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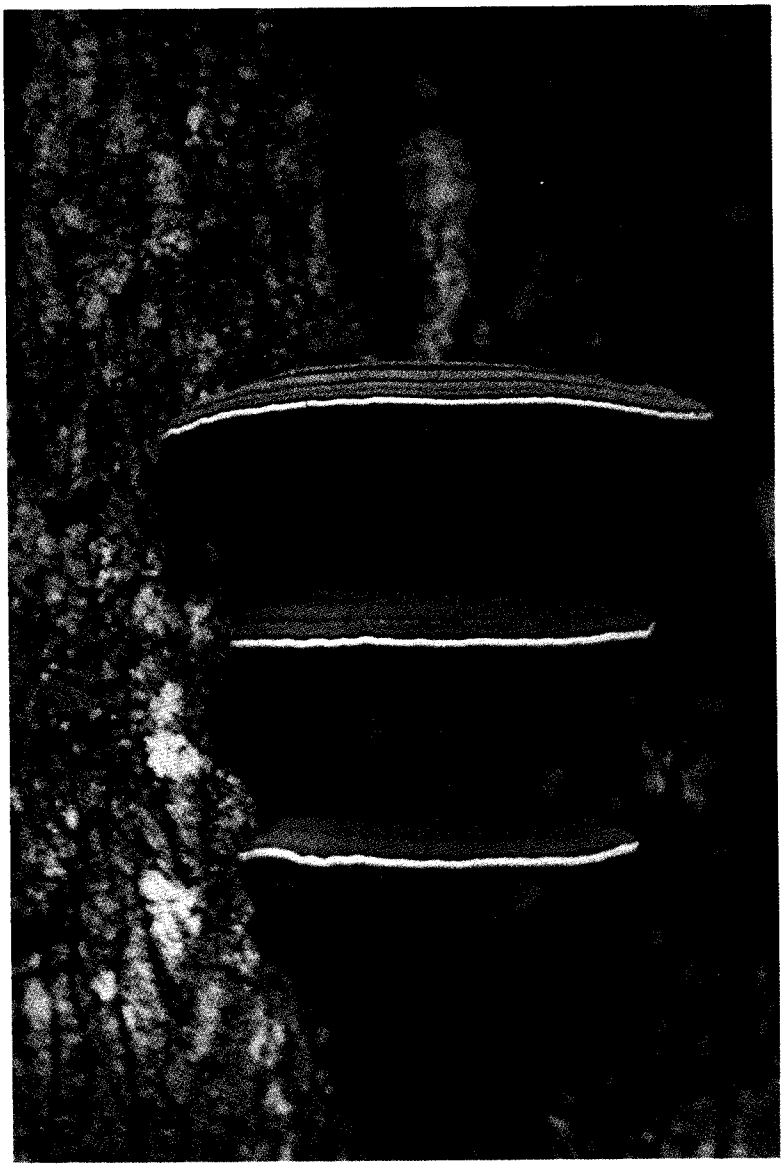
Common Fungal Diseases of Russian Forests

Evgeny P. Kuz'michev
Ella S. Sokolova
Elena G. Kulikova



Abstract

Describes common fungal diseases of Russian forests, including diagnostic signs and symptoms, pathogen biology, damage caused by the disease, and methods of control. The fungal diseases are divided into two groups: those that are the most common in Russian forests and those that are found only in Russia. Within each group, diseases are subdivided by plant organ attacked, i.e. fruit, seeds, leaves, needles, roots, stems, and branches.

The Authors

EVGENY P. KUZ'MICHEV is Corresponding Member of the Russian Academy of Agricultural Sciences, Professor (Ecology and Forest Pathology), Doctor of Biology. He was Deputy Chief, Federal Forest Service of Russia, when this project was initiated; he is currently Deputy Rector, International Independent University on Ecology and Politology, Moscow.

ELLA S. SOKOLOVA is Associate Professor (Forest Pathology) and Researcher, Department of Ecology and Forest Protection, Moscow State Forest University.

ELENA G. KULIKOVA was Associate Professor (Forest Protection), Department of Ecology and Forest Protection, Moscow State Forest University, when this project was initiatied; she is currently Division Head, Department of International Cooperation, Ministry of Natural Resources of the Russian Federation, Moscow.

Cover Photo

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

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Contents

Introduction

Contacts in forestry between Russia and the United States range from programs that exchange information and/or scientists to those associated with bilateral economic relations. Forest products and raw materials routinely cross the borders of the two countries, and a variety of phytopathogenic microorganisms can accompany them. Accidental introductions of forest insects and diseases can be unpredictable and result in serious damage to forested ecosystems. In the United States, the devastation caused by epiphytotics such as Dutch elm disease and Endothia cankers of chestnut has been well documented. These pathogens were introduced to North America from Europe. Less well known is the damage caused by blister rust of cork pine (*Pinus strobus*) caused by *Cronartium ribicola* Ditr., which was transported across Russia on host-plants. Today, this disease affects many five-needle pine species (e.g., *P. sibirica* and *P. strobus*), including endemic species of pine.

This publication is part of an effort to determine whether there are differences between pathogenic microflora of Russian and U.S. forests. Accordingly, we present descriptions of the most common fungal diseases of forest plants in Russia, including pathogenic fungi that are found only in Russian forests. Because there was no list of pathogenic fungi that affect forest plants in Russia, we had to summarize data from numerous, albeit highly regarded, sources. Also, not all fungi are fully described because some species have not been investigated completely. Nor is the area of distribution for certain fungi precise, as many species have been reported only in a single publication. Still other fungi are scattered throughout Russia. Among the fungal species not found in the United States are dangerous pathogens that could pose a serious threat to U.S. forest ecosystems as well as species whose role in Russia is insignificant.

Although many of the major fungi of Russia described in this report are familiar to the American forestry community, U.S. scientists and research foresters can gain an awareness of the current situation in Russian forests (most research papers on fungal diseases of forest trees are not available to forestry groups outside of Russia). Because the distribution of some diseases differs in different countries, causes can range from resistance of host-plants and environmental peculiarities to intraspecific, strain diversity of fungi and their properties.

Most Common Fungal Diseases of Russian Forests

Diseases of Fruits and Seeds

Seed quality exerts considerable influence on the health of seedlings in both artificial and natural forest regeneration. Fungal diseases reduce the quality and yield of fruits and thus seedling production in different regions of Russia. Fruit and seed pathogens differ significantly with respect to virulence and host specialization, development characteristics, and symptoms. Some diseases that develop during the summer change the shape, color, structure, or size of seeds and fruits. They are easily recognized when the latter are harvested. In the case of seed infection that occurs after maturity and dispersal, it is impossible to determine external disease symptoms during harvest. As a result, diseased seeds that are stored with healthy ones can serve as the source of inoculum for infection of healthy seeds.

Fungal infection of fruits and seeds can be internal, damaging the embryo and cotyledons, or external on the seedcoat. In the latter case, the seeds are not infected but the superficial mycelium can infect the germinating seedling. Fungal diseases cause partial losses of fruits and seeds. Sometimes an entire crop is lost. Most of these diseases reduce a seed's ability to germinate. Some diseases reduce germination power during storage or cause heavy damage and seed loss on growing trees. Other diseases delay the growth and development of seedlings.

Birch Seed Mummification

Class/Order: Ascomycetes, Helotiales

Pathogen
Sclerotinia betulae Woron.

Hosts
Species of birch (*Betula*)

Diagnosis
Sclerotia form as a black, horseshoe-shaped rim on the boundary between the seed's achene and wing. Affected achenes are dark. Germinating sclerotia produce funnel-shaped apothecia 1-4 mm in diameter, with tiny stalks 3-15 mm long. The outside surface of the apothecia is brown and the base of the stalk is covered with dark-brown hairs. A dirty-white or brown-yellow asci layer (hymenium) forms on the inside surface of the apothecia. Asci are cylindrical, 130 x 5-6 μ. Ascospores are oval, colorless, with a verrucose cover, 10-12 x 4.5 μ.

Biology
During the flowering period in spring, ascospores mature in apothecia on autumn-infected seeds. Ascospores are windborne to catkins and infect young seeds. Mycelium penetrates the seed tissues and then the wing; sclerotia are formed here. Apothecia form on sclerotia the following spring. The disease occurs primarily in birch stands. Single trees and groups of birches growing in open areas are rarely affected significantly, an important factor when harvesting seeds.

Damage
Reduces germination power, sometimes reducing seedling yields by 90-100 percent

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

Fruit Deformation

The form, color, and anatomical structure of fruits are affected. Seeds of affected fruits fail to develop or remain underdeveloped.

Class/Order: Ascomycetes, Taphrinales

Pathogen
Taphrina alni-incanae (Kuhn.) Magn.

Hosts
Species of alder *(Alnus)*, including European *(A. glutinosa)*, speckled *(A. incana)*, and Manchurian *(A. hirsuta)*

Diagnosis
Flowers and seed scales of young fruits become elongate, about 2 cm long, and vary in form. Asci with ascospores develop on these deformed parts.

Damage
Reduces seed production

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

♦♦♦

Pathogen
Taphrina johansonii Sad.

Hosts
Species of poplar (*Populus)*, including gray *(P. canescens)*, and Bolle's *(P. pyramidalis)*, and European aspen *(P. tremula)*

Diagnosis
Seeds enlarge to several times normal size. A yellow-orange layer of asci forms on the surface of affected seeds. Every ascus has 8 spores, but sometimes ascospores form buds and fill the sac.

Damage
Reduces seed production

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

♦♦♦

Pathogen
Taphrina rhisophorus Sad.

Host
White poplar (*Populus alba*)

Diagnosis
The seeds enlarge to several times normal size. A waxy, golden-yellow layer of asci with ascospores forms on the surface of affected seeds. Asci are elongate, clavate, thin on the base, 120-160 x 22 µ. Ascospores are globose, colorless, 4 µ.

Damage
Reduces seed production

Distribution
Middle and southern areas of European part of Russia, southwestern Siberia

♦♦♦

Pathogen
Taphrina pruni Fckl.

Hosts
Species of cherry (*Padus, Prunus*)

Diagnosis
The wall of the ovary enlarges but the embryo fails to develop, and an elongate, sac-like or pocket-like, hollow fruit develops. A waxy, gray layer of asci with ascospores forms on the surface of affected fruits. Asci are cylindrical, 40-60 x 8-15 µ.

Damage
Reduces seed production

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

Fruit Spots

Spots occur primarily on seed wings of maple (*Acer*) and ash (*Fraxinus*), and on fruits of nut-bearing trees (*Juglans*). They rarely form on the seeds and fruits of other species. Some affect other plant organs, including leaves. Under favorable conditions for fungal development, these diseases can significantly reduce the germination power of seeds and infect germinating seeds and seedlings. The following are the most common spot diseases of seeds and fruits.

Class/Order: Deuteromycetes, Hyphomycetales

Pathogen
Cercospora acerina Hart.

Hosts
Species of maple (*Acer*)

Diagnosis
Dark-brown or dark-red, small, coalesced spots form on the seed wings. Clusters of conidiophores with conidia form on the spots. Conidia are reversely clavate, pointed on top, brown-olive, 45-180 x 5-8 µ.

Damage
Reduces germination power of seeds and kills leaves

Distribution
European part of Russia

♦♦♦

Pathogen
Heterosporium fraxini Ferd. et Winde.

Hosts
Species of ash (*Fraxinus*)

Diagnosis
Gray spots form on the seed wings. Conidiophores form on spots as small, black tufts. Conidia are elliptic-elongate, thorny, 2- or 4-celled, yellow, 5-6 x 1.7 µ.

Damage
Reduces germination power of seeds

Distribution
European part of Russia

Class/Order: Deuteromycetes, Melanconiales

Pathogen
Cylindrosporium platanoides (Allesch.) Died.

Host
Norway maple (*Acer platanoides*)

Diagnosis
Dark-brown, elongate spots form on the seed wings. Sporodochia form on the spots. Conidia are thread-like, 4-celled, pale green, 28-80 x 5-3 µ.

Damage
Reduces germination power of seeds and affects seedling leaves

Distribution
European part of Russia

♦♦♦

Pathogen
Gloeosporium fagi West.

Host
European beech (*Fagus sylvatica)*

Diagnosis
Circular or irregular, brown or green spots with dark borders and light centers form on the nuts. Sporodochia are brown and appear as concentric circles. Conidia are 1-celled, colorless. There are two types of conidia: macroconidia are oval or widely spindle-like, 10-16 x 4-5 µ; microconidia are elongate-oval, 4-6 x 1.5-2.0 µ.

Damage
Reduces germination power of seeds; seedlings are infected and killed

Distribution
Southeastern area of European part of Russia

♦♦♦

Pathogen
Marssonina juglandis (Lib.) P. Magn.

Host
Persian walnut (*Juglans regia*)

Diagnosis
Brown or gray-brown spots of various shapes and dimensions form on the fruits. Black, dotted, convex sporodochia form on the spots as concentric circles. There are two types of conidia: macroconidia are stick-like with one opaque septa 16-30x 3-4.5 µ; microconidia are stick-like, straight or slightly curved, 6-12 x 1-1.5 µ.

Damage
Immature fruits drop; leaves, petioles, and young shoots are infected.

Distribution
Southern area of European part of Russia

Class/Order: Deuteromycetes, Sphaeropsidales

Pathogen
Phyllosticta aceris Sacc.

Host
English field maple (*Acer campestre*)

Diagnosis
Small, round, yellow (later white) spots with a dark border form on seed wings. Pycnidia are globose, black, about 120 µ in diameter, and imbedded in wing tissue but later break through tissues. Conidia are egg-shaped, elongate, colorless, 5-7 x 2.5-3 µ.

Damage
Reduces germination power of seeds; leaves also are infected.

Distribution
European part of Russia

Pathogen
Phoma samarorum Desm.

Hosts
Species of maple (*Acer*)

Diagnosis
Pycnidia form on the surface of seed wings and are imbedded in the tissue. Pycnidia tops form on the wing as small, brown hillocks. Conidia are oval-elongate, colorless, 1-celled, 5-7 x 2-3 µ.

Damage
Immature seeds drop

Distribution
European part of Russia

Molds

Seed molds are caused by saprophytic fungi and rarely by facultative parasites. Seeds and fruits of nearly all tree and shrub species are affected. A characteristic external symptom of molds is superficial mycelium on infected tissues of seeds and fruits. Infection occurs during storage under high moisture conditions. Initially, the mycelium of mold fungi develops superficially and does not influence seed germination power. However, it can destroy the seedcoat and penetrate interior tissues. Infection of interior tissue reduces germination power and often destroys the embryo. Affected seeds rot and are useless for sowing.

Class/Order: Deuteromycetes, Hyphomycetales

Pathogen
Penicillium expansum (Link.) Thom., and *P. italicum* Pers.

Hosts
Primarily species of birch (*Betula*), oak (*Quercus*), beech (*Fagus*), and chestnut (*Castanea sativa*)

Diagnosis
Bright-brown or red, sharply outlined, and gradually coalesced spots form on the surface of seeds. Green or blue powdery mycelium forms on the spots. The seed tissue becomes friable and brown. Conidiophores form coremia. The upper part of the coremia resembles a brush. Conidia are elliptical, green, connected in chains, 3 x 3.4 µ.

Damage
Reduces germination power and kills seeds

Distribution
Throughout Russia

♦♦♦

Pathogen
Trichothecium roseum Link.

Hosts
Primarily species of maple (*Acer*), birch (*Betula*), ash (*Fraxinus*), oak (*Quercus*), spruce (*Picea*), pine (*Pinus*), and larch (*Larix*)

Diagnosis
Dark-brown or nearly black, sharply outlined spots form on the surface of infected seeds. Pink (rosy) powdery mycelium with conidia develops on the spots. Conidia are pear-like, 2-celled, 12-18 x 8-10 µ.

Damage
Reduces germination power

Distribution
Throughout Russia

♦♦♦

Pathogen
Fusarium *spp.*

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

Diagnosis
Rosy or crimson mycelium forms on the seed surface. Infected tissues of pulpy seeds turn red. The embryo can die. There are two types of conidia: microconidia are oval, cylindrical-oval or ellipsoid, usually 1-celled, sometimes 2-celled, colorless, numerous, 4-12 x 3-8 µ; macroconidia are multicelled, fusiform and slightly curved, 10-60 x 2-5 µ.

Damage
Reduces germination power and causes seed and seedling rot and damping-off

Distribution
Throughout Russia

♦♦♦

Pathogen
Botrytis cinerea Pers.

Hosts
Primarily species of fir (*Abies*), larch (*Larix*), spruce (*Picea*), pine (*Pinus*), elm (*Ulmus*), rose (*Rosa*), oak (*Quercus*), and chestnut (*Castanea)*

Diagnosis
A thin, downy, dark-gray web of mycelium that consists of hyphae and conidiophores forms on the seeds. Seeds eventually decay, and compact black sclerotia form on them. The conidiophores produce clusters of conidia which are egg-shaped or round, 1-celled, colorless or smoky, 9-12 x 5-10 µ.

Damage
Reduces germination power and causes seed and seedling rot and damping-off

Distribution
Throughout Russia

♦♦♦

Pathogen
Alternaria tenuis Nees.

Hosts
Primarily species of fir (*Abies*), larch (*Larix*), spruce (*Picea*), pine (*Pinus*), birch (*Betula*), elm (*Ulmus*), oak (*Quercus*), chestnut (*Castanea*), and Siberian pear tree (*Caragana arborescens*)

Diagnosis
A dark-brown or olive-black thin mycelium and conidia form on seeds and fruits. Conidia are single or connected in clusters or chains, reversely clavate, with 1-9 transverse septa and 1 or more longitudinal septa, and dark-olive or olive-brown, 7-130 x 6-22.5 µ.

Damage
Reduces germination power and causes seed and seedling rot and damping-off

Distribution
Throughout Russia

♦♦♦

Pathogen
Cladosporium herbarum Link.

Hosts
Primarily species of fir (*Abies*), spruce (*Picea*), pine (*Pinus*), oak (*Quercus*), and ash (*Fraxinus*)

Diagnosis
A dark-olive, velvety, turf-like mycelial web forms on seeds and fruits. Conidiophores are single or in clusters, with septa. Egg-shaped or elliptical conidia are 1-celled; cylindrical conidia are 2- or 3-celled, olive-brown, 12-28 x 6-7 µ.

Damage
Reduces germination power of seeds and causes mold of needles and leaves

Distribution
Throughout Russia

♦ ♦ ♦

Pathogen
Aspergillus niger Link.

Hosts
Primarily species of beech (*Fagus*), oak (*Quercus*), spruce (*Picea*), and pine (*Pinus*)

Diagnosis
Round spots with a black, turf-like mycelial web form on seeds and fruits. Conidiophores are numerous, straight, brown. Conidial heads are round, 20-50 µ in diameter. Conidia are oval, 1-celled, olive-brown, 2.5-5 µ, connected in chains.

Damage
Reduces germination power

Distribution
Throughout Russia

Class/Order: Zygomycetes, Mucorales

Pathogen
Mucor spp.

Hosts
Species of oak (*Quercus*), beech (*Fagus*), and Persian walnut (*Juglans regia*)

Diagnosis
Gray or gray-white, downy mycelium forms on seeds and fruits. The surface of mycelium is covered with distinct, dark-brown, spherical sporangia heads.

Damage
Delays seed germination

Distribution
Throughout Russia

♦ ♦ ♦

Pathogen
Rhizopus nigricans Ehr.

Hosts
Primarily species of oak (*Quercus*), apple (*Malus*), mulberry,*(Morus alba)*, blackberry *(Rubus)*, and Persian walnut *(Juglans regia)*

Diagnosis
White or gray, downy, mycelium forms on seeds and fruits. Numerous bead-like black sporangia form on the mycelium. Spores are ellipsoid, angular, dark, 8-14 x 6-11 µ.

Damage
Delays seed germination

Distribution
Throughout Russia

♦♦♦

Pathogen
Thamnidium elegans Link.

Hosts
Primarily Siberian pea tree *(Caragana arborescens)*, spindle tree (*Euonymus*), elderberry (*Sambucus)*, lime (*Tilia*), and honeysuckle (*Lonicera*)

Diagnosis
Sparse, white, yellow, or gray mycelium forms on seeds and fruits. Sporangia are spherical, with a colorless cover. Spores are colorless, elliptical, 8-10 x 6-8 µ.

Damage
Delays seed germination

Distribution
Throughout Russia

Seed and Fruit Rots

The rots most often damage fruits with excess moisture and nutrients. They distort seeds and fruit tissue structure and later decompose the tissue. Seed and fruit infection occurs during their harvest, transport, and especially, storage under high moisture and poor ventilation conditions.

Class/Order: Deuteromycetes, Sphaeropsidales

Pathogen
Phomopsis quercella (Sacc.) Died.

Hosts
Species of oak (*Quercus*)

Diagnosis
Dark, initially gray, spots form on cotyledon surfaces. Later, the spots enlarge and spread over the entire cotyledon. In high humidity, luxurious white pellicles develop on the cotyledons. Black pycnidia, 1.5 mm in diameter, develop within the mycelial mat. The seedcoat becomes erumpent and then bursts. Mature pycnidia produce orange conidial masses. There are two kinds of conidia: fusiform, with sharp ends and 2 oil drops, colorless, 7-11 x 1.5 -2 µ, and thread-like, curved, hook-like, colorless, 22-66 x 0.2-0.7 µ.

Damage
Kills acorns in storage and withers germinating seedlings.

Distribution
European part of Russia, southern Urals, Far East

♦♦♦

Pathogen
Cytospora intermedia Sacc.

Hosts
Species of oak (*Quercus*)

Diagnosis
Dark-brown, sharply outlined spots with white pellicles form on cotyledons. Later, the pellicles turn dark, enlarge, and cover the entire cotyledon. Black stromata with pycnidia form on the mycelium and

arise on the surfaces of acorns through cracks in the seedcoat. Pycnidia produce horn-like conidial masses. Conidia are cylindrical, slightly curved, colorless, 1-celled, 5-6 x 1.5 µ.

Damage
Reduces germination power and causes seedling mortality.

Distribution
European part of Russia, southern Urals, Far East

Control
Observation
- Monitor seed production plantations for appearance and distribution of seed and fruit disease to determine species, levels of damage, and dynamics of disease development.
- Collect and analyze seeds and fruits twice a year according to periods of pathogen development.
- Inspect seeds and fruits before sowing, check for fungal or bacterial infection, and apply seed treatments.

Cultural
- Harvest seeds and fruits only from special seed plantations to maintain healthy seeds with high genetic and germination qualities.
- Select quality healthy stands for seed plantations to maintain tree species ecotypes and forms that are the most resistant to diseases and abiotic factors.
- Avoid seed and fruit injury during harvest, transport, extraction, and storage of seeds.
- Store seeds and fruit at optimal temperature, moisture, and ventilation conditions.

Chemical
- Disinfect instruments and scales before and after every seedlot harvest.
- Disinfect storage areas with sulfur fumigation before storing new harvests of seeds and fruits.
- Use specific chemicals for specific diseases.

Class/Order: Deuteromycetes, Melanconiales

Pathogen
Gloeosporium quercinum West.

Hosts
Species of oak (*Quercus*)

Diagnosis
Gray-brown, dark-brown or nearly black, irregularly shaped, sharply outlined spots form on cotyledons. The spots become thicker and enlarged. Affected cotyledons are covered by black spots and become dry. Under humid conditions, yellow pellicles form on affected parts of acorns. Small yellow-brown cushion-like sporodochia develop on them in concentric circles. The conidial mass is white and slimy. There are two kinds of conidia: elongate-oval, colorless, 8-17 x 3.5-7.5 µ, and cylindrical or wedge-like, colorless, 4-8 x 1.5-2 µ.

Damage
Reduces acorn germination power and causes leaf spot

Distribution
European part of Russia, southern Urals, Far East

Class/Order: Basidiomycetes, Aphyllophorales

Pathogen
Schizophyllum commune Fr.

Hosts
Species of oak (*Quercus*)