Damage to reproductive structures of broadleaf woody plants. Chapter 7

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7
Damage to reproductive structures of broadleaf woody plants

A. Roques, V. Talgø, J.-T. Fan and M.-A. Auger-Rozenberg

7.1. Flower (blossom, catkin, flower-head) galling

Description: Flower (catkin) distorted, swollen, or with tissue outgrowth(s) of any shape.
Possible damaging agents: Insects: Diptera (Cecidomyiidae midges: Figs. 7.1.5, 7.1.6), Hymenoptera (Cynipidae: Figs. 7.1.3., 7.1.4.), **Mites** (Acari, Eriophyiidae: Figs. 7.1.1., 7.1.2., 7.1.6.), **Fungi** (Ascomycetes, Taphrinales: Figs. 7.1.7., 7.1.8.), **Bacteria, Phytoplasma**.

Fig. 7.1.1. Newly-developed inflorescence of ash (*Fraxinus excelsior*), galled by a mite (Acari, Eriophyiidae: *Aceria fraxinivora*). Marcillac, France, AR.

Fig. 7.1.2. Cauliflower-like gall finally resulting from mite damage shown in Fig. 7.1.1. Hungary, GC.

Fig. 7.1.3. Berry-like gall on a male catkin of oak (*Quercus* sp.) caused by a gall wasp (Hymenoptera, Cynipidae: *Neuroterus quercusbaccarum*). Hungary, GC.

Fig. 7.1.4. Male catkin of *Quercus myrtifoliae,* deformed by a gall wasp (Hymenoptera, Cynipidae: *Callirhytis myrtifoliae*). Florida, USA, GC.

Fig. 7.1.5. Inflorescence of birch (*Betula* sp.) deformed by a gall midge (Diptera, Cecidomyiidae: *Semudobia betulae*). Hungary, GC.

Fig. 7.1.6. Symmetrically swollen catkin of hazelnut (*Corylus* sp.) caused by a gall midge (Diptera, Cecidomyiidae: *Contarinia coryli*) or a gall mite (Acari Eriophyiidae: *Phyllocoptes coryli*). The damaging agent can only be ascertained by catkin dissection. Germany, HJB.

Fig. 7.1.7. Catkin of poplar (*Populus* sp.) deformed by a fungus (Ascomycota, Taphrinales: *Taphrina johansonii*). Hungary, GC.

Fig. 7.1.8. Tongue-like gall on female catkin of alder (*Alnus glutinosa*) induced by a fungus (Ascomycota, Taphrinales: *Taphrina alni*). Germany, HJB.

Additional information: Dissect the gall to check for the presence of insect larva(e) or minute mites. If insects and mites are absent without visible exit holes, check for fungi, bacteria or phytoplasmas. For insect sampling and preservation, see Chapter 3 and for fungal preservation, see Chapter 4.

7.2. Bacterial blight

Description: Tissue infected by bacteria will have a dark (blackish) appearance. Under humid conditions, droplets of bacterial exudates may occur.
Possible damaging agents: Bacteria (Enterobacteriaceae: *Erwinia*).

Fig. 7.2.1. Flowers and fruits of *Cotoneaster bullatus*, with fire blight due to a bacterium (Bacteria, Enterobacteriaceae: *Erwinia amylovora*). Hordaland county, Norway, AS.

Fig. 7.2.2. Young fruits of *Malus* sp., infected by fire blight due to a bacterium (Bacteria, Enterobacteriaceae*: Erwinia amylovora*). Slovakia, JM.

Additional information: Bacteria attacking reproductive structures are often transferred by pollinating insects and may lead to blossom blight, fruit rot and proceed to shoots.

7.3. Internal feeding by larva

Description: Flower remaining closed, with larval tunnels visible when the flower is opened.

Possible damaging agents: Insects: larvae of Coleoptera (Curculionidae (weevils): Figs. 7.3.1, 7.3.2, 7.3.8), Diptera (Anthomyiidae (maggots): Fig. 7.3.3, Cecidomyiidae (midges): Fig. 7.3.6), Hymenoptera (Tenthredinidae (sawflies): Fig. 7.3.4), Lepidoptera (Geometridae: Figs. 7.3.5, 7.3.6., Noctuidae, Tortricidae, Yponomeutidae).

Fig. 7.3.1. *Salix* catkin with brown frass on the top due to damage by a weevil larva (Coleoptera, Curculionidae: *Dorytomus taeniatus*). Cesana Torinese, Italy, AR.

Fig. 7.3.2. The *Salix* catkin shown in 7.3.1 sliced open to show the weevil larva tunnelling the axis (Coleoptera, Curculionidae: *Dorytomus taeniatus*). Cesana Torinese, Italy, AR.

Fig. 7.3.3. *Salix* catkin damaged by a maggot (Diptera, Anthomyiidae: *Egle* sp.), showing woolly fluff expelled by the larva (top) and the emerging maggot larva (bottom). Marcillac, France, AR.

Fig. 7.3.4. Dried tip of a *Salix phylicifolia* catkin, indicating the presence of a catkin-mining sawfly larva (Hymenoptera, Tenthredinidae: *Pontopristia* sp.) inside the catkin stem. Oulu, Finland, TN.

Fig. 7.3.5. Male catkin of walnut (*Juglans regia*) infested internally by moth larvae (Lepidoptera, Geometridae). Marcillac, France, AR.

Fig. 7.3.6. Male catkin of walnut (*Juglans regia*) with emerging unidentified moth larvae (Lepidoptera, Geometridae). Marcillac, France, AR.

Fig. 7.3.7. Flower of *Crataegus* sp. opened to show damage by a midge larva (Diptera, Cecidomyiidae: *Dasineura oxyacanthae*). Copenhagen, Denmark, SH.

Fig. 7.3.8. Flower of *Malus* sp., remaining closed following infestation by a weevil larva (Coleoptera, Curculionidae: *Anthonomus pomorum*), and manually opened to show the larva. Slovakia, JM.

Additional information: Dissect the flower to ascertain the presence of larva(e) or pupa(e). Note larva colour, if it is legless or not, and if it has a visible head or not. For insect preservation, see Chapter 3.

7.4. External feeding

Description: Flower gnawed or with cutout(s) (Figs. 7.4.1, 7.4.2, 7.4.3); fruit fed from exterior (Fig. 7.4.4.).

Possible damaging agents: Insects: Adults of Coleoptera (e.g., Cantharididae, Cetoniidae, Rutelidae, Scarabaeidae: Figs. 7.4.1, 7.4.2, 7.4.4) and Hymenoptera (Tenthredinidae), larvae of Lepidoptera (Fig. 7.4.3).

Fig. 7.4.1. Flower of quince (*Cydonia oblonga*) cut out by unidentified scarab beetles (Coleoptera, Rutelidae). Marcillac, France, AR.

Fig. 7.4.2. Flower of wild rose (*Rosa* sp.) with adult scarab beetles feeding on pollen (Coleoptera, Rutelidae: *Hoplia* sp.). Briançon, France, AR.

Fig. 7.4.3. Flower of quince (*Cydonia oblonga*) damaged by an early-instar moth larva (Lepidoptera, Lasiocampidae: *Malacosoma neusstria*). Marcillac, France, AR.

Fig. 7.4.4. Fruit eaten by adult beetles (Coleoptera, Cetoniidae*: Cetonia* sp.). Slovakia, MZ.

Additional information: Observation by chance or by beating flowering branch over a Japanese umbrella. For insect collection and preservation, see Chapter 3.

7.5. Sucking arthropod damage

Description: Flower completely dried, often shed.
Possible damaging agents: Insects: Adults of Thysanoptera (Thrips: Fig. 7.5.1), nymphs and adults of Hemiptera (Aphididae: Fig. 7.5.2).

Fig. 7.5.1. Catkin of *Betula* sp. covered by a colony of bug nymphs (Hemiptera, Acanthosomatidae: *Elasmucha grisea*). Hungary, GC.

Fig. 7.5.2. Flower bud of wild rose (*Rosa* sp.) covered by an aphid colony (Hemiptera, Aphididae: *Macrosiphum rosae*). Slovakia, MZ.

Additional information: Dissect the flower to look at the presence of minute insects (thrips); check the presence of aphid or bug colonies on the external part of the flower or on the pedicel.

7.6. Abiotic damage

Description: Flower completely dried, often shed; seed empty, without frass and without the remains of embryo.
Possible damaging agents: Late frosts, drought, genetic incompatibility.

Fig. 7.6.1. Flowers of *Sorbus* sp. killed by frost and then colonized by aphids. Rodez, France, AR.

Fig. 7.6.2. Apple flower (*Malus* sp.) with dark brown centre, indicating that it was killed by frost. Michigan, USA, ML.

Additional information: Dissect flowers to ascertain the absence of pests as well as of pest damage (e.g., tunnels and frass).

7.7. Fungal growth on catkins and fruits

Description: Catkins and fruits discoloured, with irregular chlorotic to necrotic spots with blighted margins or larger necrotic (yellowish) blotches.
Possible damaging agents: Fungi: Ascomycota (Figs. 7.7.1 – 7.7.4).

Fig. 7.7.1. *Colletotrichum acutatum* (Ascomycota, Glomerellaceae) on *Rhododendron* sp. Norway, VT.

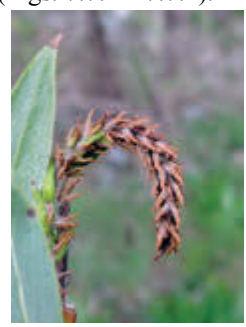

Fig. 7.7.2. Necrosis on a *Salix* catkin caused by an unidentified fungus. Briançon, France, AR.

Fig. 7.7.3. Berries of Mountain ash (*Sorbus aucuparia*) infested by *Colletotrichum acutatum* (Ascomycota, Glomerellaceae). Buskerud county, Norway, VT.

Fig. 7.7.4. Detail of a holly fruit (*Ilex aquifolium*) infested by *Fusarium acuminatum*-like fungi. Rogaland county, Norway, VT.

Additional information: Anthracnose causes dark, slightly sunken lesions on flowers and fruits. Under humid conditions, the disease may develop and spread quickly.

7.8. Petal Blight

Description: Flower discoloured with tan, water-soaked spots or soft blighted tissue; petals stuck together and often shed prematurely.
Possible damaging agents: Fungi (Figs. 7.8.1, 7.8.2).

Fig. 7.8.1. Flowers of *Prunus* sp. infected during bloom by brown rot fungus (Ascomycota, Helotiales: *Monilinia laxa*) to be compared to normally developed fruits on the same branch. Slovakia, JM.

Fig. 7.8.2. Flowers of *Rhododendron* sp., infected by a petal blight fungus (Ascomycota, Helotiales: *Ovulinia azaleae*). Maryland, USA, UME.

Additional information: Petal blight is a commonly occurring problem on *Rhododendron* spp. and other woody plants and may destroy their economic and aesthetic value.

7.9. Damage on flowers by stone fruit scab

Description: Flower discoloured with black/blight necrosis, flecking, streaks on catkins (flowers) and/or with lesions. Stone fruit scab is caused by fungal infection (*Cladosporium carpophilum*), so there cannot be bacterial slime.
Possible damaging agents: Fungi (Ascomycota, Pleosporales).
See photos of final damage in 7.20.

7.10. External damage by sap feeders

Description: Fruit surface (partially) covered with insects, insect secretions or fungal structures, waxy or woolly covers and/or honeydew on surface.
Possible damaging agents: Insects: adults and nymphs of Hemiptera, especially scales (Coccoidae, Diaspididae: Figs. 7.10.1, 7.10.3), aphids (Aphididae: Fig. 7.10.2) and psyllids (Psyllidae: Fig. 7.10.4)

Fig. 7.10.1. Fruits of apple tree (*Malus* sp.) infested by the San Jose scale (Hemiptera, Diaspididae: *Diaspidiotus perniciosus*). Slovakia, JM.

Fig. 7.10.2. Acorn of *Quercus ilex* with the basis covered by aphids (Hemiptera, Aphididae: *Thelaxes* sp.). Toscana, Italy, GC.

Fig. 7.10.3. Twigs and fruits of *Euonymus* sp. covered by scales (Hemiptera, Diaspididae: *Unaspis euonymi*). Hungary, GC.

Fig. 7.10.4. Russeting damage to pear fruit due to feeding by psyllids (Hemiptera, Psyllidae: *Psylla pyricola*). USA, EHB.

Additional information: Note whether the organism present on the surface is protected by a soft or hard covering (scale), or if it is free living (aphid, woolly adelgid). Note the presence of honeydew. The damage symptoms caused by psyllids and mites are rather similar, but psyllid damage is typified by the presence of honeydew on the fruit. For insect preservation, see Chapter 3.

7.11. Rust diseases

Description: Yellow/orange/red spores/blisters and/or pustules on the fruit surface.
Possible damaging agents: Fungi: Basidiomycota (Pucciniales: Figs. 7.11.1 – 7.11.4).

Fig. 7.11.1. Rose hip (*Rosa* sp.) covered by a rust fungus (Basidiomycota, Pucciniales: *Phragmidium* sp.). Akershus county, Norway, VT.

Fig. 7.11.2. Rose flower (*Rosa* sp.) infected by a rust fungus (Basidiomycota, Pucciniales: *Phragmidium* sp.). Briançon, France, AR.

Fig. 7.11.3. Fruit of pear (*Pyrus communis*) with medusa-like head due to a secondary infestation by hawthorn rust (Basidiomycota, Pucciniales: *Gymnosporangium clavariiforme*), the primary host being *Juniperus.* Slovakia, MZ.

Fig. 7.11.4. *Salix* sp. attacked by a rust fungus (*Melampsora* sp.). Sør-Trøndelag County, Norway, VT.

Additional information: Rust fungi are highly host specific, produce up to five spore stages and commonly need an alternate host to fulfil the life cycle.

7.12. Moulds

Description: Dark grey, green, blue or white velvet-like powdery mycelium on reproductive surfaces.

Possible damaging agents: Fungi: Heliothales (Sclerotinicaeae: Figs. 7.12.1 – 7.12.2).

Fig. 7.12.1. Flowers of *Rhododendron luteum* infected by grey mould (Heliothales, Sclerotinicaeae: *Botrytis cinerea*). Akershus county, Norway, VT.

Fig. 7.12.2. Detail of photo 7.12.1.

Additional information: Moulds may grow on honeydew substances secreted by aphids and other insects, turn seed coats blackish, and form dark grey spots on cotyledon surfaces.

7.13. Powdery Mildew

Description: White velvet powdery mycelium on fruits and dark grey spots on cotyledon surfaces of the seeds.
Possible damaging agents: Fungi: Ascomycota (Erysiphales: Figs. 7.13.1 – 7.13.4).

Fig. 7.13.1. Fruit of American gooseberry, *Ribes uva-crispa*, infested by mildew (Ascomycota, Erysiphales: *Podosphaera mors-uvae*). Slovakia, JM.

Fig. 7.13.2. Achene of maple (*Acer* sp.) with necrotized parts due to a fungus (Ascomycota, Erysiphales**:** *Sawadea bicornis*). The necrotized sections were at first chlorotic, and covered with a whitish powdery coating. Zürich, Switzerland, OH.

Fig. 7.13.3. Fruit of peach, *Prunus persica,* infected by powdery mildew (Ascomycota, Erysiphales: *Podosphaera pannosa* var. *persicae*). Slovakia, JM.

Fig. 7.13.4. Fruits and leaves of *Rhododendron* (*Azalea molle* X *sinense*), infected by powdery mildew (Ascomycota, Erysiphales: *Erysiphe azaleae*). Bergen, Norway, VT.

Additional information: Generally, powdery mildew is easy to recognize and most species are host specific.

7.14. Fruit galling

Description: Fruit clearly deformed, swollen, enlarged, or with uneven development. When the fruits are opened, larva(e), insect chamber(s), or galleries are visible.

Possible damaging agents: Insects: Larvae of Diptera (Cecidomyiidae midges: Figs. 7.14.4, 7.14.5) and Hymenoptera (Cynipidae: Figs. 7.14.1 – 7.14.3); **Mites:** Acari (Eriophiidae: Fig. 7.14.6).

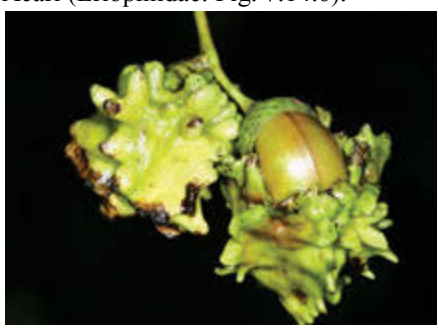

Fig. 7.14.1. Acorn of oak (*Quercus robur*), completely deformed by a gall wasp (Hymenoptera, Cynipidae: *Andricus quercuscalicis;* asexual generation). Hungary, GC.

Fig. 7.14.2. Acorn of oak (*Quercus robur*), with a spiny gall due to a wasp (Hymenoptera Cynipidae: *Andricus lucidus*; asexual generation). Hungary, GC.

Fig. 7.14.3. Acorn of *Quercus cerris*, sliced open to show the larval chambers of a gall wasp (Hymenoptera, Cynipidae: *Pseudoneuroterus saliens*; sexual generation). Hungary, GC.

Fig. 7.14.4. Fruit of linden (*Tilia cordata*) galled (reddish) by a midge larva (Diptera, Cecidomyiidae: *Contarinia tilliarum*). Hungary, GC.

7.14.5. Young fruit of pear (*Pyrus communis*) galled in the calyx cavity by larvae of pear gall midge (Diptera, Cecidomyiidae: *Contarinia pyrivora*). Slovakia, JM.

7.14.6. Fruit of walnut (*Juglans regia*) with protruding galls on the surface, due to a mite (Acari, Eriophyidae: *Aceria tristriata*). Slovakia, JM.

Additional information: Dissect the gall to check for the presence of insect larva(e) or minute mites. Note if there are distinct larval chambers. The insects and mites may have already left the gall, check also for the presence of exit holes. Such galls may also contain parasites, predators, or inquiline species. For insect preservation, see Chapter 3.

7.15. Fruit fungal deformation

Description: Fruit clearly deformed, swollen, enlarged, or with uneven development. An elongated, sac or pocket-like hollow fruit develops without an embryo, and without larva(e) or larva tunnel(s) inside.
Possible damaging agents: Fungi: Ascomycota (Taphrinomycetes: Figs. 7.15.1, 7.15.2).

Fig. 7.15.1. Plum tree (*Prunus domestica*) with an elongated, slightly curved fruit due to infection by the plum pocket fungus (Ascomycota, Taphrinomycetes: *Taphrina pruni*). Sogn og Fjordane county, Norway, AS.

Fig. 7.15.2. *Prunus* fruits infected by plum pocket fungus (Ascomycota, Taphrinomycetes: *Taphrina pruni*) at an advanced stage, showing a thick flour-like white coating. Later the deformed fruits will dry and rot, but may persist for a long time on twigs as mummies. Slovakia, JM.

Fig. 7.15.3. Fruits of wild cherry (*Prunus padus*) infected by plum pocket fungus (Ascomycota, Taphrinomycetes: *Taphrina pruni*). Akershus county, Norway, VT.

Fig. 7.15.4. Detail of a deformed fruit shown in Fig. 7.15.3.

Additional information: *Taphrina pruni* commonly occurs on plum trees, but can also be found on other woody plants, e.g *Prunus padu*s (Figs. 7.15.3 – 7.15.4).

7.16. Bacterial diseases and viruses

Description: Bacteria form black or brown lesions or blotches where bacterial exudate may ooze out under humid conditions. Virus attacks result in chlorotic ring structures or other patterns on the fruits.

Possible damaging agents: Bacteria (Fig. 7.16.1), **Viruses** (Figs. 7.16.2 – 7.16.4)

Fig. 7.16.1. Oozing canker on walnut (*Juglans regia*) due to a bacterium (Bacteria, Proteobacteria, Xanthomonadales*: Xanthomonas arboricola* pv. *juglandis*). Slovakia, JM.

Fig. 7.16.2. Fruit of peach (*Prunus persica*) with chlorotic ring structures on the fruit surface due to plum pox virus (sharka) (Virus, Potyviridae). Slovakia, JM.

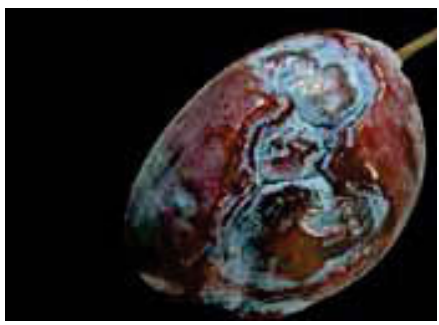

Fig. 7.16.3. Plum fruit (*Prunus domestica*) with blotches due to plum pox virus (sharka) (Virus, Potyviridae). Slovakia, JM.

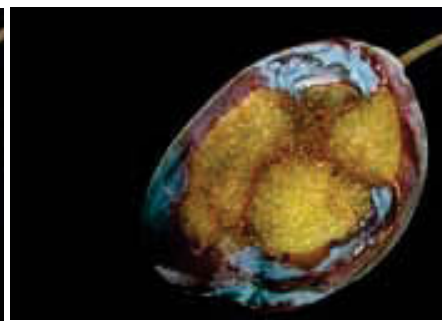

Fig. 7.16.4. Sharka blotches becoming harder as the plum fruit shown in 7.16.3 is maturing. Slovakia, JM.

Additional information: Look for presence of aphids on the plant, which may transmit and inject bacteria into the fruit.

7.17. Nut rot

Description: Fruit entirely or partly discoloured; black or tan-brown discoloration on the inside or outside of the fruit, with presence of small raised, cream-coloured fruiting structures.
Possible damaging agents: Fungi: Ascomycota (Figs. 7.17.1 – 7.17.2).

Fig. 7.17.1. Mummified nuts of hazelnut (*Corylus avellena*) due to a brown rot fungus (Ascomycota, Helotiales: *Monilinia laxa*). Slovakia, JM.

Fig. 7.17.2. Nut of pecan tree (*Carya illinoinensis*) showing shuck rot due to a fungus (Ascomycota: *Glomerella* sp.). USA, WR.

Additional information: Infected nuts often die before they are fully grown. Diseased, mature nuts may have fungal growth on the seed inside the nutshell.

7.18. Hull Rot (mummification) of stone fruits

Description: Fruit entirely or partly discoloured. Shrivelled stone fruits or intermixed acorn tissues held together by fungal mycelium. Fruits turn chalky and sponge-like.

Possible damaging agents: Fungi: Ascomycota (Helotiales: Figs. 7.18.1 – 7.18.4).

Fig. 7.18.1. Apple fruit (*Malus sylvestris*) with superficial, circular, brown spots expanding on the surface due to a brown rot fungus (Ascomycota, Helotiales: *Monilinia fructigena*), Slovakia, MZ.

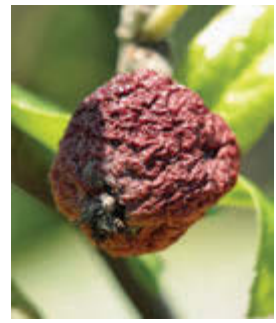

Fig. 7.18.2. Mummified apple fruit (*Malus sylvestris*) as the final result of damage by a brown rot fungus (Ascomycota, Helotiales: *Monilinia fructigena*), Slovakia, MZ.

Fig. 7.18.3. Mummified plum (*Prunus domestica*) due to a brown rot fungus (Ascomycota, Helotiales: *Monilinia laxa*). Slovakia, JM.

Fig.7.18.4. Fruit of pear (*Pyrus communis*) with a circular brown spot expanding on the surface due to a brown rot fungus (Ascomycota, Helotiales: *Monilinia fructigena*). Slovakia, MZ.

Additional information: Look for presence of mummified fruits on the ground or still attached to the tree.

7.19. Black rot (mummification) of acorns

Description: Fruit entirely or partly discoloured. Shrivelled stone fruits or mixed acorn tissues held together by fungal mycelia. Fruits turn chalky and sponge-like.
Possible damaging agents: Fungi: Ascomycota (Helotiales: Figs. 7.19.1, 7.19.2).

Fig. 7.19.1. Acorns of oak (*Quercus* sp.) partly infected by a ciboria fungus (Ascomycota, Helotiales: *Ciboria batschiana*). Slovakia, AK.

Fig. 7.19.2. Acorns of oak (*Quercus* sp.) totally infected by a ciboria fungus (Ascomycota, Helotiales: *Ciboria batschiana*). Slovakia, AK.

Additional information: Infected acorns will normally fail to germinate.

7.20. Stone fruit scab

Description: Fruit entirely or partly discoloured. Extensive crusty corky spotting on the surface of fruit with cracks, lesions or necrosis, often clustered near the stem end of the fruit.

Possible damaging agents: Fungi: Ascomycota (Pleosporales: Figs. 7.20.1 – 7.20.4).

Fig. 7.20.1. *Pyrus communis* fruit covered by brown-black spots due to pear scab fungus (Ascomycota, Pleosporales: *Venturia pyrina*). Slovakia, JM.

Fig. 7.20.2. *Malus sylvestris* fruit covered by brown-black spots due to apple scab fungus (Ascomycota, Pleosporales: *Venturia inaequalis*). Slovakia, JM.

Fig. 7.20.3. *Prunus persica* fruit covered by brown-black spots due to peach scab fungus (Ascomycota, Pleosporales: *Venturia carpophila*). Slovakia, JM.

Fig. 7.20.4. Nuts of pecan tree (*Carya illinoinensis*) showing increasing degrees of pecan scab (Ascomycota, Pleosporales: *Fusicladium effusum*). USA, WR.

Additional information: Scab greatly reduces the fruit quality for consumption. Thus, proper management is required in the fruit producing industry.

7.21. Fruit spot

Description: Fruit entirely or partly discoloured. Circular or irregular, elongated, bright or dark brown, red, nearly black, distinct and gradually coalescing or sharply outlined spots of various dimensions, but no larva or tunnel present when the fruit is opened.

Possible damaging agents: Fungi: Ascomycota (Capnodiales: Figs.7.21.3 – 7.21.4; Diaporthales: Figs. 7. 21.1 – 7.21.2).

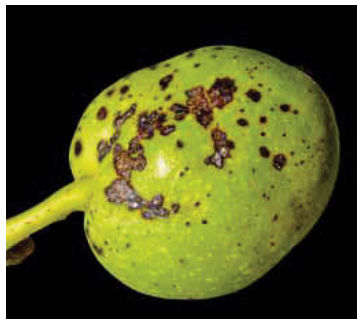

Fig. 7.21.1. Nut of walnut (*Juglans regia*) showing brown patches due to walnut-leaf blotch fungus (Ascomycota, Diaporthales: *Gnomonia leptostyla*). Slovakia, AK.

Fig. 7.21.2. The same damage as 7.21.1., but at the end of the growing season: the blotches having merged. Slovakia, AK.

Fig. 7.21.3. Apricot fruit, covered by spots due to a shot-hole disease fungus (Ascomycota, Capnodiales: *Thyrostroma carpophilum* = *Stigmina carpophila*). Slovakia, JM.

Fig. 7.21.4. Peach fruit (*Prunus persica*) with spots due to a shot-hole disease fungus (Ascomycota, Capnodiales: *Thyrostroma carpophilum* = *Stigmina carpophila*), Slovakia, JM.

Additional information: Be aware that fruit spots may also be caused by bacterial infections.

7.22. Internal fruit feeding by insect larva

Description: Fruit entirely or partly discoloured or with scattered deposits of gum (thick sap: Fig. 7.22.1) or frass (larval excrements: Figs. 7.22.3, 7.22.4) on the surface. When the fruit is cut open, larva(e) or tunnel(s) are visible (Figs 7.22.2, 7.22.6, 7.22.7).

Possible damaging agents: Insects: larvae of Coleoptera (Curculionidae and Rhynchitidae weevils: Figs. 7.22.5, 7.22.6), Diptera (Cecidomyiidae, Phoridae, Sciaridae and Tephritidae fruit flies: Fig. 7.22.7), Hymenoptera (Tenthredinidae sawflies: Fig. 7.22.8) and Lepidoptera (Gelechiidae, Geometridae, Noctuidae, Tortricidae, Yponomeutidae: Figs. 7.22.1 – 7.22.4).

Fig. 7.22.1. Plum fruit (*Prunus domestica*) with gum deposit on the surface, resulting from internal feeding by a moth larva (Lepidoptera, Tortricidae: *Cydia funebrana*). Slovakia, JM.

Fig. 7.22.2. The plum fruit shown in Fig. 7.22.1., sliced to show the moth larva and its damage. Slovakia, JM.

Fig. 7.22.3. Apple fruit (*Malus sylvestris*) with protruding frass resulting from internal damage by a larva of codling moth (Lepidoptera, Tortricidae: *Cydia pomonella*). Slovakia, MZ.

Fig. 7.22.4. Hip of wild rose (*Rosa* sp.) with protruding frass due to a moth larva (Lepidoptera, Tortricidae: *Carposina scirrhosella*). Hungary, GC.

Fig. 7.22.5. Apple fruit (*Malus sylvestris*) attacked by larvae of apple fruit weevil (Coleoptera, Rhynchitidae: *Tatianaerhynchites aequatus*). Slovakia, MZ.

Fig. 7.22.6. Chestnut fruit (*Castanea sativa*) sliced to show damage by weevil larvae (Coleoptera, Curculionidae: *Curculio* sp.). Marcillac, France, AR.

Fig. 7.22.7. Cherry fruit (*Prunus cerasus*) sliced to show the damage caused by a larva of a fruit fly (Diptera, Tephritidae: *Rhagoletis cerasi*). Slovakia, JM.

Fig. 7.22.8. Apple fruit (*Malus sylvestris*) with a gallery along the underside of the epidermis made by a sawfly larva (Hymenoptera, Tenthredinidae: *Hoplocampa testudinea*). Slovakia, JM.

Additional information: Note whether the extruded frass is coarse or light, and combined or not with gum. If the fruit is only partly discoloured and without exit holes, the damaging larvae are still present. Carefully cut the fruit longitudinally, like in Figs. 7.22.2, 7.22.6 and 7.22.7, and check the discoloured parts for the presence of larvae. Note the position of the larvae and the larval tunnels. Then, extract larvae, and note the shape of the tunnel. Note that infested fruits can be secondarily attacked by fungal pathogens. For insect preservation, see Chapter 3.

7.23 Mite-induced discoloration

Description: Fruit noticeably speckled or russeted.
Possible damaging agents: Mites: Acari (Eriophyiidae: Figs. 7.23.1 – 7.23.2).

Fig. 7.23.1. Fruit of plum (*Prunus domestica*) attacked by silver mites (Acari, Eriophyiidae: *Aculus fockeui*). Slovakia, JM.

Fig. 7.23.2. Russeting of pear fruit by pear rust mite (Acari, Eriophyiidae: *Epitrimerus pyri*). California, USA, JKC.

Additional information: Look for the presence of minute mites on the fruit. For collection and preservation, refer to Chapter 3.

7.24. Larval emergence hole

Description: Presence of irregular exit hole(s) on the surface.
Possible damaging agents: Insects: mature larvae, falling down to pupate on the ground, of Coleoptera (Curculionidae and Rhynchitidae weevils: Figs. 7.24.1 – 7.24.3), Diptera (Cecidomyiidae, Phoridae, Sciaridae and Tephritidae fruit flies: Fig. 7.24.6), Hymenoptera (Tenthredinidae sawflies: Fig. 7.24.4), and Lepidoptera (Gelechiidae, Geometridae, Noctuidae, Tortricidae, Yponomeutidae: Fig. 7.24.5); immature larvae of Lepidoptera may move from one fruit to another.

Fig. 7.24.1. Apple fruit (*Malus sylvestris*) with exit holes of larvae of apple fruit weevil (Coleoptera, Rhynchitidae: *Tatianaerhynchites aequatus*). Slovakia, MZ.

Fig. 7.24.2. Fruit of chestnut (*Castanea sativa*) with exit holes of weevil larvae (Coleoptera, Curculionidae: *Curculio elephas*). Gorduno, Switzerland, BW.

Fig. 7.24.3. Hazelnut (*Corylus avellana*) with an exit hole of a weevil larva (Coleoptera, Curculionidae: *Curculio nucum*). Slovakia, JM.

Fig. 7.24.4. Plum (*Prunus sylvestris*) with an exit hole of a sawfly larva (Hymenoptera, Tenthredinidae: *Hoplocampa minuta*). Slovakia, JM.

Fig. 7.24.5. Hip of wild rose (*Rosa spinosissima*) with an exit hole of a moth larva (Lepidoptera, Tortricidae: *Carposina scirrhosella*). Briançon, France, AR.

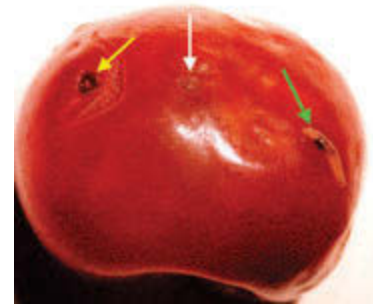

Fig. 7.24.6. Cherry fruit oviposition sting (central arrow), exit hole for larva (left arrow) and the larva (right arrow) of a fruit fly (Diptera, Tephritidae: *Drosophila suzukii*). Howard County, Maryland, USA, GB.

Additional information: Usually, no more larvae are present, but check for the presence of dead specimens which could not emerge from the fruit. Note the shape and size of the exit hole, which can help the identification of the insect.

7.25. Adult emergence hole

Description: Presence of exit hole(s) of regular shape on fruit surface.
Possible damaging agents: Insects: adults of Coleoptera seed beetles (Bruchidae, Curculionidae: Fig. 5.25.3) and Hymenoptera seed chalcids (Eurytomidae: Fig. 5.25.4, Torymidae: Figs. 5.25.1 – 5.25.2).

Fig. 5.25.1. Hip of wild rose (*Rosa* sp.) with an emergence hole of an adult seed chalcid (Hymenoptera, Torymidae: *Megastigmus* sp.). Lijiang, China, AR.

Fig. 5.25.2. Fruit of *Rhus natalensis* showing an adult exit hole of a seed chalcid (Hymenoptera, Torymidae: *Megastigmus transvaalensis*). Ronge Nyika, Kenya, RC.

Fig. 5.25.3. Pods of *Prosopis juliflora* with insect exit holes (among others, seed beetles belonging to Coleoptera, Bruchidae). Moshi District, Tanzania, RE.

Fig. 5.25.4. Almond fruits (*Prunus dulcis*) with exit holes of adult seed chalcids (Hymenoptera, Eurytomidae: *Eurytoma amygdali*). Sallèles, France, AR.

Additional information: Usually, no more insects are present, but check for the presence of dead specimens, which could not emerge from the fruit. Also, check the presence of exit holes on seeds. Note the diameter of the exit hole. Emerging parasites of the phytophagous pests may also bore similar circular holes to emerge from the fruit.

7.26. Seed galling

Description: Seed noticeably deformed.
Possible damaging agents: Insects: Larvae of Diptera (Cecidomyiidae gall midges: Fig. 7.26.1) and Hymenoptera (Cynipidae gall wasps: Fig. 7.26.2), **Mites**: Acari (Eriophyiidae).

Fig. 7.26.1. Seed of birch (*Betula* sp.), galled by a midge larva (Diptera, Cecidomyiidae: *Semudobia betulae*). North Zeeland, Denmark, LKT.

Fig. 7.26.2. Oak acorn (*Quercus* sp.) sliced to show the gall chambers (note the larvae) of a gall wasp (Hymenoptera, Cynipidae: *Callirhytis glandium*). Hungary, GC.

Additional information: Collect mature seeds/acorns. The seed must be opened or, better, X-rayed if possible to ascertain the presence of larvae. Alternatively, for a more easy identification of the damaging species, infested seeds can be reared until adult emergence. For insect preservation see Chapter 3.

7.27. Seed rot

Description: Seed partly/completely discoloured with dark grey, green, blue, white velvet-powdery mycelium on the seed coat.
Possible damaging agents: Fungi: Ascomycota (*Penicillium, Fusarium, Phoma* and others).

Fig. 7.27.1. Seed of European beech (*Fagus sylvatica*) infected by *Penicillium* sp. (Ascomycota, Eurotiales). Vestfold county, Norway, VT.

Fig. 7.27.2. Seed of European beech (*Fagus sylvatica*) infected by fungal rot (Ascomycota, Pleosporales: *Phoma* sp.). Vestfold county, Norway, VT.

7.28. Seed insect damage

Description: Presence of circular hole(s) in external seed coat or presence of larva(e) or pupa(e) in the seed when opened (or larvae/pupae visible using X-rays).

Possible damaging agents: Insects: Larvae of Coleoptera seed beetles (Bruchidae, Curculionidae: Figs. 7.28.4 left – 7.28.5), Diptera seed midges (Cecidomyiidae, Phoridae: Fig. 7.28.7), Hymenoptera seed chalcids (Eurytomidae: Fig. 7.28.6, Torymidae: Fig. 7.28.8) and Lepidoptera (Nepticulidae, Yponomeutidae, Tortricidae: Figs. 7.28.1, 7.28.2, 7.28.3, 7.28.4 right).

Fig. 7.28.1. Seed of maple (*Acer pseudoplatanus*) with an exit hole of a lepidopteran seed moth (Lepidoptera, Tortricidae: *Pammene regiana*). Hungary, GC.

Fig. 7.28.2. Seed of maple (*Acer pseudoplatanus*) with a larva of a lepidopteran seed moth (Lepidoptera, Tortricidae: *Pammene regiana*). Hungary, GC.

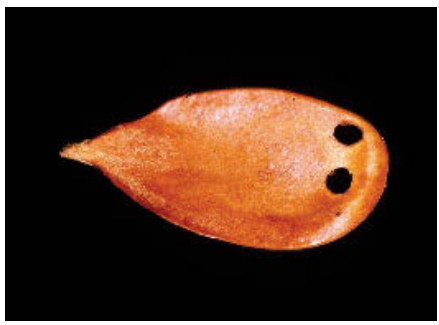

Fig. 7.28.3. Acorn of beech (*Fagus sylvatica*) with emergence holes of a seed moth (Lepidoptera, Tortricidae: *Cydia* sp.). Hungary, GC.

Fig. 7.28.4. Acorns of oak (*Quercus* sp.), sliced to show damage by a weevil larva (Coleoptera, Curculionidae: *Curculio* sp.) (left) and a moth larva (Lepidoptera, Tortricidae: *Cydia* sp.) (right). Hungary, GC.

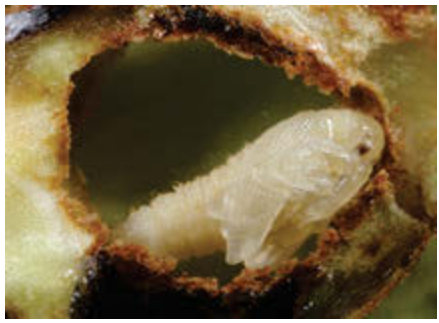

Fig. 7.28.5 Seed of maple (*Acer pseudoplatanus*) dissected to show the pupa of a seed weevil (Coleoptera, Curculionidae: *Bradybatus kellneri*). Hungary, GC.

Fig. 7.28.6. Seed of pistachio (*Pistacia lentiscus*) with an exit hole of a seed chalcid (Hymenoptera, Eurytomidae: *Eurytoma plotnikovi*). Tabarka, Tunisia, AR.

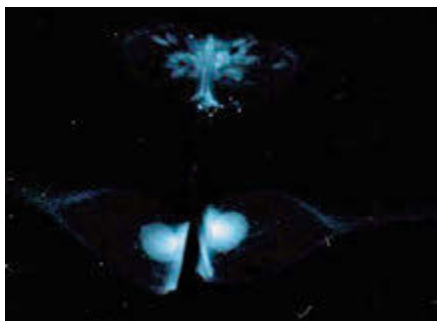

Fig. 7.28.7. X-ray picture of seed of maple (*Acer pseudoplatanus*), to show seed infested by dipteran larva (top) (Diptera, Phoridae: *Megaselia* sp.) and sound seed (bottom). Grenoble, France, AR.

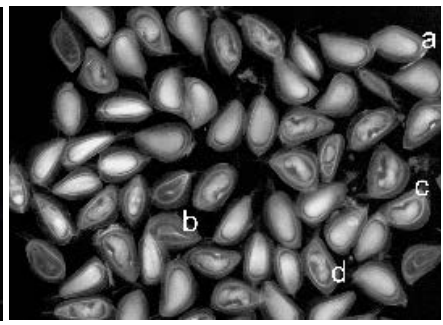

Fig. 7.28.8. X-ray picture of seed of wild rose (*Rosa odorata*), infested by chalcid larva (c) and pupae (d) (Hymenoptera, Torymidae: *Megastigmus* sp.) and sound (a) and empty (b) seed. Lijiang, China, AR.

Additional information: Collect mature seeds. Usually, an infested seed does not differ from a healthy one in shape, colour or weight, although exceptions exist. The seed must be opened or, better, X-rayed if possible to ascertain the presence of larvae. Alternatively, for a more easy identification of the damaging species, infested seeds can be reared until adult emergence. For insect preservation see Chapter 3.