutrient levels (especially nitrogen), indicating adaptation to such conditions.
- Volatile organic compounds (VOCs) – low to moderate tolerance; exposure leads to visible thallus alterations in areas with industrial emissions or heavy traffic.
- Heavy metals (Cu, Cr, Cd, Pb, Hg, etc.) – moderate tolerance; resistant to low to moderate concentrations. Prolonged exposure, however, causes discoloration, thallus fragility, and reduced regenerative capacity.
- The species is commonly found in eutrophicated areas, adapting to high nitrogen and phosphorus levels.
- It is one of the few species that persists in polluted urban areas where other sensitive lichens disappear.
- Under chloric conditions (industrial atmosphere or intense chemical pollution), it reacts quickly with thallus discoloration and thinning or loss of apothecia.

Sensitivity

- Deterioration may lead to a loss of yellow intensity, making the thallus appear paler or discolored.
- The thallus can dry out, becoming fragile with a changed texture (less compact).
- Partial loss of apothecia or a reduction in their number may occur.

Pollution Score: 7

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Melanelixia glabratula

Parmeliaceae

Thallus Typology

The thallus is foliose, with a leaf-like appearance, flat and well-defined lobes arranged radially, partially attached to the substrate, making it easy to detach.

Morphological Description

- Color ranges from olive green to reddish-brown, may darken.
- Lobes are short and rounded, varying in length.
- The surface lacks soredia and pores in the upper layer.
- The thallus may have a surface with small visible granules or be covered with fine grains (called soredia) that aid in lichen reproduction.
- Small isidia cover the central area of the thallus.
- Apothecia are rare.

Habitat

- Trunks and branches of deciduous trees, fences, and rocks.

Easily Observable Features

- Green in color, with a brown thallus.
- Surface glossy, flat with small raised areas.
- Tends to “camouflage” on tree bark.

Ecological Tolerance

- Sulfur dioxide (SO_2) – low tolerance, even intolerance to pollution.
- Nitrogen oxides (NO_x) – low tolerance; reduced vitality (photosynthesis decreases due to chlorophyll loss and

damage to cell membranes), thallus compression, and disruption of nutrient balance.

- Ammonia (NH_3) and other nitrogen compounds – intolerance; the species is not found in areas rich in ammonia (near farms or regions with intensive agriculture). Excess of these compounds creates a toxic environment.
- Volatile organic compounds (VOCs) – moderate to low tolerance; reduces growth and energy production, causes chlorophyll loss.
- Heavy metals (Cu, Cr, Cd, Pb, Hg, etc.) – moderate to high tolerance; accumulation leads to reduced growth, toxicity, physiological damage (enzyme disruption, chlorophyll loss, nutrient absorption blockage).
- The species is commonly found in eutrophicated areas, adapting to high nitrogen and phosphorus levels.
- It is one of the few species that persists in polluted urban areas where other sensitive lichens disappear.
- Under chloric conditions (industrial atmosphere or intense chemical pollution), it reacts rapidly with thallus discoloration and thinning or loss of apothecia.

Sensitivity

- The species is very sensitive to ammonia, disappearing from areas rich in this substance..
- It disappears or fails to develop in polluted environments.

Pollution Score: 6

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Peltigera canina

Peltigeraceae

Thallus Typology

Foliose with distinct layers and well-differentiated upper and lower surfaces. It has broad lobes, with the upper surface slightly hairy and a color ranging from gray to brown. The lower surface is densely hairy, featuring pale cross-veins along with visible rhizines.

Morphological Description

- ➔ Color variable, from gray-brown to brown-green, becoming lighter when dry and intensely green when wet.
- ➔ Lobes are broad (up to 1–2 cm), rounded, flat or slightly raised toward the edges, with an irregular outline and a smooth, slightly velvety upper surface.
- ➔ The lower surface is hairy, with a well-defined network of veins and dense, well-developed rhizines, pale or brown in color, anchoring the lichen to the substrate.

Habitat

- ➔ It develops predominantly on moist, acidic or neutral soils, especially in meadows, forest road edges, clearings, as well as in shaded areas with stable and well-drained substrates.
- ➔ It often occurs on mineral or humus-rich soil but can also colonize moss, decaying stumps, exposed roots, or even rock covered with organic substrate.
- ➔ Prefers partially shaded locations with high atmospheric humidity, commonly found in deciduous and mixed forests, particularly in areas with good air circulation.

- Avoids fully sunny or excessively dry areas but can tolerate moderate light exposure under sufficient moisture conditions.
- It is not common in urbanized habitats, preferring natural ecosystems with minimal soil and vegetation disturbance.

Easily Observable Features

- It may become pale under deteriorating conditions.
- Granules (soredia) develop at the edges and tips of the lobes, appearing smooth.
- The lower surface is white with gray-brown shades and white rhizines.

Ecological Tolerance

- Dehydration – very high; tolerates dry periods and intense sun exposure well.
- Sulfur dioxide (SO_2) – very low tolerance; disappears rapidly from areas affected by industrial pollution, especially near fossil fuel combustion sources.
- Heavy metals (Pb, Zn, Cd, Cu) – very low tolerance; almost completely absent from mining, industrial, or contaminated urban areas.
- Nitrogen oxides (NO_x) – low tolerance; sensitive to NO_x accumulation; rarely present in heavily trafficked urban areas, with visible thallus damage.
- Ammonia (NH_3) and other nitrogen compounds – moderate tolerance; can survive in areas with slight eutrophication, but growth is slowed and symbiosis with cyanobacteria may be disrupted.
- Suspended particles – low tolerance; thallus becomes fragile, brownish, or dehydrated in dusty environments. Frequency decreases near roads or quarries.
- Volatile organic compounds (VOCs) – moderate tolerance; thallus reacts with discoloration and reduced growth.

Sensitivity

- Dehydration – The thallus can dry out, becoming fragile.
- Deterioration may lead to a loss of color intensity.

Pollution Score: 2

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Phaeophyscia orbicularis

Physciaceae

Thallus Typology

Orbicular thallus, irregular and sometimes confluent with the lichen body. It has a flattened circular shape and lies very close to the substrate.

Morphological Description

- ➔ Color can vary from light gray with a bluish tint to slightly greenish gray or dark brown, depending on the environment of origin.
- ➔ The thallus has an orbicular structure, composed of lobes nearly attached to the substrate.
- ➔ The lobes of the lichen are short, rounded, often overlapping.
- ➔ Simple black rhizines are present on the lower surface, anchoring the lichen to the substrate.
- ➔ Soredia and isidia (asexual reproductive structures) are present in the marginal areas of the lichen. The soredia are fine, granular, and similar in color to the thallus.
- ➔ Apothecia are rare or absent.

Habitat

- ➔ It develops on both tree bark and rocks or man-made structures, commonly found in deciduous forests, parks, gardens, as well as urban areas.

Easily Observable Features

- ➔ The thallus is orbicular, gray-green or gray-bluish, becoming slightly darker when dry. It may appear greener in areas with high humidity.
- ➔ Lobes are small, rounded, and overlapping, with edges often slightly raised.

- The upper surface can be gray-bluish, gray-green, or slightly brown depending on moisture.
- The lower surface is black, with lighter areas toward the center.
- Pruina is not very pronounced.

Ecological Tolerance

- Dehydration – moderate tolerance. Tolerates sun exposure and dry periods, not dependent on constant moisture.
- Sulfur dioxide (SO_2) – moderate to high tolerance. Phaeophyscia orbicularis is also present in urban areas.
- Nitrogen oxides (NO_x) – high tolerance.
- Other nitrogen compounds (NH_3, nitrates) – moderate to high tolerance. Develops in areas affected by traffic and pollution.

Sensitivity

- Tolerant to pollution, especially nitrogen compounds and urban pollutants. Survives in environments with moderate to high levels of sulfur dioxide and nitrogen oxides.
- Prefers basic and neutral substrates: concrete, limestone, tree bark. Does not develop on acidic substrates (such as siliceous rocks or acidic conifer bark, e.g., spruce).
- Tolerant to dryness, capable of surviving in moderate to dry conditions. Grows in shaded or sunny locations, including sun-exposed trunks or urban walls.
- Has a wide thermal tolerance. Present in both temperate and warmer climates.

Pollution Score: 8

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Evernia prunastri

Parmeliaceae

Thallus Typology

The thallus is flexible, smooth to the touch, and branched, with ribbon-like lobes.

Morphological Description

- The thallus color varies: the upper surface ranges from yellowish-green to grayish-green, while the lower surface is whitish-yellow or silky white, becoming pale and almost white when dry.
- The lobes are thin, flat, and broad, with smooth or slightly wavy margins.
- The surface of the thallus is smooth, with fine longitudinal branching, sometimes slightly glossy when moist.
- The thallus may have small granules or be covered with fine grains (soredia) that aid in reproduction.
- The lower surface is white or pale yellowish, matte, without sheen, with sparse and short rhizines.
- Apothecia are extremely rare, very small, brown in color, with smooth or slightly wavy margins.

Habitat

- Bark of deciduous trees (e.g., Willow, Maple, Elm).
- Open and well-lit areas (parks, roadsides, hedgerows).
- Wooden fences, rocks, or nutrient-rich walls.

Easily Observable Features

- Yellowish-green or grayish-green on the upper surface. The lower surface is pale yellowish, becoming lighter when dry.

- ➔ No pruina is visible (the surface is smooth or slightly striated, without a whitish powder).
- ➔ Apothecia are extremely rare and very small, brown in color with smooth or slightly wavy margins. They may be completely absent in specimens affected by pollution or deterioration.

Ecological Tolerance

- ➔ Sulfur dioxide (SO_2): low tolerance – the species is sensitive to high concentrations, showing thallus discoloration and reduced vitality in heavily polluted environments.
- ➔ Nitrogen oxides (NO_x): moderate tolerance – it can persist in environments with moderate NO_x levels, but increased exposure affects thallus structure and physiology.
- ➔ Nitrogen compounds (NH_3, nitrates): moderate to high tolerance – frequently occurs in eutrophic habitats with elevated nutrient levels, indicating adaptation to such conditions.
- ➔ Volatile organic compounds (VOCs): low to moderate tolerance – exposure causes visible thallus alterations in industrial or high-traffic areas.
- ➔ Heavy metals (Cu, Cr, Cd, Pb, Hg, etc.): moderate tolerance – resistant to low to medium concentrations; however, prolonged exposure leads to discoloration, thallus fragility, and reduced regenerative capacity.
- ➔ The species is commonly found in eutrophic areas, adapted to high levels of nitrogen and phosphorus.

Pollution Score: 4

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Flavoparmelia caperata

Parmeliaceae

Thallus Typology

Flavoparmelia caperata is a foliose lichen with a rosette-shaped thallus. Its lobes are rounded, broad, with slightly wavy margins.

Morphological Description

- ➔ The upper surface is yellow-green to gray-green, often wrinkled.
- ➔ The lower surface is black with a brown margin.
- ➔ It has simple, unbranched black rhizines.
- ➔ Apothecia are rare, resembling small brown discs.

Habitat

- ➔ Prefers deciduous trees with acidic or slightly acidic bark – for example: oak, beech, birch, maple.
- ➔ Frequently occurs in moist forests with clean air, wooded meadows, forest edges, parks, and gardens, provided the air is only lightly polluted.
- ➔ Grows optimally in temperate climates with regular precipitation, in moist but well-ventilated areas where moisture does not stagnate for long periods.

Easily Observable Features

- ➔ The stem in a rosette, rounded lobes, yellow-green coloration, black underside.

Ecological Tolerance

- ➔ Sulfur dioxide (SO_2) - Degrades rapidly in areas with high concentrations.
- ➔ Cadmium (Cd) - Affects photosynthesis, alters secondary metabolism.
- ➔ Ozone (O_3) - Generates oxidative stress, activates antioxidant enzymes.
- ➔ NOx - Disrupts photosynthetic function.
- ➔ Heavy metals and other industrial pollutants affect growth and reproduction.
- ➔ Does not tolerate prolonged droughts or very dry areas.
- ➔ Has low shade tolerance, preferring well-lit areas.

Pollution Score: 5

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Usnea subfloridana

Parmeliaceae

Thallus Typology

Fruticose thallus in the form of long, branched tufts resembling a beard. Can reach 10–30 cm in length in favorable conditions. Branches are cylindrical, thin, and flexible. The surface is covered with fine projections, and secondary branches may be abundant or sparse, depending on age.

Morphological Description

- Color: ranges from yellowish-green to grayish-green, with pale shades under unfavorable conditions.
- Lobes: thin, cylindrical, with abundant branching and a flexible central axis.
- Thallus surface: covered with fine hairs (projections).
- Reproductive structures: soredia (fine white or green grains) present on branches, without isidia.
- Underside: not attached (thallus is aerial, not directly anchored to the substrate).
- Apothecia: extremely rare, small, brownish-black, with smooth margins.

Habitat

- Tree bark (especially conifers – pine, spruce, fir, but also deciduous trees – beech, willow, birch).
- Shady areas in forests.
- Locations with clean air (away from pollution sources).

Easily Observable Features

- Can appear as a network of green or yellow threads hanging from branches.
- Sometimes clusters into dense tufts, but always remains aerial (not attached to the substrate).
- In dry environments, becomes rigid, brittle, and pale.
- Yellow-green to bright yellow, not orange (unlike Xanthoria).
- No pruina (fine whitish layer) observed.
- Granules (soredia) develop at the lobe margins, giving a fringed appearance – almost never smooth.
- Underside is whitish and matte with simple white rhizines that aid in attachment to the substrate.

Ecological Tolerance

- Sulfur dioxide (SO_2): extremely low tolerance – the species is hypersensitive to even small concentrations of SO_2, showing immediate discoloration and complete disappearance in industrially polluted areas.
- Nitrogen oxides (NO_x): low tolerance – can survive only in areas with minimal NO_x levels, and exposure leads to halted growth and thallus fragmentation.
- Non-oxidized nitrogen compounds (NH_3, nitrates): low tolerance – avoids eutrophicated habitats with high nitrogen concentrations.
- Volatile organic compounds (VOCs): extremely low tolerance – severely affected by aromatic compounds, disappearing completely in areas with industrial sources or heavy traffic.
- Heavy metals (Cu, Cr, Cd, Pb, Hg, etc.): low to moderate tolerance – can accumulate heavy metals but suffers severe vitality impairment. Prolonged exposure leads to rapid thallus degeneration.
- The species is extremely sensitive to pollution – completely absent from urban and industrial areas, serving as an excellent indicator of clean air.
- It is one of the most sensitive lichen species – disappearing before other lichens at the first signs of pollution.

Sensitivity

- Rapid loss of green color, turning grayish-white or brown.
- Thallus loses elasticity, drying out and becoming extremely fragile.
- Fragmentation and loss of secondary branches.
- Disappearance of characteristic hairs from the thallus surface.
- Drastic reduction in the number of soredia (up to complete disappearance).

Pollution Score: 2

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Ramalina farinacea

Ramalinaceae

Thallus Typology

The thallus is fruticose and tufted, forming low shrubs with numerous flattened branches.

Morphological Description

- Thallus color is gray-green on both upper and lower surfaces.
- Branches converge from a single point.
- Does not form multiple rhizines on the thallus, attaching to tree bark through a single point (attachment disc).
- Thallus surface is branched, with narrow, flattened lobes.

Habitat

- In agricultural and urban areas (on hedges or posts).
- In low to mid-altitude forests, on tree bark.
- On the bark of isolated trees.
- Very rarely on cliffs or rocks.

Easily Observable Features

- Fruticose and branched thallus structure.
- Long branches that can reach up to 7 cm.
- Thallus color: light gray-green.
- Has a mealy appearance due to soredia on the lobe margins (hence the name “farinacea”) or sometimes matte.
- No multiple rhizines observed on the underside of the thallus.

- Not to be confused with Evernia prunastri, whose thallus, although similarly gray-green, is foliose (leaf-like).

Sensitivity

- Sulfur dioxide (SO_2), which has caused the disappearance of the species in areas where it is present in high concentrations.
- Toxic metals such as Pb, Cd, and Hg, which affect enzyme function and cellular metabolism of the lichen, leading to growth inhibition or death.
- Compounds such as benzene, toluene, or formaldehyde. These VOCs can interfere with gas exchange and alter the structure of the lichen thallus.

Ecological Tolerance

- Shows moderate to low tolerance to nitrogen oxides or other nitrogen compounds. Increased nitrogen levels can favor other tolerant species, leading to competition, which may reduce the presence of Ramalina in that habitat.
- Effects of dehydration: In general, lichens are subjected to oxidative stress induced by dehydration, and during rehydration, they release large amounts of reactive oxygen species (ROS).
- Ramalina farinacea has the ability to biosynthesize endogenous nitric oxide (NO), which reduces ROS production.
- Additionally, NO regulates oxidative stress caused by toxic metals such as lead (Pb), cadmium (Cd), and mercury (Hg).

Pollution Score: 4

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Ramalina europaea

Ramalinaceae

Thallus Typology

Fruticose thallus, slightly pendent, often branched, with thin gray-green branches that are smooth or slightly rough. Branches can be flat or cylindrical, with slightly twisted tips. The thallus is attached to the substrate by a single point of attachment (rhizines are rudimentary or absent), generally growing on tree bark or shrubs, rarely on rock.

Morphological Description

- The lichen is gray-green to pale green, sometimes with yellowish tinges toward the branch tips.
- Thallus is fruticose, with thin, straight or slightly pendent branches, often branched, with a fine and delicate appearance.
- Branches are flat or cylindrical with twisted tips.
- Surface is slightly rough with marginal, powdery soralia, pale white to yellowish, often located near branch tips.
- Underside is similar to the upper surface, without clear differentiation. Rhizines are absent or poorly developed.
- Apothecia are rare, small, pale to light brown, sometimes faintly pruinose.

Habitat

- A common species in Europe, especially in temperate regions, including Romania, where it occurs in both lowland and lower mountain areas.
- Grows predominantly on the bark of deciduous trees, less frequently on conifers, but can also be found on shrubs or occasionally on siliceous or calcareous rock.

- ➔ Prefers well-ventilated areas with good light, such as groves, orchards, parks, gardens, hedges, or forest edges.
- ➔ Sensitive to shade and avoids dense forests.
- ➔ Can also be found in urban-rural habitats, growing on exposed twigs and trunks, sometimes even on stone or walls.

Easily Observable Features

- ➔ Gray-green to yellow-green color – in light, may exhibit glossy or silvery reflections.
- ➔ Lobes thin, often flat or cylindrical, slightly twisted toward the tips.
- ➔ Soredia frequently present in marginal soralia.
- ➔ Forms well-defined structures at the branch tips.
- ➔ Underside similar to the upper surface, without evident rhizines. Attachment point weak.

Sensitivity

- ➔ Thallus becomes paler or yellowish in polluted environments, with poorly developed or absent soralia.
- ➔ Branches become fragile and thin.
- ➔ Overall coloration loses intensity, and the structure deteriorates.

Ecological Tolerance

- ➔ Sulfur dioxide (SO_2): low tolerance – disappears quickly from areas with heavy industrial pollution.
- ➔ Nitrogen oxides (NO_x): moderate tolerance – occurs occasionally in areas with heavy traffic, though thallus is visibly affected.
- ➔ Ammonia (NH_3) and nitrogen compounds: high tolerance – can colonize mildly eutrophicated habitats; indicates adaptability in agricultural or suburban areas.
- ➔ Suspended particles (PM_{10} / $PM_{2.5}$): relatively high tolerance – grows in dusty environments, though thallus is smaller and more fragile.
- ➔ Heavy metals (Pb, Zn, Cu, Cd): low tolerance – very sensitive, rarely present in industrial or mining areas.
- ➔ Volatile organic compounds (VOCs): moderate sensitivity – thallus changes in shape and color under continuous exposure.
- ➔ Ramalina europaea is sensitive to strong pollutants but can persist in environments with low to moderate atmospheric contamination.

Pollution Score: 3

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Cladonia fimbriata

Cladoniaceae

Thallus Typology

The primary thallus is squamulose, with numerous basal squamules, often quite small and discreet, elongated and incised.

The secondary thallus is fruticose. Podetia can be gray to green-brown. Cups are small, with toothed margins abruptly connected to a long stalk.

Morphological Description

- Cladonia fimbriata can be found growing on humus-rich soils, among mosses, on decaying logs and stumps at the base of trees.
- Podetia are thin, stem-like structures, usually 1–2 cm tall. They are gray-green in color and covered with fine soredia. They expand abruptly into a cup shape at the top, lacking a distinct cortex.
- Cups are cup-shaped, often with slightly irregular margins. They may be dotted with small, brown apothecia along the edges.
- The primary thallus consists of small basal squamules, bright green, crested, and sometimes slightly sorediate.

Habitat

- Often associated with mosses in places such as rotting wood, gardens, and old walls, occasionally in heathlands and dunes. Absent from wet mountain areas, primarily found at low to mid altitudes, in shaded conditions.

Easily Observable Features

- Color: Primary thallus is usually gray-green or light green, with a slightly glossy appearance when wet.
- Pruina is often present on the thallus margins, giving a whitish, powdery look.
- Apothecia are small, reddish-brown, and typically appear on the margins or tips of the lobes.
- Basal lobes (squamules) are small, rounded at the edges, closely overlapping, forming a rosette at the base.
- Podetia are often described as trumpet-shaped.

Ecological Tolerance

- Dehydration: Shows high tolerance to moisture fluctuations, able to withstand complete drying and rapidly reactivate upon rehydration.
- Sulfur dioxide (SO_2): Low tolerance, persists only at very low concentrations.
- Nitrogen oxides (NO_x): Low to moderate tolerance, survives at low levels, but thallus is affected if NO_x concentration increases.
- Other nitrogen compounds (NH_3, nitrates): Low tolerance, prefers oligotrophic habitats. Tolerance decreases significantly in eutrophicated areas.
- Heavy metals (Cu, Cr, Cd, Pb, Hg, etc.): Very low tolerance; accumulates metals but cannot withstand constant heavy metal pollution.
- Volatile organic compounds (VOCs): Low tolerance; prolonged exposure reduces photosynthesis and thallus integrity.

Sensitivity

- Dehydration: Low sensitivity, tolerates periods of complete drying well.
- Sulfur dioxide: High sensitivity.
- Nitrogen oxides: Moderate to high sensitivity.
- Heavy metals: High sensitivity.
- Volatile organic compounds: Moderate sensitivity; chronic exposure reduces photosynthesis.

Pollution Score: 2

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Lobaria scrobiculata

Lobariaceae

Thallus Typology

Foliose, green or olive-green when wet, bluish-gray when dry, with a reticulated appearance. Lobes are large and prominent, often with raised margins and a concave surface.

Morphological Description

- ➔ Large thallus, smooth to rough, often displaying a "pitted" (scrobiculate) texture, from which the species gets its name.
- ➔ May contain cyanobacteria internally, giving it increased sensitivity to pollutants.
- ➔ Displays numerous soralia (asexual reproductive structures) on the upper surface.

Habitat

- ➔ Prefers moist, clean forests with unpolluted air.
- ➔ Occurs predominantly in montane or submontane forests.
- ➔ Grows on the trunks of old deciduous trees (beech, hornbeam), especially in shaded areas with high humidity and low sun exposure.
- ➔ Serves as an indicator of undisturbed forests with high biological age.

Easily Observable Features

- ➔ Olive-green thallus, large with a pitted surface, "spongy" or "oddly sculpted" appearance – easily recognizable.
- ➔ Can cover large portions of the tree trunk. Distinguished from other

lichens by its size and fresh color (when wet).
- ➔ Displays whitish or green soralia on the upper surface, without visible apothecia, differentiating it from other species.
- ➔ Soralia have a powdery appearance and are spread across the upper surface of the thallus.

Ecological Tolerance

- ➔ The large, adherent thallus, positioned vertically on trunks, allows rapid water runoff, reducing the accumulation of soluble compounds and protecting against rapid evaporation.
- ➔ NO_x deposits can cause nutritional imbalances in the thallus, disrupting the symbiotic balance between the fungus and the algal partner. Excess nitrogen can reactivate photosynthetic processes, but if it exceeds a critical level, it leads to a decline in chlorophyll content.
- ➔ Its presence decreases dramatically in urban environments or near heavily trafficked roads, where NO_x, ammonia, and VOCs are high.
- ➔ It is one of the most sensitive lichen species to air pollution.
- ➔ The loss of this species is an early indicator of air quality degradation.
- ➔ Requires a stable microclimate with high humidity and moderate temperatures.

Sensitivity

- ➔ Sensitivity to dryness: color changes visibly.
- ➔ Intensely green when wet and bluish-gray when dry.
- ➔ Becomes brittle and recedes from trunks under unfavorable conditions.

Pollution Score: 1

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Parmelia sulcata

Parmeliaceae

Thallus Typology

Parmelia sulcata is a foliose lichen with a flat thallus, composed of lobes radiating outward to form a rosette up to 10–20 cm in diameter. Lobes have slightly raised margins and may have twisted tips.

Morphological Description

- ➔ Upper surface of the thallus is gray-green, leaf-like in appearance due to a network of cracks and filaments.
- ➔ Underside is black, with unbranched or sparsely branched rhizines. The species reproduces mainly vegetatively through soredia. Apothecia are rare.

Habitat

- ➔ Parmelia sulcata grows predominantly on tree bark, less frequently on rocks or walls.
- ➔ Prefers bright, well-ventilated locations, often found on tree trunks at medium heights.
- ➔ It is a temperate species, distributed in Europe, North and South America, Asia, and Africa.

Easily Observable Features

- ➔ Rosette thallus with striated, foliose lobes. Upper surface gray-green, underside black with rhizines. Displays soralia, commonly developing on the middle portions of tree trunks.

Ecological Tolerance

- Dehydration: Tends to withstand moderate desiccation better than more sensitive species and can recover quickly after prolonged drying.
- The species tolerates moderate air pollution, surviving in environments with low to moderate levels of sulfur dioxide and nitrogen oxides.
- Often used as a bioindicator of air quality in urban and peri-urban areas. However, it disappears completely in heavily polluted environments.

Sensitivity

- Dehydration: Loses water rapidly in dry air.
- Especially affected by sulfur dioxide, which reduces thallus vitality and can lead to the species' complete disappearance in heavily polluted areas, such as industrial zones.
- Nitrogen oxides and ammonia can also disrupt the physiological balance of the lichen symbiosis, particularly in dense urban areas or near agricultural sources.
- Parmelia sulcata can accumulate heavy metals such as lead, zinc, and cadmium in its structure, affecting cellular respiration and photosynthesis, especially under chronic pollution.
- Compared to other sensitive species, Parmelia sulcata persists longer in ecosystems with moderate pollution levels, making it a useful bioindicator for areas ranging from clean to moderately polluted air.

Pollution Score: 7

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Hypogymnia physodes

Parmeliaceae

Thallus Typology

Loose, up to 10 cm in diameter. Can form rosettes or spread irregularly. Upper surface smooth, gray-green, with brown lobe tips. Underside dark in color, pale brown, becoming strongly wrinkled toward the edges.

Morphological Description

- Attached to the substrate by rhizines, with lobe tips twisted and white on the underside.
- Thallus is foliose, with soredia appearing at the lobe tips.
- Thallus is easily detached from the substrate, often found in lightly polluted environments.

Habitat

- The species is commonly found on trees, rocks, moss, or grass. Prefers acidic substrates and is sensitive to nitrogen pollution.
- Rarely occurs on rocky or mossy soil.
- Can be found wherever woody substrate is present.
- Ubiquitous in forests at low to mid altitudes.
- In Romania, occurs in montane and submontane areas, in coniferous forests and locations with moderate humidity.

Easily Observable Features

- Small to medium in size.
- Gray-green to gray in color, with a black ventral surface.
- Lobes are swollen, tubular.

- ➔ Found mainly on conifer bark, exhibiting slow growth.
- ➔ Displays apical soredia – whitish powder visible at the lobe tips.
- ➔ Underside is bicolored.
- ➔ Has a clean, smooth appearance.

Ecological tolerance and sensitivity

- ➔ The vertical position of lichens growing on trunks allows rapid runoff of rainwater, while coverage from branches and leaves reduces absorption and assimilation of harmful substances.
- ➔ Nitrogen oxides can cause nutritional imbalances in the lichen thallus physiology, affecting photosynthesis by damaging the symbiotic algae. This can lead to decreased chlorophyll content and, ultimately, lichen death in heavily polluted areas.
- ➔ Serves as a pollution indicator, being sensitive to nitrogen oxide pollution. Its presence is reduced in cities or along heavily trafficked roads, but it is commonly found in areas with clean air.

Pollution Score: 5

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Pseudevernia furfuracea

Parmeliaceae

Thallus Typology

Foliose, with strap-shaped lobes 1–4 mm wide, branched, and a matte upper surface, gray-white to cream. Underside dark (black to brown), without evident rhizines.

Morphological Description

- ➔ Thallus approximately 10 cm in diameter, composed of divergently branched lobes resembling fingers.
- ➔ Upper surface gray-white to cream, matte, often slightly rough, densely covered with isidia; soralia rarely present.
- ➔ Underside channelled, gray-black to black-brown, with folded margins similar to the upper surface; rhizines absent.
- ➔ Apothecia are rare.

Habitat

- ➔ Epiphytic on exposed, acidic bark of conifers (beech, pine, spruce) and deciduous trees (less common).
- ➔ Also grows on worked wood (including posts/fences) and very rarely on siliceous rocks.
- ➔ Widespread in temperate, montane regions of Europe, Asia, North Africa, and North America.

Easily Observable Features

- ➔ Color: upper surface gray-white, underside black-brown; upper surface lightens when dry.
- ➔ Pruina: absent; thallus matte, sometimes rough due to isidia.
- ➔ Apothecia: rare.
- ➔ Isidia large and densely covering the surface; soralia rare.

- ➔ Underside dark, channelled, without rhizines; margins folded.

Ecological Tolerance

- ➔ VOCs: moderate to high tolerance — Exposure in traffic or industrial areas does not eliminate the species, though ozone can cause severe damage, degrading the thallus.
- ➔ SO_2: moderate sensitivity — Frequently used for biomonitoring; accumulation of SO_2 is documented, with low tolerance at high concentrations.
- ➔ NO_x: moderate tolerance — Shows physiological damage at high concentrations (oxidative stress, DNA damage) in polluted environments.
- ➔ NH_3, nitrogen compounds: low to moderate tolerance — Epiphytic on acidic tree bark; rare occurrence in slightly eutrophicated areas indicates low tolerance to eutrophication.
- ➔ Heavy metals (Cu, Cr, Cd, Pb, Hg, etc.): moderate tolerance — Accumulation of high levels induces oxidative stress and physiological changes.

Sensitivity

- ➔ Under severe pollution (metals, SO_2, NO_x), damage occurs: chlorophyll alterations, oxidative stress, DNA damage.
- ➔ Prolonged presence in urban or heavily trafficked industrial areas leads to decreased isidia density, with the thallus becoming more fragile, darker, and sparser.
- ➔ In areas with high SO_2 or NO_x concentrations, thallus regeneration and apothecia development are reduced.

Pollution Score: 3

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Lecanora conizaeoides

Lecanoraceae

Thallus Typology

Lecanora conizaeoides has a crustose thallus, firmly attached to the substrate and difficult to remove. The thallus is thin, smooth or slightly granular, gray-green to brown-green, often with greenish hues when wet. The surface may feature fine or granular soralia (asexual reproductive structures) that facilitate rapid spread.

Thallus margins are poorly defined, often diffuse, and apothecia (sexual reproductive structures) are rare or absent, especially in polluted environments. When present, apothecia are small, flat, with a brown disc and pale margin.

Morphological Description

- Thick, granular thallus, gray-green, with frequent soredia. Soralia dominate the entire thallus surface. Isidia are absent.
- Apothecia small, round, with a dark brown disc and a lighter, slightly raised margin.
- Surface smooth or finely granular, gray-green, brown-green, or sometimes brownish under dry conditions.

Habitat

- Grows on acidic substrates: tree bark (especially conifers, but also deciduous trees), worked wood (fences, posts), siliceous rocks, peat soils, and rubber materials.
- Historically very common on tree trunks in lowland areas of Great Britain. Currently, found predominantly on conifers and worked wood.

Ecological Tolerance

- Resistance to volatile organic compounds (VOCs) – can tolerate moderate concentrations, allowing survival in urban areas or near emission sources.
- Tolerance to nitrogen oxides (NO_x) – grows in areas with heavy traffic or near fossil fuel combustion sources.
- Resistance to ammonia (NH_3) – present mainly in agricultural areas or near farms, without significantly affecting its development.
- Ability to tolerate heavy metals (e.g., Pb, Cd, Zn) – can colonize tree bark and metal-contaminated areas, unlike sensitive species.

Sensitivity

- High tolerance to pollution, especially sulfur dioxide (SO_2), a common pollutant in urban and industrial areas.
- Very resilient compared to other sensitive lichens, which disappear under polluted conditions.
- Grows well on tree bark, particularly in areas affected by industrial activities or heavy traffic.
- Considered an opportunistic species, colonizing areas where other species can no longer survive.
- In unpolluted or natural areas, it is less common, being less competitive than sensitive, but well-adapted species.
- Used as a bioindicator of polluted air, signaling moderate to high levels of atmospheric pollution.

Pollution Score: 10

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Cladonia rangiferina

Cladoniaceae

Thallus Typology

Primary thallus crustose, extensively branched, evanescent (gradually disappearing), each branch dividing into 2–3 smaller branches. Thicker branches approximately 1–1.5 mm in diameter.

Morphological Description

- Color ranges from gray-white to gray-brown and bluish.
- Branches form extensive layers, reaching up to 10 cm in height.
- Growth is slow (3–11 mm/year), fastest in young (under 60 years), shaded forests, and slowest in older, thinned forests.
- Branches are straight. Cladonia is a voluminous lichen that prefers indirect light and a moist environment to maintain its spongy texture.
- Lobes 4–10 cm tall, upper parts brown, gray-blue toward the tips.
- Surface uniform.
- Becomes lighter in color when dry.

Habitat

- Dominant in marshy areas, acidic forests, and on deep humus over rocks.
- Found in boreal pine forests, tundra, and taiga.
- In southern regions, threatened by habitat loss due to overexploitation of mountain pastures.
- Widespread in alpine zones alongside Cladonia pyxidata ("moss trumpet").

Easily Observable Features

- Forms extensive, dense, voluminous, tree-like layers.
- Reaches heights of up to 10 cm, standing out from the substrate. Thallus has a fluffy appearance, easily recognizable visually.
- Light color (gray-white to gray-blue) makes it highly visible, especially when dry.
- Branches are straight, regularly dividing into 2–3, creating a symmetrical, bushy structure.
- Common in boreal and tundra forests, growing on soil or moss in groups visible from a distance.
- Contrasts with surrounding vegetation, particularly in shaded or filtered-light areas.

Ecological Tolerance

- Exhibits high photosynthetic rates year-round and under almost all conditions.
- Shows a strong affinity for copper and thallium, greater than for nickel.
- Copper and thallium cause potassium loss from the thallus, whereas manganese and nickel require higher concentrations for the same effect.
- Exposure to Ni^{2+} induces oxidative stress and mobilizes antioxidants (ascorbic acid).
- Accumulates uranium in various forms (UO_2^{2+}).
- Sensitive to SO_2 and NO_x; gases are absorbed across the thallus surface, affecting photosynthesis and respiration.
- UV-B exposure leads to accumulation of usnic acid and melanins.

Sensitivity

- Highly sensitive to atmospheric pollutants (SO_2, NO_x), which affect photosynthesis and respiration. Affected by heavy metal pollution (Cu, Tl, Ni); Ni^{2+} induces oxidative stress, triggering mobilization of ascorbic acid.
- Accumulates radioactive metals, including uranium, making it a useful bioindicator for radioactive contamination.
- Low tolerance to UV-B radiation, which induces the synthesis of usnic acid and melanin pigments for protection.
- Impacted by prolonged drying and direct sun exposure; prefers moist, shaded environments.
- In southern regions, threatened by habitat loss due to exploitation of mountain pastures and young forests.

Pollution Score: 1

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Physcia adscendens

Physciaceae

Thallus Typology

Physcia adscendens has a foliose thallus, leaf-like in shape, with a well-defined, easily recognizable structure. The thallus consists of small lobes, narrow at the base, often slightly raised from the substrate, giving the lichen an "ascending" appearance.

Thallus surface gray-white to gray-blue, sometimes with slight brownish tones. Lobe margins bear small hair-like projections, visible upon close inspection. Frequently presents isidia, appearing as whitish, powdery spots on the margins or upper surface of the lobes. Thallus typically grows on tree bark but can also occur on rocks or artificial surfaces, adapted to urban or slightly polluted conditions.

Morphological Description

- → Foliose thallus, small to medium in size, composed of thin, elongated lobes.
- → Lobes slightly raised from the substrate ("ascending"), a distinctive feature of the species.
- → Thallus color gray-white to gray-blue, sometimes brownish when dry.
- → Lobe margins bear fine, hair-like filaments, visible under magnification.
- → Whitish isidia frequently occur on the margins or upper surface of the lobes as powdery patches, used for vegetative reproduction.
- → Underside whitish to brown, with short rhizines anchoring the lichen to the substrate.
- → Apothecia are rare; when present, they have a dark brown disc.

Habitat

- Common along the east and west coasts of North America, in Great Britain and Ireland, among other regions.
- Found in low to mid-elevation forests and open shrublands, common in agricultural, urban, and suburban areas; from partial shade to full sun.
- Very frequently occurs on nutrient-rich tree bark, as well as on limestone, gravestones, cement, and other substrates.
- Can be tightly attached to bark and upper surfaces of branches of various plants in nitrogen-rich soils. Often found alongside Physcia tenella. Occurs on twigs, bark, concrete, and rocks.

Easily Observable Features

- Color gray-green to gray-white, sometimes with silvery reflections in strong light. Often shows a whitish tint at lobe tips, slightly pruinose.
- Lobes narrow (1–2 mm), raised at the margins, slightly ascending (distinctive feature). Margins ciliate, with black or dark cilia about 1 mm long. Thallus loosely attached to the substrate.
- Soredia occur on marginal areas or beneath lobe tips in helmet-shaped soralia, fine and whitish, aiding identification.
- Underside whitish to gray, with sparse rhizines, white to black, more prominent toward the center.
- Lower cortex visible only under a microscope.
- Apothecia rare; when present, up to 2 mm in diameter, flat, blackish, sometimes with pruinose margins.

Ecological Tolerance

- Sulfur dioxide (SO_2): low to moderate tolerance — affected in heavily polluted areas, but can survive in urban environments with lower levels.
- Nitrogen oxides (NO_x): moderate tolerance — occurs in traffic-affected areas, but high concentrations impair thallus development and reduce apothecia formation.
- Ammonia (NH_3) and nitrogen compounds: high tolerance — can colonize slightly eutrophicated habitats, indicating adaptation to reactive nitrogen (often from agriculture or traffic).
- Suspended particulates (PM_{10} / $PM_{2.5}$): relatively high tolerance — can grow in dusty urban areas or near power plant emissions, though growth is reduced.
- Heavy metals (Pb, Zn, Cu, Cd): low to moderate tolerance — accumulation affects growth and coloration; presence is rare in heavily industrially contaminated areas.
- Volatile organic compounds (VOCs): relatively high sensitivity — prolonged exposure alters morphology.
- Physcia adscendens shows overall moderate sensitivity and is frequently found in urban-rural habitats but absent in heavily polluted city centers.

Sensitivity

- Thallus becomes paler or gray-brown under high pollution conditions.
- Marginal cilia may become sparse or fragile, diminishing the characteristic appearance.
- Apothecia become rarer or absent in heavily impacted environments.

Texture becomes more brittle, and soredia may be less developed.

Pollution Score: 9

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Lepraria incana

Stereocaulaceae

Thallus Typology

Corticolous, with a powdery appearance. Relatively large in size, spreading quickly across the substrate. Up close, small spherical granules are visible; from a distance, the thallus resembles a "crust" deposited on the surface.

Morphological Description

- ➔ Color green, ranging from green to green-blue or green-yellow.
- ➔ Powdery surface; lobes not visible.
- ➔ No well-defined lower surface, thallus attached directly to the substrate.
- ➔ No apothecia.
- ➔ Generally reaches about 8 cm in diameter.

Habitat

- ➔ Tree bark and other wooden surfaces.
- ➔ Areas with low sun exposure, shaded.
- ➔ High-humidity sites, protected from direct rain.
- ➔ Rocks and other surfaces that can retain moisture.

Easily Observable Features

- ➔ Color green, green-blue, or green-yellow; may become pale under stress or damage.
- ➔ No apothecia; lobes not visible.

Ecological Tolerance

- Sulfur dioxide (SO_2): high tolerance — one of the few species able to survive in areas with poor air quality.
- Nitrogen oxides (NO_x): moderate tolerance — can persist in environments with moderate NO_x levels, though high exposure affects thallus structure and function.
- Non-oxidized nitrogen compounds (NH_3, nitrates): moderate to low tolerance — high exposure leads to lichen and thallus degradation.
- Heavy metals (Cu, Cr, Cd, Pb, Hg, etc.): moderate tolerance — resistant to low to medium concentrations; a study in Slovenia observed Lepraria incana growth in heavy-metal-contaminated areas.
- Frequently found in eutrophicated zones, adapting to relatively high nitrogen levels.
- One of the species that persists in polluted urban areas where more sensitive lichens disappear.

Sensitivity

- Damage may cause color fading, making the thallus appear paler or discolored.
- The thallus can dry out, becoming fragile with a changed, less compact texture.

Pollution Score: 6

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