Contents

Introduction 1

Most Common Fungal Diseases of Russian Forests 2

Diseases of Fruits and Seeds 2
Birch Seed Mummification 2
Fruit Deformation 2
Fruit Spots 4
Molds 6
Seed and Fruit Rots 9

Diseases of Needles and Leaves 11
Needle Diseases 11
Lophodermium Needle Casts 11
Snow Blight 15
Meria Needle Blight 16
Brown Felt Blight 18
Rhizosphaera Needle Casts 18
Needle Rusts of Pine 20
Leaf Diseases 22
Powdery Mildews 22
Leaf Spots 23
Leaf Rusts 35

Diseases Of Roots, Stems, And Branches 36
Diseases in Tree Nurseries and Young Forests 36
Damping - off 36
Diseases of Forest Stands 38
Wilts 38
Verticillium Wilt 38
Dutch Elm Disease 39
Oak Wilt 41
Dieback and Canker Diseases 42
Cenangium Dieback of Pine 42
Nectria Canker and Dieback 44
Cytospora Canker 45
Dothichiza Canker of Poplar 46
Clithris Canker and Dieback of Oaks 48
Nummularia Canker 48
Black Naemospora Canker 49
Thyrostroma Canker and Dieback 50
Ascocalyx Scleroderris Shoot Canker 52
European Larch Canker 53
Lachnellula Canker of Siberian Pine Understory 54
Stem Rust of Pine 55
Broom Rust of Fir 56
Perennial Nectria Canker 58
Black Hypoxylon Canker 60
Cytophoma Canker of Ash 60
Wood-Decaying Diseases 62
Annosum Root and Butt Rot 62
Armillaria Root Rot 65
Butt and Trunk Rot of Conifers 67
Trunk and Limb Rot of Hardwoods 75

Fungal Diseases that Occur Only in Russian Forests 89

Diseases of Fruits and Seeds 89
Thecopsora Rust of Spruce Cones 89
Acorn Mummification Deformity 89

Diseases of Needles and Leaves 91
Needle Diseases 91
Hypodermella Needle Cast of Pine Hosts 91
Chrysomyxa Rust of Spruce 91
Leaf Diseases 93
Powdery Mildew of Siberian Pea Tree 93
Other Powdery Mildews 94
Orange Leaf Spot of Padus 95
Red Spot of Ussurian Plum 96
Foliage Anthracnoses, Spots, and Blights 96
Leaf Rusts 108
Taphrina Diseases: Leaf Blisters, Leaf and Shoot Deformation 110

Diseases of Roots, Stems, and Branches 111
Diseases in Tree Nurseries and Young Forests 111
"Infectious Damping" of Coniferous Seedlings 111
Sclerophoma Disease of Pine Shoots 112
Pine Shoot Rust 113
Chrysomyxa Rust of Spruce Shoots and Needles 114
Diseases of Forest Stands 116
Dieback and Canker Diseases 116
Black Cytospora Canker of Poplar 116
Biatorella Canker 117
Pitch Blister Rust Canker 119
Endoxylina Canker of Ash 120
Cankers and Diebacks 122
Wood-Decaying Diseases 128
Ganoderma Butt Rot of Beech 129
Vuillemenia Decay 129
Trunk and Limb Rots 130

Acknowledgment 133

Appendix A
Pathogens That Affect Trees and Shrubs in Russia 134

Appendix B
Host Trees, Shrubs, and Herbs Listed in this Report 137

Control

Observation

- Survey stands during summer to locate new and developing disease centers.

Cultural

- Timely remove affected dying and dead trees.
- Destroy felling residue as a source of inoculum.
- Create optimal conditions for plantation growth.

Wood-Decaying Diseases

Annosum Root and Butt Rot

Class/Order: Basidiomycetes, Aphyllophorales

Pathogen

Heterobasidion annosum (Fr.) Bref. (syn. *Fomitopsis annosa* (Fr.) Karst.)

Hosts

Species of fir (*Abies*), spruce (*Picea*), pine (*Pinus*), larch (*Larix*), arborvitae (*Thuja*), beech (*Fagus*), and birch (*Betula*)

Diagnosis

In pine stands, existing disease centers are characterized by weakened and dying trees, previous-year dead trees, and tipped and windthrown trees. Group mortality and blowdown occur and grassy glades develop in the opening (**Fig. 33**). Disease centers in grassy glades have relatively distinctive boundaries. These boundaries enlarge each year and new dying trees appear on the edges. Individual grassy glades coalesce and the stand becomes an open forest. By contrast, infected fir and spruce remain alive for a long time even though considerable decay develops in their roots and stems. Symptoms of infection are visible and include a reduction in radial and terminal growth, thin-crowned trees with dull green and brown shade-needles, and shoot deformities. In spruce stands, the disease often is concealed until tree mortality occurs as a result of blowdown. Conspicuous disease centers and grassy glades do not form in spruce stands as they do in pine stands (**Fig. 34**).

Disease characteristics and symptoms vary with different hosts. In pine, decay develops in the root system. In the first stage of infection, abundant resin exudes from the affected resin vessels in the roots. Resin-soaked root wood is a red-orange, sometimes lilac, becomes crystalline, and has a turpentine order. Resin accumulates under the bark on roots of diseased trees, then exudes to the surface where soil and other debris become entrapped, forming hard resin galls on the roots. As decay develops, the resin gradually disappears and the infected wood turns uniformally yellow. Small, white flecks of cellulose may be scattered throughout the wood. The final stage is characterized by the formation of numerous small pockets, and the wood becomes bastlike, stringy, and crumbles.

In fir and spruce, the fungus initially spreads in roots and then extends up the stem causing heart rot, which is bordered by a lilac-gray ring. The fungus grows about 3 to 4 m up the trunk but can reach 10 m. Initial decay is characterized by the gray-violet color of the wood, which later turns red-brown. In the final stage, wood is typically mottled, with relatively large white cellulose pockets and typical black specks. The decayed wood has a pocket-laminated structure and crumbles easily when dry.
The most reliable sign is the presence of the basidiocarps on the roots and root-stem base. They form usually in shady places, on the lower surfaces of decaying roots of windthrown trees, sometimes at the base of dead tree stumps, and on the partially decayed butts. Basidiocarps differ in shape and size. They are thin and perennial (**Figs. 35-36**). The surface is brown, with a light-brown margin and concentric furrows. The hymenophore is initially white and later yellow with a silky shine. Pores are tiny, round or angular, sometimes sloped.

Biology

Initial infection occurs by basidiospores and conidia of the fungus. Basidiospores develop in basidiocarps; conidia develop on the mycelium on the surface of decaying parts of infected stumps or roots. The spores are dispersed by air, water, and animals (primarily insects). Spores are transported to roots and, especially on mechanically wounded roots, infect them. Mycelium develops in roots and decay begins. The pathogen develops in both living and dead wood on colonized roots, stumps, and

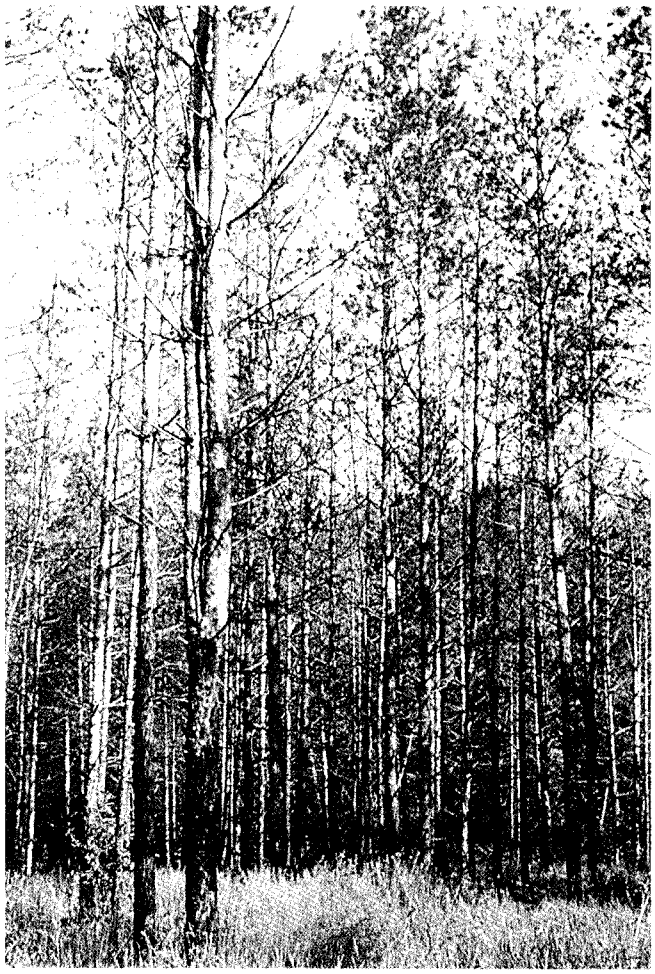

Figure 33.—Annosum root rot (*Heterobasidion annosum*). Dead and dying trees are in a 25-year-old plantation of pine (*Pinus sylvestris*).

Figure 34.—Disease gap caused by *Heterobasidion annosum* in a spruce (*Picea abies*) stand.

woody debris in forest litter. If spores settle on freshly cut stumps (e.g., after thinnings), they germinate and mycelium spreads in stump wood and extends to the roots. The disease also spreads by secondary infection of living-tree roots by direct mycelial transfer at contacts of healthy and diseased roots. Tree infection also is initiated through dead rootlets or dead ends of deep roots.

The disease occurs in nearly every forest site except swamps; bog (sphagnum) and lichen (cladina) pine stands are rarely infected. Stands of various age are affected. Initial symptoms may be visible in 15- to 20-year-old stands. Seedlings of conifers that develop in disease centers also are subjected to potential infection and death. Homogenious conifer stands suffer the most damage, especially forest plantations established on former agricultural soil, waste grounds, or areas previously affected by the fungus. The disease is rare in natural pine stands. However, spruce and fir are damaged severely both in forest plantations and in natural stands. Mixed coniferous-hardwood stands are more resistant to the disease. Excessive stand density with closely interlaced and grafted roots promotes rapid infection, development, and fungal spread. In suburban forests and parks, recreation use causes root injury, soil compaction, and poor soil aeration, predisposing trees to infection and disease development.

Damage

Causes massive decline and death of stands and significant changes in stocking. In spruce and fir, significant decay may extend up the trunk from the roots and the value of the butt log is significantly reduced. Losses of merchantable volume may reach 50 percent in spruce and 75 percent in fir. Weakening and decline of infected trees usually results in bark beetle and wood-borer infestations.

Figure 35.—Young basidiocarps of *Heterobasidion annosum* on the trunk of a young pine (*Pinus sylvestris*) tree.

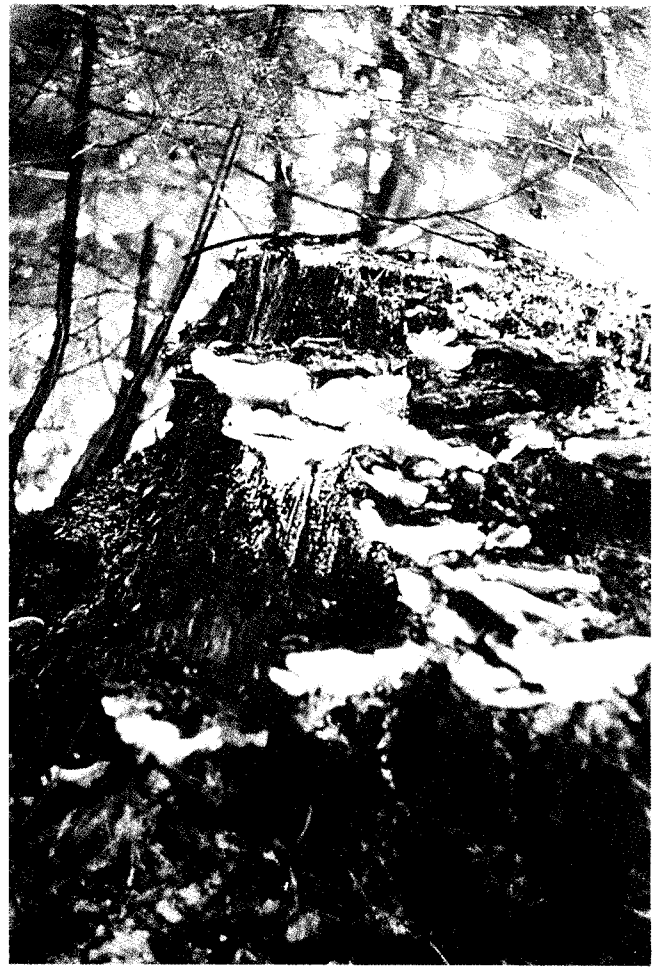

Figure 36.—Basidiocarps of *Heterobasidion annosum* on an old spruce (*Picea abies*) stump.

Consequently, disease centers also become outbreak centers for destructive insects. This intensifies stand decline.

Distribution
Throughout Russia

Control
Observation
- Survey for disease centers during normal stand assessments.

Cultural
- Conduct thinnings and sanitation cuttings in diseased stands or those predisposed to the disease.
- Perform reforestation after clear or partially clear sanitation cutting and following agricultural activities using homogenious hardwood and mixed plantations according to forest type, cutting character (features), infection level, and level of young growth. Conifers should not represent more then 30 percent of species composition and the number of planting points should not exceed 5,000/ha. Select species and mixture according to site conditions.
- Plant high quality plant material with well-developed root systems and mycorrhizae.
- Apply fertilizer (chemical) and manure (organics) on poor sandy soils for improving plantation growth and resistance.
- Regulate recreational use in suburban forests.

Figure 37.—*Armillaria mellea* (sensu lato) rhizomorphs under the bark on a spruce (*Picea abies*).

Figure 38.—A mycelial fan of *Armillaria mellea* (sensu lato) on the trunk of a dead spruce tree (*Picea abies*).

Chemical
- Treat stumps after sanitation cuttings with Carbamid, Nitrathen, (NH3)2SO4, ZnCl, and KMnO4.
- Treat the soil with Fundasol simultaneously with sanitation cutting.

Biological
- Treat seedling roots with antagonistic fungi.

Armillaria Root Rot

Class/Order: Basidiomycetes, Agaricales

Pathogen
Armillaria species – *Armillaria mellea* (Vahl.:Fr.) Kummer is the type species

Hosts
Species of fir (*Abies*), spruce (*Picea*), pine (*Pinus*), larch (*Larix*), beech (*Betula*), ash (*Fraxinus*), poplar (*Populus*), oak (*Quercus*), and elm (*Ulmus*)

Diagnosis
The primary signs of disease are the presence of branched, black rhizomorphs (**Fig. 37**) and white leathery mycelial fans that form beneath the bark (**Fig. 38**) in roots and stems. Basidiocarps develop usually in August-October in clusters on dead trees and stumps but can occur on the roots and base of

Figure 39.—Basidiocarps of *Armillaria mellea* (sensu lato) on the trunk of a birch (*Betula pendula*).

trunks of affected live trees (**Fig. 39**). The basidiocarp, which can reach 15 cm in diameter depending on species, is initially convex and later flat with a hillock in the center, yellow-brown or gray-brown, with numerous dark (or the same color) scales. The internal tissue is white and friable, with a pleasant odor. The hymenophore gills are slightly descending and initially white, later darkening. The stipe is central, cylindrical, 10-15 cm long and 1-1.5 cm in diameter, with small scales, white or light-brown and darker on the base, and a white thick fluffy-silk ring (annulus) under the cap. Decayed wood is white or light-yellow, fiberous, with characteristic sinuous black lines. Decay can extend 1-1.5 m up the trunk.

Biology
Basidiospores are dispersed by wind, rainfall, and animals, and germinate and infect stumps and roots of trees. Infection also occurs from root contact with rhizomorphs of the fungus or direct mycelial transfer from diseased to healthy roots. Stands are predisposed to this disease by abiotic and biotic stressors of temperature and moisture extremes, wind, soil compaction, air pollution, and defoliation by frost (abiotic factors), and defoliation by insects and fungi, attacks by sucking insects, and other foliar and stem diseases (biotic factors).

Damage
Causes dieback in a range of stand ages and types. Often develops into an epyphytotic, causing heavy mortality in stands of single-species conifers and in oak and birch stands. The volume of merchantable wood can be reduced by decay.

Distribution
Throughout Russia except mountain highlands, deserts, and tundra sites

Control

Observation

• Survey for disease centers during normal stand assessments primarily in coniferous stands and in stands affected by industrial pollution and other unfavorable factors.

Cultural

• Create mixed stands.

• Conduct sanitation thinnings in young and mature stands; remove diseased, dying, and dead trees to promote the vigorous growth of leave trees.

• Treat individual diseased trees in gardens and urban plantings to maintain high vitality. Selectively remove infected roots where possible.

Chemical

• Treat surface of stumps with fungicides (Topsin-M or Benomil).

Biological

• Treat surface of fresh stumps with inoculum of biofungicides such as *Peniophora gigantea* (Fr.) Mass., *Fomitopsis pinicola* (Sw. ex Fr.) Karst., and *Pleurotus ostreatus* (Fr.) Kamm.

Butt and Trunk Rot of Conifers

Class/Order: Basidiomycetes, Aphyllophorales

Pathogen

Phaeolus schweinitzii (Fr.) Pat.

Host

Species of spruce (*Picea*), pine (*Pinus*), larch (*Larix*), and, more rarely, fir (*Abies*), oak (*Quercus*), and hazel (*Corylus*)

Diagnosis

Basidiocarps develop at the base of stumps and on roots of old-growth trees (**Figs. 40-41**). They are annual, flat or funnel-shaped, thick, with yellow or brown caps, with or without a short tuber-like stalk. The upper surface is velvety-hairy, with indistinct zones lines. Internal tissues are soft-corky or spongy, rust-brown. Hymenophore tubes are short, with conspicuous angular (sometimes split) pores, rust-brown with a green shade. The decay of heartwood extends 2 to 3 m up the trunk (**Fig. 42**). Initially, infected wood is slightly dark with a red shade, later turning brown. Cracks form in decayed wood along the rays and annual rings. White, thin mycelial fans form in cracks. Decayed wood has a turpentine odor.

Biology

Living roots are infected by basidiospores or mycelium from previously infected roots. Basidiocarps form usually when moisture is high. Forest stands less than 60 years old are affected.

Damage

Causes dieback and windthrow of trees. The merchantable volume of the butt log may be reduced. Damaged trees range from 5-10 percent.

Distribution

European part of Russia, Siberia, Urals, Far East

Control

Cultural

• Conduct santitation cuttings to remove infected trees.

• Create mixed stands using resistant tree species of birch (*Betula),* lime *(Tilia),* and maple *(Acer).*

♦♦♦

Pathogen

Phellinus pini (Thore: Fr.) A. Ames

Hosts

Species of larch (*Larix*) and pine (*Pinus),* including Scots *(P. sylvestris),* white *(P. strobus),* Siberian *(P. sibirica),* and Swiss mountain *(P. montana*)

Figure 40.—Basidiocarps of *Phaeolus schweinitzii* at the base of a pine (*Pinus sylvestris*) tree.

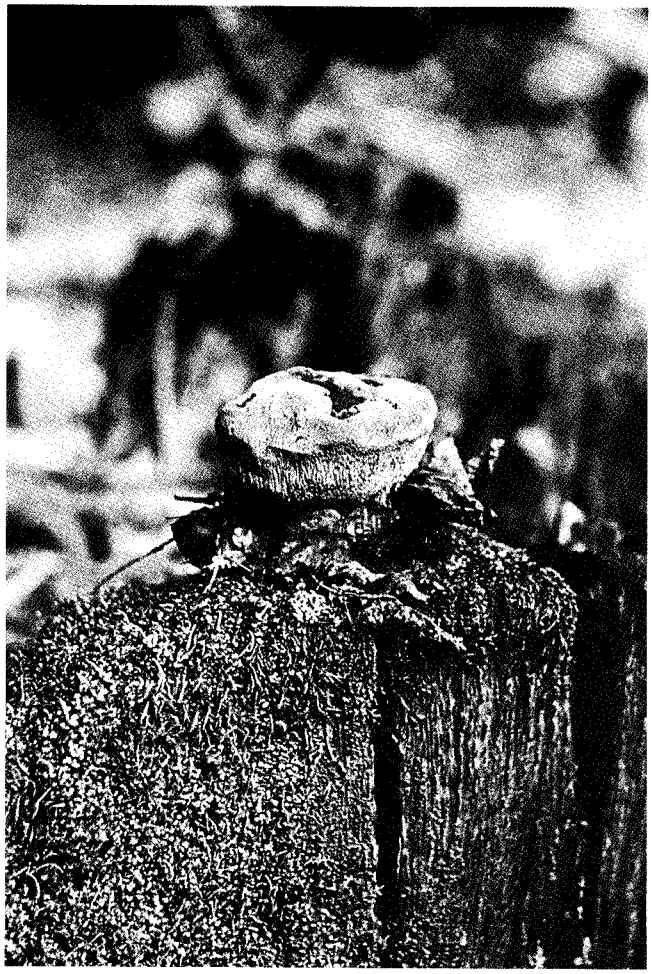

Figure 41.—Basidiocarps of *Phaeolus schweinitzii* on an old pine (*Pinus sylvestris*) stump.

Diagnosis

Basidiocarps are thick, hoof-like, or flat. They are woody and perennial, sometimes reaching 50 years of age. The upper surface is dark-brown, rough, with concentric rings and numerous radial cracks, often covered with lichens. Interior tissue is woody and yellow-brown. The hymenophore also is yellow and has large angular and labyrinth-like pores. Initially, infected wood is red-brown. Decay with pocket-like structures and white cellulose fibers form later. Cracks often arise in conjunction with annual rings. The fungus decays primarily the interior part of the trunk from 2-10 m. These tissues contain the least protective resins.

Biology

Infection by windborne basidiospores occurs in autumn through broken branches on 50- to 60-year-old trees with significant heartwood and many dying lower branches. Infection increases with the age of the stand. Pine stands in a range of growth conditions are susceptible to the disease. Disease incidence is higher in open pine stands, where branch shedding is poor. Trees are predisposed to disease by anthropogenic factors such as resin tapping, recreational activities, ground fire, and grazing.

Damage

Reduces trunk resistance to wind resulting in wind breakage. Decay reduces the merchantable volume of the butt log; commercial wood losses range from 20-60 percent. Disease in pine stands ranges from 10-60 percent.

Figure 42.—Wood decay caused by *Phaeolus schweinitzii.*

Distribution
European part of Russia, Urals, Siberia, Far East

Control
Cultural
- Maintain closed stands to promote rapid shedding of branches in young and middle-aged stands.
- Conduct timely thinnings to remove weakened and suppressed trees.

♦ ♦ ♦

Pathogen
Phellinus chrysoloma (Fr.) Donk (syn. *Phellinus pini* (Thore:Fr.) Pil. *var. abietis* (P. Karst.) Pil.

Host
Primarily species of fir (*Abies*), spruce (*Picea*), larch (*Larix*) and pine (*Pinus*)

Diagnosis
Perennial basidiocarps form on branches. They are thin, sometimes overlapping in clusters, more rarely resupinate (**Fig. 43**). The upper surface has deep concentric ridges, is roughened, and initially is sorrel, turning gray-black with age. The margin is thin. Interior tissue is hard, red-brown, 1-3 mm thick. The hymenophore has large winding, labyrinth-shaped pores covered with gray, fur-like mycelium. Decayed heartwood is initially light-purple and later red-brown. Decay develops rapidly and wood typically becomes mottled with well-defined pockets of white cellulose.

Biology
Infection occurs by windborne basidiospores through broken dead branches, scars, and other wounds. Trees 40 years old or older can be infected. Basidiocarps form on trees about 10 years afer infection. Disease occurs in a range of growth conditions and incidence increases with age.

Damage
Affected trees are weakened at the ground line and break mostly in response to wind. Decay can affect 50 percent of butt log volume, destroying most of the merchantable wood. Damage in spruce stands ranges from 10-15 percent.

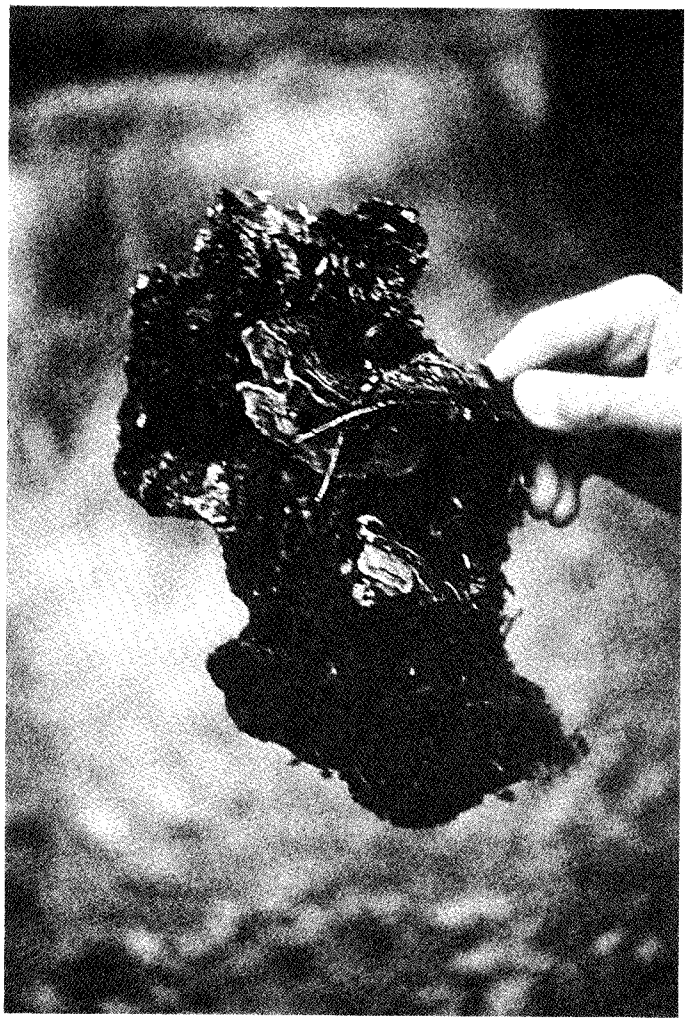

Figure 43.—Basidiocarps of *Phellinus chrysoloma* on spruce (*Picea abies*) bark.

Distribution
European part of Russia, Urals, Siberia, Far East

Control
Cultural
- Thin young stands to create biologically sustainable stands with optimal density.
- Conduct regular sanitation cuts in mid-rotation and maturing stands; remove dead and windthrown trees and/or low-vigor trees with fungal basidiocarps.
- Minimize tree wounds during tending practices.
- Regulate populations of hoofed animals, primarily elk (*Alces alces*), foraging in the forests.
- Remove basidiocarps and treat cavities in trees in parks and urban forests.

♦♦♦

Pathogen
Onnia triqueter (Lentz.:Fr.) Imaz. (syn. *Polystictus circinatus* (Fr.) P. Karst. var. triqueter Bres.)

Host
Primarily species of spruce (*Picea*) but also larch (*Larix*) and pine (*Pinus*)

Diagnosis
Basidiocarps are annual, cap-like, with or without a short stalk, and occur individually or in clusters. The caps are thin, flat, yellow-brown, with sharp margins, and hairy when young. Interior tissue is dark-brown. The hymenophore is tubular. Tubes are short, with small gray or brown pores. Basidiocarps occur on the trunk about 70 cm above ground. On severely decayed trees, basidiocarps

Figure 44.—Basidiocarps of *Phellinus hartigii* on fir (*Abies sibirica*).

can be at 1.5 m on the trunk. The fungus causes heartwood or heartwood/sapwood decay, which usually moves both downward into the roots and 2 to 4 m up the stem. Resin exudation often occurs on diseased trees. Initially, affected wood is yellow. Light-brown spots and pockets with white mycelium form later. In final stage of decay, the wood has pocket-fibrous structure.

Biology
Infection occurs by basidiospores at wounds on dead broken branches and scars in the root-stem base. Major basidiospore production and spread occurs from May to September. Overmature spruce stands are the most seriously affected.

Damage
Causes susceptibility to windthrow and breakage. Merchantable wood in the butt log is destroyed and commercial losses range from 17-50 percent.

Distribution
European part of Russia, Urals, Siberia, Far East

Control
- Conduct sanitation cuttings to remove infected and dead trees.
- Minimize damage to the trunk and roots during fellings.

♦ ♦ ♦

Pathogen
Phellinus hartigii (Allesch. et Schnabl.) Pat.

Host
Primarily species of fir (*Abies*) but also spruce (*Picea*) and pine (*Pinus*)

Diagnosis
Basidiocarps about 4-15(L) x 8-28(W) x 8-20(T) cm are perennial, hard, hoof-shaped, with thickened-rounded margins sometimes with wide concentric zones and radial cracks. The surface is yellow-brown, often gray or black with light edges (**Fig. 44**). The hymenophore is tubular, rusty-brown, with inconspicuous round pores. Tubes are stratified, with layers of sterile mycelium between stratums. Interior tissue of the basidiocarp is rusty-brown and woody. Heartwood and sometimes sapwood is

Figure 45.—Wood decay on a broken fir tree (*Abies sibirica*) caused by *Phellinus hartigii*.

decayed. Affected wood initially is red-brown, later turning dark-pink. Dark-brown conglomerations of mycelium form under the bark. In later stages of decay, the wood turns light-yellow and is soft and fibrous (**Fig. 45**).

Biology
Infection is by windborne basidiospores that penetrate tree tissues through broken dead branches or various mechanical bark injuries or canker wounds, including those caused by the rust fungus *Melampsorella cerastii* Wint. Infection occurs in mature and overmature stands over a range of site conditions.

Damage
Decay weakens the root-stem base and promotes wind breakage. It can spread up to 8 m in the stem and significantly reduces the volume of merchantable wood. Decay in fir stands ranges from 10-70 percent depending on the region in Russia.

Distribution
Southeastern area of the European part of Russia, Urals, Siberia, Far East

Control
Cultural
- Conduct sanitation cuttings in midrotation and older stands.
- Remove felling residue and windthrown timber.

♦♦♦

Pathogen
Fomitopsis officinalis (Will.) Bond. et Sing.

Hosts
Primarily species of larch (*Larix*), pine (*Pinus*), especially Siberian (*Pinus sibirica*), and fir (*Abies*)

Diagnosis
Basidiocarps about 3-15 x 5-30 x 4.5-26 cm are perennial, hoof-shaped, or elongate cylindrical. The soft upper surface is white or yellow, sometimes with dark-gray areas, covered with cracks. Interior tissue is white or creamy and soft when dry. The hymenophore is yellow. Tubes are 5-10 mm long,

with inconspicuous, round or angular pores. Affected wood initially is light-brown but later turns dark-brown. In the final stage of decay, wide cracks associated with annual rings form in the wood. Creamy-white, thick, velvety mycelial sheets develop in the cracks. The decay is cubical rot. It develops primarily in the heartwood but can colonize sapwood. It can spread 15-20 m upward in the trunk.

Biology
Infection occurs by basidiospores that penetrate tree tissues through broken dead branches and various trunk injuries. Trees more than 30 years old are affected. The disease level increases with age. The fungus affects living trees but can continue developing and remain on dead trunks and stumps for extended periods. The disease occurs over a range of site conditions.

Damage
Trees are weakened at the root-stem base and break at the ground line during windstorms. Most of the diseased trees have dead tops. Damage in larch stands ranges from 5-10 percent.

Distribution
Urals, Siberia, Far East

Control
Cultural
- Conduct sanitation cuttings to remove weakened, dying, and dead trees.

♦♦♦

Pathogen
Fomitopsis pinicola (Sw. et Fr.) Karst.

Hosts
Primarily species of fir (*Abies*), larch (*Larix*), spruce (*Picea*), and pine (*Pinus*); also birch (*Betula*), lime (*Tilia*), alder (*Alnus*), and European aspen (*Populus tremula*)

Diagnosis
Basidiocarps are perennial, hoof-shaped, with a cushion-like or flat bottom. They differ in size but can reach 0.5 m in diameter. The upper surface of the young basidiocarp is yellow-red or rusty but with age turns red-brown to nearly black with a slightly shiny crust. The margin is edged by a yellow, bright-red, or dark-cherry band. The hymenophore is yellow-white, tubular, with relatively large, round pores. The interior tissues are light-yellow and corky or woody. Decay begins in the sapwood of the stem and spreads rapidly to the central core where it spreads slowly up the trunk. In the early stage of decay, wood is yellow-brown with a silky sheen; later, white stripes of fungal hyphal form in the wood. In the final stage of decay, wood turns dark-brown with numerous cracks filled with white sheets of mycelium. The decay is a typical cubical rot.

Biology
Infections of living trees occur primarily at wounds from mechanical injury. Basidiocarps form several years after infection.

Damage
Primarily a saprotroph but can cause significant economic loss in logs left in cutting areas or stored in timber yards. The fungus decomposes wood on the forest floor, accelerating the return of nutrients to the soil. Occasionally, the fungus infects living, weakened trees, predisposing them to wind breakage. Proportion of infected trees in a stand rarely exceeds 3 percent.

Distribution
Throughout Russia except deserts, semideserts, and tundra

Control
- Prompt removal of harvested wood from the forest.

Class/Order: Basidiomycetes/Agaricales

Pathogen
Pholiota adiposa (Fr.:Fr) Kumm.

Hosts
Primarily species of fir (*Abies)*, spruce *(Picea)*, pine *(Pinus)*, and larch *(Larix)*; also alder (*Alnus*), birch (*Betula*), beech (*Fagus*), poplar (*Populus*), and lime (*Tilia*)

Diagnosis
Basidiocarps are annual, cap-shaped, 4-15 cm in diameter, with a central or lateral stalk, 2-3 cm, often forming in clusters (**Fig. 46**). Caps are round, usually convex, with central hillock, and fleshy. The upper surface is sticky, golden-yellow or brown-yellow, with rare brown scales that disappear with time. Interior tissue is yellow-white. The hymenophore has gills that are dense, wide, and brown-yellow. The stalk is compact, white, darker and thicker in the lower part, with membranous rings and scales. Decay develops in the heartwood and spreads in the butt part of the stem up to 5 m and sometimes penetrates the roots. In the early stage of decay, wood appears yellow, and then turns brown. Small pockets and narrow channels with rusty-brown mycelium form in the wood. Cavities sometimes form in the final stage of decay.

Biology
Infection occurs by basidiospores through broken branches and stem injuries. In fir stands, the fungus penetrates into tree tissues primarily through wounds caused by the canker fungus *Melampsorella cerastii* Wint. Stands affected by the fungus range from 10-50 percent.

Damage
Causes susceptibility to wind breakage. Trees are weakened when decay spreads to the roots.

Distribution
European part of Russia, Urals, Siberia, Far East

Control
Cultural
- Conduct timely sanitation cuttings to remove weakened, dying, and dead trees.
- Remove trees infected by *M. cerastii.*

Figure 46.—Basidiocarps of *Pholiota adiposa* on the trunk of a spruce (*Picea abies*).

Figure 47.—Basidiocarps of *Laetiporus sulphureus* on the trunk of a larch (*Larix sibirica*).

Trunk and Limb Rot of Hardwoods

Class/Order: Basidiomycetes, Aphyllophorales

Pathogen
Laetiporus sulphureus (Bull.) Bond. et Sing.

Host
Primarily hardwoods species of maple (*Acer),* chestnut *(Castanea),* beech *(Fagus),* poplar *(Populus),* lime *(Tilia),* willow *(Salix),* and oak *(Quercus);* some conifers species of fir *(Abies),* larch *(Larix),* spruce *(Picea),* and pine *(Pinus)*

Diagnosis
Basidiocarps are annual, usually in clusters, often with a common base (**Fig. 47 and 48**). Individual basidiocarps have flat to slightly round caps about 10-40 cm in diameter and 1-4 cm thick. Initially, they are soft and fleshy but later become hard and brittle. The upper surface is light-yellow or pink-orange; interior tissues are light-yellow, almost white. The hymenophore is tubular and gray-yellow. Tubes, about 4 mm long, have round openings initially but later become angular. Decay develops in the healthy part of the trunk. It usually is found in the lower 2-3 m but can extend upward to 15 m. In the early stage of decay, wood is pink with thin, white streaks and dots. Later it turns dark red-brown, develops cracks in annual rings, and typically becomes cubical. Compact, velvety, yellow-white mycelial sheets are formed in the cracks.

Biology
Infection occurs by basidiospores through broken branches, wounds, and burn scars, primarily on mature and overmature trees. The basidiocarps develop from early to midsummer and begin sporulating. By autumn, most are destroyed by insects that inhabit them. The fungus attacks living trees but can continue to develop for 2 to 3 years after tree death. Basidiocarps are produced abundantly in high humidity.

Damage
Decay develops in trunks of living trees, causing weakening at the root-stem base and predisposing trees to wind breakage. Trees may dieback and become hollow. Decay in oak stands affected by the

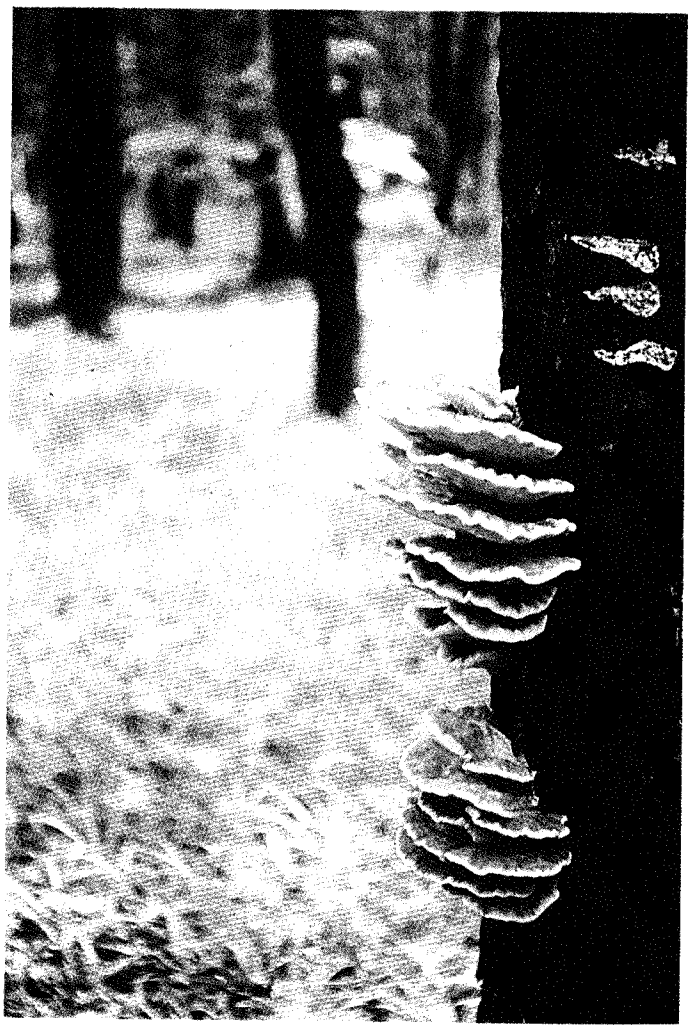

Figure 48.—Basidiocarps of *Laetiporus sulphureus* on the trunk of an oak (*Quercus robur*).

fungus occurs in 10-50 percent ot the trees; up to 20 percent of larch stands are affected. Commercial wood losses can exceed 20 percent.

Distribution
European part of Russia, Urals, Siberia, Far East

Control
Cultural
- Conduct sanitation cuttings to remove trees with basidiocarps, as well as dying and dead trees.

♦ ♦ ♦

Pathogen
Inonotus dryophilus (Berk.) Murr.

Host
Species of oak (*Quercus*)

Diagnosis
Basidiocarps, 5-12 x 6-18 x 3-8 cm, are annual, usually hoof-shaped, initially soft and then hard (**Fig. 49**). The upper surface of a young basidiocarp is bright-yellow but with age turns a dark rusty-brown or red-brown. The surface is rough initially but is smooth when mature. The interior tissue is fibrous, light- to dark-brown with a silky shine, about 3 cm thick.

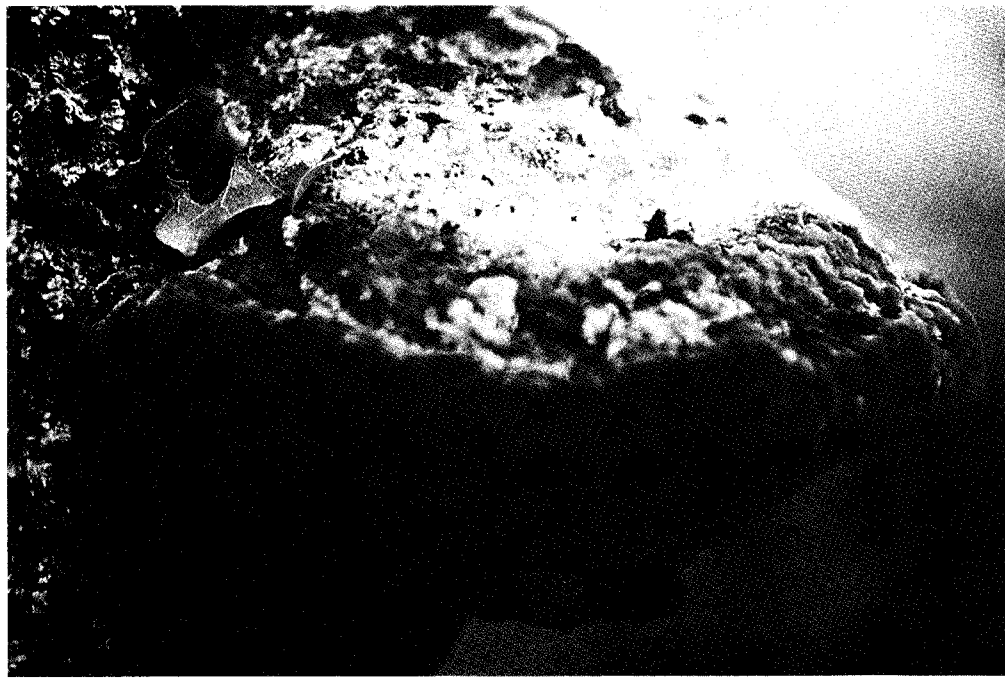

Figure 49.—Basidiocarp of *Inonotus dryophilus* on the trunk of an oak (*Quercus robur*).

The hymenophore is tubular. The tubes are about 0.5-2.5 cm long, brown or rusty-brown, with round or angular openings. Basidiocarps usually appear in June and are soon destroyed by insects. Decay develops in heartwood. Initially, brown spots appear in the infected wood, cellulose masses form in them later and the wood becomes mottled with white spots and elongate lines. In final stage of decay, wood becomes spongy and fibrous.

Biology
Infection is initiated by basidiospores that infect tree tissues through broken dead branches, frost cracks and mechanical injuries. The fungus is characterized as a prolific sporulator. Basidiospores mature and spread from June to October. High temperature and low humidity favors sporulation and dispersion. Oaks are affected at 40 years of age and older.

Damage
Causes crown dieback and radial increment losses. Decayed trees in affected oak stands range from 1-80 percent. Commercial wood losses can reach 70 percent.

Distribution
European part of Russia, Urals, Far East

Control
Cultural
- Create mixed hardwood stands.
- Conduct sanitation cuttings and remove dying and dead trees and trees with basidiocarps and scars.
- Conduct cuttings in October-May to minimize mechanical injury.

♦ ♦ ♦

Pathogen
Phellinus robustus (P. Karst.) Bourd. et Galz.

Hosts
Species of oak (*Quercus*), maple (*Acer*), buckeye (*Aesculus*), and hazel (*Corylus*)

Diagnosis
Basidiocarps are perennial, woody, cushion- or hoof-like, with a thick, wide, rusty margin, about 5-25 cm in diameter and up to 10 cm thick. The upper surface is dark-gray, nearly black, with wide concentric rings and cracks. Interior tissue is rusty-brown, woody, with concentric stripes. The hymenophore is poroid, rusty-yellow. Tubes, lighter in color than surrounding tissues, are about 2-5 mm long, with round openings. Infected wood turns brown and later becomes mottled with lighter flecks. In the final stage of decay, wood is yellow-white with thin, black, parallel lines. Rusty-orange mycelial masses often form in infected wood. The rot is primarily in heartwood but can spread to the sapwood.

Biology
Infection is initiated by basidiospores that mature and spread from June to October. High humidity favors sporulation and dispersion. Basidiospores infect tree tissues through broken dead branches, frost cracks, injuries from hoofed animals, e.g., elk, and mechanical injuries. Stand are affected at 20-30 years of age, infection and damage increase with age. Disease levels are highest in coppiced stands.

Damage
Causes tree weakening, partial crown decline, and wind breakage. Commercial wood losses range from 30-40 percent. Affected oak in stands range from 5-15 percent.

Distribution
European part of Russia, the southen Urals, Western Siberia, Far East

Control
Cultural
- Create mixed hardwood stands.
- Conduct timely thinnings to maintain optimal density.
- Conduct sanitation cuttings and remove all trees with large wounds/scars.
- Conduct cuttings in November-May when sporulation is scarce or absent.

♦♦♦

Pathogen
Phellinus igniarius (L.: Fr.) Quel.

Hosts
Species of maple (*Acer*), birch (*Betula*), hornbeam (*Carpinus*), buckeye (*Aesculus*), ash (*Fraxinus*), willow (*Salix*), lime (*Tilia*), elm (*Ulmus*) {forms: *f. igniarius* on willow (*Salix*), *f. sorbi* on mountain-ash (*Sorbus*), *f. betulae* on birch (*Betula*), *f. resupinatus* on birch (*Betula*), alder (*Alnus*), and mountain-ash}

Diagnosis
Basidiocarps are perennial, woody, hoof-shaped, with a flat or cushion-like bottom, more rarely resupinate, and 3-25 x 2-16 x 1.5-12 cm (**Fig. 50**). The upper surface is dark-gray, sometimes nearly black, with concentric rings. The hymenophore is rusty-brown with inconspicuous round pores. Tubes are stratiform, 3-5mm long, and become overgrown by white mycelium with age. Decay develops in heartwood of trunks. Affected wood is initially red-brown but later turns light-yellow and is separated from healthy wood by a thin, dark-brown ring (**Fig. 51**). A characteristic feature of the decay is the presence of winding black lines that spread as concentric circles in the affected part of wood. The extension of decay up the stem can vary but often occurs the entire length.

Biology
Infection is initiated by basidiospores. Mass sporulation occurs in early summer. Spores penetrate tree tissues mostly through dead limbs but also through bark scars. Trees are infected when they are 20-30 years old. The disease level increases with age. Timely diagnosis is difficult because the decay often develops with no external symptoms, basidiocarp formation, or signs of tree weakening.

Damage
Primarily commercial wood losses that range from 60-100 percent

Distribution
Throughout Russia

Figure 50.—Basidiocarp of *Phellinus igniarius* f. *betulae* on the trunk of a birch (*Betula pendula*).

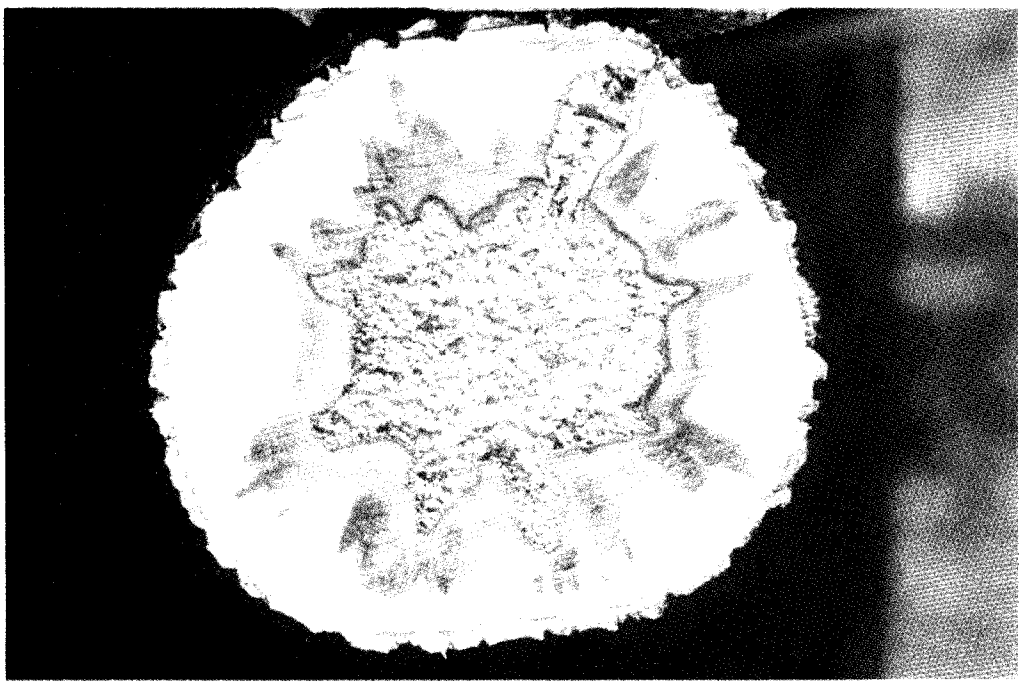

Figure 51.—Decay on birch (*Betula pendula*) caused by *Phellinus igniarius*.

Control
Cultural
- Conduct thinnings to maintain a high stem density, especially in young stands, and to promote intensive natural branching shedding.
- Conduct sanitation cuttings and remove trees with basidiocarps.

♦♦♦

Pathogen
Phellinus tremulae (Bond.) Bond. et Borisov.

Host
European aspen (*Populus tremula*)

Diagnosis
Numerous basidiocarps usually form on the affected stems. They are perennial, woody, often hoof-shaped, flat or cushion-like, more rarely resupinate, about 12 x 7 x 4 cm. The upper surface is dark-gray, sometimes nearly black, cracked, with concentric ridges. Interior tissue is rusty-brown and woody. The hymenophore is red-brown. Tubes are brown and 2-4 mm long. They become filled with white mycelium with age. Decay is separated from the healthy wood by a narrow dark-gray ring, about 1.5 cm wide. A green-brown zone about 1.5 cm wide usually forms around this ring. Rusty mycelial masses sometimes form in the decayed part of the trunk. Stems become hollow in the final stages of wood decomposition. Decay develops primarily in the middle of the trunk and then spreads to the upper part of the stem and branches, and to the lower part of the stem and roots.

Biology
Infection is initiated by basidiospores released early in the growing season. The main infection courts are dead, partly decomposed branches. More rarely infection occurs through trunk injuries; infection is enhanced if the wound is fresh. Decay develops gradually; the first symptoms appear in wood 2 to 3 years after infection and decay develops most actively in the next several years. The fungus produces basidiocarps 4 to 5 years after infection. In 30- to 40-year old aspen stands, suppressed and stunted trees are affected. Effects of decay increase with stand age. Mature stands are characterized by an accumulation of damage from wind and snow breakage of decayed branches and stems.

Damage
Causes snow and wind breakage, which increases with age. Infected trees in mature aspen stands range from 60-100 percent. Commercial wood losses range from 50-100 percent.

Distribution
European part of Russia, Urals, Siberia, Far East

Control
- Use decay-resistant aspen clones.
- Create mixed stands with other hardwood species.
- Conduct thinnings to maintain optimal growth.
- Conduct sanitation cuttings to remove weakened, dying, and dead trees, particular those with basidiocarps.

♦♦♦

Pathogen
Inonotus obliquus (Pers.:Fr.) Pil.

Hosts
Primarily species of birch (*Betula*) and alder (*Alnus*) but also maple (*Acer*), beech (*Fagus*), ash (*Fraxinus*), and mountain-ash (*Sorbus*)

Diagnosis
The characteristic feature of the disease is the formation of large sterile conks on living trunks (**Fig. 52**). Conks are black, hard, and woody, with numerous deep fissures. Interior tissue is primarily hard and rust-brown, but can be soft and light-brown with narrow yellow lines. Conks often arise at broken branches and mechanical and other trunk injuries. After tree death, basidiocarps develop under the bark near the sterile conks. They are resupinate, thin, brown, with a tubular hymenophore, can be 3-4 m long and 40-50 cm wide, and decompose quickly.

Figure 52.—Sterile conk of *Inonotus obliquus* on the trunk of a birch (*Betula pendula*).

Biology
Basidiocarps form under the bark and basidiospores are dispersed. Spores penetrate tree tissues through frost cracks, broken branches, and other bark injuries. Mycelium penetrates through the sapwood to the heardwood where active decay develops. Trees 40 years old and older are affected.

Damage
Decay results in significant wind breakage. Affected birch and alder range from 1-5 percent but can reach 20 percent.

Distribution
European part of Russia, Urals, Siberia, Far East

Control
- Conduct sanitation cuttings and remove obviously infected trees with conks.

♦ ♦ ♦

Pathogen
Fomes fomentarius (L.:Fr.) Gill.

Hosts
Primarily species of maple (*Acer*), alder (*Alnus*), beech (*Fagus*), ash (*Fraxinus*), chestnut (*Castanea*), poplar (*Populus*), oak (*Quercus*), willow (*Salix*), lime (*Tilia*), and birch (*Betula*)

Diagnosis
Basidiocarps are perennial, hoof-shaped, often more flat or almost hemispherical, 5-20 x 10-40 x 2-20 cm (**Figs. 53-54**). The upper surface is light-gray, sometimes yellow, more rarely dark-gray, smooth, with concentric ridges. Interior tissue is yellow-brown, velvety, compact. The hymenophore is light-rust, tubes are 2-10 mm long, initially gray and then yellow, with round pores filled by white mycelium with age. Decay develops in sapwood and later spreads to heartwood. Affected wood is initially brown but later turns light-yellow, almost white, with numerous black and dark-brown streaks and winding lines (**Fig. 55**). In the final stages of decay, wood becomes light in weight, separates into thin plates along the annual rings, and then becomes stringy and turns to dust.

Biology
Infection is initiated by basidiospores at points of broken dead branches, physical wounds, fire wounds, and other bark injuries. Sporulation occurs from June to September. Decay develops rapidly and by the time basidiocarps are formed, trees are broken easily by wind.

Damage.
Decay results in wind breakage. Volume loss ranges from 5-15 percent and depends on stand age and composition. Commercial wood losses can reach 100 percent.

Distribution
Throughout Russia

Control
Cultural
- Conduct timely sanitation cuttings along with thinning operations.
- Routinely remove dead trees and branches.
- Use standard arboricultural practices to stabilize hollow trees in parks, arboretums, and other areas with valuable stands.

♦♦♦

Pathogen
Polyporus squamosus (Huds.:Fr.) Fr.

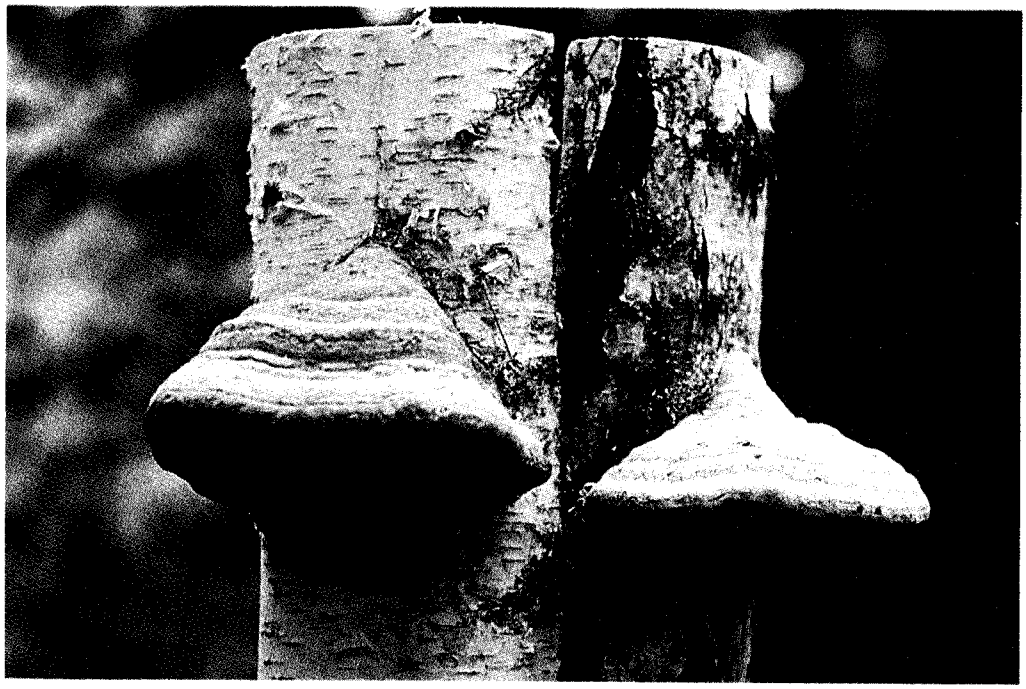

Figure 53.—Basidiocarps of *Fomes fomentarius* on the trunk of a birch (*Betula pendula*).

Figure 54.—Basidiocarps of *Fomes fomentarius* on the trunk of a fir (*Abies sibirica*).

Hosts
Primarily species of maple (*Acer*), birch (*Betula*), poplar (*Populus*), oak (*Quercus*), elm (*Ulmus*), and beech (*Fagus*)

Diagnosis
Basidiocarps are annual, 5-50 cm in diameter and 5-10 cm thick, with slightly bent margins, usually on a lateral stalk. The upper surface is slightly depressed, yellow, with large brown scales. The stalk is stout, brown, with a black base. Fresh basidiocarp tissue is white and soft, but after drying turns yellow and becomes brittle. The hymenophore is tubular; tubes are about 1-2 mm long, with large angular pores. Decay occurs mainly in heartwood but can spread to sapwood. It usually develops in the lower part of the trunk but can develop in the roots. In the advanced stage of decay, wood becomes white, often with dark lines, with numerous cracks. In the final stage, affected wood separates into plates and crumbles easily.

Biology
Infection is initiated by basidiospores from basidiocarps that form in midsummer, particularly during years with heavy precipitation. Sporulation also occurs at this time. Spores penetrate tree tissues through injuries such as frost cracks and mechanical wounds. The disease affects older forest trees and is widespread in urban forests.

Damage
Affected trees gradually weaken but few die. Affected trees in stands rarely exceed 5 percent as the fungus mostly decays wood in timber yards.

Distribution
European part of Russia, Urals, Far East

Control
Cultural
- Conduct sanitation cuttings to remove weakened trees.
- Minimize mechanical injuries of trunks during cuttings.
- Remove basidiocarps from trees in parks and street plantings before sporulation.

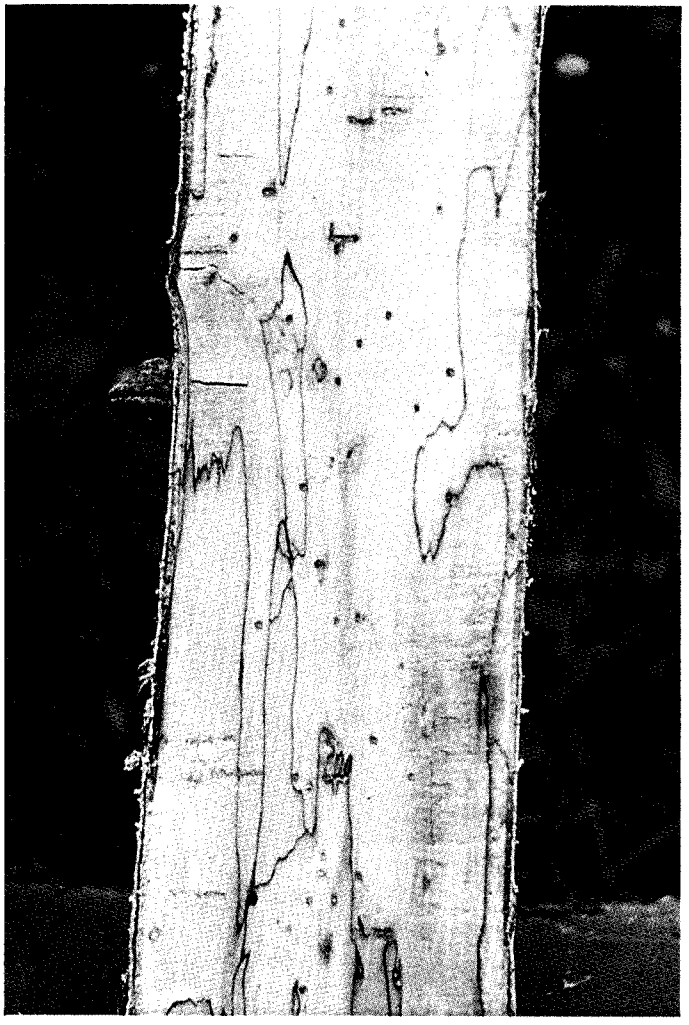

Figure 55.—Initial stage of decay in birch (*Betula pendula*) caused by *Fomes fomentarius.*

Pathogen
Oxyporus populinus (Schum. ex Fr.) Donk.

Hosts
Primarily species of maple (*Acer*), ash (*Fraxinus*), poplar (*Populus*), oak (*Quercus*), mountain-ash (*Sorbus*), lime (*Tilia*), birch (*Betula*), and elm (*Ulmus*)

Diagnosis
Basidiocarps are perennial and occur in clusters on a common base or, more rarely, individually. They are small, 5-15 x 3-5 x 1-2 cm, and have caps with a white, yellow-gray or black upper surface that is covered with green moss. Basidiocarps can be semiresupinate. Interior tissue is white or light-yellow, corky to woody, 2-6 mm thick. The hymenophore is poroid, yellow-white. Tubes are white or yellow, 2-4 mm long, with round or angular pores. In the initial stage of decay, wood is green-brown but later turns a lighter yellow. In the advanced stages, wood breaks apart along the rays. Trunk cavities often form in affected trees. Decay columns can be 5-7 m long but occasionally spread up the entire stem and penetrate the larger branches.

Biology
Infection occurs by basidiospores through frost cracks, dead branch stubs, and mechanical injuries mainly on the lower part of the trunk. The fungus can develop on stumps and woody debris on the forest floor; these can be inoculum sources.

Figure 56.—Basidiocarps of *Daedalea quercina* on an oak (*Quercus robur*) stump.

Damage
Trees are affected in the middle or lower part of the trunk; decay results in cavities and affected trees are susceptible to wind breakage. Infected trees, especially in parks, can reach 80 percent. Decay in the stem base causes commercial wood losses.

Distribution
European part of Russia, middle part of Urals, Siberia, Far East

Control
Cultural
- Conduct sanitation cuttings to remove infected trees.
- Remove woody debris.
- Treat tree cavities in parks and forest parks.

♦ ♦ ♦

Pathogen
Daedalea quercina (L.) Fr.

Hosts
Primarily species of oak (*Quercus*) but also beech (*Fagus*) and chestnut (*Castanea*)

Diagnosis
Basidiocarps are perennial, with flat caps, thickened on the base, broadly attached to the trunk, 4-12 x 6-20 x 2-5 cm (**Fig. 56**). The upper surface is light-brown or gray, smooth, with concentric zones. The hymenophore is labyrinth-like. Interior tissue is corky when young but woody with age. Decay develops in the lower part of the trunk and spreads upwards at least 3 m. Decayed wood is dark-brown with a gray shade. In the final stages of decay, narrow cracks form along rays and the wood separates into thin plates. Yellow-gray mycelial sheets develop in the cracks.

Biology
The fungus primarily invades stumps and freshly cut wood but can infect living trees. Infection is initiated by basidiospores through various injuries in the lower part of trunk. Sprouts can be infected not only by basidiospores but also by mycelium developing on the parent stumps. Weak, old and injured trees are most commonly affected.

Damage
Losses of commercial wood volume can reach 8 percent.

Distribution
European part of Russia, the southen Urals, Far East

Control
Cultural
- Conduct sanitation cuttings to remove weakened, dying, and dead trees.
- Remove cut wood from the forest.
- Restrict grazing in forest stands.

♦♦♦

Pathogen
Piptoporus betulinus (Bull.: Fr.) Karst.

Hosts
Birch species (*Betula*)

Diagnosis
Basidiocarps are annual, round or bud-shaped, with a slightly convex upper surface and a blunt rounded margin, with or without a rudimentary lateral stalk, 4-20 x 5-20 x 2-6 cm (**Fig. 57**). The upper surface is smooth, light -brown or gray, with a thin outer layer. Interior tissue is white, homogeneous, soft-corky. Hymenophore tubes initially are white but darken with age. They are 2-8 mm long. Decay develops in both sapwood and heartwood. In the first stage of decay, wood is yellow-brown and later turns red-brown; cracks develop in radial and tangential directions. Cream-white mycelial sheets can arise in the cracks. In the advanced stage, wood is typically cubical. Decay in the main stem can extend upwad to 10 m.

Biology
Infection occurs by basidiospores that penetrate tree tissues through broken branches and other wounds. Basidiocarps form from mid summer to autumn and are often quickly destroyed by insects. The disease occurs as a rule on sites unfavourable to birch but also on sites that have burned.

Damage
Decay predisposes trees to wind breakage; commercial wood losses can reach 100 percent.

Distribution
European part of Russia, Urals, Siberia, Far East

♦♦♦

Pathogen
Inonotus dryadeus (Pers.: Fr.) Murrill

Hosts
Nordmann fir (*Abies nordmanniana*) and species of chestnut (*Castanea*), beech (*Fagus*), and oak (*Quercus*)

Diagnosis
Basidiocarps are large, 30 to 40 cm in diameter, annual, cushion-like or flat, with a rounded thick margin. The upper surface is yellow-gray, gray-brown or dark-brown; margins often are lighter. The surface is irregular, rough, sometimes velvety. Hymenophore tubes are about 1.5 cm long and gray-brown; pores are small, round, or angular. The basidiocarp edge and hymenophore secrete yellow-brown drops of liquid. Interior tissue is stratiform, rusty-brown, with a silky shine. Basidiocarps form at the base of affected trees. In the early stage of decay, wood is brown but later turns yellow-white and becomes stringy.

Biology
Tree infection occurs by basidiospores through dead or damaged roots. Infection is common in mature and overmature stands; suppressed trees are the most susceptible.

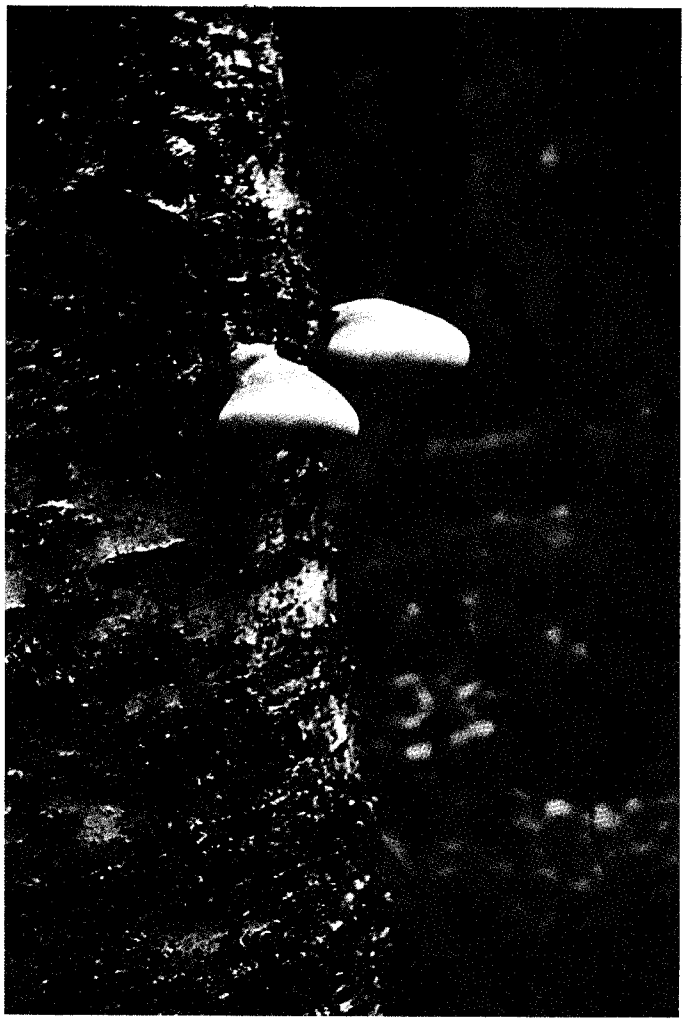

Figure 57.—Basidiocarps of *Piptoporus betulinus* on the trunk of a birch (*Betula pendula*).

Damage
Weakens trees but rarely kills them. Affected trees are susceptible to windthrow and wind breakage.

Distribution
Middle and southern areas of European part of Russia, southern Urals, Far East

Control
Cultural
- Conduct timely sanitation cuttings and thinnings.
- Maintain optimal stand density.
- Create mixed stands on favorable growing sites.

♦♦♦

Pathogen
Ganoderma applanatum (Pers.) Pat.

Hosts
Primarily species of maple (*Acer*), hornbeam (*Carpinus*), birch (*Betula*), poplar (*Populus*), willow (*Salix*), and lime (*Tilia*); also fir (*Abies*) and Siberian pine (*Pinus sibirica*)

Diagnosis
Basidiocarps are perennial, large (up to 40 cm in diameter), flat, semicircular, with relatively thick caps without stalks, sometimes hoof-shaped, and occur more often singly than in clusters (**Fig. 58**). The

Figure 58.—Basidiocarps of *Ganoderma applanatum* on the trunk of an aspen (*Populus tremula*).

upper surface is dull, chocolate-brown, sometimes gray-brown, usually irregular, rough or with concentric ridges, thin, and hard. Interior tissue is corky or velvety, brown, usually soft. The hymenophore, about 0.5-1.5 cm thick, is white initially but then turns brown. Decay begins in the heartwood and is light-yellow, with elongate pockets filled by white mycelium; later, the decay spreads to sapwood. In the final stages, wood turns white and becomes fibrous; tree cavities are common.

Biology
The fungus is found primarily on stumps and dead trees but can attack living trees. Trees can be infected through wounds to the roots and base of the trunk. Mycelium spreads in roots and the butt log. Infection occurs predominantly in mixed conifer-deciduous forests.

Damage
Causes susceptibility to windthrow and wind breakage. The disease is serious in urban and forest parks and urban plantations.

Distribution
European part of Russia, Urals, Far East

Control
Cultural
- Conduct timely sanitation cuttings to remove weakened, dying, and dead trees.
- Treat tree cavities in urban and park settings.

Fungal Diseases that Occur Only in Russian Forests

Diseases of Fruits and Seeds

Thecopsora Rust of Spruce Cones

Class/Order: Basidiomycetes/Uredinales

Pathogen
Thecopsora padi (Kze. et Schm.) Kleb. (syn. *Thecopsora aleolata* (Fr.) Magn.)

Hosts
Species of spruce (*Picea*), including Norway (*Picea abies,)* Siberian black *(P. obovata),* Finnish *(P. fennica)* and Caucasian *(P. orientalis);* alternate host is bird cherry *(Padus avium)*

Diagnosis
Infected cones darken and scales open widely. Aecia of the fungus develop on the inside surface of the cone. Initially, they are orange-brown but later turn dark-brown. Aecia are numerous, closely packed, globose, 1-2 mm in diameter, powdery, white and round or oblong, and occur in groups. Aeciospores are egg-shaped or round, yellowish, with a thick cover. Uredinia form on the lower surfaces of bird cherry leaves. Urediniospores are globose, egg-shaped, elliptical, colorless, 15.5-27 x 14-17.5 µ. Telia form on both surfaces of the leaf, but mainly on the upper surface. They are violet- or dark-brown, angular, crust-like. Teliospores are round or angular, 16-23 x 14-25 µ, with a light-brown cell wall.

Biology
This is a heteroecious, macrocyclic rust. Spermogonia and aecia develop on *Picea* cones, and uredinia and telia develop on *Padus* leaves. The pathogen overwinters in the teliospore stage on fallen leaves of *Padus.* In spring, basidia and basidiospores are produced and the spores infect young cones. Spermogonia form on the outside of cone scales in June. Later, aecia develop on the inside surfaces of the scales. Mature aeciospores infect *Padus* leaves. In late summer and autumn, urediniospores and then teliospores develop on them. The disease occurs in spruce stands where *Padus* species are common. Infection of cones is heaviest on trees growing in open stands.

Damage
Reduces the cone crop and hinders natural and artificial regeneration of spruce.

Distribution
European part of Russia, Urals, Siberia, Far East, Sakhalin, Kamchatka

Control
- Eliminate bird cherry near spruce seed plantations.

Acorn Mummification Deformity

Class/Order: Ascomycetes/Helotiales

Pathogen
Stromatinia pseudotuberosa Rehm.

Hosts
Species of oak (*Quercus*), including pedunculate (*Q. robur),* durmast *(Q. petraea),* and cork *(Q. suber)*

Diagnosis
Small, yellow-brown spots with sharp borders form on the cotyledons. These spots gradually enlarge, coalesce, and spread over the entire cotyledon. Gray, fungal mycelium forms on the surface of infected cotyledons. Interior cotyledon tissues turn dark. Eventually, the cotyledons become black, friable masses of sclerotial stroma. Affected cotyledons become enlarged and rupture the fruit coat, later separating from it. Apothecia (1 to 15) develop on the stromata. They are dark, 2-7 mm in diameter, on a stalk, 3-30 mm tall. Asci are cylindrical, 100-150 x 6-9 µ. Ascospores are oval or egg-like, colorless, 8-10 x 5-6 µ.

Biology
The fungus develops on acorns in natural forest environments as well as on acorns that are stored. In forest stands, acorn infection occurs by ascospores that are disseminated over most of the growing season. A portion of the acorn crop is infected on the tree, but most infection occurs after acorn drop. When healthy acorns contact previous-year acorns that are diseased, infection occurs by means of mycelium that penetrates acorn tissues through splits in the coat or through tracheal scars where the acorn was attached to the cup. In the forest, apothecia grow from the infected acorns the following year, but the sexual ascospore stage rarely forms. When humidity is high, the conidial stage develops on the uncovered stromata and conidia also can infect acorns. Disease development is most active during acorn storage, especially under improper storage conditions (high humidity-high temperatures). Mycelium develops on affected acorns and spreads rapidly to healthy ones.

Damage
Reduces acorn quality. Affected acorns lose germination power partially or completely. In storage, damage can reach 30 percent.

Distribution
European part of Russia, southern Urals, Far East

Control
Cultural
- Harvest acorns shortly after the shedding period.
- Collect acorns only from healthy and superior trees.
- Avoid mechanical injury during acorn harvesting and transportation.
- Dry acorns before storage; maintain temperatures below 5°C and good ventilation.
- Periodically sample stored acorns for presence of disease.

Chemical
- Apply fungicides (dust) before acorn storage.

Class/Order: Deuteromycetes/Melanconiales

Pathogen
Gloeosporium aucuparia Henn.

Host
Species of mountain-ash (*Sorbus*)

Diagnosis
Dark-brown or nearly black round spots form on the berries. Sporodochia are aggregated and resemble small, black cushions. Conidia are clavate or cylindrical, colorless, 7-14 x 3.5-4 µ.

Distribution
European part of Russia

Class/Order: Deuteromycetes-Hyphomycetales

Pathogen
Monilia linhartiana Sacc. (syn. *Ovularia necans* Pass.)

Host
Bird cherry (*Padus avium*)

Diagnosis
Initially small, later coalesced spots, 7-14 x 3.5-4 mm, form on the surface of berries. Gray, cushion-like conidiophores form on the spots in summer. In autumn, mycelium penetrates into the interior tissues; the berries turn black, become wrinkled, and fall or remain on the tree. In spring, apothecia, 3-7 mm in diameter on 2 cm stalks, form on infected berries. Conidia are spherical or lemon-like, 12-18 x 8-15 µ, and occur in chains that are colorless to gray in mass. Asci are cylindrically clavate, 200-260 x 17-19 µ. Ascospores are ellipsoid or egg-shaped, colorless, 17-18 x 9.5 µ.