Food and Agriculture Organization
of the United Nations

HANDBOOK OF THE MAJOR FOREST PESTS IN SOUTHEAST EUROPE

Handbook of the major forest pests in Southeast Europe

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1. Introduction

Maintaining forests in good health is essential to sustain timber resources and ecosystem services, but a large number of threats can cause growth losses and mortality to trees.

Forest health and vitality, therefore are considered amongst the main criteria for sustainable forest management. Causes of negative impacts on forest health include both biotic agents (such as insects, pathogens, game and other grazers) and abiotic agents (including fire, wind or snow, frost or drought). Certain anthropogenic impacts should also be included, for example poor harvesting practices or air pollution.

Globally, forest health issues are reported under the framework of the Global Forest Resources Assessment (2005); the FAO has been coordinated global forest resources assessments since 1946. Information was collected and analyzed from 229 countries and territories for 1990, 2000 and 2005. Some 40 variables were included, related to the extent, condition, uses and values of forests and other wooded land. The area of forest adversely affected by insects, disease and other disturbances reached 1.1 million ha per year, while the area adversely affected by forest fires decreased slightly.

For the forested area in Europe, ICP Forest (International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests) has a database which is the most comprehensive overview of forest condition (*www.icp-forests.org*).

Crown condition is the most widely applied indicator for forest health and vitality in Europe. In 2011 the mean defoliation of 135 388 sample trees on 6 807 transnational Level I plots (distributed over 40 countries) was 19.5 %. Of all trees assessed, 20.0 % were scored as damaged, indicating that defoliation was greater than 25%.

EFI Technical Report 66 on Prevalence of Biotic and Abiotic Hazards in European Forests, compared the 26 most abundant European tree species. Significant differences in level of damage were recorded in the period 1994-2005 (Figure 1).

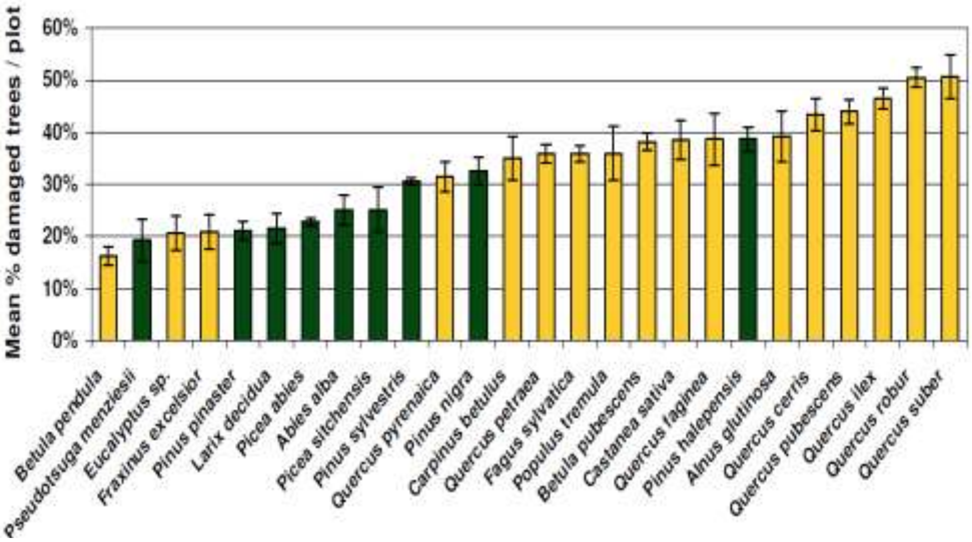


Figure 1. Percentage of damaged trees of each assessed species per plot (data were angular transformed) during the period 1994-2005. (green - conifer species; yellow - broadleaved species).

The percentage of damaged trees per plot varied from 16 % for silver birch (Betula *pedula*) to 51 % for pedunculate and cork oak (*Quercus robur* and *Q. suber*, respectively). All fourteen most damaged species were broadleaved (angiosperm) trees, with the exception of Aleppo pine (*Pinus halepensis*). By contrast, there was a majority of conifer species for the twelve least damaged species. The mean percentage of damaged trees per plot was significantly higher for broadleaved (38.7 ± 0.7 %) than for conifer species (27.4 ± 0.4 %).

Considering the 26 European tree species altogether, the relative contribution of each of the seven categories of biotic and abiotic agents to tree damage between 1994 and 2005 were, in order of increasing importance (Figure 2.). anthropogenic agents (total of 21 %), abiotic agents (22 %) and biotic agents (57 %) with the insects representing the main cause of damage (34 %).

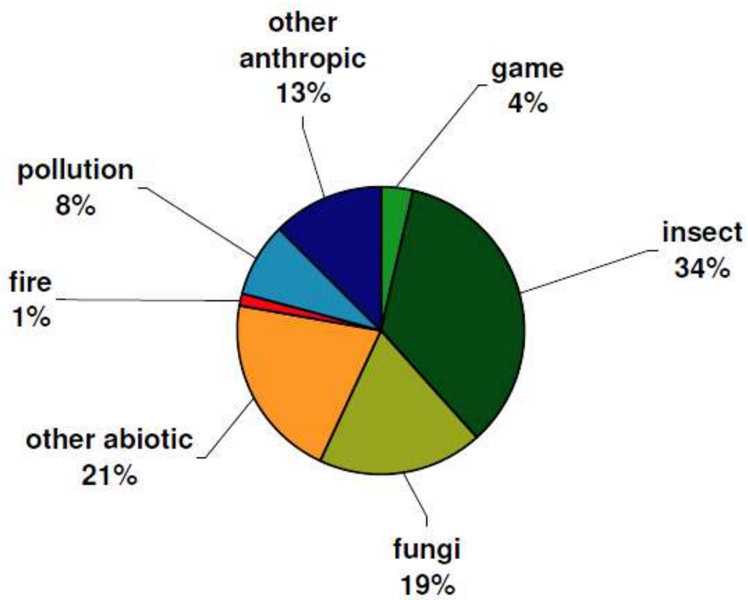


Figure 2. Proportion of damage caused to the 26 assessed European forest tree species by a range of biotic and abiotic factors between 1994-2005 . (green: biotic causes; orange: abiotic causes; blue: anthropogenic causes of damage).

The results of this study clearly show that the most prevalent hazards in European forests are of biotic origin (pest insects and pathogenic fungi), followed by abiotic agents such as drought, wind and fire. It is also evident that European forests differ greatly in exposure to these hazards, according to species composition and bioclimatic zone. These data serve as a baseline to determine the potential impact of alternative forest management practices on sanitary damage in European forests.

2. Basic morphology and biology of insects

The insect body has three parts: *head*, *thorax* and *abdomen*. Insects have three pairs of legs linked to the three thoracic segments. Adult insects usually have wings, although these structures may be absent or reduced in number from two to one pair (Figure 3.).

Head

The insect head is a capsule that contains the *compound eyes*, *simple eyes*, mouthparts, *antenna* and in many case further sense-organs.

Eye:

In most insects there is one pair of large, prominent compound eyes composed of individual units called ommatidia. There may be from 40 to 30,000 ommatidia in a compound eye. This type of eye gives less resolution than the vertebrate eye, but it gives acute perception of movement. When present, simple eyes (*ocelli*, either 2 or 3), detect low light or small changes in light intensity.

Mouth:

The 4 main mouthparts are the *labrum*, *mandibles*, *maxillae* and *labium*. The *labrum* is often called the upper lip, and moves longitudinally. The *mandibles*, or jaws, are highly sclerotized paired structures that move at right angles to the body. They are used for biting, chewing and severing food. The *maxillae* are paired structures that can move at right angles to the body and possess segmented palps. The *labium* (often called the lower lip), is a fused structure that moves longitudinally and possesses a pair of segmented palps. Mouthparts vary greatly among insects of different orders but there are two main functional groups: mandibulate and haustellate. Haustellate mouthparts can be further classified as piercing-sucking, sponging, and siphoning.

Antenna:

Antennae function almost exclusively in sensory perception. Some of the information detected by insect antennae includes: motion and orientation, odour, sound, humidity, and a variety of chemical odours. Antennae vary greatly among insects, but all follow a basic plan: segments 1 and 2 are termed the scape and pedicel, respectively. The remaining antennal segments are jointly called the flagellum.

Thorax

The insect thorax is divided into three parts: the *prothorax* (pro=first), *mesothorax* (meso=middle), and *metathorax* (meta=last). Each segment consists of hardened plates, or sclerites. Each of the three thoracic segments contains one pair of legs. Wings are found only on the meso- and metathoracic segments.

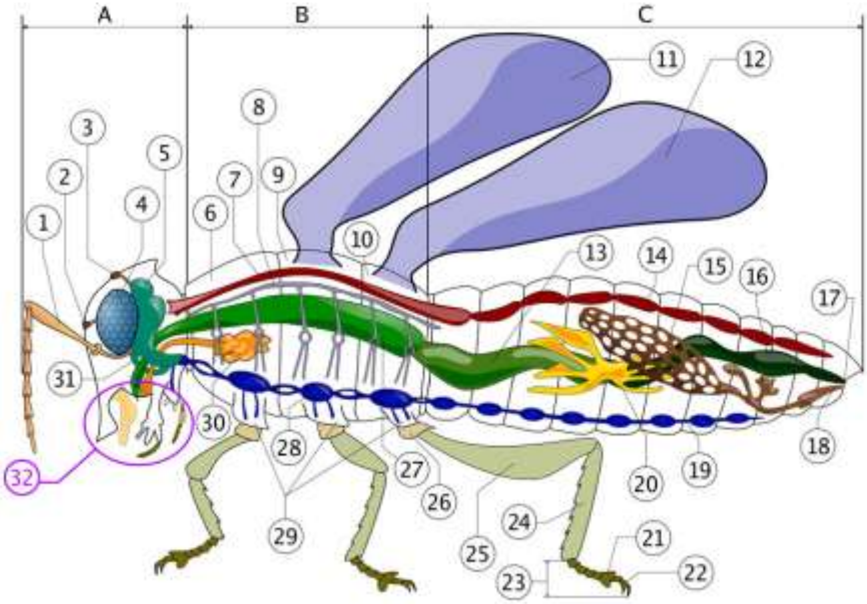
Legs:

Each leg has six major components, listed here from proximal to distal: *coxa*, *trochanter*, *femur*, *tibia*, *tarsus* and pretarsus. The femur and tibia may be modified with spines. The tarsus appears to be divided into one to five "pseudosegments" called tarsomeres. Like the mouthparts and antennae, insect legs are highly modified for different functions, depending on the environment and lifestyle of the specific insect.

Wings:
Insects have evolved many variations of the wings, and an individual insect may posess more than one type of wing. Wing venation is a commonly used taxonomic character, especially at the family and species level.

In most extant insects (Neoptera), there are three axillary sclerites that articulate with various parts of the wing. In the Neoptera, a muscle on the third axillary causes it to pivot about the posterior notal wing process and functions thereby to fold the wing over the back of the insect. However, in some groups of Neoptera, such as butterflies, the ability to fold the wings over the back has been lost. Two orders of winged insects, the Ephemeroptera and Odonata, have not evolved this wing-flexing mechanism, and their axillary sclerites are arranged in a pattern different from that of the Neoptera; these two orders (together with a number of extinct orders) form the Paleoptera.

Abdomen
The abdomen contains the reproductive organs and the majority of the organ systems. The dorsal and ventral abdominal segments are termed terga (singular tergum) and sterna (singular sternum), respectively. Spiracles usually can be found in the conjunctive tissue between the terga and sterna of abdominal segments 1-8. Reproductive structures are located on the 9th segment in males and on the 8th and 9^{th} abdominal segments in females.



(Source: Wikipedia)

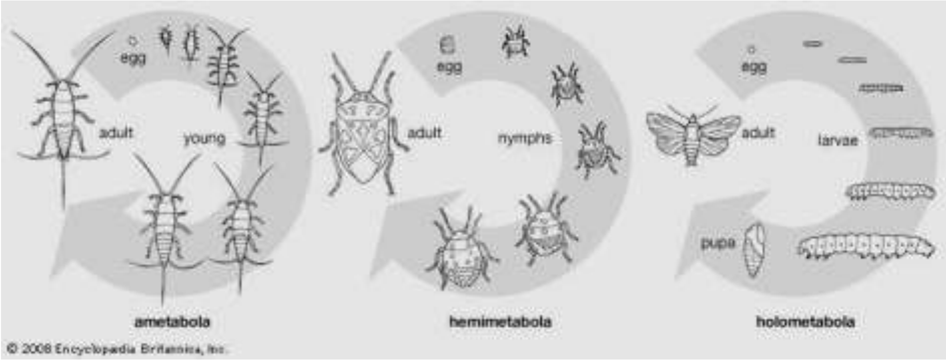
Figure 3. Schematic structure of an insect
http://upload.wikimedia.org/wikipedia/commons/f/f2/Insect_anatomy_diagram.svg
A: head, B: thorax, C: abdomen
1: antennae, 2&3: simple eyes (ocelli), 4: compound eye, 5: brain, 6: prothorax, 7: aorta, 8: spiracles (tracheal trunk), 9: mesothorax, 10: metathorax, 11: 1st wings, 12: 2nd wings, 13: midgut (mesenteron), 14: heart, 15: ovaries, 16: hindgut, 17: anus, 18: ovidukt, 19: nerve cord, 20: Malpighian tubules, 21: praetarsus, 22: ungues, 23: tarsus, 24: tibia, 25: femur, 26: coax, 27: foregut, 28: thoracic ganglia, 29: hip, 30: salivary glands, 31: subesopagheal ganglion, 32: mouthparts.

Insect Growth and Development (Metamorphosis)

Some insects develop without separate life stages (ametabolia). The vast majority of insects, however, go through several separate life stages (metamorphosis): egg, larva or nymph, pupa (complete metamorphosis only), and adult. Eggs are laid individually or in masses, in or on plants, or even inside another insect. Eventually a larva or nymph emerges from the egg. There are usually several larval or nymphal stages, called instars. During each stage the nymph grows larger and molts, or sheds its outer skin before the next stage. All the growth occurs during the larval or nymphal stages. The eggs, pupae, and adults do not increase in size.

The two types of metamorphosis typical of insects are:

- incomplete metamorphosis (hemimetabolia) (egg ⇒ nymph ⇒ adult) and
- complete metamorphosis (holometabolia) (egg ⇒ larva ⇒ pupa ⇒ adult) (Figure 4.).



(Source: Encyclopaedia Britannica)

Figure 4. Insect development types.
http://media-2.web.britannica.com/eb-media/46/102446-004-190284A4.jpg

3. Basic morphology and biology of pathogens

Fungi can live on a variety of substrates including living tree tissues and wood. For convenience, these 'life strategies' are divided into the following three categories:

- *Mycorrhizal fungi,* which form a mutually beneficial partnership with living trees;
- *Parasitic fungi*, which attack living host tissues;
- *Saprophytic fungi* that attack dead and decaying organic material.

The *thallus* of a fungus is composed of tubular, branching filaments, called *hyphae* that may or may not have crosswalls (*septa).* As several hyphae become intimately enmeshed, they collectively are called *mycelium.*

Reproduction of fungi is accomplished in varied ways, each classified into one of two types: *sexual* and *asexual*. The product of both types is some form of *spore.*

The *sexual* (*perfect*, *meiotic*) state is referred to as the *teleomorph*. Sexual reproduction is an important source of genetic variability, enabling the fungus to adapt to new environments.

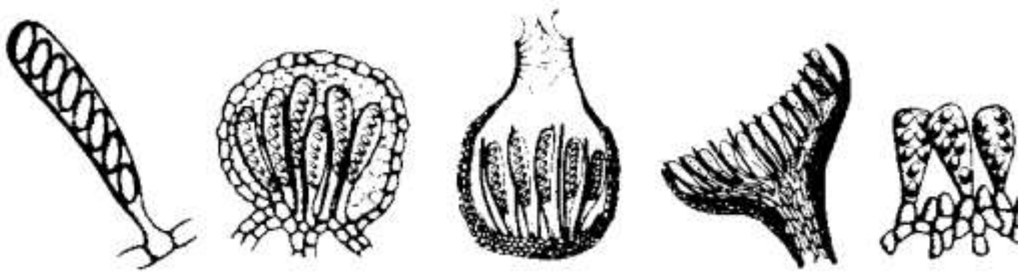
The *asexual (imperfect, mitotic)* state of a fungus is termed the *anamorph*.

The Kingdom Fungi is divided into several major *phyla*, two of which are important in forest pathology, the Ascomycota and Basidiomycota).

Members of Dikarya subkingdom Ascomycota are commonly known as *sac fungi*. The Ascomycota is the largest *phylum* of fungi with over 64 000 species. Hyphae are septate. The defining feature of this phylum is the "*ascus*" (meaning "*sac*" or "*wineskin*"), a microscopic sexual structure, in which non-motile spores, the *ascospores*, are formed. Some species of the Ascomycota, however, appear to only reproduce *asexually*, meaning that the sexual cycle with the production of *asci* and *ascospores* has not been observed.

Asci arise from a mat of fertile hyphae called the *hymenium.* Most asci are enclosed in some type of fruiting structure (Figure 5), called the *ascocarp:*

- *Cleistothecium* - ascocarp completely closed, spherical;
- *Perithecium* - ascocarp with a small opening and a wall of its own, flask-shaped;
- *Apothecium* - ascocarp open, cup- or saucer-shaped;
- *Pseudothecium* - ascocarp bearing asci in locules within a stroma.

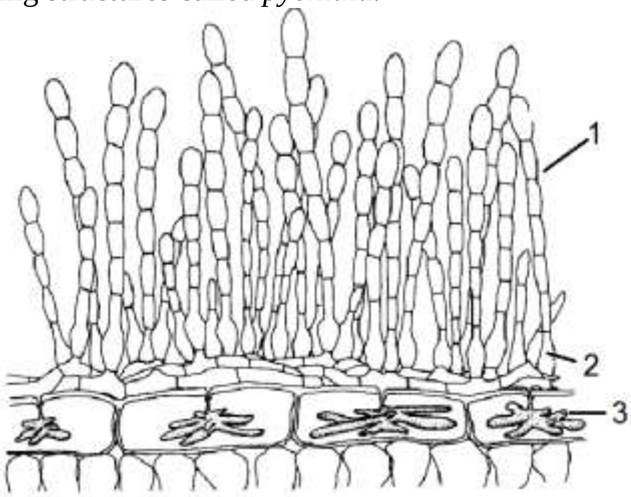


(Source: Agrios, 2005)

Ascus and ascospores | Cleistothecium | Perithecium | Apothecium | Naked asci

Figure 5. Some examples of sexual structures (fruiting body) of the Ascomycota.

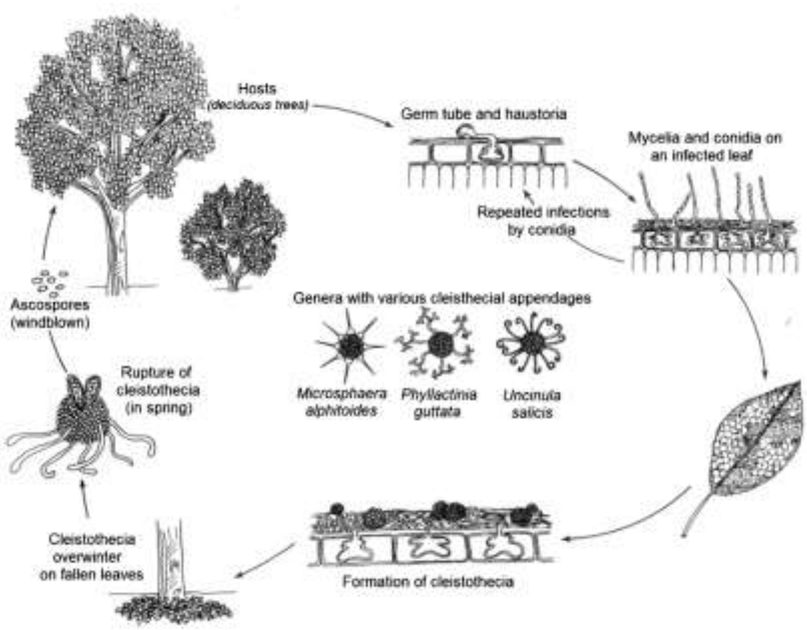
Asexual reproduction occurs through production of *conidia* (Figure 6.) borne on *conidiophores* that may occur singly, in groups, on mats of hyphae, or in enclosed fruiting structures called *pycnidia.*



(Source: Agrios, 2005)

Figure 6. The basic structural units of fungi
(*1. conidia 2. hypha and conidiophore 3. haustoria).*

Ascomycetes include causal agents of a variety of plant diseases such as *foliage diseases* (powdery mildew, needle cast, leafspots, tar spots), *wilts* and *cankers*.
The most damaging foliage diseases are *powdery mildew* and *needle cast*.
Powdery mildews are fungal diseases that affect a wide range of plants. The causal agents are *obligate* on the hosts, i.e. they require host tissues for growth and cannot be cultivated easily in the laboratory. Many different species of fungi in the order Erysiphales cause powdery mildews, and it is one of the easier diseases to identify, as the symptoms are quite distinctive. Infected plants display white powdery spots on the leaves and young stems. As the disease progresses, the spots become larger and more dense as large numbers of white asexual spores (*conidia*) are formed; the mildew may spread up and down the length of a plant if the tissues are suitable for infection. Towards the end of the summer season, sexual fruiting bodies (*cleistothecia*) appear as small black or brown specks on the mycelial mats (Figure 7.). Powdery mildews can develop well in environments with high humidity and moderate temperatures.



(Source: Blanchard and Tattar, 1981)

Figure 7. Disease cycle of powdery mildew (an obligate foliage disease)[1]

[1] *Microsphaera aliphitoides* new name is *Erysiphe aliphitoides*, while *Uncinula salicis* new name is *Sawadea salicis.*

Needle cast is caused by many different species of fungus, affecting a number of coniferous tree species. Fungi overwinter in infected needles on trees and on needles that have fallen to the ground. Fruiting bodies release ascospores or condia, causing new infections during wet conditions, primarily in spring and early summer, but infection can occur through until fall. The fungus can be spread by rain splash or dripping water, wind or by mechanical means.
High moisture levels and poor air circulation favor spread of needle casts. They commonly occur in larger plantings such as pine or spruce plantations and in nurseries.
Severe needle casts, in combination with other stresses such as drought or injury, may make trees vulnerable to stress-related pests such as bark beetles.

Wilt diseases are caused by fungi that grow into the vascular system of plants. The host translocation stream is rapidly disrupted, resulting in severe moisture stress, wilting of leaves, dieback of branching systems and often death of the tree. The ability of the wilt disease fungi to invade the vascular tissues of living trees makes this group unique. This invasion can be recognized by the presence of discoloured streaks or zones in the outer xylem.

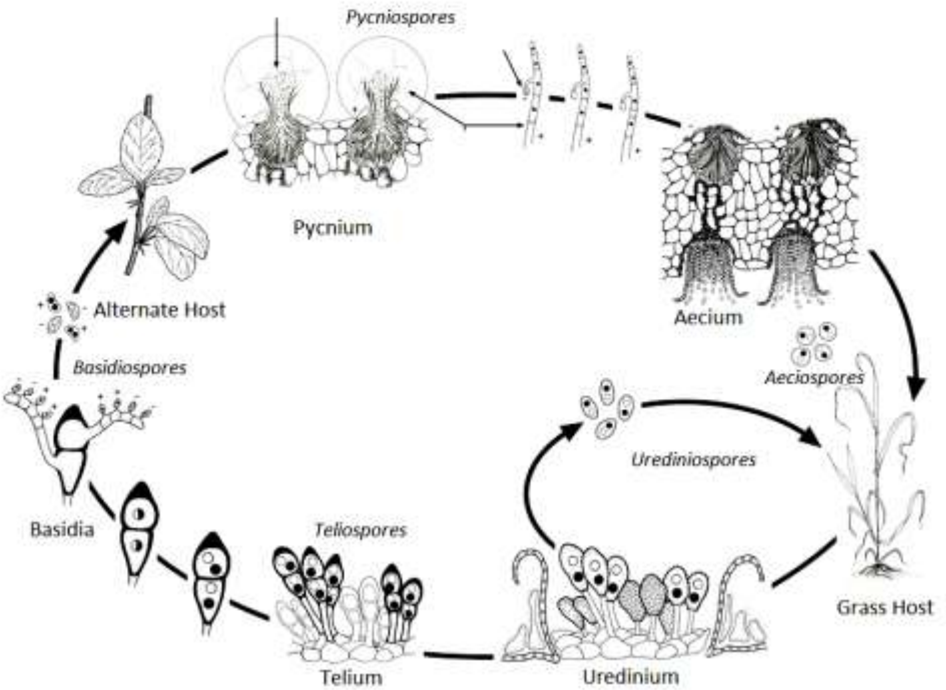
The term "*canker*" is used to describe a killed area or blister on the bark, a branch or the trunk of an infected tree. Canker-causing fungi commonly invade wounded or injured bark tissues. The bark of trees serves as a natural barrier to invasion, so most canker-causing fungi must enter the host through wounds and to a lesser extent, natural openings (*stomata*, *lenticels*, and *leaf scars*). Most trees are susceptible to one or more canker-causing agents. These may be classified as *non-infectious (abiotic) agents* such as frost and sunscald, or *infectious (biotic) agents* such as bacteria and fungi. Most infectious cankers are caused by fungi in the phylum Ascomycota.

With few exceptions, Basidiomycota only reproduce sexually via the formation of specialized club-shaped end cells called *basidia* that normally bear external spores (usually four). These specialized spores are called *basidiospores*. The typical *basidium*, sometimes called a *holobasidium*, is *aseptate* (without cross-walls), club-shaped and usually produces *four spores*. Some *basidia,* such as those of *rust fungi*, are divided into 4 cells .
Diseases most commonly attributed to *Basidiomycota* include *rust diseases* and *wood decay*. The rust life cycles typically include up to five spore stages (Table 1) and two alternating hosts (except by simplification).

Table 1. Fruiting structures and spore stages in the full life life cycle of a rust disease.

Fruiting structure	**Spore type**
pycnium (*spermogonium*)	*pycniospores* (*spermatia*)
aecium	*aeciospores*
uredinium	*urediniospores*
telium	*teliospores*
basidium	*basidiospores*

The rusts cause many serious diseases on economically important hosts, including trees. They also have the most complex life cycles of any fungi (Figure 8).



(Source: http://bugs.bio.usyd.edu.au/learning/resources/Mycology2/)

Figure 8. Full life cycle of a rust disease.

Wood decay is a deterioration of wood through the degradative activities of microorganisms. For practical purposes, fungi are the only agents of wood decay. The most important types of decay are as follows:

- *brown rot* (degradation of hemicellulose and cellulose in wood),
- *white rot* (fungi degrade the lignin, cellulose and hemicellulose in wood),
- *soft rot* **(**degrade cellulose in the wood).

In general, living trees tend to be decayed from the inside out (*heart rot*) and dead trees from the outside in (*sap rot*). The most damaging forest pathogens in this group are *root rot fungi*. These species attack and destroy the tree root system, resulting in growth loss, decay, death, and windthrow of infected trees. Trees with root disease are also more susceptible to pests, especially bark beetles.

Factors that affect the development and destructiveness of tree diseases are:

1. virulence of the pathogen;
2. total environment favourable to the pathogen;
3. susceptibility of the host population.

Figure 9. Model of disease triangle showing factors involved in disease.

The effect of these three factors can be represented by a model termed the *disease triangle* (Figure 9.). If the maximum effect of each factor is represented by the three sides of an equilateral triangle, then the maximum severity of the disease is represented by the area within the triangle. Reductions in host susceptibility, or in pathogen virulence, or changes to less favourable environmental factors for the pathogen, will reduce the severity of disease.

A *symptom* of disease is expressed as a reaction of the host to a causal agent, whereas, a *sign* is evidence of disease other than that expressed by the host. Signs are ususally structures of pathogens. A disease is first noticed by the presence of symptoms and/or signs, and recognition of the specific type of symptom or sign will aid in the eventual diagnosis of the disease.

4. Damage identification

Modified after ICP Forest guidelines.

List of symptoms with a selection of probable causes (Symptoms: underlined, Causes and causal agents: *in italics*)

I CONIFERS

I.1 Needles

I.1.1 Light green to yellow discolouration

a. of current years needles, starting at the base of pine and spruce needles on limy or boggy sites (Lime-) *chlorosis by Mn-, Fe-deficiency*; along with resin bleeding: *fungal root diseases*;
b. of older needles starting at tips of needles: *Mg-, K- deficiency*; of second years needles of pines: early senescence due to *stress e.g. drought, ozone* (of third years' needles: normal senescence)
c. of needles of all ages along with growth reduction of needles and shoots: *nutrient deficiency mainly of nitrogen*; yellow spots along with bending or curling of needles and white woolly larvae on Silver-fir: *Adelgids*

I.1.2 Reddish to brown discolouration (necrotic)

a. of current needles on insulated parts of crown: *winter desiccation*; along with shoot deformation: *late frost* or fungal infection by *Botrytis cinerea*; along with death of youngest shoots: fungal infection e.g. *Gremmeniella abietina* on pine, *Cenangium ferruginosum*, *Sphaeropsis sapinea* on pines; close to industrial plants: high concentrations of *air pollutants*; near roads: *deicing salt*;
b. of older needles on needle tips: *K-, Mg-deficiency*; on whole needles: *senescence*; mainly on second year needles with older needles missing: needle cast fungi e.g *Lophodermium macrosporum* on Norway spruce, *L. seditiosum* on Scots pine; frass and needle rests or complete brown needles in webs of silky threads: sawflies e.g. *Cephalcia abietis*;
c. of needles of all ages only in upper crown: on Scots pine *rust fungi*; in whole crown: fungal root disease e.g. by *Armillaria* spp., *Heterobasidion annosum*; along with loose bark: attack by bark beetles e.g. *Ips typographus*, *Pityogenes chalcographus* on spruce;

I.1.3 Missing or incomplete needles

a. of current year on insolated parts of crown, partial or total missing: *winter desiccation*; partial or total missing: high concentration of *air pollution*, *deicing salt*; fungal infection e.g. *Gremmeniella abietina* on spruce and pines, *Cenangium ferruginosum*, or *Sphaeropsis sapinea* on pines; thread like distorted remainder of needles on spruce: Sawfly *Pristiphora abietina*;
b. older needles partially or totally missing: *senescence*; second year and older needles missing: *needle cast fungi* [s. I.1.2.b); gaps in older needle years along with lumps of frass and needle bases: sawflies e.g. *Cephalcia abietis* on spruce;
c. needles of all ages partially or totally missing: *root infecting fungi; bark beetles*; total or partial defoliation along with remaining needles: *caterpillars* on various conifers e.g. larvae of sawfly *Diprion pini*; partially missing along with small wounds on upper side of branches: *hail damage*;

I.1.4. Deformation of needles

a. Galls on young spruce: *Sacchiphantes abietis*;
b. Bending and curling along with yellow spots and white woolly larvae on young Silver-fir: *Adelgids*;

I.2 Young shoots and buds

I.2.1 Defoliation: [s. I.1.3.a] or missing tips on pine: *Tomicus piniperda*;

I.2.2 Necrosis: *winter desiccation*, high concentration of *air pollution*, *deicing salt*; fungal infection e.g. by *Gremmeniella abietina* on spruce and pines, *Cenangium ferruginosum*, or *Sphaeropsis sapinea* on pines;

I.2.3 Abortion of shoots of pine: *Tomicus piniperda*;

I.2.4 Deformation, shoots drooping: *late frost*; bent downwards *Cu-deficiency*; on young pines curved several times: *Rhyacionia buoliana*;

I. 3 Branches

I.3.1 Foliage-free branches and tops: *frost* damage; [s. also I.1.3])

I. 3.2 Cankers, wounds, resin flow

a. Cankers on pines along with resin flow and swellings: *rust fungi*;
b. Wounds numerous, small, on upper side of branches: *hail* damage; fewer, larger, partly girdling wounds: *rodents*;
c. Resin flow: [s. I.3.2.a]

I.3.3 Deformations: Witches' brooms on silver-fir: rust fungus *Melampsorella caryophyllacearum*;

I.3 4 Nests of caterpillars e.g. *Thaumetopoea pityocampa*;

I.3.5 Misteltoes;

I.4 Stem

I.4.1 Cankers, resin flow, wounds

a. Cankers on pines along with resin flow, swellings and some signs of fungal structures: *rust fungi*;
b. resin flow from top of spruce: fungal root rot by *Armillaria ostoyae*;
c. wounds long stripe with central line of loose splints: *lightning*; long narrow radial cracks partly or completely closed by callusing: *drought* cracks on spruce; single narrow vertical wounds or series of several oblique wounds: *felling* damage;

I.4.2 Signs of insects: boring holes, brown or white boring dust, pitch tubes *bark or wood inhabiting insects*;

I.4.3 Signs of fungi

a. yellow to orange blisters on pines: blister rust;
b. conks or other carpophores: wood rotting fungi;
c. sunken areas soaked in resin on pines: *rust fungi*;

I.4.4 Swellings on silver-fir: rust fungus *Melampsorella caryophyllacearum*; on larch: perennial canker caused by *Lachnellula willkommii*;

I.5. Collar

I.5.1 Resin flow: root rotting fungi. e.g. *Armillaria* spp. ;

I.5.2 Signs of insects: boring holes, brown or white boring dust *bark or wood inhabiting insects*;

I.5.3 Signs of fungi: conks or other carpophores *wood and root rotting fungi*.

II. BROADLEAF TREES

II.1 Leaves

II.1.1 Yellow discolourations

a. tip triangle on beech: *Rhynchaenus fagi* (interrupted development);
b. marginal and/or intercostal fields: *nutrient deficiencies, drought, pollution*;
c. fine spots on leaves of birch and poplar, beginning at lower crown: *rust infection*;
d. total except all veins, in parts of oak and beech crowns on limy sites: *Lime chlorosis*;
e. total in parts of beech crowns: perennial canker by *Nectria ditissima* partly girdling branches;
f. total starting from top of crown on beech, birch, poplar: *drought*;

II.1.2 Bronzing on upper leaf surface: *Ozone; UV-irradiation;*
II.1.3 Brown discolouration (necrosis)

a. partial necrotic lesions, beginning in lower crown, excluding top: *fungal infection*;
b. partially necrotic leaves with holes on beech: *Rhynchaenus fagi*;
c. interveinal or marginal necrosis: *nutrient deficiencies, drought, pollution*;
d. total necrosis, beginning in top of crown: *drought*;
e. total necrosis, beginning in lower parts of crown: *late frost, fungal infection*;

II.1.4 Coverings on leaves

a. black: *sooty molds*;
b. white: *Powdery mildew*;

II.1.5 Small, premature abscision, notched, missing leaves

a. small leaves, sparse foliage: partial girdling of stem by fungi and/or insects e.g. *beech bark disease*;
b. premature leaf abscision: *drought, fungal root disease,* e.g. *Phytophthora*;
c. notches and holes on partly devoured leaves: *caterpillars*; *Rhynchaenus fagi*;
d. missing leaves: defoliation by *caterpillars* e.g. of *Operophthera brumata, Tortrix viridana, Lymantria dispar*, gaps on lammas shoots of oak: *Powdery mildew*;

II.2 Young shoots
II.2.1 Dieback: early stages of *oak decline, beech bark disease*;
II.2.2 Premature loss of developing flowers or seed in oak and poplar: mainly *drought*;
II.2.3 Necrosis mainly in lower parts of crowns: *frost; fungal infection*;

II.3. Branches
II.3.1 Bare branches

a. top dying, dieback: advanced stages of *oak decline, beech bark disease*; fungal root diseases e.g by *Armillaria*, *Phytophthora* spp.; in open edges of beech stands: *sun sclad with secondary insects*; on shallow or hydromorphic soil: *drought* or *water logging;*
b. bark reddened by woodpeckers: larvae of *bark beetles, e.g. Scolytus* spp. or *borers*, e.g. *Agrilus* spp. in late phase of oak or beech decline;

II.3.2 Cankers, slime flux, wounds

a. cankers as swellings with irregular or target like callusing: *perennial cankers*, e.g. by *Nectria* spp.;
b. slime flux on beech: *Agrilus viridis*;
c. wounds numerous, small, on upper side of branches: *hail* damage; fewer, bigger wounds, partly girdling branches: *rodents*

II.3.3 Deformations

a. Galls, tumors: *Bacteria, Fungi, Insects*; swellings: *perennial cankers* [s. II.3.2.a]; growth irregularities of unknown causes
b. Witches' brooms on birch, cherry, hornbeam: *Taphrina* spp.

II.4 Stem

II.4.1 Cankers, slime flux, wounds,

a. cankers as swellings with irregular or target like callusing: *perennial cankers*, e.g. *Nectria* spp.;
b. slime flux on upper parts of stems: *annual cankers* caused by fungi e.g. *Nectria coccinea;* or insects e.g. *Agrilus* spp.; slime flux on lower parts of stem: fungal root disease e.g. *Armillaria* spp., *Phytophthora* spp.;
c. wounds in long narrow stripes on southern side of stem: *winter frost*; shorter and wider wounds on lower, southern part of stem: *sun scald*; long narrow stripes with central line of loose splints: *lightning*; single narrow vertical wounds or series of several oblique wounds: *felling* damage;

II.4.2 Signs of insects

a. boring holes, boring dust, reddening of bark by woodpecker activities: *bark or wood inhabiting insects*;
b. white dots on beech: *beech scale*, egg deposits of caterpillars e.g. *Gipsy moth*;

II.4.3 Signs of fungi

a. sunken areas or stripes and longitudinal cracks e.g. on oak: *Phellinus robustus*, on beech: *Fomes fomentarius*
b. Conks of various *wood rotting fungi*

II.4.4 Deformations

a. Galls, tumors : *Bacteria, Fungi, Insects*; swellings: *perennial cankers* [s. 1I.3.2.a]; growth irregularities of unknown causes
b. longitudinal ridges around the base of stem, mainly on oak: *„frost cracks"*

II.5 Collar
II.5.1 Slime flux on beech or oak: *Phytophthora*: *Armillaria*;
II.5.2 Signs of insects boring holes, boring dust (brown, white): *bark or wood inhabiting insects*;
II.5.3 Signs of fungal infection: conks e.g. *Ganoderma* spp. on beech

5. Assessment guidelines

Forest owners and forest managers are usualy required by law to report pests and pathogens occurring in their forests to forestry authorities concerning forest health. It is not expected that any pests and diseases which have no economic significance should be reported. It is expected, however, that if the forest owner or manager becomes aware of major threatening damage he/she has to inform the forestry authority.
We are aware that damage estimation is prone to error, even with the best intentions. Therefore, an estimation (tolerance) accuracy of 10% is recommended.
The damage report has usuly the following steps:

- After discovery of the damage the following data must be determined:
  - Location (locality, compartment)
  - Tree species affected
  - Damage type: based on Chapter 4 and a detailed description (Chapters 7-8-9 of this manual). The code assigned to the damage type should be used.
  - Damaged area
  - Damage frequency (% of affected trees)
  - Damage intensity (% within a tree)
  - Damaged wood mass (if applicable)
- If any kind of protection was carried out:
  - Method used
  - The effectiveness and impact
- To report: send the completed table to forestry authorities.

The report shall be made four times a year, on the followingdates:

- 31st March
- 30th June
- 30th September
- 31st December

Even if no damage was observed in a certain area an ‘empty’ report should be produced by the year end (31st December).

If quarantine pests (separate list) appear, the authorities must be notified immediately.

The report usualy can be submitted in electronic or paper format. The sample table is given at the end of this manual (Annex).

6. Abiotic factors

Snow damage
(Code: SNOWDAM)


(Photo: S. Mirtchev)

Accumulation of wet snow on pine trees


(Photo: S. Mirtchev)

Symptoms of snow damage are concentrated in small groups

Hosts: All conifers are susceptible.
Distribution: Throughout Europe wherever the incidence of wet snow is significant.
Damage: Snow damage is caused by large amounts of snow accumulating on tree crowns and stems. Within Europe snow damage affects an estimated 4 million m^3 of timber every year. Snow damage depends upon the quantity of snow and the type of snow. Wet snow is most likely in late autumn or early spring. Wind can cause snow to be shed, but can also lead to large accumulations of wet snow. The severity of snow damage is related to tree characteristics. Stem taper and crown characteristics are the most important factors controlling the stability of trees. Heavy snowfall can cause significant mortality in young plantations. Following snow damage, trees are often susceptible to several kinds of consequential damage. Both insect and fungal attacks can occur and can lead to significant mortality of damaged trees. The insects which most affect Scots pine and Norway spruce after snow damage are bark beetles.

Signs and Symptoms: In younger trees snow damage consists of temporarily or permanently bent main stems, depending upon duration and movement of the snow pack, with branch and stem breakage. Uprooting does not occur as often as stem breakage, possibly be due to the fact that forest soils are usually frozen at the time of the heaviest snow loading. Symptoms are concentrated in small groups or are seen on scattered individual trees in affected stands. Stem breakage is the most common type of snow damage, especially in middle-aged pine stands. Branch or stem scars and top breakage act as entry points for disease.
Control: It is best to use resistant tree species in high-risk areas. However, it is far from clear whether such species would survive and grow on the sites of highest risk currently occupied by Scots pine and Norway spruce. Another possible way to increase resistance against snow loading is to grow trees in mixed stands or to follow natural succession.
Reporting time: 31st March (I.), 31st December (IV.).

Wind damage
(Code: WINDDAM)


(Photo: S. Mirtchev)
Damage from strong winds


(Photo: S. Mirtchev)
Wind damage may occur in conjunction with bark beetle attacks and wood rotting fungi

Hosts: All species can be damaged by strong winds.
Distribution: Throughout Europe wherever the incidence of strong wind is significant.

Damage: Periodic exposure to high winds can greatly reduce crown and stem quality and height growth. Toppled trees with root structure attached; broken stems and branches mainly in the crown. Tree mortality occurs when a tree is toppled. Trees subjected to continuous wind exposure, especially in higher elevations, are vulnerable to winter desiccation damage. Wind is responsible for more than half of the damage by volume to European forests and is predicted to continue to increase with current management practices and the changing climate. In January, 2005, a severe storm "Gudrun" raged through Northern Europe, blowing over and damaging nearly a timber volume equivalent to the normal annual harvest (75 million m^3) for the whole of Sweden. In 2007, the storm “Kyrill” caused extensive damage across NW lowland Europe. In January 2009 another major storm “Klaus” damaged forests over large areas.
Signs and Symptoms: Types of wind damage include windbreak, which occurs when the wind load on a tree is greater than the breaking stress of the wood, and wind throw, which occurs when wind load is less than stem strength but greater than root anchorage such that the tree does not break but rather uproots and topples. Strong winds can also cause branches to break off. Damage can be restricted to small areas or extended to larger areas. Trees injured and broken by wind are susceptible to secondary bark beetles and wood rotting fungi. Usually conifers decay more slowly than hardwoods. Trees susceptible to wind damage are often diseased, along the margin of a harvested area, have shallow roots or are stressed by other factors.
Control: The risk of wind damage could be reduced both at stand and regional level by proper forest management (e.g. tree species choice in regeneration, tending of seedling stand, type and intensity of thinning, rotation length, temporal and spatial patterns of final cuts).
Reporting time: 31^{st} March (I.), 30^{th} June (II.), 30^{th} September (III.), 31^{st} December (IV.).

Temperature Extremes
(Code: TEMPEXT)


(Photo: S. Mirtchev)

Frost cracks are usually seen on older trees


(Photo: S. Mirtchev)

Damage from high-temperature on a tree with thin and dark bark

Hosts: All trees of all ages are susceptible.
Distribution: Throughout Europe, particularly in areas of poor air movement (frost pockets) or hot and dry weather.
Damage: Late spring frosts are usually more injurious for conifers than early fall frosts. Frost lesions or frost cracks act as entry points for canker and decay fungi or can lead to stem breakage. Several canker fungi act as weak pathogens following frost damage.
Frost can cause mortality of broadleaves if the tree is girdled by cankers. The main concern is the introduction of diseases through cracks and cankers. Frost cracks are especially common on oaks and other trees with wide heart-shaped rays. Areas of dead bark may allow the entry of decay-causing fungi. Damaged trees may be more susceptible to insect damage.
Signs and Symptoms: *Low temperatures.* Frost can damage or kill foliage, buds, and twigs when unusually cold temperatures occur at certain times of the year. These types of injury may occur in late spring, when emerging foliage and shoots are still succulent and tender, or in the early fall before the buds and shoot tips are ready to withstand the severe weather.
Frost cracks are caused by abnormal shrinkage of the sapwood. In the case of frost cracks, wood shrinkage is chiefly across the annual growth rings (radial shrinkage). The tree boles (trunks) may crack. This type of damage is characterized by long, vertical cracks in the main stem and can be as high as 10 meters above the ground. Frost cracks are usually seen in older trees, especially with oak species.

High temperatures. Needles or leaves can be damaged by a sudden increase in air temperature (foliage scorch). Leaf margins look seared or scorched. Conifer needles rapidly change from healthy green to red.

Large trees suffer top-kill (dieback) from sustained high temperatures during the summer and fall when soil moisture levels are low. The third kind of high-temperature injury is bark scorch (sunscald or heat canker), which can develop when bark and cambial tissues are exposed suddenly to solar heating. Forest managers risk this disease when a dense stand is thinned during the summer season, especially if the trees have thin and dark bark.

Control: Although abiotic injury can't be averted completely, damage can be prevented or minimized through planning, good silviculture, and stewardship. People are the key to coping with abiotic injury through different forestry techniques.

Reporting time: 31st March (I.), 30th June (II.), 30th September (III.), 31st December (IV.).

Wounds: Fire, Mechanical and Animal
(Code: WOODDAM)


(Photo: S. Mirtchev)
Fire wounds are identified by charred and blackened bark tissues


(Photo: S. Mirtchev)
Resin tapping wound on *Pinus nigra*

Hosts: All trees of all ages are susceptible.
Distribution: Throughout Europe.
Damage: *Fire wounds.* In recent years, the occurrence of large wildfire episodes with extreme fire behaviour has affected different regions of Europe. People cause wildfires more often and fire injury can lead to growth impairment, loss of wood quality, and death. Fire injury can due to direct burning or from radiant heat.
*Mechanical wounds***.** Mechanical damage caused directly or indirectly by humans affects tree survival and growth. The common element in this kind of damage is human negligence. Mechanical damage is caused by impacts or rubbing from various sources such as vehicles (skidders, cars, etc.), falling trees or branches hitting other trees, or other contact sources.
Animal wounds. Ungulates often damage trees in two main ways (i) by browsing seedlings, suckers, saplings and foliage, or (ii) by rubbing antlers (fraying) on saplings and larger trees.

Trees with thinner bark are more susceptible to wounds. It is important to recognize that minor wounds (not serious enough to restrict tree growth) might provide entrance points for pathogens or decay fungi, and/or destructive insects. Trees that survive such injuries are sometimes more prone to attack by root, butt, or stem decays and/or by bark beetles.

Signs and Symptoms: Open wounds on the bark and broken stems or branches may result from fire, mechanical and animal damage.

Fire wounds are identified by the charred and blackened bark tissues. Over time, some evidence of charring usually remains on the bark and/or on exposed wood at the base of the trees.

Mechanical wounds, typically caused by logging activities, are commonly found as gouges on the lower trunk or buttressing roots. Wounds may exude resin (conifers), and callus ridges eventually form at the edges of the damage. Depending on wound size, the callus can form new bark over time and the wound can close over the damage.

Broken branches indicate antler rubbing by ungulates. Bark may also be removed with lower incisors, leaving vertical grooves on the trunk and branches. Livestock can cause similar damage. Local knowledge of mammal populations may assist in identifying the source of damage. To determine the source of the animal damage, signs of the ungulate such as droppings and foot prints may be located near the damaged tree.

Control: Wildfires typically occur during periods of increased temperature and drought. These periods last from early spring until late fall when the weather is often hot and dry. Fire management should include elements of fire prevention. Many forest fires are caused by people and public education is one of the best options for minimizing the problem. After fire, sanitation cuts can be used to remove damaged trees with large wounds before they are colonized by decay fungi and wood boring insects.

For mechanical damage associated with logging, prevention options include: minimize stand entry during management, keep vehicles away from remaining standing trees, and include fines for the numbers of trees damaged.

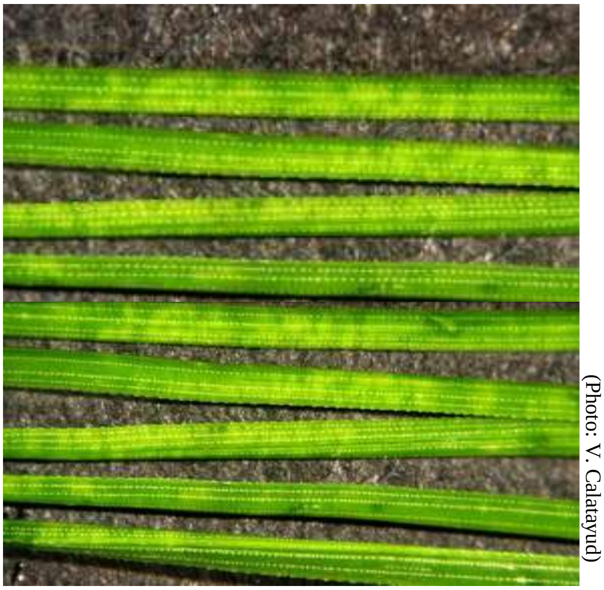
One popular option for protecting forests from wild animals is reducing big game populations through hunting. Severe animal damage usually occurs only during a short period of the year or within small parts of the forest. In such cases fencing can be employed to reduce animal damage. Several fencing designs are available to meet specific needs.

Human hair has a repellent odor to many wild mammals. In early spring small mesh bags containing human hair are attached to trees around the protected forest and replaced monthly throughout the growing season. This method is simple and costs very little, as hair can be obtained at hairdressing salons and barbers.

Reporting time: 31st March (I.), 30th June (II.), 30th September (III.), 31st December (IV.).

Air pollution
(Code: AIRPOLL)

Symptoms of Ozone damage on *Fagus sylvatica* foliage.



Symptoms of Ozone damage on needles of *Pinus* spp.

Hosts: All trees of all ages are susceptible.
Distribution: Throughout Europe.
Damage: Air quality has become a significant stressor for forest health and responsible for important plant damages. Air pollutants cause changes in tree physiology, and in biogeochemical cycling; these changes lead to lowered tree resistance to insects and disease. Air pollutants affecting forest health include increasing concentrations of ozone, atmospheric carbon dioxide (CO_2), and acidic precipitation. Emissions of sulphur dioxide (SO_2), oxides of nitrogen (NO_x) and a number of other pollutants such as ammonia (NH_3) emissions from animal feeding operations affect forests particularly in rapidly industrializing regions of the world. Increasing levels of ultraviolet-*B* radiation from stratospheric O_3 depletion on a global scale are possibly a threat to forest health. In addition, there is evidence for increasing emissions of persistent organic pollutants (*POPs*).
The area of forest at risk from O_3, *S* and acidification is expanding under current economic and social trends. The most pervasive air pollutant affecting forests now and into the future is O_3. The potential negative impact of ozone on trees, especially on growth, leaf/needle visible injuries, productivity or forest biodiversity, is well documented. In some parts of

Europe, ambient ozone levels are high enough to cause visible injury in native species.

Control: Assessment of visible injury is a feasible way to detect the impacts of air pollutant in forest plants and to identify potential risk areas. Crown condition is the most widely applied indicator for forest health and vitality in Europe. Parameters assessed in addition to crown condition include discolouration and damage caused by biotic and abiotic factors. The aim of the damage cause assessment is to collect as much information as possible on the causal background of tree damage in order to enable differential diagnoses.

Reporting time: 30th June (II.), 30th September (III.).

7. Biotic factors

Pests and pathogens of particular host trees are described here.

Legend for the life cycle tables:
E: egg, L: Larva, P: Pupa, I: Imago;
Time of the developmental stage:
Damage:

7.1. Coniferous tree species

7.1.1. Polyphagous pests and pathogens on coniferous tree species

Hylobius abietis – Large pine weevil
(Code: HYLOABI)



(Photos: Gy. Csóka)

Hylobius abietis larva, beetle, damage

Hosts: Polyphagous species on a wide range of conifers .
Distribution: Europe and a large part of Asia. Present in Southeast Europe wherever coniferous trees are grown. Damage occurs particularly when stumps of recently felled trees and young seedling are present at the same time.
Morphology: The beetle is dark brown with yellow lines on the elytra (wing cases); hairs all over the body gives a first impression of a yellowish brown colour. The adult beetle is 8-16 mm in length. Larvae are typical of weevils : yellowish white, without legs.

Life cycle: The first new generation of beetles can appear at the end of the summer, but usually do not feed at this time. After overwintering a large number of beetles may emerge within a short period of time around the end of March. The beetle live for several years, and adults can, therefore, be found all year around. After copulation female beetles lay eggs on stumps of recently felled trees or on remaining wood pieces (with bark) in the forest. Larval development takes 2-5 weeks. Pupation lasts for an additional 2-5 weeks. Development is highly influenced by temperature, with more rapid development at higher temperatures. Freshly emerging beetles forage for young trees where they feed on the epidermis/bark at the base and on roots (maturation feeding). After egg laying adults again feed on young trees. Beetles can not fly.

Damage, symptoms: The beetle feeds on the bark of young (2-3 years old) seedlings. Larval galleries are mainly on lower plant parts, sometimes also on the roots. Drain-like galleries are typical for the species. Maturation feeding often causes tree mortality.

Control: Avoid large clearcut areas and reforestation at the same time. There are beetle specific lures available (with varying efficiencies), but bark pieces from Douglas fir (*Pseudotsuga* spp.) make ideal beetle collection points (place the inner bark in contact with the soil: beetles will aggregate under the bark).

Reporting time: 30th September (III.).

Life cycle and damage period:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
I												
E												
L												
P												
I												

Ips amitinus – Small European spruce bark beetle
(Code: IPSAMIT)


(Photo: M. Jurc)

Ips amitinus beetle,


(Photo: F. Lakatos)

galleries

Hosts: Spruce (*Picea*) and pine (*Pinus*) species.
Distribution: Europe at higher elevations in mountainous areas (above 1000m). In Southeast Europe present at higher elevations in pine and spruce stands.
Morphology: Very similar to European spruce bark beetle (*I. typographus*); only well-trained specialists can differentiate correctly between the two.
Life cycle: The species usually has 1, sometimes 2 (part) generations each year, depending on elevation and climatic conditions.
Damage, symptoms: The beetle attacks old and large trees (with thick bark). Mother galleries do NOT run parallel to the trunk axis. Usually 2-3 mother galleries are made per family. In most cases the species is accompanied by other bark beetle species (e.g. *Pityogenes chalcographus*).
Control: The most effective protection method is so-called ‘clean management’, which rqeuires the reduction of breeding materials left in the forest after management operations: removal of attacked trees, removal of harvested timber from the forest stands particularly before the beetle swarming period (e.g. end of March).
Reporting time: 30th September (III.).

Trypodendron lineatum
(Code: XYLOLIN)


(Photo: M. Jurc)


(Photo: P. Kapitola)

Trypodendron lineatum beetle, galleries

Hosts: All coniferous tree species.
Distribution: Europe, Asia and North America. Present in Southeast Europe wherever coniferous trees are grown.
Morphology: The beetle is 3-4 mm in length, brown, with pale brown stripes on the elytra.
Life cycle: Up to 2 generation per year. First emergin beetles fly very early in the year, at the end of February; the second generation flies in June. Adult beetles construct galleries in the wood and also cultivate ambrosia fungi in the galleries (hence the name ‘ambrosia beetles’). Both the adult beetles and the larvae also feed on these fungi . Galleries become black after a few days.
Damage, symptoms: Galleries are in the wood not under the bark, as happens with bark beetles. The strcutures are called ladder galleries based on their shape. The sawdust coming from the entrance holes areiswhite (wood boring beetle) instead of brown (bark beetles).
Control: The removal of suitable trees and woody material such as logs of felled trees, is the best methods for protection .
Reporting time: 30th September (III.).

Fomitopsis pinicola - Red banded polypore
(Code: FOMIPIN)


(Photo: S. Mirtchev)

The fruiting body of *Fomitopsis pinicola*


(Photo: S. Mirtchev)

Pore surface is pale with yellow small tubes

Hosts: all conifers are susceptible.
Distribution: common in most countries of mainland Europe.
Life cycle: Brackets can be seen all year round, but the spores of these perennial fungi are shed in late summer and autumn. Brackets can live for several years; when cut through the number of tube layers in the bracket can easily be counted, enabling the fruiting body age to be determined. Wood decay begins in living trees when damage occurs, such as stem wounds or breakage of branches and tops .

Storm injury leads to the development of decay in exposed wood. Fire is another major cause of tree injury in some forests, as is harvesting with heavy equipment .

Signs and Symptoms: The fruiting body (conk) is hoof-shaped or triangular, and hard, with a tough texture, with a size of up to 30-40 x 25 x 10 cm. The upper surface is more or less smooth, at first orange-yellow with a white margin, later dark reddish to brown and frequently with an orange margin. *F. pinicola* grows on living and dead coniferous or (less commonly) deciduous trees. The fruiting body is woody with pores lined with *basidia* on the underside. The pore surface is pale yellow to leather-brown, with 3-4 pores

per mm. As in most other *polypores*, the fruiting body is perennial with a new layer of pores produced each year in a layer developing underneath the old pores.
Control: It is very difficult to manage wood decay in genearl, but a number of factors can reduce the risk of serious damage. First, minimize wood decay by protecting trees from injuries.
Reporting time: 30th June (II.), 30th September (III.).

***Heterobasidion annosum* – Annosus root disease**
(Code: HETEANN).


Brown decay in the spruce roots and buttress


The fruiting body of *Heterobasidion annosum*

(Photos: S. Mirtchev)

Hosts: all conifers are susceptible; many broadlaeaved species, particularly beech, may suffer decay.
Distribution: common in most countries of mainland Europe.
Life cycle: Sporophores are usually produced at the base of the main stem, on roots, and on stumps of infected trees and sometimes on coniferous slash. *Basidiospores* are released through pores on the underside of the fruiting body and serve as inoculum to establish new infections. *Basidiospores* are carried in air currentsto freshly cut stumps; where the pathogen grows rapidly into the body of the stump and into the root system. At points of root-to-root contact, or sometimes root grafts, with standing trees, the pathogen can cross from the infected host into an uninfected host. In this way *H.*

annosum continues to spread to adjacent trees in a roughly circular pattern, causing serious decay and, in pines or when there is a large inoculum load, resulting in mortality killing .

Sign and Symptoms: Pines or badly affected spruce and fir, exhibit poor growth, produce short needles, and hold them for only the current season. As an indication of infection the colour of the needles may turn light green to yellow and as the disease progresses the crown turns completely brown and the tree dies. Abundant cone crops may also be seen as a symptom. The infected tree may be blown down while still alive due to instability caused by decayed roots, or, especially with pines, the tree may be killed from trunk girdling by the pathogen and remain standing. Extensive brown decay in the roots (all conifers) and buttress (spruce and fir) areas can usually be found in the windblown trees and also often in dead standing trees. The fruiting bodies of *H. annosum* (syn. *Fomes annosus*) can usually be found at the base of dead trees and on trees in the advanced stages of infection. They have a dark brown top and a creamy-white pore layer.

Control: forest management should focus on minimizing activities likely to create good primary infection courts, e.g., wounds on roots, stems and branches, and stumps. On high hazard sites, protect freshly cut stumps of conifers with applications of urea, or borax, or the wood rotting fungus *Phlebiopsis gigantea*. Reduce the number of thinnings per rotation. On flat, very high hazard sites, it may be economically viable to destump prior to replanting.

High hazard for conifers: particularly those growing on well drained soil with medium to high fertility, often former agricultural land. Low hazard: poorly drained soils with low fertility.

Reporting time: 30th June (II.), 30th September (III.).

7.1.2. Pest and pathogens on Pines (*Pinus* spp.)

***Acantholyda* (*Hycorsia*) spp. (e.g. *A. hieroglyphica*) – Web spinning pine sawfly**
(Code: ACANHIE)

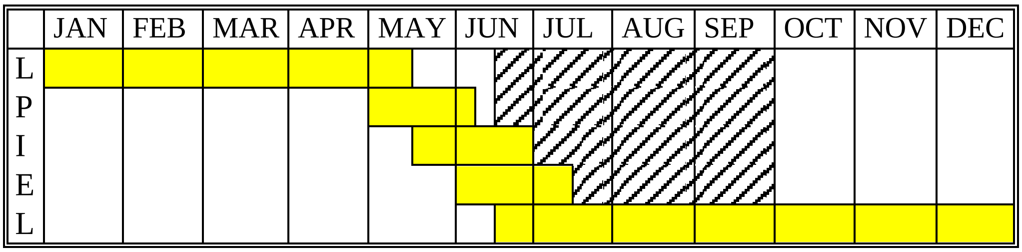

(Photo: Gy. Csóka)

Acantholyda hieroglyphica nest closeup


(Photo: F. Lakatos)

nest

Hosts: Major host is Scots pine, but larvae also feed on the needles of various other pine species, especially on younger trees.
Distribution: Europe, wherever pine trees are available.
Morphology: The adult sawfly has a 12-17 mm wingspan. Head and thorax is black, abdomen reddish. Larvae are grayish green, without prolegs.
Life cycle: The species has one generation per year. Overwintering is as prepupa in the soil; adults fly from mid May to the end of June. Larvae feed on the needles from mid June to the end of the vegetative period.
Damage, symptoms: Loose webs of the larvae filled with brown frass are typical on the upper parts of the branches. On young trees there is a tendency for mass outbreaks and heavy defoliation.
Control: Larval nests protect against harmful environmental factors including insecticides. The damage level usually does not require insecticide application.
Reporting time: 30th September (III.).
Life cycle and damage period:



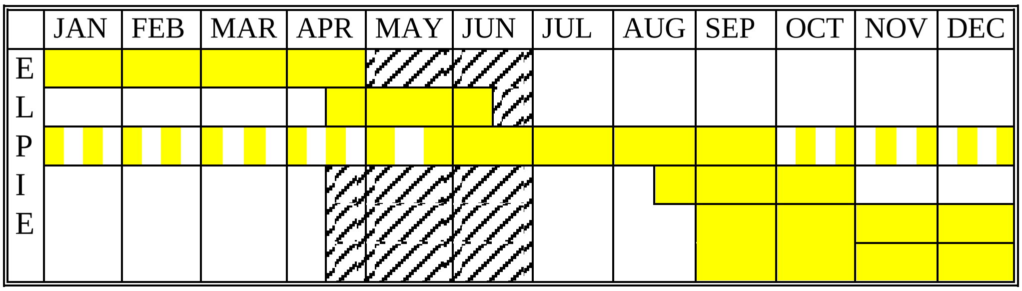
Neodiprion sertifer – European pine sawfly
(Code: NEODSER)

Neodiprion sertifer eggs on the needles

larvae

(Photos: Gy. Csóka)

Hosts: Various pine species, especially Scots pine (*Pinus sylvestris*).
Distribution: Eurasia. In Southeast Europe present both in mountainous and hilly areas, especially in plantations.
Morphology: Larvae green with black head (⇔ *Diprion pini*). Sawflies are 6-9mm long, female brownish-yellow, male black, with typical comb like antennae.
Life cycle: One generation per year (⇔ *Diprion pini*). Sawflies fly from July to October; after copulation females lay the eggs on the needles in rows. The egg is the overwintering stage. Larvae hatch in April and feed in groups. If disturbed larvae stiffen to a recurved pose. Pupation occurs in the soil.
Damage, symptoms: Larvae feed on the previous year needles in large groups. Current year needles remain intact. Massed caterpillars are highly visible on the uppermost branches.
Control: During mass outbreaks insecticide application might be necessary (a virus preparate available).
Reporting time: 30th June (II.)
Life cycle and damage period:



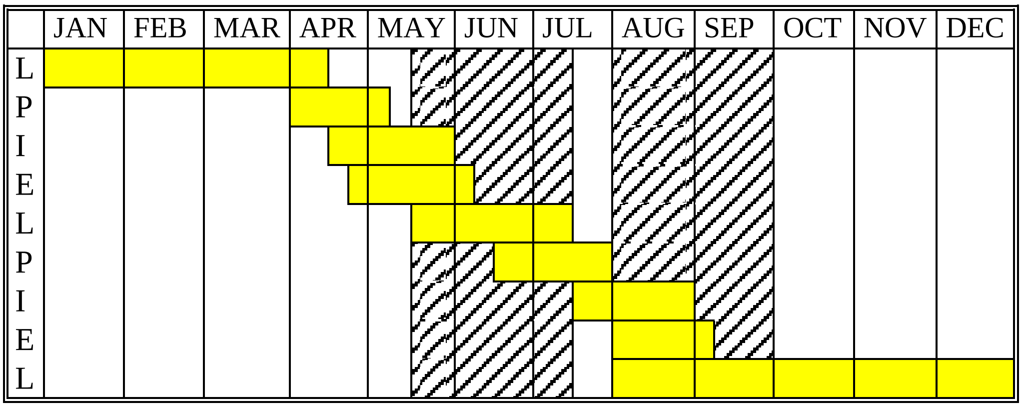
Diprion pini – Pine sawfly
(Code: DIPRPIN)


Diprion pini larvae


sawfly

(Photos: Gy. Csóka)

Hosts: Various pine species, main host: Scots pine.
Distribution: All over Europe. In some areas not so common as *N. sertifer*.
Morphology: Larvae are yellowish with a brown head (⇔ *Neodiprion sertifer*). Adult sawfly has a 8-10 mm wingspan.
Life cycle: Two generations per year (⇔ *Neodiprion sertifer*). Sawflies adults fly in May (1st generation) and August (2nd generation). Larvae feed in groups. The first generation pupates in the soil or in the crown, whilst the second only in the soil. Larvae overwinter in the soil as prepupa. Pupation occurs in the following spring.
Damage, symptoms: Feeds on needles from recent years and current year, which can lead to complete defoliation and tree mortality. Larvae also sometimes feed on the bark of young twigs.
Control: In mass outbreak areas insecticide application might be necessary.
Reporting time: 30th September (III.).
Life cycle and damage period:



Thaumetopoea pityocampa – Pine processionary moth
(Code: THAUPIT)


(Photo: F. Lakatos)

Thaumetopoea pityocampa nest


(Photo: B. Forster)

caterpillars

<u>Hosts:</u> Various pine species (*Pinus* spp.).
<u>Distribution:</u> All over the Mediterranean area of Europe and North-Africa. Gradually spreading northwards in Europe.
<u>Morphology:</u> Adult moths have cream forewings with brown markings, and white hindwings. The caterpillar is hairy and colored orange-brown with blue bands. Like its close relative the oak processionary moth (OPM), the larvae move about in nose-to-tail processions. The caterpillars have shorter hairs than OPM, are less variable in length than on OPM and present in dense clumps .
<u>Life cycle:</u> Caterpillars overwinter in tent-like nests high in pine trees, and form processions on the ground in early spring before pupating in the soil until late summer. This pupal stage can, however, remain dormant, extending the life cycle over two years. Moths fly in May to July, although individuals live for only about a day. After copulation eggs are laid in pine trees. Caterpillars hatch in autumn and begin feeding on the tree needles in autumn.
<u>Damage, symptoms:</u> The species causes much greater human health problems, than forest damage. Both the living caterpillars and the old, abandoned nests have thousands of the irritating hairs, which can cause a severe urticarial rash. Larval nest are visible also from large distances on the top of the trees. Caterpillars are most likely to seen in winter and early spring.
<u>Control:</u> Mechanical protection (if possible), such as pruning out badly affected branches.

Reporting time: 30th December (IV.).
Life cycle and damage period:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
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Rhyacionia buoliana - Pine shoot moth
(Code: RHYABOU)

Rhyacionia buoliana larva damage
(Photos: Gy. Csóka)

Hosts: Various pine species.
Distribution: Europe, but introduced to N-America. In Southeast Europe is very common wherever pines are growing.
Morphology: The wingspan of the moth is 9-12 mm, the first wing reddish, the second grey. The caterpillar is up to 6-8 mm long.
Life cycle: Moths fly from May to June. Eggs are laid close to the primary buds. The emerging larva eats into the bud and remains there for the full development (including overwintering).
Damage, symptom: Larvae feed inside primary shoots causing heavy deformation . After regeneration the shoot remains deformed. Later this deformation can be seen from large distances .
Control: Currently no effective method available.

Reporting time: 30th June (II.)
Life cycle and damage period:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
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Monochamus spp. – Longhorned beetles
(Code: MONOSP)


(Photo: F. Lakatos)

Monochamus spp. adults by copulation

Hosts: Various conifer tree species (pine, spruce, …). Major problem on pine is vectoring the pine wood nematode.
Distribution: Europe (excluding the UK), but several *Monochamus* species exist in continental Asia. More common in mountainous areas, but also present in plantations at lower altitudes.
Morphology: Larvae are typical longhorned beetle larva. Beetles 18-24 mm large. The body is black, but hairs on the prothorax and elytra make the beetle lighter in appearance.
Life cycle: One generation per year. Beetles emerge in June-July (depending on elevation). After maturation feeding (see below) and copulation females lay eggs on logs lying on the forest floor, or on dying trees.
Damage, symptoms: Larvae feed initially under the bark, but in late stages bore into the wood, later pupating there. Important damage follows maturation feeding of the newly emerged adults, when the pine wood nematodes residing under the elytra from the dying tree are transferred to a healthy pine. Exit holes are O shaped.

Control: Until the pine wood nematode (PWN) is present in a region, no protection is needed. If the PNW is introduced a strict eradication should be initiated. The beetle can be introduced to new areas easily by transport of wood if the bark is attached.
Reporting time: 30th September (III.).

Pissodes **spp. (e.g.** ***P. notatus, P. pini, P. piniphilus*****) – Pissodes weeveils**
(Code: PISSOSPP)


(Photo: PDI Library)
Pissodes piniphilus beetle


(Photo: M. Zubrik)
damage

Hosts: All pine tree species.
Distribution: All over Europe, where pine trees are present. Present in Southeast Europe, but in low numbers. Typical in young and old pine plantations.
Morphology: The beetle is brown with various scales on the pronotum and elytra. Patterns of the scales are typical for the different species. 4-9 mm in length. Larvae 1-8 mm long: typical weevil larva without legs.
Life cycle: Beetles fly from April to August. During this period feeds on young twigs and buds. Eggs are laid onto the bark in small groups (2-6). Larvae hatch after 3 weeks and begin constructing typical larval galleries. Pupation occurs in a typical pupation chamber filled with long wood particles. Adults emerge through an 'O-shaped' hole. Pupal development takes 4-5 weeks. Overwinters as beetle, sometimes over several years.
Damage, symptoms: Dieback of parts of the crown , sometime entire trees. Several larval galleries around the places of egg laying and pupal chambers are typical symptoms. Usually the red color of the needles and the dying crown are the first signs of the attack. Some species (e.g. *P. notatus*) prefer young trees, whilst others (e.g. *P. pini*) older trees.

<u>Control:</u> The removal of attacked trees reduces the population of beetles and the risk of further attack. Insecticides are not effective against these beetles (protected development).
<u>Reporting time:</u> 30th September (III).
<u>Life cycle and damage period:</u>

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
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Tomicus piniperda **– Large pine shoot beetle**
(Code: TOMIPIN)


Tomicus piniperda beetle,

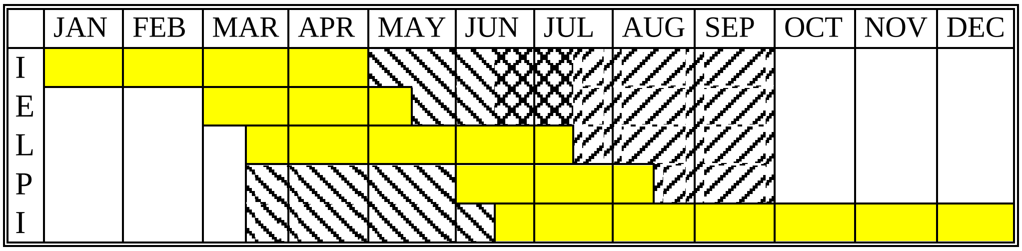

damage in the shoot,


galleries

(Photos: Gy. Csóka)

<u>Hosts:</u> Pine tree species.
<u>Distribution:</u> Palearctic (Europe and Asia). In Southeast Europe present where host trees (pines) are present.
<u>Morphology:</u> Beetles are dark brown, the head and prothorax black. Elytra with hairs, at the end small funiculus.
<u>Life cycle:</u> 1-2 generations per year. Overwintering beetles fly very early (end of February). Egg laying onto cut logs or stressed standing trees. Larval development takes 5-7 weeks. Maturation feeding in the shoots of the crown . Tends to have mass outbreaks especially after wind and/or snow damage.

<u>Damage, symptoms:</u> Reproduction is on cut logs and stressed standing trees. Mother galleries are an elongated S shape. Maturation is in the pith of young (1-3 years old) shoots . Shoots die and degrade rapidly. Overwintering: in the lower bole of standing trees.
<u>Control:</u> Removal of affected trees (e.g. the removal of cut logs from the forest) helps to reduce the population density. Beetle specific pheromones are available to monitor the flying periods and population density.
<u>Reporting time:</u> 30. September (III).
<u>Life cycle and damage period:</u>



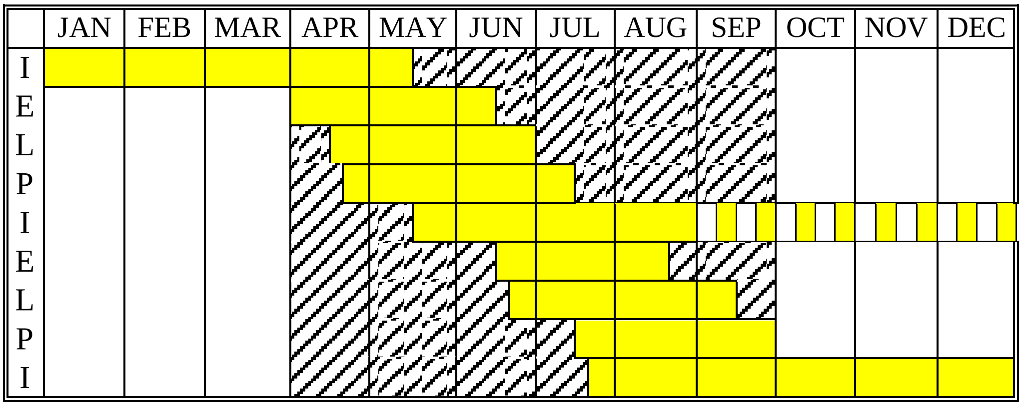
Ips sexdentatus – Six toothed bark beetle
(Code: IPSSEX)

Ips sexdentatus beetle, galleries

(Photos: Gy. Csóka)

<u>Hosts:</u> Pine species, mainly *Pinus sylvestris* and *P. nigra*. Occasional on other pines and other genera of conifers.
<u>Distribution:</u> Continental Europe and Asia. In Southeast Europe present where the host plant occurs.

Morphology: One of the largest European bark beetle species. Adults are 6-8 mm in length, light (young) or dark (old) brown. Six ‘teeth’ protrude from the end of the elytra , the 4th of which is the biggest.
Life cycle: Usually 2 generations per year, in higher elevations only one. First generation flies in April, the second in August.
Damage, symptoms: Attacks cut logs and weakened standing trees. Entry holes (usually with sawdust) are large (2 mm diam.). Mother galleries (2-4/family) are very long (up to 2m). Mating chamber is large. Larval galleries are short, pupal chamber large, easily visible. Galleries formed in the bark, notin the wood. with high quantities of suitable breeding material mass outbreaks may occur.
Control: Removal of suitable breeding material (cut logs) helps to reduce the population density. Pheromone is known and available: it can be used for monitoring.
Reporting time: 30. September (III).
Life cycle and damage period:



Lophodermium seditiosum – Pine needle cast
(Code: LOPHSED)

(Photo: P. Kapitola)

Fruiting structures (apothecia) of *L. pinastri*

(Photo: A. Kunca)

Fruiting structures (apothecia) of *L. seditiosum*

Hosts: *Lophodermium* needle cast occurs on numerous species in the genus *Pinus*. Pine needle cast is mainly caused by two fungi of the genus *Lophodermium (L. seditiosum* and *L. pinastri*). *L. pinastri*, however, fruits only on dying or dead needles: its fruiting bodies can be found almost everywhere in the pine-litter.

Distribution: common in most European countries.

Life cycle: The development of *L. seditiosum* is very irregular and depends on environmental factors. When high moisture is present, the fruiting bodies (*apothecia*) split longitudinally to release minute *ascospores*. This process often occurs during cool rain events in late summer and fall and the *ascospores* spread from the needles on the ground, to germinate on the surface of living needles. The conidial stage (*pycnidia*) of the fungus develops first and can sometimes be observed before the needles are shed. These asexual spores are unable to germinate and their significance in the fungus lifecycle is unknown. After infected needles have died or fallen, the *apothecia* of the fungus develop as dark elliptical spots on the foliage surface.

Signs and Symptoms. Needle cast is a general term used to describe diseases in which needle-like foliage is shed from a host. Specific needle casts can differ with respect to age of needles attacked and time of year affected, depending on the species of fungus and host infected. Most needle casts, however, have some common characteristics. Symptoms of pine needle cast are generally not apparent until the spring of the year following infection. At this time, infected needles begin to change color, first yellowing and then turning reddish brown (some of which may have yellow margins) by the time the new shoots are elongating. Depending on the strength of the wind, the

infected needles generally drop from the tree, leaving only more healthy ones in the crown. Severely affected seedlings may be completely devoid of needles for some time, until the new shoots have developed fresh needles.
Fruiting bodies (*apotheciua*) occur on dead portions of infected needles or on fallen needles, on one or both surfaces of infected needles. The fruiting body is elliptic when viewed towards the surface of the needle, and has a length of 1-2 mm and a width of about half that size.
Control: Practical control measures for needle casts of forest trees are not known, except in nurseries and some young plantations in which fungicide applications during infection periods can be used for effective control. Timing of fungicide applications may vary with geographic location. Fungicides should not be applied during rain, as the chemicals tend to wash off. Spraying is best during periods of low air movement, in the early morning, for example.
Reporting time: 30th June (II.), 30th September (III.).

Sphaeropsis sapinea - Sphaeropsis blight
(Code: SPHASAP).

(Photo:P. Kapitola)

Pycnidia on infected second-year cone scales

(Photo: L. Graney)

Pycnidia on infected dead needles

Hosts: Austrian pine (*Pinus nigra*) is the most susceptible hostm followed by Scots pine (*P. sylvestris*).
Distribution: *Sphaeropsis sapinea* is a serious pathogen of pines in the temperate zone of Europe and elsewhere in the world.
Life cycle: The disease normally infects mature trees weakened by stress, such as drought, root injury, excess shade and wounds caused by hail, or insects. The disease rarely occurs on young trees, possibly because the fungus builds up mainly in the tissues of old, dead seed cones. Thus, until a

tree has acquired a quantity of old cones, the chances for infection remain low. Seedlings and young trees can become infected, however, if growing near older infected trees. T*Sphaeropsis* overwinters as black *pycnidia* on infected trees or on cones that have fallen. In wet weather, from early spring into late autumn, spores (*conidia*) are liberated from the *pycnidia* and spread by wind and splashing rain. The fungus can also be spread as mycelium on pine seeds and can prevent seed germination of *Pinus* species.

Signs and Symptoms. The most noticeable symptom of sphaeropsis blight is a browning, stunting, and twisting of new shoots and needle growth. Usually the lower branches of the tree are the first and most seriously affected; sometimes infection is concentrated over a small area in the crown or on one side of a tree. In wet springs, branches throughout the crown of a tree may have brown tips. A brown discoloration first appears near the base of the needles, progressing toward the tips. Infected needles usually die after reaching one-half to three-quarters of the normal length. Generally, all needles developing on an infected shoot die. Black, pinhead-sized specks are the fungal fruiting bodies (*pycnidia*), forming near the base of infected dead needles, in the bark of infected twigs or branches, and on infected second-year cone scales.

Control: In nurseries fungicide protection is required from bud burst until the needles are half extended. Where feasible, remove all infected branches and seed cones from old pine trees or from the ground around nurseries.

Reporting time: 30th June (II.), 30th September (III.).

Gremmeniella abietina - Brunchorstia disease
(Code: BRUNPIN).

(Photo: Biologische Bundesanstalt für Land- und Forstwirtschaft Archive)

Symptoms of *Gremmeniella abietina*: bare shoots appear like candles

(Photos: P. Kapitola)

Fruiting structures (*pycnidia*) on young shoots

Hosts: The host range of *G. abietina* is mostly confined to species of *Abies*, *Picea* and *Pinus*. The main hosts are *Picea abies* and *Pinus sylvestris*.

Distribution: Three strains of the fungus from Europe, North America and Asia have been identified. The European strain is most virulent and has a wider host range.

Life cycle: After infection, the fungus kills the bud and grows downward into the stem and needle fascicles. Small, black *pycnidia* appear at the base of dead needles or on dead shoot tips, but *conidia* are not abundant until late fall or the following spring. Spore dissemination is primarily by rain splash. The European strain seldom produces a sexual form (*apothecia*), but the North American strain does not. *Apothecia* develop in the fall of year 2 or the spring of year 3 and occur in the same position as *pycnidia* but 1 year after the shoots have died. *Ascospores* are dispersed during July and August. In severe infections all the foliage on the host may be affected and die. *G. abietina* is most damaging to conifers growing near the limits of their climatic range and attacks are favored by shaded conditions, and in badly aerated plantations in which humidity is high. Climatic conditions including wet springs and cool summer months, with high precipitation and mist are reported to favor serious outbreaks of the disease.

Signs and Symptoms. The first evidence of the disease is seen in spring when the previous year's needles begin to turn yellow and then red-brown from the base to the tip, followed by needle-cast as the result of dieback of the affected shoots. The needle-free, naked shoots look like candles. A characteristic yellow colora in the xylem tissues can also be observed on cutting into affected shoots. One year later bunches of light-green needles may develop from adventitious buds, present at the base of the dead shoots, sometimes giving the appearance of small witches' brooms. In late fall or spring, *pycnidia* form in leaf scars near the transition area. These structures are dark-brown to black, up to 1 mm wide. Very small trees, such as nursery seedlings, are very susceptible to *G. abietina* and die soon after infection, usually in the first year. Most larger trees take several years to succumb, usually dying one branch at a time.

Control: In nurseries fungicides have been used with varying success. The disease may be controlled by fungicides applied from May to mid-August. In the forest or in a plantation, however, once *G. abietina* is established it is almost impossible to control.

Reporting time: 30th June (II.), 30th September (III.).

Cenangium ferruginosum - Cenangium canker
(Code: CENAFER).

(Photo: S. Mirtchev)

Needles brown from the base toward the tip

(Photo: P. Kapitola)

Cup like fruiting structures (*apothecia*) on branch

Hosts: A fungal disease commonly found on most species of pine, spruce and fir.
Distribution: common in most European countries.
Life cycle: The disease usually occurs on lower, shaded branches of mature trees. Germinating spores cannot penetrate directly through intact bark, and infection through needles is not known to occur. The predisposing factors are not totally clear but pines stressed by drought, wounding, insects, or other factors, suffered most often from infection. Small, black fruiting bodies (*apothecia*) appear on dead branches. In dry weather *apothecia* are shriveled, but on re-wetting open to expose an orange inner surface. Spores produced in these fruiting bodies (*ascospores*) are wind-disseminated to new sites of infection. The disease can infect trees anytime between May and September.
Signs and Symptoms: *C. ferruginosum* is often associated with dieback of parts of the crown in *Pinus sylvestris* and *P. nigra*. Cenangium canker may affect pines of all ages. The disease has several diagnostic features. Browning of needles associated with branch death may occur. Needles brown from the bases toward the tips. A sharp boundary between brown, dead bark and living tissue exists (discoloration with Scleroderris canker is yellow-green). Characteristic clusters of small, cup-like structures (*apothecia*) on the bark can also be seen. Little or no resin is produced on

infected tissue. Browning of needles associated with branch death may occur rapidly with the onset of hot, dry weather in early summer.
Control: At present, there are no chemicals registered or recommended for management of Cenangium canker. In forest stands of pines, careful thinning can increase vigour of healthy or only slightly infested trees and prevent secondary infections.
Reporting time: 30th June (II.), 30th September (III.).

***Melampsora pinitorqua* - Pine twisting rust (PTR)**
(Code: MELAPIN).

Main symptoms are bent or broken shoots

The hosts of *Melampsora pinitorqua* (hosts)

(Photos: P. Kapitola)

Hosts: Scots pine *(Pinus sylvestris)* and European aspen *(Populus tremula)*.
Distribution: Pine twisting rust occurs throughout Europe.
Life cycle: The pathogen is *macrocyclic* rust with five spore stages on two hosts. Pines are susceptible to the fungus for a limited period during flushing, and only if this critical period coincides with the dissemination of *basidiospores*, which in turn is influenced by climatic factors. The extensive presence of twist rust on pine is usually been connected with damp weather conditions in spring and early summer. The *basidiospores* are sensitive to desiccation, which normally limits the dispersal range between aspen foliage on the ground and the pine shoots. The fungus' *spermogonia* and *aeciospores* appear pines near the end of flushing. *Uredospores* and *teliospores* occur on the leaves of *Populus tremula*. The *teliospores* over winter on fallen aspen

leaves germinating in spring to produce *basidia*, from which *basidiospores* are released and infect nearby pines at the time of flushing.

Signs and Symptoms: The main symptoms are bent or broken shoots in the upper crown of young Scots pines, which can result in reduced growth and timber quality. Younger trees are at greater risk of mortailty or permanent injury. In some cases the wound formed during the *aecial* stage heals, leaving and a small scar on the bark. Often the leader is bent and breaks off at the site of the wound caused by the infection. Multi-stemmed trees may result.

Control: To reduce the risk of pine twisting rust, aspen should be eliminated from pine stands, including Scots pine regenerations and around nurseries. Seedlings in nurseries and some plantations can generally be treated by protective fungicide applications during infection periods.

Reporting time: 30th June (II.), 30th September (III.).

***Cronartium ribicola* - White pine blister rust**
(Code: CRONRIB)

(Photo:W. Schwandt)

Yellow-brown cankers on infected pine branches


(Photo: L. Anderson)


(Photo: USDA Forest Service Archive)

The spore stages on two hosts: *Ribes* and *Pinus* spp.

Hosts: 5-needled *Pinus* spp. and the species of *Ribes*.

Distribution: This rust is believed to be native to Asia or eastern Europe but was introduced to North America at the end of the 19th Century. European five-needles pines e.g. Macedonian pine ***(****Pinus peuce****)*** and Swiss pine *(Pinus* *cembra)* are mostly resistant to the disease. The recorded history of white pine blister rust in Europe begins after initial introductions of *P. strobus* from North America.

Life cycle: The pathogen is a *macrocyclic* rust with five spore stages on two hosts. In the fall, germinating *teliospores* on *Ribes* leaves produce *basidiospores* which are windblown to pine needles and enter through the stomata. The fungus invades progressively into the twigs, branches and into the main stem. Two to three years after initial infection, cankers are formed and develop over the next several years. *Pycnidia* are first produced under the bark and the following year, *spermatization* of the rust, *aecia* form and continue to be produced each year as long as the canker is active.

Aeciospores are windblown to leaves of *Ribes* where *uredia* are produced, containing *urediospores* that can reinfect other *Ribes* leaves. *Telia* replace the *uredia* on the *Ribes* leaves later in the vegetation season. The *teliospores* overwinter on the dead leaves of *Ribes* and in the spring germinate to form *basidia*, from which *basidiospores* again infect pines.

Signs and Symptoms: Yellow-brown cankers appear on infected pine stems and branches. Resin flows from the canker margin and coats the trunk and lower branches. The crown above the canker exhibits sparse growth, becomes progressively chlorotic and eventually dies once the infection girdles the tree. Cankers begin as yellow-orange swellings and typically develop a diamond shape. Black pycnial scars can be seen with the naked eye around the periphery of the cankers. In the spring, *aecial* blisters appear, releasing orange *aeciospores* which infect the alternate host. *Basidiospores* produced from teliosori on dead foliage of IRbies infect pine needles in the late summer to fall. Trees of all ages can be infected but mortality occurs most rapidly on juvenile trees.

Control: Prevention of pathogen attack may be achieved through silvicultural activities such as removal of heavily diseased pine trees and elimination of alternate hosts. Therapeutic sanitation includes canker treatments with biocides, biological control agents, branch pruning, and bole scribing to reduce blister rust severity and infection rate.

Reporting time: 30th June (II.), 30th September (IV.).

Cronartium flaccidum – Scots pine blister rust
(Code: CRONFLA)


(Photo: S. Krejcik)

The pine stem is flattened and deformed around the aecial canker



(Photos: M. Deml)

Cronartium flaccidum on secondary hosts

Hosts: The spermogonial and aecial stages occur on two-needled pines, and the uredinial and telial stages on foliage of herbaceous species such as Asclepiadaceae, Paeoniaceae and Scrophulariaceae.
Distribution: Europe especially northern Europe (Finland, Norway, Sweden), south to Italy.
Life cycle: *C. flaccidum* infects pine hosts by aerially dispersed *basidiospores* that arise on teliopsores formed on leaves of the alternate herbaceous hosts. On pine shoots, *spermagonia* and *aecia* develop; aerial spread of the rust to alternate hosts is via *aeciospores*. A period of several years may elapse between infection and the appearance of the *aecial* state on infected pine tissues. After successful disease establishment, *uredinia* form on foliage of herbaceous species, followed as the vegetative season progresses, by *telia* formation from *uredinia*. After germination of teliospores, *basidia* form and release *basidiospores*. The cycle then repeats. The pathogen survives winter as mycelium within host tissues. Several

environmental factors influence the development of the disease and the life cycle. The optimum temperature for germination of *aeciospores*, *urediniospores*, and *basidiospores* is between 15°C and 20°C. High moisture levels and precipitation increase the incidence of disease.

Signs and Symptoms: The pathogen grows in the host and the abundant resin produced by the tree results in the loss of xylem conductivity. As an indication of infection in the shoot, the color of the needles on branches above the lesion turn light green to yellow. Bark discoloration, cankers (lesions) and deformed growth are commonly observed symptoms. Resinosis from the lesion may be obvious. Once the leader is killed, the top of the tree is dead, but branches below the lesion remain living. Cankers on stems also bear blister-like pustules, the *aecia*, in which orange-yellow *aeciospores* form. The disease may occur on pines of all ages. Disease development can be rapid and lethal to seedlings and young trees.

Control: *Cronartium flaccidum* has been controlled by sanitation fellings of heavily diseased trees, but despite this procedure, epidemics regularly occur throughout its distribution range. Therapeutic sanitation includes canker treatments with biocides, biological control agents, branch pruning, and bole scribing to reduce blister rust severity and infection rate.

Reporting time: 30th June (II.), 30th September (III.).

Can be confused with: symptoms of *C. ribicola*, the causal agent of white pine blister rust, but this rust does not infect two-needle pines such as *Pinus sylvestris*; *C. flaccidum* does not infect five-needle pines or *Ribes* species. Other rusts in Europe may attack two-needle pines and have similar life cycles:

- ✓ *Coleosporium* spp., the pine needle rusts, shares a few telial hosts with blister rust, but produce *spermagonia* and *aecia* on pine needles, not on the stems.
- ✓ *Melampsora pinitoqua* infects the shoots of pines, causing shoot bending and/or tip death but the *telial* host is European aspen *(Populus tremula)*.

7.1.3. Pest and pathogens on Spruce (*Picea* spp.)

Cephalcia abietis - spruce web-spinning sawfly
(Code: CEPHABI)


(Photo: P. Kapitola)

Cephalcia abietis nest


(Photo: P. Kapitola)

larva

Hosts: Spruce (*Picea* spp.).
Distribution: In Europe present wherever the host trees grow.
Morphology: The sawfly is 11-16 mm in length; head and thorax black with yellow motifs. Larvae yellow or light green.
Life cycle: Adults fly from April to July. Eggs laid on needles in small (5-21) groups. Larvae emerge after 4 weeks and begin to form a light web. Overwinters in soil as prepupa. Large proportion of the population does not emerge in the following year; diapause can last up to 5 years.
Damage, symptoms: Attacks the top of the trees. Larvae feed first on the old needles; shoot tips remain intact. Larvae produce a web with debris and frass. Tends to occur in mass outbreaks.
Control: Insecticide application may be necessary, although implementation as an aerial spray makes it difficult.
Reporting time: 30th September (III.).
Life cycle and damage period:

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Pristiphora (Lygaeonematus) abietina - gregarious spruce sawfly
(Code: PRISABI)

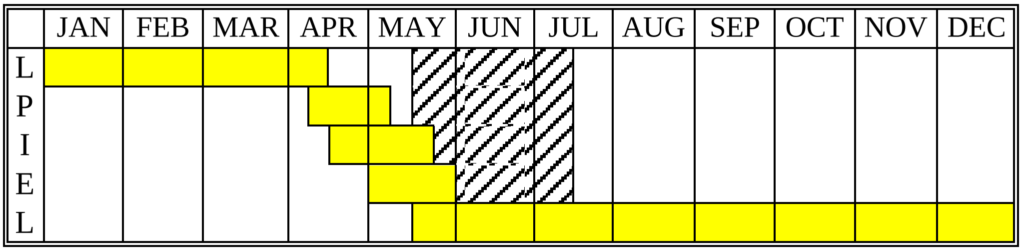
(Photo: P. Kapitola)

Pristiphora abietina damage

(Photo: P. Kapitola)

larvae

Hosts: Spruce (*Picea* spp.), especially young trees.
Distribution: Europe, wherever spruce trees grow.
Morphology: Adult sawfly is 4-6 mm in length. Larvae are green, 10-15 mm in length.
Life cycle: Adults fly in April-May. After copulation, eggs are laid at the top of the shoots. Larvae feed in small groups, exclusively on the needles of the young shoots. Overwinters as prepupa/pupa in the soil; this inactive period can last for several years.
Damage, symptoms: Feeds on needles of young shoots. Current year needles become dry, as if the tree was scalded.
Control: Damage is usually at an acceptable level.
Reporting time: 30th June (II.)
Life cycle and damage period:



Pityogenes chalcographus - Six toothed spruce bark beetle
(Code: PITYCHA)


(Photo: M. Jurc)

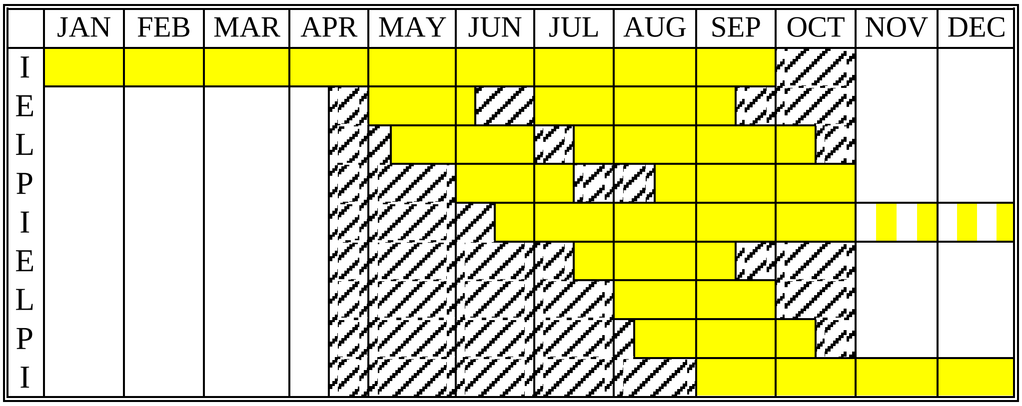
Pityogenes chalcographus beetle


(Photo: F. Lakatos)

galleries

Hosts: Spruce (*Picea* spp.); however, after mass attacks, other conifers can be damaged.
Distribution: Europe and Asia. In Southeast Europe anywhere spruce is grown.
Morphology: The beetle is small (2 mm long), dark brown. At the rear of the elytra, there are 3-3 teeth. These teeth are larger on males than females.
Life cycle: 2 main generations per year, but also several sister-broods. The first generation fly in April-May, the second in August. Overwintering beetles do not die after egg laying, but after a short regeneration produce further progeny (sister-brood). The number of generations depends on weather and climatic conditions (e.g. elevation).
Damage, symptoms: The beetle attacks young trees, or tops of older trees (thin bark parts). This species is frequently found together with the European spruce bark beetle (*Ips typographus*). Star-shaped maternal galleries (3-6/family). Larval galleries are sparse. The species tends to occur in mass outbreaks, especially following forest management activities (e.g. thinning), where crown residues remain on the forest floor.
Control: Removal of tree debris (including small ‘valueless’ branches and crown shoots) reduce the population density considerably. Aggregation pheromone is available for monitoring. The use of insecticide has very low efficiency.
Reporting time: 30th June (II.) and 31st December (IV.).

Life cycle and damage period:



***Ips typographus* - European spruce bark beetle**
(Code: IPSTYPO)


(Photo: M. Jurc)
Ips typographus beetle


(Photo: F. Lakatos)
galleries

Hosts: Spruce (*Picea* spp.); in mass outbreak, it may attack other coniferous tree species.
Distribution: Europe and Asia. In Southeast Europe present wherever spruce grows.
Morphology: Three *Ips* species are morphologically very similar (*I. typographus*, *I. amitinus* and *I. cembrae*). Only well-trained specialists can distinguish these species correctly (based on elytral structure and antenna). However, on spruce *I. typographus* dominates and in most cases only this

species is present. The beetle is brown, 4-5 mm in length. At the rear end of the elytra there are 4-4 large spines/teeth, where the 3rd ones are the largest.

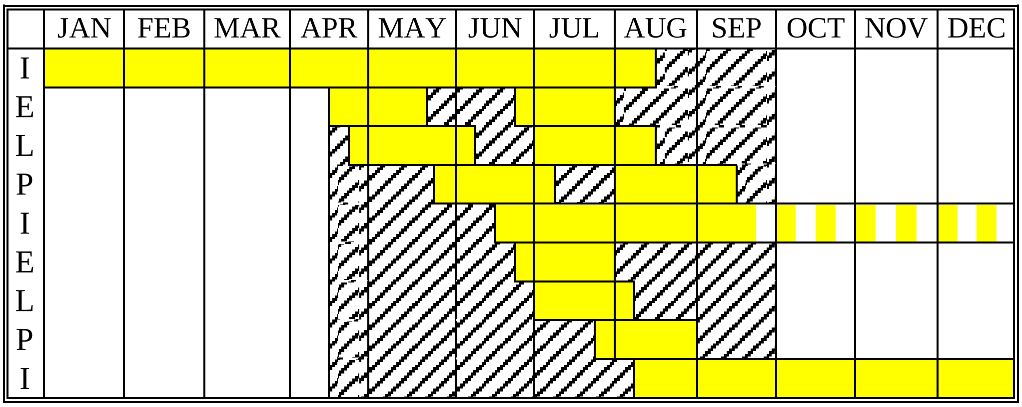
Life cycle: The species has 1-3 generations per year, depending on latitude and elevation. After overwintering, beetles swarm in April, when the daily maximum temperature reaches 20C (depending on latitude and elevation: from the beginning of April until the end of May). After egg laying a large portion of the population remains alive, and after a short regeneration feeding, copulates again prior to egg laying. The second generation flies in June/July, the third – when it occurs – in August. The duration of larval development depends strongly on weather conditions.

Damage, symptoms: The beetles attack old and large spruce trees (with thick bark). Maternal galleries run parallel to the trunk axis. Usually 2, sometimes 3-5 mother galleries/family. Further symptoms of spruce bark beetle attack are: brown sawdust (frass) at the base of the tree, loss of green needles and loss of bark pieces. Outbreaks are typical in areas after wind damage, storms and tree harvesting operations (including illegal logging). In most cases the species is accompanied by other bark beetle species (e.g. *P. chalcographus*).

Control: The most effective protection method is through sanitation management, in which breeding materials in the forest are removed: attacked trees, harvested timber, before the beetle swarming period at the end of March. Aggregation pheromone is available and widely used throughout Europe both for monitoring and in many cases for mass trapping.

Reporting time: 30th June (II.) and 31st December (IV.).

Life cycle and damage period:



7.1.4. Pests and pathogens on Fir (*Abies* spp.)

Dreyfusia nordmannianae - Silver fir woolly aphid
(Code: DREYNOR)


(Photos: M. Zubrik)

Dreyfusia nordmannianae aphids, damage

Hosts: Various fir (*Abies*) species.
Distribution: Originates from the Black Sea region; introduced to Europe in the 19th century, but currently present all over Europe. Also introduced to North America. Present in Southeast Europe wherever fir trees grow.
Morphology: Based on the morphology of the aphids it is hard to determine the species (a specialist is needed).
Life cycle: Originally the species had two hosts (fir and spruce) with a complex life cycle switching between the hosts. In Europe the species can pass its full life cycle on fir only.
Damage, symptoms: The aphids suck sap from young fir needles. The aphids prefer trees exposed to warm, sunny conditions: young trees under the canopy of older trees are less affected.
Control: No effective protection method is available (no insecticide permitted).
Reporting time: 30th June (II.).

Pityokteines spp. (_P. curvidens, P. spinidens_) – Fir bark beetles
(Code: PITKTSP)

(Photo: M. Jurc)
Pityokteines curvidens beetle,

(Photo: M. Jurc)
galleries

Hosts: Various fir (*Abies*) species.
Distribution: Europe and Asia. Present wherever fir trees gorw in Southeast Europe.
Morphology: Beetles are an even blackish colour, with yellowish-brown antennae and legs and marked sexual dimorphism. Body is 2.5-3.2 mm long. Males bear three pairs of prominent denticles on the elytral declivity; the hook-shaped median tooth is strongest. Females have teeth on the elytral declivity reduced in size but approximately the same shape.
Life cycle: Two to three generations per year. The species overwinters mainly in the adult stage under the bark of dead trees. Adults leave the overwintering sites, beginning the reproductive phase from the second half of April. After finding suitable trees to colonize, pioneer males start boring their galleries under the bark, feeding on the living tissues. A 'family' usually comprises one male plus two, three or rarely four females. Embryonic development takes 6-17 days. The larvae feed by digging galleries 5-8 cm long, orthogonal to the maternal galleries; larval development lasts between 30 to 50 days depending on environmental conditions. Pupation lasts 10-18 days. Adults emerge from the tree bark after maturation feeding on phloem tissues for 17-39 days.
Damage, symptoms: The species prefers well exposed edge trees. Colonization of a new host plant starts from the tip, eventually reaching the base. Even very old trees with thick bark can be attacked.
Control: The most effective protection method is through clean management protocols: reduction of breeding materials in the forest by removal of attacked trees and harvested timber before the beetle swarming period (e.g. end of March).
Reporting time: 30th June (II.).

Melampsorella caryophyllacearum - Witches' brooms
(Code: MELACAR)

(Photo: S.K. Hagle)

Witches'-brooms caused by
Melamsporella caryophyllacearum infection on fir

(Photo: R. Kelley)

Infected needles on a fir tree

Hosts: Firs (*Abies alba* Mill.) and species in the Caryophyllaceae.
Distribution: The pathogen occurs all over Europe
Life cycle: Rust infections form *spermogonia* and *aecidia* on infected needles of fir trees. The *uredospore* and *teliospore* stages occur on species in the Caryophyllaceae. *Teliospores* overwinter on dead needles and in spring germinate to form *basidia*, on which *basidiospores* form, which again infect fir trees. High attack frequencis of the pathogen occur in particular microclimatic conditions (light, temperature and humidity) and the presence of suitable host plants. Low-light conditions and high humidity favour the complete lifecycle of *M. caryophyllacearum*.
Signs and Symptoms: The pathogen causes obvious morphological changes on fir stems and branches. Distinctive, greenish-yellow, upright brooms are visible in summer. The colour of the brooms contrasts with the deep green of healthy needles on the same tree. Broom needles are pale yellow, shorter and thicker than normal needles, and arranged in a spiral. In summer, the undersides of these needles are covered with blisters filled with yellow or orange *aeciospores*. Broom needles abscise in fall and a new flush appears in the following spring. At the base of the broom, infected branches and stems

are swollen, forming a canker or a gall. Witches' brooms present conditions under which secondary pests or pathogens can attack.
Control: Prevention of pathogen attack is achieved through silvicultural activities, including taking care to remove diseased fir trees.
Reporting time: 30th June (II.), 30th September (III.).

7.2. Broadleaved tree species

7.2.1. Polyphagous pest and pathogens on broadleaves

Geometrid moths (e.g. *Erannis defoliaria* – mottled umber moth, *Operophtera brumata* – winter moth)
(Code: GEOMMOT)

Erannis defoliaria larva/caterpillar

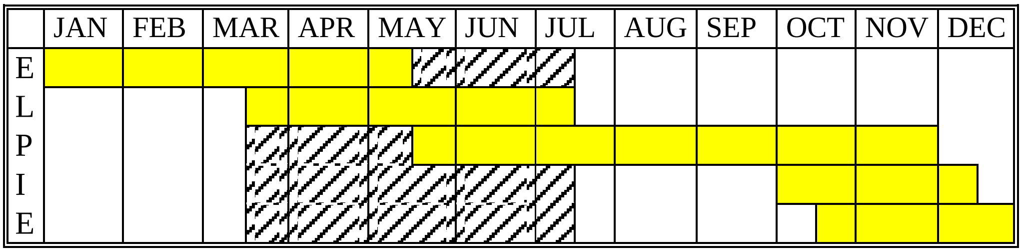
Operophtera brumata copulating adults

(Photos: Gy. Csóka)

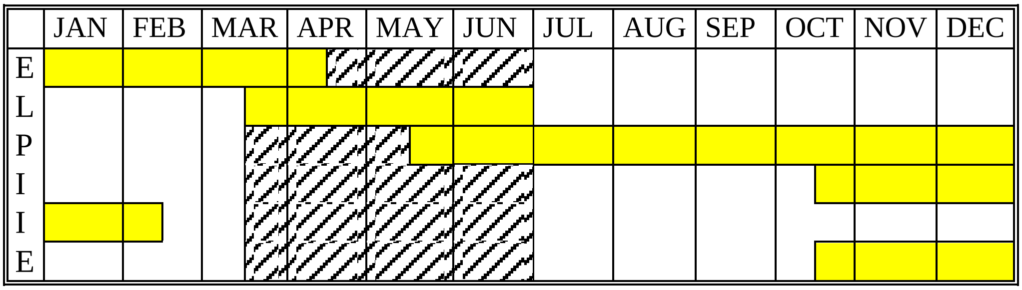
Hosts: Most Geometrid moths are polyphagous on broadleaved tree species. The main host tree species are: oaks (*Quercus*), hornbeam (*Carpinus*).
Distribution: A wide distribution areas including large parts of Europe and Asia.
Morphology: Because of the lack of prolegs in the middle portion of the body (only two or three pairs at the end of the body) the locomotion of the larva is typically looper. Adults females are mostly flightless; males have two well-developed wings.

Life cycle: Most of the damaging species (e.g. *E. defoliaria*, *O. brumata*) fly in late autumn and on warm winter days (hence 'winter moths'). Wingless females climb into the crown to lay eggs in small groups. Larvae/caterpillars hatch in early spring, just after budburst and feed on the leaves.
Damage, symptoms: Damage caused by feeding caterpillars is recognizable only if the larvae are also present. Some larvae produce light webs and feed in this web.
Control: Usually not necessary, not even during mass outbreaks. Monitoring is possible using light or pheromone traps. The number of egg laying females can be reduced by applying a sticky band to the tree trunk; the flightless females become trapped in the sticky glue when climbing into the crown from the soil.
Reporting time: 30th June (II.).
Life cycle and damage period:

Erannis defoliaria



Operophtera brumata

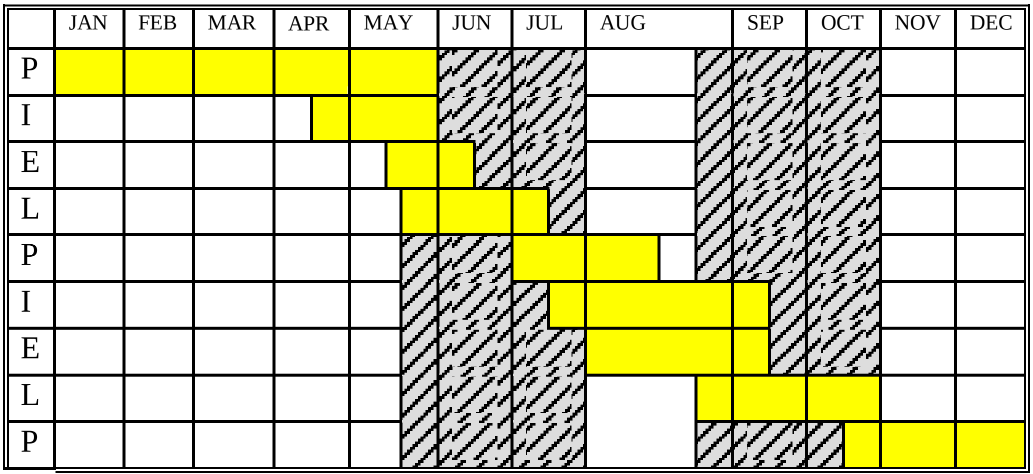


Hyphantria cunea – Fall webworm
(Code: HYPHCUN)

(Photo: M. Zubrik)

Hyphantria cunea larvae

Hosts: highly polyphagous. Over 250 plant species have been reported as hosts.
Distribution: Originates in North America, but was introduced to Europe during WWII, firstly to Hungary, later spreading to France. Now distributed all over Europe.
Morphology: The moth is white, with some small black spots on the forewings. The male has a 19-32 mm wingspan, the female 25-34 mm. The caterpillar is yellowish, light greenish with grey stripes and a number of brown warts, from each of which 1-1 hair emerges.
Life cycle: 2 generations per year. First generation adults fly in May, the second in July-August. Eggs are laid onto the lower surface of leaves in groups. The hatching larvae construct a light web, including leaves. Larvae feed first in small groups, later singly.
Damage, symptoms: Larvae feed in the tree tops and progress downwards. They construct a light web. Most common on forest margins, roadsides and in orchards.
Control: Not common in closed forest, but rather typical in orchards and open forest areas. Mechanical treatment (collection of caterpillar nests) has been used to reduce population density. Currently, various insecticides are in use against this species.
Reporting time: 30th June (II.).
Life cycle and damage period:



Agrilus viridis - Green jewel beetle

(Code: AGRIVIR)

Agrilus viridis beetle,

larva,

galleries

(Photos: F. Lakatos)

Hosts: Various broadleaved tree species, but mainly considered a pest on oak and beech.
Distribution: Europe, Asia-Minor and North Africa.
Morphology: The beetle is metallic green with several color variants, 6-10mm in length. Distinguishing the different *Agrilus* species is very difficult; a specialist is required for accurate identification. Larvae are yellowish-white and have a uniform width from head to tail. Before pupation, larvae attain lengths of 10-12 mm.
Life cycle: Full generation cycle usually 2 years, but under optimum climatic conditions (e.g. hot and dry summer) make take 1 year. Beetles fly from June to September. Eggs are laid on the bark surface in small groups of 6-10. After hatching larvae bore into the bark and construct typical 'snake like' galleries under the bark, before overwinting as larva. In the second year, may persist in larval stage or pupate April-May. Newly emerged adults carry out maturation feeding on fresh leaves.

Damage, symptoms: *A. viridis* attacks both the crown parts and trunk of standing trees. The snake like galleries of the larvae are typical for all *Agrilus* species. The pupal chamber is in the wood; exit holes are D-shaped.
Control: In general, a secondary pest, but in the recent years became primary. It is hard to control this species. The removal of the damaged tree helps to reduce population density, but efficiency of this process is low. Beetles prefer sun-exposed trees for egg laying. Maintaing dense stands helps to reduce numbers of potential host trees.
Reporting time: 30th June (II.).
Life cycle and damage period:

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Viscum album - European mistletoe
(Code: VISCALB).

(Photo: P. Kapitola)

The shrubs have stems 30–100 centimetres

(Photo: R. Videki)

The fruit is a white berry

<u>Hosts:</u> Coniferous *(Abies, Pinus, Larix)* and broad-leaved trees (*Populus, Tilia, Malus*).
<u>Distribution:</u> *Viscum album* is classified as adapted to temperate climates, outside the extreme continental regions. Normally it occurs at sites exposed to the sun, such as with a southerly aspect. It has been reported that the response of *V. album* to cool summers can be compensated by mild winters.
<u>Life cycle:</u> Mistletoe is disseminated by birds that eat the berries before excreting the seeds, or by smearing the sticky pulp containing seeds off their beaks. The berries are poisonous to humans. Under proper conditions, the seeds germinate and the proto-roots penetrate the branch of the host tree, forming a haustorium into the host xylem. Mistletoe is considered a *semiparasitic* plant because it synthesizes its own chlorophyll but depends on the host for its supply of water and minerals.
<u>Signs and symptoms:</u> Leafy m,istletoe is a hemi-parasitic shrub, which grows on the stems of trees. Mistletoe stems are 30–100 centimetres long with dichotomous branching. The leaves are in opposite pairs, entire, 2–8 centimetres long, 0.8–2.5 centimetres in width and a yellowish-green in colour. This species is *dioecious*: male and female flowers are borne on

separate plants and are insect-pollinated. The fruit is a white or pale yellow berry containing one (very rarely several) seed embedded in a very sticky, glutinous fruit pulp. Mistletoe is evergreen and the stem grows without branching for the first 3 or 4 years. The shoot then branches once per year, so the approximate age of a mistletoe can be calculated by counting the number of forks in the stem and adding 3.

Control: Although in some cases the mechanical removal of mistletoe appears successful and effective, control using this method is difficult to achieve in a larger area because it is labour intensive. Furthermore, mechanical removal of whole crown infections will be an extensive shock for the tree and disrupts regular crown formation.

Reporting time: 30th June (II.), 30th September (III.).

Loranthus europaeus **- Yellow mistletoe**

(Code: LORAEUR)

Loranthus europaeus is a 80 cm high shrub

The yellow fruits ripen in late autumn

(Photos: S. Mirtchev)

Hosts: Yellow mistletoe has been found on 10 tree species: *Quercus robur*, *Q. petraea*, *Q. cerris*, *Q. pubescens*, *Q. frainetto*, *Q. rubra*, *Q. palustris*, *Castanea sativa* and *Carpinus betulus*.

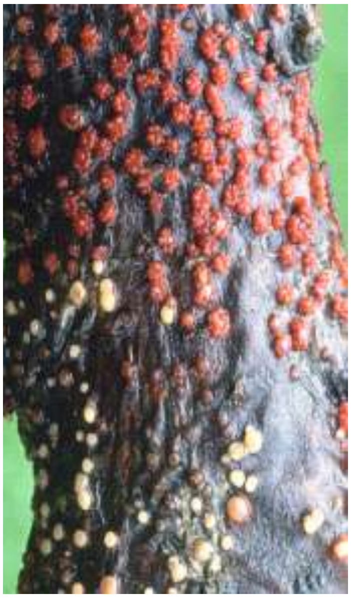
Distribution: *L. europaeus* is restricted to central-southeastern Europe and Asia-Minor.

Life cycle: This genus of parasitic plants grows on the branches of woody trees. In contrast to *Viscum album* this species is deciduous. The plant grows vigorously on ageing trees, particularly in the middle of old branches. Once

established, the mistletoe takes minerals and water from the host tree, and blocks sunlight through its dense foliage. The most important vectors of yellow mistletoe are birds (e.g. *Turdus viscivorus*, *Garrulus glandarius*).
Signs and Symptoms: *L. europaeus* reaches 80 cm in height, with opposite branching, brown stems, twigs break off easily at the nodes . Leaves are 4-6 cm long, opposite, simple, dark green, with short petioles. The flowers are light green, male in terminal racemes, female in terminal, loose spikes. Flowers are produced in May and June. The fruit is up to 1 cm in diamter, roundish, yellow, a berry-like drupe, which remains sticky even after drying. The fruits ripen in late autumn, and gradually fall off in late winter.
Control: Pruning out branches carrying *L. europaeus* before it spreads to other branches of the tree may help to control the problem. For some species, larvae of the Indian Common Jezebel butterfly (*Delias eucharis*), the larvae of which feed on *Loranthus* foliage, can give natural control. The larvae grow in scores and hence can quickly defoliate the mistletoe. Reporting time: 30th June (II.), 30th September (III.).

Nectria ditissima **- Nectria canker**
(Code: NECTDIT)


Nectria ditissima - a canker


The salmon-pink pustules on the branches

(Photos: S. Mirtchev)

Hosts: Over 100 tree species.
Distribution: The most common canker in beech forests.
Life cycle: The coral spot pathogen, cause of spot *Nectria* canker, has both *sexual* and *asexual* fruiting structures that occur separately on the same host. The sexual structure is the *perithecium*, containing *ascospores*. The asexual

spores are *conidia*. Both *ascospores* and *conidia* can infect the host. Red fruiting bodies (*perithecia*) form in clusters clearly visible to the naked eye. The fungus survives through the winter in cankers, and produces fruiting structures during the spring. Windblown and water-splashed spores infect trees through wounds and branch stubs. The fungus cannot directly infect living wood, but enters through dead tissues around wounds, especially in early spring and in damp conditions. From the wounds, it enters the water transport system (*xylem*) and spreads throughout the trees.
Signs and Symptoms: Annual formation of wound phellogen and callus around colonization points on the bark, form a typical circular target canker. Salmon-pink pustules appear on the infected trees, particularly on and around dead wood (e.g. from dieback). Sometimes (usually in spring) similar-sized red pustules appear. Large branches may wilt in summer if badly affected near the base, resulting in girdling and dieback. This disease usually does not kill trees, but causes serious volume losses.
Control: It is very difficult to manage, but a number of factors can reduce the risk of serious damage. The most effective method is to protect trees from injuries.
Reporting time: 30th June (II.), 30th September (III.).

***Fomes fomentarius* - Tinder fungus, hoof fungus**
(Code: FOMEFOM)

Fomes fomentarius - fruiting bodies on the lower trunk

The underside has round pores

(Photos: S. Mirtchev)

Hosts: Decay pathogen on broadleaf trees, particularly beech and poplar.

Distribution: Rare in southern Europe but more common in northern Europe. Life cycle: Wood decay-causing pathogens enter living trees through wounds, Branch stubs or broken tops. Storm injury causing broken tops and branches leads to the establishment of decay fungi in exposed wood, with subsequent slow spread. Fire is a major cause of tree injury in some forests. Harvesting with heavy equipment became can also be a major cause of injury to forest trees. Birds and insects make deep wounds that deform and weaken stems and initiate internal discoloration and decay. Larger animals such as bear, deer and wild-boar, remove bark and expose wood to infection. Decay begins in both live and dying sapwood and spreads into dead heartwood.
F. fomentarius is parasitic on broadleaf trees, particularly on beech, poplar and birch, but is also saprotrophic on dead trunks. Fruiting bodies are present all year round, shedding *basidiospores* in late spring into summer and fall.
Signs and Symptoms: *F. fomentarius* has a fruit body of between 2 and 45 cm across, which is attached broadly to the host tree, and typically shaped like a horse's hoof. The fruit body typically has broad, concentric ridges on the upper surface, with a blunt and rounded margin. The upper surface is hard and woody, varying in color, usually a light brown or grey. The underside has round pores at a density of 2 – 3 per mm, cream-coloured when fresh, maturing to brown; the pore surface darkens when handled. The tubes are 2 to 7 mm long and a rusty brown color.
White rot caused by *F. fomentarius* can be present in both the (dead) sapwood and heartwood. Brown to black zone lines often appear with decayed wood. Radial cracks in the decayed wood may be filled with yellow mycelium, giving the decayed wood a mottled appearance.
Control: Tinder fungus usually occurs on old, large trees. It is very difficult to manage, but protecting trees from injury can reduce the risk of serious damage. Reporting time: 30th June (II.), 30th September (III.).

Laetiporus sulphureus - Sulphur polypore
(Code: LAETSUL)

(Photo: C. Young)

Laetiporus sulphureus - some fruit bodies

(Photo: D. Brown)

The fungus causes a brown heart rot

Hosts: Dead or dying hardwood, mainly oak, beech, sweet chestnut; occasional on yew.
Distribution: Throughout central, northern and some parts of southern Europe
Life cycle: Wood decay in living trees is initiated through wounds. Fruit bodies shed basidiospores from late spring to fall. This wood-decay fungus, primarily affects dead heartwood, but can also sometimes attack live sapwood, particularly on older trees.
Signs and Symptoms**:** The fruiting body is soft and fleshy, from 10 to 40 cm across and variable inthickness, from 3 to 12 cm. Conks are produced annually and appear solitarily or in clusters, usually in late summer to fall; they become hard, brittle, and white with age. Conks do not appear until many years after the onset of decay and indicate extensive internal damage. The fungus causes a brown cubical heart rot and is amongst the most serious causes of decay in the forest. A light brown stain appears in the heartwood in the early stages of decay. As the rot advances, the wood degrades into small, red-brown cubes. In the shrinkage cracks surrounding the cubes, white mycelial mats may form. The young conk is edible.

Control: It is very difficult to manage, but a wood decay can be minimized by protecting trees from injuries.
Reporting time: 30th June (II.), 30th September (III.).

Pleurotus ostreatus - Oyster Mushroom
(Code: PLEUOST)

(Photo: S. Krejcik)

Pleurotus ostreatus- some fruit bodies

Hosts: Deciduous trees: poplar, beech and linden trees in particular.
Distribution: Occurs in most parts of Europe.
Life cycle: Initial infections occur through open wounds, and decay is most extreme when wounds are large. A cluster of shelf like mushrooms is produced annually and can indicate localized decay or heart rot that extends in above and below the wound. Basidiospores are released in late summer and fall

Signs and Symptoms: The mushroom cap is 5–25 cm in diameter; natural specimens range from white to grey or tan to dark-brown. The margin is in-rolled when young, smooth and often somewhat lobed or wavy. The flesh is white, firm, and varies in thickness due to stipe arrangement. The gills of the mushroom are white to cream, and descend onto the stalk if present. If so, the stipe is off-center with a lateral attachment to wood. The stipe can often be absent. When present, it is short and thick. The fungus decays both heartwood and sapwood, causing a white, flaky rot. It is a common cause of decay and death of beech and less often of several other tree genera, including oak. This mushroom is edible.
Control: Minimize the chance of development of wood decay by protecting trees from injuries.
Reporting time: 30th June (II.), 30th September (III.).

Armillaria mellea & A. ostoyae **- Honey fungus**
(Code: ARMIMEL)

(Photo: J. Cepelak)

Armillaria ostoyae - some fruit bodies

(Photo: S. Mirtchev)

The rhizomorphs under the bark

Hosts: *Armillaria mellea* commonly kills broadleaved trees; *A. ostoyae* is more common killing coniferous species (see below).
Distribution: *A. mellea* occurs throughout Europe, becoming lles common in the far north.

Life cycle: *Armillaria* spp. are a persistent fungi common in most forests worldwide. It can persist as a saprophyte in a vegetative state indefinitely in dead roots or other woody debris in the soil, attacking roots of healthy trees via *rhizomorphs* or when the growing roots contact the colonized debris below ground. After penetration of the healthy tree, the pathogen invades the roots and buttress area, killing the vascular cambium and later decaying the xylem. The ability of the fungus to penetrate and progressively invade roots is directly related to the health of the tree. Trees with root injury, recently transplanted trees, or trees that have suffered severe stress, such as prolonged drought or insect defoliation, are more susceptible to attack by *Armillaria* spp. in general . During early fall the sexual *basidiocarp* (a mushroom) stage develops and releases windblown *basidiospores*, which can become established on recent root or buttress wounds, stumps or on dead woody tissue.

Signs and Symptoms: Affected trees usually exhibit loss in vigour, including decreased crown growth, dieback, and general decline. In fact, it is estimated that over 70% of the root system will have died before crown symptoms become apparent.The pathogen causes death and decay of roots. Infected trees are also subject to windthrow due to weakened support of the root system. Dark brown to black strands of fungus mycelium termed *rhizomorphs*, often form, radiating into the leaf litter from around the outside of the root. In the early fall mushrooms may appear at the base of an infected tree or around trees recently killed by the disease. Large clusters of mushrooms can form on infected trees and stumps in late summer to mid-autumn. The cap is 5 to 15 cm in diameter; color ranging from honey-yellow to red-brown, with a darker area near the centre. The specific epithet *mellea* means '*of honey*' and is a reference to the colour of caps of this species rather than to their flavour. The cap is white and initially deeply convex. Fine scales cover the young caps, most noticeably towards the centre. When young, the stems are white, turning yellow or yellowish-brown and finely woolly as the fruit body matures. A pale yellowish ring usually persists on the stem to maturity, distinguishes them from A. tabescens.. Although the mushroom stage is short-lived, the shriveled mushrooms can often be detected for several months. The mushrooms are edible but some people may be intolerant of them.

Control: Prevention can best be achieved by helping trees avoid stresses such as moisture imbalance, insect defoliation and other infections. When planting trees, select planting sites that allow for vigorous root growth. Where possible, avoid competition from lawn grasses.

Reporting time: 30th June (II.), 30th September (III.).

Can be confused with: *Armillaria ostoyae* (Code: ARMIOST), sometimes known as the “dark honey fungus”, which attacks, kills and decays the root systems of conifer hosts, rarely broadleaved trees. The stem ring of the fruiting body can persist to maturity and may help to distinguish *A. ostoyae* from *A. mellea*. The first has a white stem ring with dark brown or black scales on its underside. Although a pathogen and tree-killer, *A. ostoyae* can also maintain viability in dead woody material in the soil for many years as a saprophyte.

7.2.2. Pest and pathogens on Oaks (*Quercus* spp.)

Tortrix viridana - Green oak moth
(Code: TORTVIR)

(Photo: Gy. Csóka)

Tortrix viridana caterpillar,

(Photo: P. Kapitola)

rolled leaves

Hosts: Various oak (*Quercus*) species, particullaarly *Q. robur*.
Distribution: Throughout Europe especially on *Q. robur* trees, but rolled leaves are also constructed on other oak species.
Morphology: Wingspan of the moth is 9-11mm. First pair of wings light green, second pair grey. Caterpillar is green with a black head.
Life cycle: One generation per year. Strong association exists between insect and host tree. The hatching caterpillars need buds immediately after budburst (slightly opened buds). If the buds are still closed, or the tree is already fully foliated, the larvae die of starvation. Moths fly from May to June. Paired eggs are laid in the top of the crown.
Damage, symptoms: Rolled leaves allover the crown. Larve of several Tortricid moths (e.g. *Archips xylosteana*, *Aleimma loefflingiana*), but also other insect species (e.g. leaf roller beetles) roll the leaves to build protection. Individual trees with varied budburst times have different

infection levels. Trees with later budburst are usually less damaged than others. Populations of these moths tend to fluctuate greatly.
Control: A huge number of experiments have been carried out on biological protection against this species (e.g. use of ants, birds), but none proved very effective. *Bacillus thuringiensis* preparations were effective.
Reporting time: 30th June (II.).
Life cycle and damage period:

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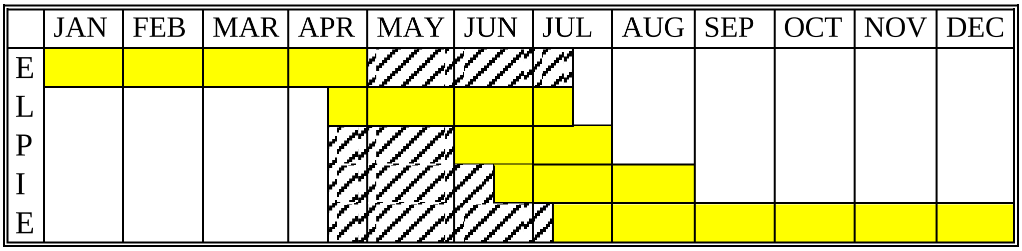
***Lymantria dispar* - Gypsy moth**
(Code: LYMADIS)

(Photos: F. Lakatos)

Lymantria dispar egg mass, caterpillar

Hosts: Polyphagous; the main hosts are oaks and other broadleaved tree species.
Distribution: Eurasia. In Europe, females cannot fly, wherea females of the Asian strain can. The species was introduced into North America in the 19th Century, where it is one of the most important invasive insect species in the Northeastern states. Common throughout Southeast Europe, especially in oak forests at lower elevations.

Morphology: Male moth wingspan 35-50 mm, brownish-grey with well-developed antennae. Female wingspan 45-80mm, rather white on the first wings with some grey stripes. Abdomen much better developed than males, antennaw slim. The caterpillar is dark brown, with colored warts in two rows on the back. The first 5 pairs of warts are blue, the last 6 red.
Life cycle: One generation per year. Moths fly from July to August. Females cannot fly; they wait on the trees for the males and copulation. Eggs are laid onto the tree trunk. Overwinters as egg stage. First caterpillars hatch in mid April and start to feed on the leaves. During the first three larval phases (L1-L3) larvae can be blown long distances by the wind . In the final larval phases considerable foliage consumption occurs, sometimes leading to complete defoliation of the trees. Pupation occurs in a loose net on the tree trunk or in the crown.
Damage, symptoms: Foliage consumption by the caterpillars is not useful in species identification. If the larvae are visible, identification is simple. Major outbreaks occur regularly, at 10-11 year intervals and last for 2-3 years. The species can cause heavy defoliation, although the trees can re-sprout after complete defoliation ('Johannistrieb').
Control: Males can be captured (and monitored) using pheromones or light traps. Damage estimation is made based on the number (and quality) of egg masses. Earlier, egg masses were treated with various oils to kill the eggs on the tree. Nowadays, insecticides and virus preparations are in use against this species. Different countries have different regulations for the use of insecticides against gypsy moth (e.g. *Bacillus thuringiensis* preparations).
Reporting time: 30th June (II.).
Life cycle and damage period:



Euproctis chrysorrhoea – Goldafter
(Code: EUPRCHR)

(Photo: Gy. Csóka)

(Photo: F. Lakatos)

Euproctis chrysorrhoea caterpillar, nest

Hosts: Oak species, especially *Q. robur*. Caterpillars can feed on hardwood forests trees and may also attack fruit and ornamental trees too.
Distribution: Europe, but the species have been introduced to North America.
Morphology: The moth wingspan is 20-35 mm; wings are white with scattered, small black spots on the first pair. Abdomen is thick, with dense hairs. The terminal part of the female's abdomen has dense gold colored hairs. The caterpillar is brownish, with one red stripe between two white ones on the back. The 9th and 10th segments carry red warts.
Life cycle: One generation per year. Moths fly during summer (July), especially the males. Females fly more rarely. Eggs are laid onto the lower surface of the leaves in groups and covered with the hairs from the female abdomen. Caterpillars hatch by August and skeletonize the leaves. Later a nest is constructed at the end of the branches, where overwintering occurs. After budburst the caterpillars continue leaf consumption. During the last larval stage the caterpillars are solitary and feed during both day and night.
Damage, symptoms: Larvae feed in the crown, and construct a nest for overwintering , usually at the tips of the branches. These nests are easily visible from large distances (e.g. during wintertime). Populations fluctuate, with episodic major outbreaks occur in, which can last for several years.
Control: Moths can be monitored using light traps. Mechanical protection (removal of larval nests) is difficult because of the height of the trees. Insecticides and biopreparations (e.g. *Bacillus thuringiensis*) can be uses for protection.
Reporting time: 30th December (IV.).

Life cycle and damage period:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
L												
P												
I												
E												
L												

Thaumatopoea processionea – Oak processionary moth
(Code: THAUPRO)

(Photo: Gy. Csóka)

(Photo: F. Lakatos)

Thaumatopoea processionea caterpillars, nest

Hosts: Various oak tree species (*Quercus* spp.).
Distribution: Naturall in Central and Southern Europe; now spreading northwards. The species prefer warm and dry oak stands.
Morphology: The wingspan is 23-30 mm. The first pair of wings is grey with some dark lines, the second pair is white. The caterpillar has dense hairs. These hairs are irritative and can cause dermatitis.
Life cycle: One generation per year. Overwintering in egg stage. Caterpillars hatch at the time of budburst and feed in groups in loose silk nests. After the 3rd larval stage, a large nest is constructed close to the base on the tree trunk. The caterpillars ‘process’ from the nest to the crown on a daily basis for feeding (processionary). Pupation occurs in the nest, and takes 20-40 days.

After emergence the moths copulate and lay eggs on small branches in the crown.

Damage, symptoms: Feeds on oak leaves. However, leaf consumption of the caterpillars is rarely significant. Much more important is the effect of the hairs, which is similar to the problem caused by the pine processionary moth (PPM). As with the PPM, the OPM forms large nets, but on the lower 2 m of the trunk, rather than at branch tips (PPM).

Control: Nests can be removed from the trunk mechanically (dense protection clothing is required!). General and specific insecticides can be applied against the caterpillars.

Reporting time: 30th June (II.).

Life cycle and damage period:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
E												
L												
P												
I												
E												

Attelabus nitens – Oak leaf roller

(Code: ATTENIT)

(Photos: M. Zubrik)

Attelabus nitens beetle, leaf rolls

Hosts: Mainly oaks (*Quercus* spp.), but rolled leaves can be also be found on chestnut, alder and nut.

Distribution: Throughout Europe. Widely distributed in Southeast Europe.

Morphology: The beetle is 4-6 mm in length. The body is black, but the elytra and the pronotum red.

Life cycle: One generation per year. Overwinters as larvae in rolled leaves, usually in the litter. After a short pupation period in spring, the beetles emerge and begin leaf rolling. The rolls are ideal places for egg laying and larval development, giving good protection.
Damage, symptoms: Rolls parts of oak leaves to lay eggs. Leaf rolls are visible from a distance.
Control: Damage rarely attains levels requiring intervention.
Reporting time: 30th September (III.).
Life cycle and damage period:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
L												
P												
I												
E												
L												

***Scolytus intricatus* – Oak bark beetle**
(Code: SCOLINT)


(Photo: M. Zubrik)
Scolytus intricatus beetle,


(Photo: F. Lakatos)
galleries

Hosts: Oaks, rarely other broadleaved tree species (e.g. beech).
Distribution: Middle and Southeast Europe present in oak forests.

Morphology: The beetle is 2-4mm in length. Pronotum is black, elytra brown. Larva is a typical weevil larva: curved without legs.
Life cycle: Usually one generation per year, sometimes two. Overwinters in the larval stage. Short pupation in spring. Maturation feeding occurs on young shoots in the crown (this process may vector pathogens, e.g of oak

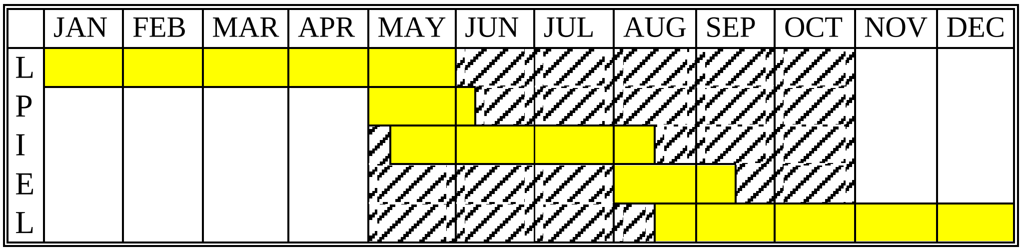
decline, although this is uncertain). Females construct maternal gallery and lay eggs (max. 20) on each side of the gallery.

<u>Damage, symptom:</u> Beetles develop under the bark. The single maternal gallery is short (1-3 cm long) and horizontal. Larval galleries are longer (10-15 cm) and parallel to the fibres.

<u>Control:</u> Pheromones are known, but are not very effective in practical control. The removal of attacked trees helps to reduce the population density.

<u>Reporting time:</u> 30th September (III.).

<u>Life cycle and damage period:</u>



Microsphaera alphitoides - Oak powdery mildew
(Code: MICRALP)

Microsphaera alphitoides (oak powdery mildew)

Oak powdery mildew: *cleistothecia*

(Photos: S. Mirtchev)

Hosts: *Quercus* spp.
Distribution: *M. alphitoides* is the most widespread and frequent disease in oak forests (and nurseries) in Europe.
Life cycle: Oak powdery mildew overwinters as *cleistothecia* dormant on leaves in the litter. Under warmer conditions, however, the fungus may overwinter as asexual *conidia* or mycelium on living host plants. Both *ascospores* and *conidia* serve as primary inoculum and are dispersed by wind. Spores do not require free water to germinate, only high relative humidity. Conidia are produced frequently during the growing season, and serve as secondary inoculum as growth and reproduction are repeated throughout the vegetation season. Powdery mildew is particularly prevalent on the second and third flushes of leaves that develop in July and August.
Signs and Symptoms: From mid to late spring, infected leaves appear as though dusted with powder, hence the common name "*powdery mildew*". The powdery appearance is the pathogen itself, resulting from a combination of mycelium and asexual spores (*conidia)* growing on the leaf surfaces. Some chlorosis may be seen in tissues beneath the fungus. During late summer and fall, tiny specks, first orange and later black, can be seen throughout the powdery material. These structures are the sexual fruiting

bodies – *cleistothecia* of the fungus. Occasionally, symptoms such as discoloration, dwarfing, or distortion may be seen on heavily infected leaves, especially those infected early in the vegetation season. Major hosts are *Q. robur* and *Q. petraea*, particulary on young trees. On mature trees, the disease is generally less damaging, but in combination with other factors (drought, defoliation by insects, *Phytophthora* root infections) powdery mildew can contribute to oak decline.

Control: Sulphur-based fungicides registered for the control of oak mildew had a relatively good and stable effectiveness. Because of the desire to reduce chemical applications, and the possibility of the pathogens building resistance to fungicides, biological control is becoming increasingly important.

Reporting time: 30th June (II.), 30th September (III.).

***Daedalea quercina* - Oak mazegill**
(Code: DAEDQUE)

Daedalea quercina – a fruit body

(Photos: S. Mirtchey)

The Underside characteristic - maze-like appearance

Hosts: *Quercus* spp..

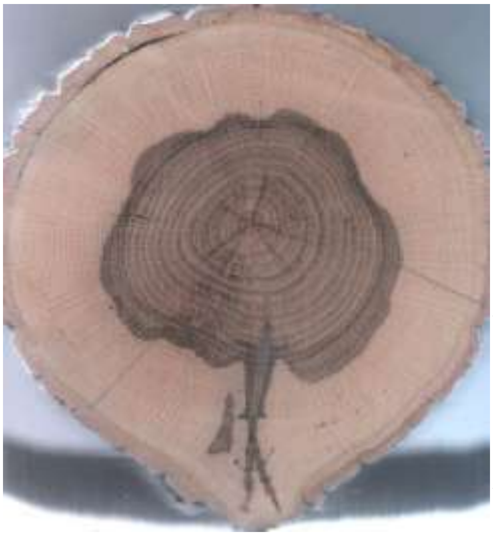
Distribution: common in oak forests of Europe.

Life cycle: Parasitic on oak trees, saprotrophic on dead/fallen trunks. Present all year round; *basidiospores* shed in late spring and summer.

It is important to note that stem decay increases with stand age. Obviously heartwood decay is completely natural process and as longer a tree lives, the more likely it is to become infected (e.g. more infection and heartwood in older trees; wounds clsoe more slowly in older trees).
Signs and Symptoms: The sessile, fan-shaped fruiting bodies are typically 3–20 centimeters in diameter and up to 8 centimeters thick and occur as solitary carpophores or in tiered groups, usually on decaying oak. The upper surface of the cap may be various shades of brown, and is sometimes zonate. The under surface, white to tan in color, is initially porous, but as the fruit body matures, some of pore walls break down, forming slits with blunt partitions. This results in the characteristic maze-like (daedaloid or labyrinthine/labyrinthiform) appearance. Decay is initiated in both live and dying sapwood and spreads into dead heartwood. *D. quercina* causes brown rot.
Control: It is very difficult to manage heartrot, but protecting trees from wounding injury can minimize the probability of serious damage. Reporting time: 30th June (II.), 30th September (III.).

Inonotus nidus-pici - Inonotus canker
(Code: INONNID)

Inonotus nidus-pici - a fruiting body,



The fungus causes a brown heart rot and enters the tree mainly from a frost crack

(Photos: S. Mirtchev)

Hosts: Common Turkey oak (*Quercus cerris* L.); occasional on other broad-leaved species.
Distribution: *Q. cerris* L. is a submediterranean-mediteranean species, growing in areas with warm climate and long vegetation season.

Life cycle: This fungus usually enters the tree through bark wounds, mainly via frost cracks. It causes tree bark damage visible as vertical fractures on the southerly surfaces of tree trunks. In winter when the sun sets or the sky clouds over, the temperature of the tree drops very quickly; the bark cools more quickly than the wood and the differential contraction results inlong tears in the bark rips. Frost crack is distinct from sun scald and sun crack.
Symptoms**:** The genus *Inonotus* contains over 100 species which are parasitic/saprophytic mainly on broadleaved trees around the world. Most produce an annual fruiting body. All cause decay of heartwood in broadleaved trees. *Inonotus nidus-pici* produces a wart-like reddish/brown fruiting body often around a decay hole in the trunk or branch of the tree. It is a brown-rot wood-decay fungus.
Control: The main way of avoiding damage by this fungus is to avoid wounding the bark of trees. Once infected it is only a matter of time the heartwood becomes damaged by the resulting wet rot.
Reporting time: 30th June, 30th September.

7.2.3. Pests and pathogens on Beech (*Fagus* spp.)

***Phyllaphis fagi* – Wooly beech aphid**
(Code: PHYLFAG)


(Photo: F. Lakatos)
Phyllaphis fagi aphids

(Photo: M. Zubrik)
Phyllaphis fagi aphids

Hosts: Beech (*Fagus* spp.)
Distribution: Central and Southern Europe. The species was also introduced to North America.

Morphology: Based on the insects themselves it is very hard to identify the species. There are several very similar species and various developmental stages. The wooly aphid excretions are typical for the species, and is a useful feature for the identification of the species.
Life cycle: Complex development with various life stages and morphologies.
Damage, symptoms: Aphids are found on the lower surface of the leaves of beech trees from where they suck phloem sap. The wooly coverage and the host tree species are typical for the insect. In heavy infestations leaves can become yellow and abscise.
Control: No effective methods available. Because of the low economic importance of the species usually not necessary.
Reporting time: 30th September (III.).

Orchestes fagi – Beech flea weevil
(Code: ORCHFAG)

(Photo: L. Borowiec)

(Photos: F. Lakatos)

Orchestes fagi beetle, damages

Hosts: Main host is beech (*Fagus* spp.), but mines can be found on hornbeam, birch, willow and many other broadleaved tree species.
Distribution: In Europe very common wherever beech is grown.
Morphology: The beetle is 2-2.5 mm in length, black, but covered in greyish hairs making it appear lighter. Antenna and the legs are light brown. Larva is typical of weevils: curved without legs.
Life cycle: One generation per year. Overwinters as adult in the leaf litter, soil or under the bark and other shelter. Main swarming period is mid April – mid May. During this period the beetles feed on the buds and shoots, making holes on young leaves. Eggs are laid on the lower surface of the leaves, one by one. Hatching larvae enter the leaf and construct mines towards the leaf-

tip . Pupation also in the leaves. First adults of the next generation appear in June. Beetles of the new generation may skeletonize the leaves.
Damage, symptoms: Both the beetle and the larvae feed on the leaves of beech. There are two different symptoms. A) Larvae are constructing uneven-shaped mines in the leaves; B) beetles may skeletonize the leaves or make puncture holes. Heavy infestation can cause reductions in tree growth and a lack of natural regeneration.
Control: To date, no insecticide applications have been made.However, in recent years, damage caused by this species has increased.
Reporting time: 30th September (III.).
Life cycle and damage period:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
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E												
L												
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Ganoderma applanatum - Artist's conk
(Code: GANOAPP)

Ganoderma applanatum - a fruit body

The underside has small tubes

(Photos: S. Mirtchev)

Hosts: A common cause of decay (white rot) and death, particularly of old oak and beech, but also on conifers.
Distribution: *G. applanatum* is found throughout Europe and is common in central and northern Europe.
Life cycle: Infections in living trees are initiated through wounds. Fruit body is present all year round; shedding *basidiospores* from late spring to late fall. The fungus can spread between trees through natural root grafting. As a

wood-decay species, *G. applanatum* primarily attacks dead heartwood, but can also affect live sapwood, particularly on older or low vigour trees. The artist's conk is a common cause of decay and death of beech, oak and poplar. Stem decay increases with stand age. Wood decay is usually a problem on old, large trees. Obviously, the older a tree, the more likely it is to become infected.

Signs and Symptoms: The fruiting bodies are semicircular conks, with a brown upper surface and white lower surface. Stalks are absent. Conks usually occur near ground level, but columns of decaying wood can extend long distances above and below the conk. A common sight where trees fall and are not harvested, this large bracket fungus occasionally forms large, tiered groups at the base of trees.

The small round pores are white when the fruiting body is young, turning brown with age. When the underside surface is rubbed or scratched with a sharp implement, causes a dark brown on the pore surface, producing visible lines and shading, hence the name artist's conk. The incipient stage of decay is indicated by a bleached appearance of the wood, surrounded by a dark brown stain. In advanced stages, the bleached wood becomes white, mottled, and spongy. Black zone lines are sometimes present in the decayed wood.

Control: Minimize injuries to trees. Otherwise, it is extremely difficult to prevent decay from occurring in older trees.

Reporting time: 30th June (II.), 30th September (III.).

7.2.4. Pest and pathogens on Chestnut (*Castanea* spp.)

Curculio spp. (e.g. _C. glandium, C. elephas_) – Acorn weevils

(Code: CURCSPP)

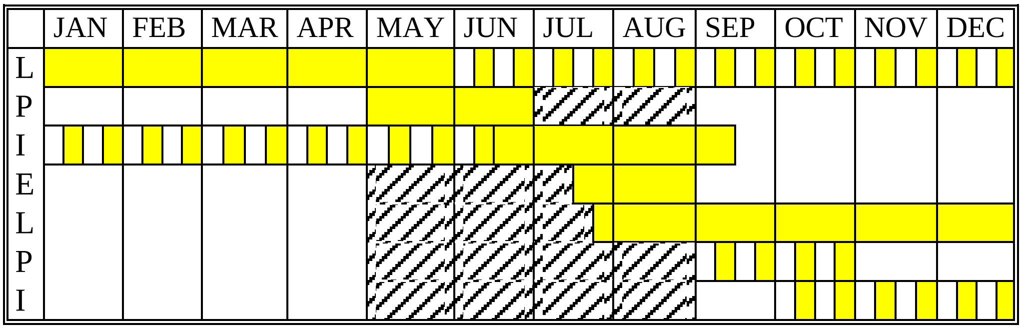
(Photos: Gy. Csóka)

Curculio spp. beetle, larva

Hosts: Main hosts are oaks and chestnut, but larvae can also feed on beech and hazelnut.

Distribution: Eurasia, except the most northern regions. Common in oak and chestnut stands in Southeast Europe.

Morphology: The beetle is 4-8 mm in length, brown. Identification of different species requires specialist knowledge. Rostrum very long, longer in females than males. Larva is a typical weevil larva: curved without legs.
Life cycle: One generation per year. Overwintering in larval stage in leaf litter, but also possible in imago stage. Pupation, sometimes for several years, also in leaf litter. Emerging beetles feed initially on leaves. After copulation, females construct an egg hole in the acorns, where the eggs are laid. Larvae (up to 5/acorn) feed inside the acorn.
Damage, symptoms: Larva feed on acorns, chestnuts and hazelnut. Symptom similar to chestnut tortrix, but the larvae differ (weevil: curved without legs; tortrix: reddish caterpillar with several legs). The exit hole is ‘o’ shaped.
Control: If acorn production is the main aim of a stand (e.g. reproduction), insecticide application may be necessary. In natural stands any kind of protection is complicated and not recommended.
Reporting time: 30th September (III.).
Life cycle and damage period:



Cydia spp. (e.g. *C. splendana, C. amplana*) – Acorn/Chestnut tortrix
(Code: CYDISPP)


Cydia splendana larva,


Cydia amplana larva

(Photos: Gy. Csóka)

Hosts: Oak and beech, but also chestnut, nut and walnut.
Distribution: In Southeast Europe, present where the host trees are grown.
Morphology: Adult moth wingspan is 16-19 mm. The first pair of wings are light gray to graywhile hindwings are dark grayish brown. The caterpillar is reddish-white with several legs (⇔ acorn weevil). The head is light brown.
Life cycle: One generation per year. Overwinters in the leaf litter as larva. Pupation in spring. After moth emergence, eggs are laid in acorns, nuts and walnuts in the middle of summer (July).
Damage, symptoms: Caterpillar feeds on acorns, chestnuts and walnuts. Exit holes are an elongated 'o' shape (⇔ acorn weevil). Caterpillars form light silk nests.
Control: As for the acorn weevil.
Reporting time: 30th September (III.).
Life cycle and damage period:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
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P												
I												
E												
L												

Cryptonectria parasitica - Chestnut blight
(Code: CRYPPAR)

Cryptonectria parasitica - a diffuse girdling canker

Orange pycnidia on chestnut tree bark

(Photos: L. Haugen)

Hosts: Sweet chestnut (*Castanea sativa, C. dentata*), but may also attack oaks (*Quercus* spp.).
Distribution: Chestnut blight was introduced into North America from the Far East at the end of the nineteenth century. The pathogen was first discovered in Europe in 1938 and spread very rapidly from initial establishment regions to almost all European countries where *Castanea sativa* is grown.
Life cycle: The fungus enters the host through wounds in the bark. Germ tubes entering these wounds arise from both *conidia* and *ascospores*. The fungus penetrates the inner bark and kills the vascular cambium. The outer bark over the diseased tissue swells and eventually begins to split. Orange *pycnidia* are formed from the fungal tissue. Single-celled conidia are exuded from the *pycnidia* in long cirrhi, held together by a gelatinous matrix. The *conidia* are dispersed passively by rainsplash, or actively by insects, birds and other animals. After *pycnidia* are produced, clusters of black *perithecia* form in the same fungal tissues. These *perithecia* are embedded in a *stroma* and have long necks that extend to the bark surface. Bicellular ascospores are forcibly discharged and carried by the wind to new hosts.

Signs and Symptoms: The first noticeable symptom is usually a "*flag*", a dead branch with yellow or brown wilted leaves. A diffuse girdling canker can usually be found on the branch below the discoloured foliage. Water sprouts (epicormic shoots) frequently develop just below the canker.

On young, smooth-barked branches, blight-infected patches are bright brown, in contrast to the olive-green colour of normal bark. On older stem infections, the discoloration is less obvious. When the cambium is killed rapidly a sunken area results, but where disease progress is slower new layers of bark form under the affected areas and there is some swelling and subsequent cracking of the outer bark. Masses of yellow-orange to reddish-brown pustules, the size of pin-heads, develop on infected bark and exude long orange-yellow tendrils of spores in moist weather. Characteristic pale-brown mycelial fans form in the inner bark and may be exposed by cutting away the outer bark.

Control: Development of disease-resistant varieties is and has been the major control effort for chestnut canker. Considerable progress has been made in the USA towards breeding disease-resistant hybrid chestnuts by making use of the more resistant Asian species.

To date, however, many of the resistant varieties have not shown the desired growth characteristics of the chestnut. Natural development of resistant trees is hindered by the fact that sprout trees are often killed before reaching sexual maturity, thus limiting genetic variation. The use of hypovirulent strains (containing mycoviruses) offers some prospect for control. The application of a hypovirulent strain around developing lesions may enable these lesions to recover and can convert the virulent strain into a hypovirulent strain as potential control measures for high value trees. The North Americans believe they do have hybrids with characteristics that will enable the trees to replace the lost American chestnut.

Reporting time: 30th June (II.), 30th September (III.).

8. Damage tables or pests

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POLYPHAGOUS ON CONIFERS												
Hylobius abietis			X	X	X	X	X	X	X			
Ips amitinus					X	X	X	X	X			
Trypodendron lineatum			X	X	X	X	X	X	X			
Fomitopsis pinicola			X	X	X	X	X	X	X			
Heterobasidion annosum	X	X	X	X	X	X	X	X	X	X	X	X
PINE (Pinus spp.)												
Acantholyda spp.						X	X	X	X			
Neodiprion sertifer				X	X	X						
Diprion pini					X	X	X	X	X			
Thaumetopoea pityocampa	X	X	X	X					X	X	X	X
Rhyacionia buoliana				X	X	X						
Monochamus spp.	X	X	X	X	X	X	X	X	X	X	X	X
Pissodes spp.			X	X	X	X	X	X				
Tomicus piniperda			X	X	X	X	X	X	X			
Ips sexdentatus				X	X	X	X	X	X			
Lophodermium spp.	X	X	X	X	X				X	X	X	X
Sphaeropsis sapinea				X	X	X	X	X	X			
Gremmeniella abietina				X	X	X	X	X	X			
Cenangium ferruginosum				X	X	X	X	X	X			
Melampsora pinitorqua				X	X	X	X					
Cronartium ribicola				X	X	X	X	X	X			
Cronartium flaccidum				X	X	X	X	X	X			
SPRUCE (*Picea* spp.)												
Cephalcia abietis						X	X					
Pristiphora abietina					X	X	X					
Tetropium castaneum	X	X	X	X	X	X	X	X	X	X	X	X
Pityogenes chalcographus				X	X	X	X	X	X	X		
Ips typographus				X	X	X	X	X	X			
FIR (*Abies* spp.)												
Dreyfusia nordmannianae			X	X	X	X						
Pityokteines spp.				X	X	X	X	X	X			
Melampsorella caryophyllacearum				X	X	X	X	X	X			

POLYPHAGOUS ON BROADLEAVES												
Erannis defoliaria			///	///	///	///	///					
Operophtera brumata			///	///	///	///						
Hyphantria cunea					///	///	///	///	///	///		
Agrilus viridis	///	///	///	///	///	///	///	///	///	///	///	///
Viscum album	///	///	///	///	///	///	///	///	///	///	///	///
Loranthus europaeus	///	///	///	///	///	///	///	///	///	///	///	///
Nectria cinnabarina				///	///	///	///	///	///			
Laetiporus sulphureus					///	///	///	///	///			
Pleurotus ostreatus					///	///	///	///	///			
Armillaria mellea									///	///		
OAKS (*Quercus* spp.)												
Tortrix viridana				///	///	///						
Lymantria dispar				///	///	///	///					
Euproctis chrysorrhoea				///	///	///		///	///			
Thaumatopoea processionea				///	///	///	///					
Attelabus nitens					///	///	///	///				
Scolytus intricatus					///	///	///	///	///	///		
Microsphaera and *Phyllactinia spp.*					///	///	///	///	///	///	///	
Daedalea quercina	///	///	///	///	///	///	///	///	///	///	///	///
BEECH (*Fagus* spp.)												
Phyllaphis fagi				///	///	///	///	///	///			
Orchestes fagi				///	///	///	///	///				
Fomes fomentarius	///	///	///	///	///	///	///	///	///	///	///	///
Ganoderma applanatum	///	///	///	///	///	///	///	///	///	///	///	///
CHESTNUT (*Castanea* spp.)												
Curculio spp.					///	///	///	///				
Cydia splendana					///	///	///	///	///			
Cryptonectria parasitica	///	///	///	///	///	///	///	///	///	///	///	///

9. Reporting periods

	I. 30th March	II. 30th June	III. 30th September	IV. 31st December
POLYPHAGOUS ON CONIFERS				
Hylobius abietis			X	
Ips amitinus			X	
Trypodendron lineatum			X	
Fomitopsis pinicola		X	X	
Heterobasidion annosum		X	X	
PINE (*Pinus* spp.)				
Acantholyda spp.			X	
Neodiprion sertifer		X		
Diprion pini			X	
Thaumetopoea pityocampa				X
Rhyacionia buoliana		X		
Monochamus spp.			X	
Pissodes spp.			X	
Tomicus piniperda			X	
Ips sexdentatus			X	
Lophodermium spp.		X	X	
Sphaeropsis sapinea		X	X	
Gremmeniella abietina		X	X	
Cenangium ferruginosum		X	X	
Melampsora pinitorqua		X	X	
Cronartium ribicola		X	X	
Cronartium flaccidum		X	X	
SPRUCE (*Picea* spp.)				
Cephalcia abietis			X	
Pristiphora abietina		X		
Tetropium castaneum			X	
Pityogenes chalcographus		X		X
Ips typographus		X		X
FIR (*Abies* spp.)				
Dreyfusia nordmannianae		X		
Pityokteines spp.		X		
Melampsorella caryophyllacearum		X	X	
POLYPHAGOUS ON BROADLEAVED TREE SPECIES				
Erannis defoliaria		X		
Operophtera brumata		X		
Hyphantria cunea		X		
Agrilus viridis		X		
Viscum album		X	X	
Loranthus europaeus		X	X	
Nectria ditissima		X	X	
Fomes fomentarius		X	X	
Laetiporus sulphureus		X	X	
Pleurotus ostreatus		X	X	
Armillaria mellea		X	X	

OAKS (*Quercus* spp.)				
Tortrix viridana		X		
Lymantria dispar		X		
Euproctis chrysorrhoea				X
Thaumatopoea processionea		X		
Attelabus nitens			X	
Scolytus intricatus			X	
Microsphaera and *Phyllactinia spp.*		X	X	
Daedalea quercina		X	X	
Inonotus nidus-pici		X	X	
BEECH (*Fagus* spp.)				
Phyllaphis fagi			X	
Orchestes fagi			X	
Ganoderma applanatum				
CHESTNUT (Castanea spp.)				
Curculio spp.			X	
Cydia splendana			X	
Cryptonectria parasitica		**X**	**X**	

10. Glossary

A

abdomen – the hind-most part of the insect body; contains the insect's digestive tract and reproductive organs.

acervulus – mat of hyphae, generally associated with a host, forming erumpent lesions with short, densely packed conidiophores.

aecium – cuplike asexual fruiting structure of the rust fungi.

antenna – insect sensory organs on the fore-most segment of the insect head.

apothecium – open, cuplike ascocarp of Ascomycota.

ascocarp – sexual fruiting body of the Ascomycota containing one or more asci.

ascospore – sexual spore produced in an ascus.

ascus – sac-like structure containing ascospores formed as a result of karyogamy and meiosis.

autoecious – completing the entire life cycle on one host; generally applied to certain rust fungi.

B

basidiocarp – sexual fruiting body of the Basidiomycota containing basidia.

basidiospore – spore produced on a basidium.

basidium – generally club-shaped structure on which basidiospores are produced as a result of karyogamy and meiosis.
blight – rapid killing of foliage, blossoms, and twigs.
blotch – large, irregular lesions on leaves, shoots, and stems.

C

callus – growth of plant tissues at the margins of wounds and diseased tissues.
canker – necrotic, often sunken lesion in the cortical tissues of stems and roots.
chlamydospore – thick-walled asexual resting spore, formed from a vegetative cell.
chlorosis – chlorophyll degradation (or failure to form) in normally green tissues.
clamp connection – bridgelike hyphal connection between cells, characteristic of Basidiomycota.
cleistothecium – closed ascocarp.
compound eye – eye made up of an aggregation of separate visual elements, known as ommatidia, each of which corresponds to a single facet of the cornea.
conidiophore – specialized hyphal branch on which conidia are produced.
conidium (pl. conidia) – asexual spore formed on a conidiophore.
coxa – the basal segment of the insect leg.

D

decay – disintegration of dead tissues through the action of microorganisms.
diagnosis – identification of disease from its symptoms and signs.
dieback – progressive death of twigs and branches from the shoot tips toward the trunk.
disease – any deviation from the normal state of an organism that impairs its vital functions, developing in response to an infection, genetic defects or to an unfavorable environmental factor.

F

femur – the 3rd (counting out from the body) and often the largest segment of the insect leg.
flagellum – the distal (furthest away from the body) part of the antenna, the 3rd primary segment of the antenna.
fungicide – substance that kills fungi.

fungus – achlorophyllous, spore-bearing eukaryote with a walled thallus and absorptive nutrition .

G

gall – swelling or outgrowth on a plant, caused by a pathogen.

gill – lamellate structure on the underside of a mushroom cap.

H

haustorium – absorbing organ of a fungus which penetrates a host cell wall, without penetrating the plasma membrane.

heteroecious – requiring two unrelated hosts to complete the life cycle; generally applied to rust fungi.

hypha – tubular, branching filament of the fungal thallus.

hypovirulent – condition of suppressed virulence of a pathogenic strain.

I

incubation – period between inoculation and appearance of visible symptoms.

infection – establishment of a food relationship between a parasite and a host. Usually applied to pathogens.

infestation – condition in which a parasitic organism establishes in abundance to feed in or on a host plant, usually causing growth reductions.

inoculate – artificially apply a pathogen to a suitable point of entry on the host.

inoculum – any part of a pathogen capable of growing and causing infection.

intolerance – a characteristic of certain tree species that does not permit them to survive in the shade of other trees.

introduced species – a non-native species that was intentionally or unintentionally brought into an area by humans.

L

labium – the mouthparts, or appendage on the sixth head segment of an insect, forming a 'lower lip'.

labrum – the 'upper lip' of the insect mouth-parts: not a true appendage, but a movable sclerite on the front of the head.

lesion – usually a local, well-defined, diseased area.

M

macroconidium – large conidium of fungi which have conidia of two distinct sizes

mandibles – the jaw of an insect. It may be sharply toothed and used for biting, as in grasshoppers and wasps, or it may be drawn out to form a slender needle as in mosquitoes.

maxilla – one of the two components of the insect mouth-parts lying just behind the jaws. Assists with the detection and manipulation of food and often drawn out into tubular structures for sucking up liquids.

mesothorax – the 2nd segment of the thorax.

metathorax – the 3rd and last segment of the thorax.

microconidium – small conidium of fungi which have conidia of two distinct sizes.

mildew – cobwebby or powdery superficial growth, usually on foliage and young shoots.

mushroom – **(=toadstool)** umbrella-shaped fruiting structure of many Basidiomycota in the class Hymenomycetes.

mycelium – a mass of fungal threads or hyphae.

mycorrhiza – structure resulting from a mutualistic relationship between fungal mycelia and the roots of trees and other higher plants.

N

necrosis – death.

O

obligate – generally refers to parasites which must grow on or in living cells.

ocelli – see simple eye.

oospore – sexual resting spore resulting from the union of unlike gametes.

ooze – viscid mass made up of plant juices and often pathogen cells.

ostiole – a pore through which spores are released, generally associated with perithecia, pycnia, and pycnidia.

P

parasite – an organism that lives on or in another organism.

pathogen – any factor or agent capable of causing disease.

perithecium – characteristically flask-shaped, ascus-containing fruiting body with an ostiole and a wall of its own.

predisposition – environmental modification of resistance barriers making plants more susceptible to pests or pathogens.

propagule – an organism or part of an organism capable of generating a new organism.

prophylaxis – preventative treatment.

prothorax – the 1st or anterior thoracic segment of an insect.

pseudothecium – fruiting body bearing asci in locules within a stroma.

pycnidium – asexual, hollow fruiting body containing conidia.

pycniospore – spore borne in pycnia of the rusts which acts as a male

gamete, fusing with receptive hypha.
pycnium – fruiting structure of rust fungi in which hyphae and pycniospores are produced receptive .

R
rhizomorph – cordlike strand of fungal hyphae.
rosetting – crowded condition of foliage due to lack of internode elongation.
rot – a tree defect characterized by woody decay in a standing tree or log. **S**
saprophyte – (saprotroph) an organism that lives on dead organic matter.
scab – roughened, crust-like lesion.
scald – blanching of the epidermis and adjacent tissues.
sclerotium – hard, compact, resting body composed of aggregated fungal hyphae.
scorch – browning of leaf margins from death of tissues.
shot-hole – circular holes in leaves occurring when the central necrotic areas of spots falls out.
simple eye (ocelli) – one of the simple eyes of insects, usually occurring in a group of three on the top of the head, although one or more may be absent from many insects.
sporangiospore – asexual spore borne within a sporangium.
sporangium – enlarged tip of specialized hyphal branch in which sporangiospores are produced.
spore – general name for a single to several celled propagule in the fungi **sporodochium** – cushion-shaped stroma covered with conidiophores
stipe – stem of a mushroom.
stocking – the number and density of trees in a forest stand. Stands may be classified as understocked, well-stocked or overstocked.
stratification – division of a forest, or any ecosystem, into separate layers of vegetation that provide distinct niches for wildlife.
stroma – compact mass of fungal hyphae on or within which fruiting structures are formed.
symbiosis – a living together of two unrelated species(mutualism).
symptom – any condition in a host that indicated the presence of disease.

T
tarsi (singulat tarsus) – a single segment beyond the tibia, but usually consisting of several subdivisions or segments in most living insects.
teliospore (=teleutospore) – in the rusts, the spore in which karyogamy and meiosis occur.
telium (=teleutosorus) – sorus containing teliospores.
thallus – vegetative growth phase of a fungus.

therapy – treatment of disease by application of chemicals or heat to eliminate the pathogen or application of elements to cure deficiency diseases.
thorax – the middle of the three major divisions of the insect body. The legs and wings (if present) are always attached to the thorax.
tibia – the forth leg segment between the femur and the tarsus of insects.
tolerance – the capacity of tree species' capacity to grow in shade or to be infected without loss in vigour.
trochanter – the second segment of the insect leg, between coxa and femur: often very small and easily overlooked.
tumefaction – tumorlike or gall-like overgrowth of tissue.

W
windthrow – a tree blown down by wind. Windthrows, also known as blowdowns, are common with shallow-rooted species and in areas where cutting has reduced stand density.

11. Reporting table (sample)

Important Notice: Not valid if not completed in full (including date and signature)

A

Name and code (if there are any) of the personnel			**E-mail:**	
Name and code of the forest owner			**Quarter**	
			Telefon: +381	

Line	Locality, compartement, ...			Tree species	Damage						Protection		Sign	Others
					Damage Code	Affected area (ha)	Frequency (%)	Intensity (%)	Affected wood mass (m^3)	Observation date (day/month)	Method	Effect		
1		12	C	B	11	20	30	60	-	30/5	-			
2														
3														
4														
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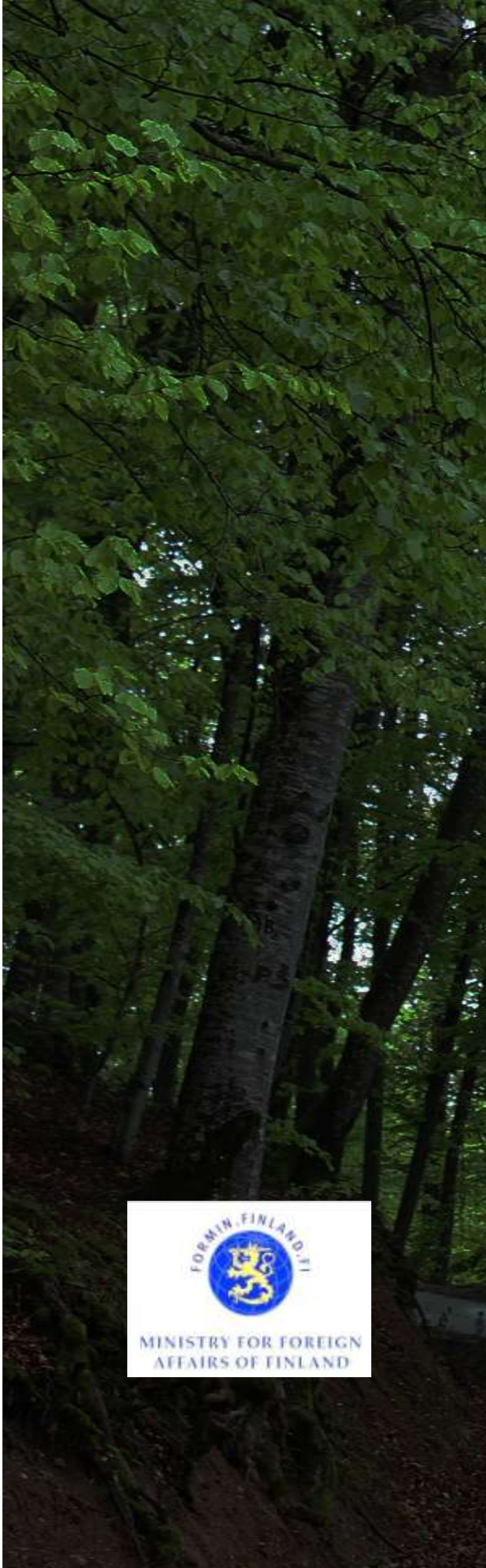

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