



Field Guide to Tree-related Microhabitats

Descriptions and size limits for their inventory

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This guidebook may be downloaded at the following link:
www.wsl.ch/fg-trems

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Introduction

A habitat tree is defined as a tree bearing at least one tree-related microhabitat (Fig. 1). A tree-related microhabitat (abbreviated as TreM) is a morphological feature present on a tree, which is used by sometimes highly specialised species during at least a part of their life cycle. These features may create shelters, breeding spots or crucial hibernating or feeding places for thousands of species. Various biotic or abiotic events can create tree-related microhabitats: for example, a falling rock could injure the bark, lightning could strike a tree and crack open the wood, or a woodpecker could dig a breeding cavity in the trunk. For some TreMs like vertebrate nests or witches' broom, the tree is merely a physical support. Only morphological features that are known to have a direct link with one or more associated species are classified as TreMs (LARRIEU *et al.* 2018).

Each tree-related microhabitat provides very specific conditions depending on its characteristics: size, shape, position in the tree, degree of decomposition of the surrounding wood, state of the bearing tree (living or dead), exposure to sunlight, etc.

Each associated species prefers a specific type of TreM. The more diversified the microhabitats in a stand, the greater the variety of species that can find the right conditions to thrive there. Since tree-related microhabitats have a limited life span, the more often the same type of microhabitat occurs in a stand, the easier it is for its associated organisms to colonize a new microhabitat when their previous support disappears.

To reinforce biodiversity in a stand and thus improve its resilience, it makes sense to know which tree-related microhabitats are present, and to preserve and favour them through adapted management practices.

This field guide describes 47 different tree-related microhabitats, according to LARRIEU *et al.* (2018), and classifies them into 15 groups and seven types. The guide also indicates recommended minimum inventorying sizes for each TreM and gives information about its frequency of occurrence and its replacement rate in the stand.

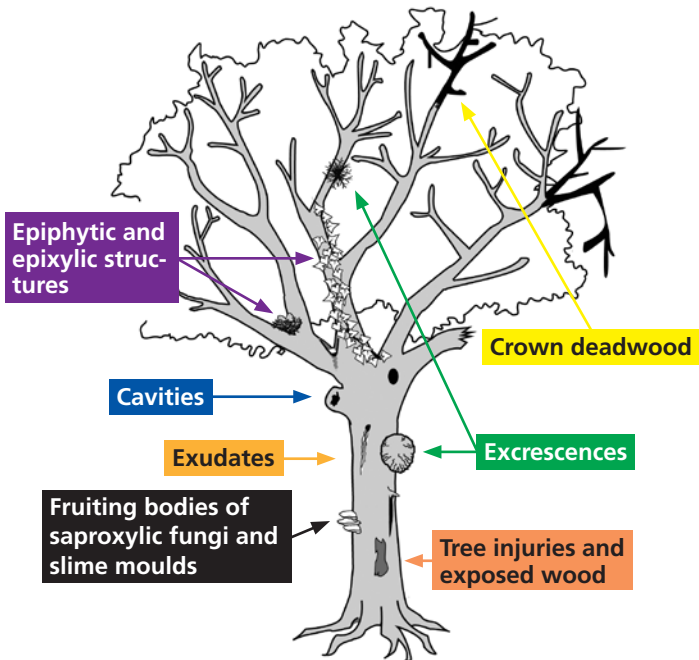


Fig. 1. A habitat tree bearing tree-related microhabitats essential to specialised species for shelter, breeding spots, hibernating or feeding, or even for their entire life cycle (adapted from EMBERGER and LARRIEU, eTreMs application).

Legend and definitions



Natural forest



Managed forest



Slow replacement rate in the stand: This type of tree-related microhabitat either takes a very long time to develop (for example, a rot-hole developing from an injury left by a broken-off branch) or is linked to rare, random events (lightning strikes, for example).



Rapid replacement rate in the stand: This type of tree-related microhabitat is generated by frequently occurring events (for example, bark injuries due to falling rocks in mountain forests), or it is immediately functional upon creation (woodpecker foraging excavations, for example).

Frequency: Frequency of occurrence of the microhabitat on either living or dead trees. Some microhabitats are more frequent on standing dead trees (for example, the fruiting bodies of saprophytic fungi). The frequency of occurrence indicated for managed forests pertains only to that type of forest and not to natural forests. The frequency values indicated are calculated from a European database and may differ at the local level.

Minimum size: Minimum size required for the tree-related microhabitat to be recorded in a survey. Certain size thresholds are related to the ecological requirements of the associated species. When these thresholds are unknown, the indicated values were defined by experts in order to reduce observer effect as much as possible ("experts' threshold").

Associated species: Species or species groups with a close relationship to the associated tree-related microhabitat, according to at least one reference in the scientific literature or based on the authors' own observations. The list below is not exhaustive and the species mentioned should be taken as examples.



Coleopterans



Birds



Dipterans



Bats



Hymenopterans



Rodents



Ants



Carnivores



Butterflies



Amphibians



Aphids



Reptiles



True bugs



Gastropods



Spiders



Mosses



Myriapods



Fungi



Springtails



Lichens



Flagellates



Vascular plants



Rotifers



Ferns



Nematodes

Saproxylic species: a species that depends on senescent trees, decomposing wood or other saproxylic species for at least a part of its life cycle (from the Greek words “sapro” = rotten, and “xylon” = wood).

Saproxylation: the decomposition process of deadwood

Generally, five wood decay stages are distinguished:

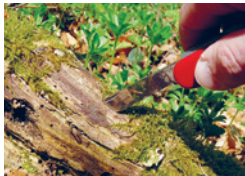
Stage 1: Current-year deadwood; the wood is very hard and shows little or no alteration. All of the bark is still well attached.



Stage 2: The wood is hard and only slightly altered; a knife blade will penetrate the wood with difficulty (<1 cm), even parallel to the grain. Virtually all the bark is intact, though it may no longer adhere very well.



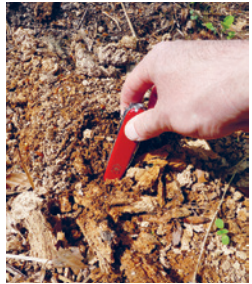
Stage 3: The wood shows clear signs of decay and the surface has become soft or spongy; a knife will penetrate from one to several cms, parallel to the grain. The bark has partly or mostly fallen off (except for certain species, e.g. beech). The piece of deadwood has not lost any of its initial volume.



Stage 4: The wood has decayed considerably; a knife will penetrate to the hilt, at least in some places. There is no more (or very little) remaining bark. The piece of deadwood has lost some of its initial volume.



Stage 5: The wood has lost its structure and is easily scattered with the foot. Remnants contain saproxylic and soil-dwelling organisms (for example, earthworms). An in-depth inspection is necessary to identify the tree species.



Tree-related microhabitat forms

Cavities: holes or sheltered spots in the tree, dry or wet, with or without tree-hole mould, located on the trunk, in the crown or at the root collar.

- **Woodpecker breeding cavity:** cavity excavated by a woodpecker for nesting
- **Rot-hole:** cavity containing tree-hole mould (a mixture of decomposing wood, animal excretions and remains)
- **Insect galleries:** holes and galleries excavated by saproxylic insect larvae
- **Concavity:** hole or hollow in the wood, either wet or dry, or a sheltered spot with no mould and which was not excavated by insect activity

Injuries and exposed wood: sapwood or heartwood is exposed due to bark loss, splitting or breakage.

- **Exposed sapwood:** bark loss has exposed the sapwood only
- **Exposed sapwood and heartwood:** breakage or splitting has exposed both sapwood and heartwood

Crown deadwood: deadwood located in the crown of the tree.

Excrecences: Excrecences caused by a reaction of the tree to light or a bacterial, fungal or viral attack.

- **Twig tangle:** excrecence forming a dense packet of small twigs
- **Burrs and cankers:** ball-shaped excrecences of more or less dense woody material

Fungal fruiting bodies and slime moulds: the reproductive organs of saproxylic fungi or slime mould plasmodia, lasting at least several weeks.

- **Perennial fungal fruiting bodies:** the fruiting bodies of saproxylic fungi that develop over several years
- **Ephemeral fungal fruiting bodies and slime moulds:** the fruiting bodies of saproxylic fungi that develop over only one year, or slime mould plasmodia

Epiphytic and epixylic structures: structures or living organisms that use the tree mainly as a support.

- **Epiphytic and parasitic cryptogams and phanerogams:** vascular plants, mosses and lichens that use the tree as a physical support
- **Nests:** vertebrate or invertebrate nests (excluding woodpecker breeding cavities) placed in the tree or in a cavity
- **Microsoil:** a small amount of newly-created soil originating from the decomposition of organic matter from twigs, leaves, bark or mosses

Fresh exudates: fresh sap runs or resinosis.

Cavities

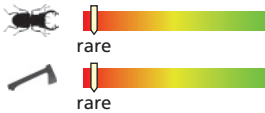
Small woodpecker breeding cavity ($\varnothing < 4$ cm)

Woodpecker breeding cavity with a round entrance < 4 cm in diameter. Lesser Spotted Woodpecker cavities are generally found in dead tree branches.



Minimum size: Cavity entrance $\varnothing < 4$ cm

Frequency:



Replacement rate: fairly rapid



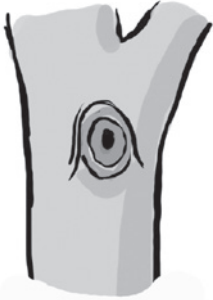
Associated species:



Did you know? In natural temperate forests, cavity density ranges from approximately 5 to 60 per hectare. In Central Europe, around 35% of forest birds nest in cavities.

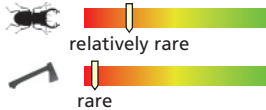
Medium-sized woodpecker breeding cavity ($\varnothing = 4\text{--}7\text{ cm}$)

Woodpecker breeding cavity with a round entrance 4–7 cm in diameter. The nesting cavities of medium-sized woodpeckers (*Dendrocopos major*, *D. medius*, *D. leucotos*, *Picus viridis*, *P. canus*, *Picoides tridactylus*) are usually excavated in decaying wood (dead branches, snags, branch scars).



Minimum size: Cavity entrance \varnothing 4–7 cm

Frequency:



Replacement rate: fairly rapid



Associated species:

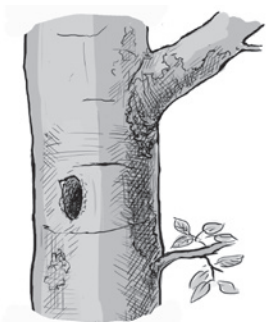


Did you know? Nesting cavities found on oak tree trunks are associated, in 95% of the cases, with the presence of wood-decay fungi like *Phellinus robustus*.

Cavities

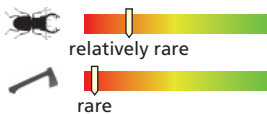
Large woodpecker breeding cavity ($\varnothing > 10$ cm)

Woodpecker breeding cavity with an oval entrance > 10 cm in diameter. The Black Woodpecker generally excavates its cavities in the main tree trunk.



Minimum size: Cavity entrance $\varnothing > 10$ cm

Frequency:



Replacement rate: fairly rapid



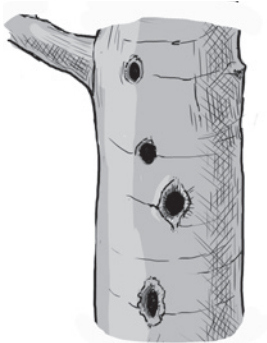
Associated species:



Did you know? The vertebrates that are secondary users of woodpecker cavities can transport large quantities of branches, grass and other materials into the cavity. Nitrogen input in the form of faeces, leftover food or carcasses becomes a source of energy for the many invertebrates that also live inside the cavities.

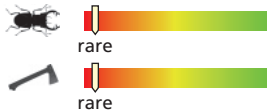
Woodpecker "Flute" (breeding cavity string)

At least three woodpecker nesting cavities aligned on the trunk with less than 2 m distance between two neighbouring cavities.



Minimum size: ≥ 3 cavities on one line; cavity entrance $\varnothing > 3$ cm

Frequency:



Replacement rate: slow



Associated species:

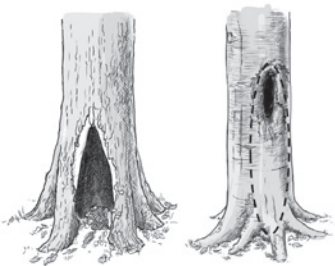


Did you know? There are three groups of invertebrates associated with woodpecker breeding cavities:

- Parasites on vertebrates
- Insects that feed on nesting materials and other residue
- Predators and parasites of the first two groups.

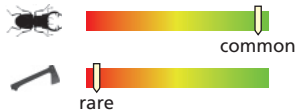
Trunk-base rot-hole (closed top, ground contact)

These cavities contain decomposed organic material, or treehole mould (the quantity of which depends on rot-hole development stage). The bottom of the cavity is in contact with the ground. Even so, the cavity entrance may be located relatively high up on the trunk. The cavity is protected from the external microclimate and rain (a roof is present).



Minimum size: Cavity entrance $\varnothing > 10$ cm

Frequency:



Replacement rate: very slow

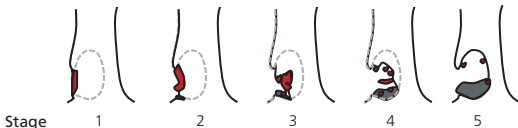


Associated species:



Did you know? Rot-hole development stages

■ Decomposing dead wood ■ Accumulated mould



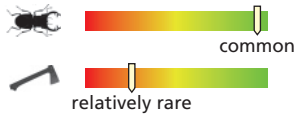
Trunk rot-hole (closed top, no ground contact)

These cavities contain decomposed organic material, or treehole mould, (the quantity depends on rot-hole development stage). The cavity is protected from the external microclimate and rain (a roof is present). The bottom of the cavity is not in contact with the ground.



Minimum size: Cavity entrance $\varnothing > 10$ cm

Frequency:



Replacement rate: very slow



Associated species:



Did you know? As a cavity develops and becomes bigger, its structure becomes more complex and the diversity of its associated species increases. The mould inside has a high pH level, which favours specific rare species. Some rare bryophytes and lichens only grow on tree bark below a rot-hole, where pH is higher due to leakage from the cavity.

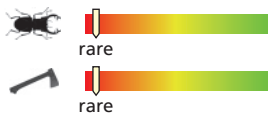
Semi-open trunk rot-hole

The cavity is not completely protected from the external microclimate and rain can enter. Note that the bottom of the cavity is not necessarily in contact with the ground and that the entrance may be located relatively high up on the trunk.




Minimum size: Cavity entrance $\varnothing > 30$ cm (experts' threshold)

Frequency:



Replacement rate: very slow



Associated species: 

Did you know? A very diverse fauna lives in the treehole mould at the bottom of these cavities. In one kilogramme of cavity soil, researchers have found an average of 2500 individual arthropods, mostly springtails and Acariens. In very long-lived trees like oaks, these base rot-holes can persist for several hundred years.

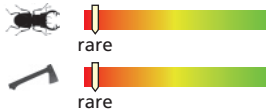
Chimney trunk-base rot-hole (in contact with the ground)

The cavity is open at the top, often due to stem breakage. The cavity base reaches ground level so the bottom of the cavity is in direct contact with the soil.



Minimum size: Cavity entrance $\varnothing > 30$ cm (experts' threshold)

Frequency:



Replacement rate: very slow



Associated species:



Did you know? Species associated with rot-holes, which are long-lasting tree-related microhabitats, generally have a more limited dispersal capacity than do species associated with ephemeral tree microhabitats.

Chimney trunk rot-hole with no ground contact

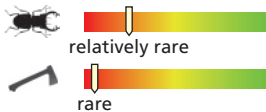
The cavity is open at the top, often resulting from stem breakage. The cavity base does not reach ground level, so there is no direct contact with the soil.



Minimum size: Cavity entrance $\varnothing > 30$ cm (experts' threshold)

Frequency:

Replacement rate: very slow



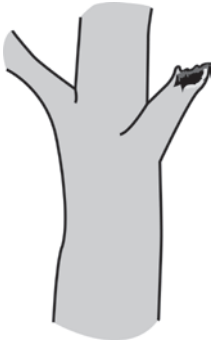
Associated species:



Did you know? Both microclimatic (humidity and temperature) and physico-chemical conditions (at the interface between cavity mould and soil humus) are different in suspended cavities and trunk-base cavities. As a result, the organisms associated with the two types of cavities are not the same.

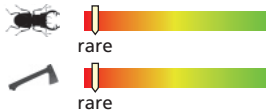
Hollow branch

A rot-hole located on a large broken limb, often forming a more or less horizontal, tube-shaped shelter.



Minimum size: Cavity entrance $\varnothing > 10$ cm (experts' threshold)

Frequency:



Replacement rate: slow to rapid



Associated species:



Did you know? Certain insects can raid other species' food caches. This is known as kleptoparasitism. For example, carpenter bees store pollen and nectar for their larvae in microcavities, and this can attract other foragers.

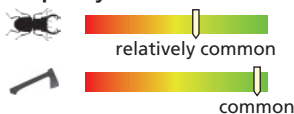
Insect galleries and bore holes

Emergence holes left by xylophagous insects indicate the presence of a cavity network in the wood. An insect gallery is a complex system of tunnels and chambers.



Minimum size: Bore hole $\varnothing > 2$ cm or multiple smaller bore holes > 300 cm² (A5; experts' threshold)

Frequency:



Replacement rate: fairly fast



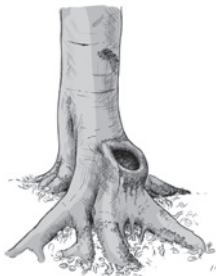
Associated species:



Did you know? Xylophagous insects are sometimes considered to be forest pests. However, the vast majority of these species consume dead or altered wood and do not cause tree dieback.

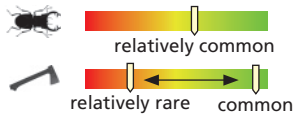
Dendrotelm

Cup-shaped hollows where rainwater can accumulate and then gradually evaporate. Healthy bark may have sealed the inside of the hollow or the edges and bottom may be in a state of decay.



Minimum size: Opening $\varnothing > 15$ cm

Frequency:



Replacement rate: slow



Associated species:



Did you know? There are only around 15 dendrotelm-dwelling insect species in Europe, but half of them are strictly associated with this specific microhabitat. Amphibians may sometimes use dendrotelms to moisten their skin. Decomposing leaves are the main energy source for dendrotelm-dwelling communities.

Cavities

Woodpecker foraging excavation

Hollows resulting from woodpecker foraging. The hole is cone-shaped: the opening is larger than the cavity itself.



Minimum size: Depth > 10 cm; opening \varnothing > 10 cm

Frequency:



Replacement rate: fairly rapid



Associated species:



Did you know? When woodpecker foraging excavations are large enough, birds may use them to shelter their nests.

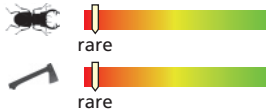
Bark-lined trunk concavity

A natural hollow in the tree trunk with a hard bottom and bark on the inside walls.



Minimum size: Depth > 10 cm; opening \varnothing > 10 cm

Frequency:



Replacement rate: slow



Associated species:



Did you know? Several species of undemanding cavity-nesting birds, for example the blackbird, use bark-lined trunk concavities.

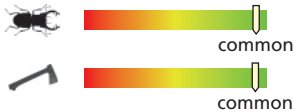
Buttress-root concavity

A natural hollow with a hard bottom and bark on the inside walls formed between buttress roots or the buttress and the ground. There is no presence of mould (if mould is present, see "Trunk base rot-hole").



Minimum size: Opening > 10 cm; depth > 10 cm;
"ceiling" angle < 45° (experts' threshold)

Frequency:



Replacement rate: slow



Associated species:



Did you know? The formation of buttress-root concavities is linked to tree growth and varies depending on tree species and site conditions. Ground slope especially has an influence; trees growing on steep slopes often have buttress-root concavities.

Tree injuries and exposed wood

Bark loss

Bark is missing and the sapwood is exposed (bark loss due to tree felling, skidding operations, falling trees, rock fall, bark removal by mammals, etc.).



Minimum size: Surface > 300 cm² (A5; experts' threshold)

Frequency:

Replacement rate: rapid



Associated species:



Did you know? Areas of exposed sapwood are easily colonised by fungi and insects. They may eventually become mould-filled rot-holes.

Tree injuries and exposed wood

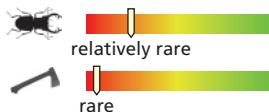
Fire scar

Fire scars located near the base of the trunk. They are often triangular in shape and alter the lower part of the tree. Charred wood may be visible and, in conifers, pitch flows may occur on the exposed wood or surrounding bark.



Minimum size: Surface > 600 cm² (A4; experts' threshold)

Frequency:



Replacement rate: very slow–rapid



Associated species:

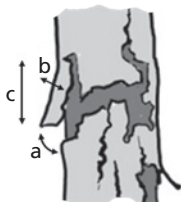


Did you know? The so-called pyrophilous insects and fungi cannot survive without fire. Charred wood is rapidly colonised by ascomycetes, themselves a food source for certain insects.

Tree injuries and exposed wood

Bark shelter

Loose hanging bark creates a shelter along the trunk (with an opening at the bottom).



a > 1 cm
b > 10 cm
c > 10 cm



Minimum size: Space between bark and sapwood > 1 cm;
width > 10 cm; length > 10 cm (experts' threshold)

Frequency:



relatively common



relatively rare

Replacement rate: slow



Associated species:

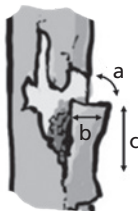


Did you know? Some bats, like the western barbastelle (*Barbastella barbastellus*), take shelter under loose bark to rest during the day, or even to mate.

Tree injuries and exposed wood

Bark pocket

Slabs of bark detached from the trunk at the top that create pockets where mould/humus can accumulate.



$a > 1 \text{ cm}$
 $b > 10 \text{ cm}$
 $c > 10 \text{ cm}$



Minimum size: Space between bark and sapwood $> 1 \text{ cm}$; width $> 10 \text{ cm}$; length $> 10 \text{ cm}$ (experts' threshold)

Frequency:



common



relatively rare

Replacement rate: slow



Associated species:

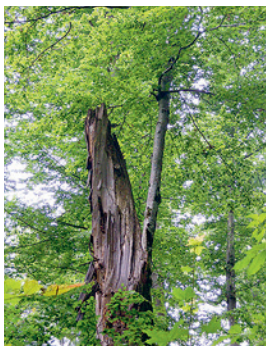


Did you know? Many arthropods, including arachnids (false scorpions) live in the organic matter that accumulates in the pockets formed by the detached bark.

Tree injuries and exposed wood

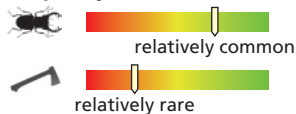
Stem breakage

The trunk has broken off and the heartwood has been exposed. The tree is still alive. The dead wood below the breakage is in contact with living wood where the sap still flows.



Minimum size: Stem $\varnothing > 20$ cm at breakage (experts' threshold)

Frequency:



Replacement rate: rapid



Associated species:



Did you know? When a new top grows from a broken stem, decomposition and growth occur at the same time in very close proximity within the tree. The juxtaposition of these two processes creates a vital tree-related microhabitat for a few highly specialised invertebrates (Diptera and Heteroptera).

Tree injuries and exposed wood

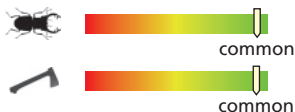
Limb breakage (heartwood exposed)

A large limb or a fork has broken off and the heartwood has been exposed. The damaged area is surrounded with living wood where the sap still flows.



Minimum size: Exposed surface > 300 cm² (A5; experts' threshold)

Frequency:



Replacement rate: rapid



Associated species:



Did you know? Because heartwood is dead, it has a very different chemical composition from that of the sapwood, and this influences its roster of associated species.

Tree injuries and exposed wood

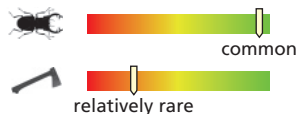
Crack

Cracks through the bark and into the underlying wood. If the crack was caused by lightning, see "Lightning scars".



Minimum size: Length > 30 cm; width > 1 cm; depth > 10 cm

Frequency:



Replacement rate: slow



Associated species:



Did you know? Bats prefer relatively deep cracks (> 10 cm) from 1 to 5 cm in width and located more than 1 m above the ground. Cracks are more common in dead trees than in living trees.

Tree injuries and exposed wood

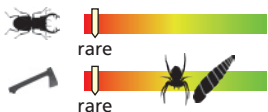
Lightning scar

A crack caused when a tree is struck by lightning; a lightning scar generally spirals along the trunk and the wood has splintered (multi-fissured crack).



Minimum size: Length > 30 cm; width > 1 cm; depth > 10 cm

Frequency:



Replacement rate: rare event



Associated species:



Did you know? The multiple fissures created by the splintered wood in a lightning scar often have such different characteristics that a wide variety of animals can co-exist in the same split trunk: spiders, bats, birds and gastropods.

Tree injuries and exposed wood

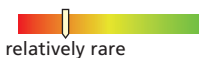
Fork split at the intersection

Crack at the intersection of a tree fork. If one of the main branches of the fork has fallen off, see "limb breakage (heartwood exposed)".



Minimum size: Length > 30 cm (experts' threshold)

Frequency:



Replacement rate: slow



Associated species: 

Did you know? Cracks formed by the separation of the two limbs at a fork offer shelter but little protection from precipitation. Furthermore, falling organic material (leaves, twigs, etc.) often accumulates in the opening created; this material decomposes and can create a "crown microsoil", where secondary tree roots can grow.

Crown deadwood

Dead branches

Dead branches in relatively shaded parts of the crown.



Minimum size: Branch $\varnothing > 10$ cm, or branch $\varnothing > 3$ cm plus $> 10\%$ of the crown is dead (experts' threshold)

Frequency:



Replacement rate: fairly slow



Associated species:



Did you know? Unlike deadwood lying on the forest floor, dead crown branches are subjected to frequent desiccation and widely varying temperatures. Certain invertebrates and fungi are specialists of dead tree branches. Other types of tree-related microhabitats (cavities, fungal sporophores...) sometimes complement dead branches in the crown, thus increasing the biodiversity of the associated species. This type of crown deadwood cannot simply be replaced by downed woody debris because the associated species assemblages are quite different.

Crown deadwood

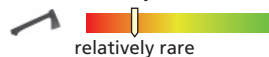
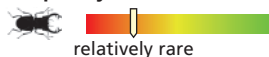
Dead top

The entire top of the tree has died and the deadwood is generally exposed to the sun.



Minimum size: $\varnothing > 10$ cm at the base (experts' threshold)

Frequency:



Replacement rate: fairly slow



Associated species:



Did you know? Unlike dead branches inside the crown, dead tops are exposed directly to the sunlight. Their decomposition is carried out by more thermophilous species, which are able to withstand contrasted microclimatic conditions.

Crown deadwood

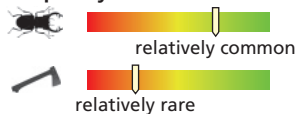
Remnants of a broken limb

A large limb has broken off. The remaining stub has shattered but the injury does not affect the trunk of the tree (if so, see "Limb breakage with exposed heartwood").



Minimum size: Branch $\varnothing > 20$ cm at the break, stub length > 50 cm (experts' threshold)

Frequency:



Replacement rate: fairly rapid



Associated species:



Did you know? Large broken limbs provide both cracks and large volumes of deadwood.

Witches' broom

A dense mass of intertwined twigs on a branch.



Minimum size: $\varnothing > 50$ cm (experts' threshold)

Frequency:



relatively rare



relatively rare

Replacement rate: fairly rapid



Associated species:



Did you know? The mass of intertwined twigs caused by witches' broom sometimes support the nests of small passerines like the short-toed treecreeper or the Eurasian wren, but birds of prey like the common buzzard may also build nests there.

Epicormic shoots

A dense mass of shoots on the trunk sprouting from dormant buds under the bark.



Minimum size: > 5 shoots (experts' threshold)

Frequency:



relatively rare



relatively rare

Replacement rate: fairly slow



Associated species:



Did you know? The intertwined epicormic shoots sometimes support the nests of small birds like the song thrush and the blackbird.

Excrescences

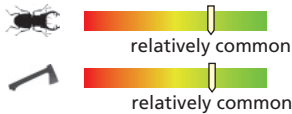
Burr

Proliferation of cells with rough bark but no rotten wood.



Minimum size: $\varnothing > 20$ cm (experts' threshold)

Frequency:



Replacement rate: slow



Associated species: 

Did you know? Unlike the wood found in cankers, burr wood has no rot and the bark appears intact. Certain *Synanthedon* larvae (Sesiidae family) mature in the cracked bark on burrs.

Canker

Canker with rotten wood and exposed sapwood, caused by *Melampsorella caryophyllacerum*, *Nectria* l.s., for example.



Minimum size: $\varnothing > 20$ cm or covering a large part of the trunk (experts' threshold)

Frequency:



relatively rare



relatively common

Replacement rate: slow



Associated species:



Did you know? Some very rare fungi like *Inonotus obliquus* colonise cankers. The pH of the bark located under a canker is higher than on other parts of the trunk, thus favouring rare, threatened bryophytes. The rough surface of a canker also attracts foraging insect-eating birds.

Fruiting bodies of saproxylic fungi and slime moulds

Perennial polypore

Fruiting bodies (conks) of perennial bracket fungi with a woody texture and several layers of tubes (if more than 1 year old).



Minimum size: $\varnothing > 5$ cm (experts' threshold)

Frequency:



Replacement rate: slow



Associated species:



Did you know? Conks are a sign of often extensive wood decay. Woodpeckers sometimes excavate their cavities just below conks since the wood there is more tender and the conk shelters the entrance. In Europe, an estimated 600 species of arthropods live inside *Fomes fomentarius* (or Tinder Polypore, Tinder Fungus, Hoof Fungus) conks.

Fruiting bodies of saproxylic fungi and slime moulds

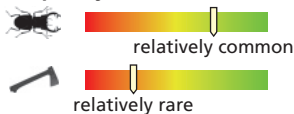
Annual polypore

Fruiting bodies of annual polypores remaining for several weeks. European annual polypores have only one layer of tubes and are generally rather elastic and supple (with no woody parts).



Minimum size: $\varnothing > 5$ cm or group of > 10 fruiting bodies (experts' threshold)

Frequency:



Replacement rate: slow



Associated species:



Did you know? Fungal sporophores are a much richer energy source than wood. For example, the nitrogen content is 2 to 10 times higher in sporophores than in fresh wood. Associated invertebrates consume the spores, the tubing or the mycelium of the fruiting body. Sporophores host the smallest Coleopteron in the world (0.3-0.6 mm long).

Fruiting bodies of saproxylic fungi and slime moulds

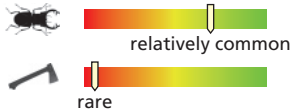
Pulpy agaric

Large, thick, and pulpy or fleshy, gilled sporophores (Agaricales order), generally remaining for several weeks.



Minimum size: $\varnothing > 5$ cm or group of > 10 fruiting bodies (experts' threshold)

Frequency:



Replacement rate: slow



Associated species:



Did you know? Most agaricales sporophores decompose too fast for insect larvae to complete their development. They are therefore used exclusively as a food source.

Fruiting bodies of saproxylic fungi and slime moulds

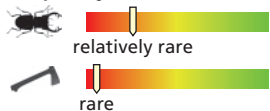
Large pyrenomycete

Hard, black sporophores, hemispherical in shape, that resemble lumps of coal.



Minimum size: Fruiting body $\varnothing > 3$ cm or group covering > 100 cm² (experts' threshold)

Frequency:



Replacement rate: slow



Associated species:



Did you know? Pyrenomycetes are generally quite small (several mm in diameter) and cover patches of the trunk with hard dark bumps. One species, however, *Daldinia concentrica*, often found on the common ash, can reach several cm in diameter. The flat bug *Aradus bimaculatus* lives in the stromata of the pyrenomycete *Hypoxyylon mammatum* (aspen canker).

Fruiting bodies of saproxylic fungi and slime moulds

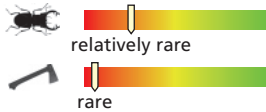
Myxomycetes (slime moulds)

An amoeboid slime mould in its plasmodial stage. Slime moulds are gelatinous when fresh.



Minimum size: $\varnothing > 5$ cm (experts' threshold)

Frequency:



Replacement rate: fairly rapid



Associated species:



Did you know? This slimy jelly-like mass is neither animal, plant nor fungus yet it can move up to several centimetres per hour when foraging for its food, which consists of bacteria, algae or fungi. Most of the species that consume slime moulds are strictly dependant on the relationship.

Epiphytic and epixylic structures

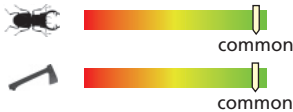
Bryophytes (mosses and liverworts)

Trunk covered in moss and liverworts (Hepaticophyta).



Minimum size: > 10 % of the trunk is covered (experts' threshold)

Frequency:



Replacement rate: fairly rapid



Associated species:

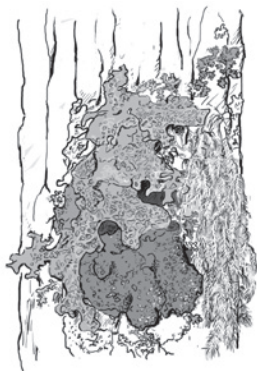


Did you know? The epixylic species (mosses and lichens) carry out their own photosynthesis. They therefore live only on the surface of the tree and do not use the wood as a source of energy. Certain lichens grow only on a carpet of moss.

Epiphytic and epixylic structures

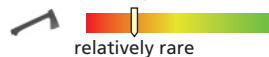
Foliose and fruticose lichens

Trunk covered in foliose lichens (lobe-shaped) or fruticose lichens (bushy).



Minimum size: > 10% of the trunk is covered, thickness > 1 cm (experts' threshold)

Frequency:



Replacement rate: slow



Associated species:



Did you know? Because of their small size and slow growth, lichens must find habitats that are relatively hostile to plants or they will be out-competed. Tree trunks, like stones and rocks, provide such habitats. Certain fungi grow only on epiphytic lichens.

Epiphytic and epixylic structures

Ivy and lianas (woody vines)

Lianas and other climbing phanerogams such as ivy, clematis.



Minimum size: > 10 % of the trunk is covered (experts' threshold)

Frequency:



Replacement rate: fairly rapid



Associated species:



Did you know? Ivy flowers in the autumn and its fruit is available at the end of winter, during a time when plants offer little food. In addition, its leaves and twisted branches create small shady, moist niches where specialized epiphytic fungi grow.

Epiphytic and epixylic structures

Ferns

Ferns growing directly on the trunk or at the intersection of a branch (as an epiphyte).



Minimum size: > 5 fronds (experts' threshold)

Frequency:



relatively rare



rare

Replacement rate: slow



Associated species:

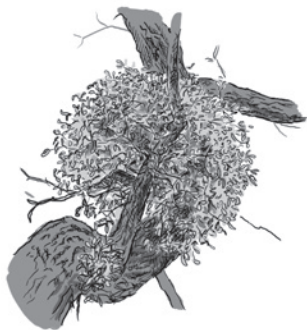


Did you know? Ferns are rarely fed upon by insects. Nonetheless, in Western Europe, 22 species of sawflies (Hymenoptera) spend their entire life cycle on fern fronds.

Epiphytic and epixylic structures

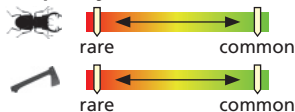
Mistletoe

These hemiparasitic epiphytes generally grow in the tree crown. Examples include *Viscum* spp., *Arceuthobium* spp. and *Loranthus* spp.



Minimum size: $\varnothing > 20$ cm for *Viscum* spp. and *Loranthus* spp.;
> 10 clumps for *Arceuthobium* spp. (experts' threshold)

Frequency:



Replacement rate: fairly rapid



Associated species:



Did you know? In Europe, there are eight known insect species specific to the common mistletoe *Viscum album*. Its fruit is appreciated by certain birds in the winter, when food is scarce.

Epiphytic and epixylic structures

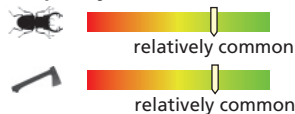
Vertebrate nest

Bird or rodent nest.



Minimum size: $\varnothing > 10$ cm

Frequency:



Replacement rate: rapid



Associated species:



Did you know? Large bird nests provide nesting sites among their twigs for small birds as well as habitat for invertebrates like the Coleoptera in the Histeridae family (clown beetles).

Epiphytic and epixylic structures

Invertebrate nest

Nest containing invertebrate larvae. Examples include pine processionary caterpillars, saproxylic ants and wild bees.



Minimum size: Presence (direct observation or associated insects; experts' threshold)

Frequency:



Replacement rate: fairly slow



Associated species:

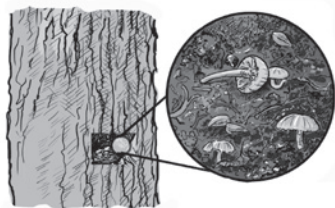


Did you know? More than 60 species of arthropods have been recorded in pine processionary caterpillar nests.

Epiphytic and epixylic structures

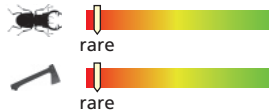
Bark microsoil

Microsoil on the trunk bark formed from moss, lichen or epiphytic alga residues and old, thick and decaying bark.




Minimum size: Presence (direct observation or fungi; experts' threshold)

Frequency:



Replacement rate: slow



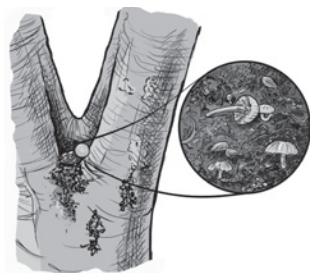
Associated species: 

Did you know? Bark microsoils provide a habitat for a few highly specialised saprophytic fungi, which are sometimes dependant on a single host species.

Epiphytic and epixylic structures

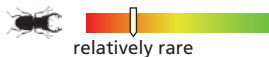
Crown microsoil

Crown microsoil is formed from debris and litter originating in the canopy, and is often colonised by secondary roots from the tree. Crown microsoil is mostly found in flat areas of the crown, in forks or between two joined trees.



Minimum size: Presence (experts' threshold)

Frequency:



relatively rare



relatively rare

Replacement rate: slow



Associated species:



Did you know? Old beech trees often harbour microsoil pockets in their crown where roots develop into veritable mycorrhizal systems. The same phenomenon is found in conifers. Tree microsoils are much richer in organic carbon than the soil on the ground and can be more easily penetrated by fine roots. Though the phenomenon has long been recognised in tropical forests, it is still little known in temperate forests.

Exudates

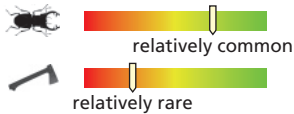
Sap run

Sap running along the trunk.




Minimum size: Length > 10 cm (experts' threshold)

Frequency:



Replacement rate: fairly slow



Associated species: 

Did you know? Sap runs are an attractive food source for numerous adult insects. In Japan, more than 100 species have been identified feeding on oak (*Quercus acutissima*) sap runs. Insect larvae living in sap runs do not consume the sap itself but rather the yeasts and bacteria that develop there.

Exudates

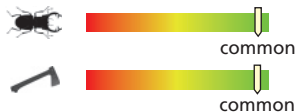
Heavy resinosis

Flow of fresh resin.



Minimum size: Length > 10 cm (experts' threshold)

Frequency:



Replacement rate: fairly rapid



Associated species:



Did you know? Resin is excreted by certain conifers to form a protective barrier rich in antimicrobial elements, which prevent pests and pathogens from penetrating the bark and entering the wood. The resulting antiseptic substratum is therefore quite inhospitable to living organisms. Even so, *Sorocybe resiniae*, a microscopic ascomycete, lives exclusively in resin flows.

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