Rots

A rot is a decay, a decomposition or disintegration of plant tissue. It may be a hard dry decay or a soft and squashy one. It may affect root or rhizome, stem, tree trunk, blossom or fruit. Some rots also affect leaves, but diseases that are primarily of foliage are more often designated leaf spots or blights. Rots caused by bacteria are discussed under Bacterial Diseases.

There are a great many wood rots of trees, recognized by the sporophores or conks of the various species of *Fomes, Polyporus*, and other shelving or bracket fungi. By the time these signs appear, it is usually too late to do anything about the disease. The tree-rot fungi enter through unprotected wounds – either pruning cuts or breaks due to wind and icestorms. For proper pruning methods and treatment of wounds, see U. S. Department of Agriculture Farmers' Bulletin 1896, *Care of Damaged Shade Trees, Tree Maintenance* by P. P. Pirone or *Tree Experts Manual* by Richard R. Fenska. The fact that tree wound dressings are now available in convenient aerosol bombs should make it easier for home gardeners to protect pruning cuts from wood-rotting fungi.

Physalospora (Acanthorhynchus)

Ascomycetes, Amphisphaeriales

Perithecia separate, innate, beaked; spores one-celled, dark.

Acanthorhynchus vaccinii (see ►*Physalospora vaccini*). Cranberry Blotch Rot, a common fruit rot thriving in warmer sections, more important in New Jersey than in Massachusetts.

Physalospora vaccini (formerly *Acanthorhynchus vaccinii*). Cranberry Blotch Rot, a common fruit rot thriving in warmer sections, more important in New Jersey than in Massachusetts. The rot starts as a small, light-colored spot on the berry, spreading to destroy the whole fruit, with dark blotches on the skin. The fungus may invade leaves, but it seldom fruits on them until they have fallen. Cranberry bogs in New Jersey may need three or four sprays of Bordeaux mixtures starting at midbloom, but in Massachusetts two are sufficient.

Acremonium

Acremonium sp. Root Rot on melon and watermelon.

Alternaria

► Blights.

Alternaria alternata Fruit Rot on tomato and black pit disease on potato tubers (stored).

Alternaria citri Alternaria Rot of citrus fruits, navel-end rot, black rot, widespread, prevalent in warm dry sections, but not too serious. In oranges the rot is most common in the Washington Navel variety – a firm, dry, black rot at the navel end, often in only one segment, with fruit coloring prematurely, appearing sound on the outside.

R.K. Horst, *Westcott's Plant Disease Handbook*, DOI 10.1007/978-94-007-2141-8_41,

In lemons the disease is a soft, dark internal rot of old or weak fruit in storage. Firm dark brown spots are formed on the rind. Grapefruit sometimes has a dark internal storage rot, not readily discernible externally.

Control Chemical treatment after picking is not very satisfactory. Produce sound fruit in the orchard; avoid holding too long on the tree; avoid holding weak or old fruit too long in storage; store at low temperatures.

Alternaria mali Fruit Rot, widespread storage rot of apple, sometimes quince. Also a weak parasite enlarging injured spots on foliage. Try captan at 6-to 14-day intervals.

Alternaria radicina (Syn. *Stemphylium radicinum*). Black Rot of carrots, a soft storage rot of roots held over winter. Rot may start at the crown or from some wound on the side of the root. Initial infection may be in field or in storage house; a black mycelial weft with large, brown muriform spores develops over the rotted tissue. There is no control except to choose firm, healthy roots for storage and to store at low temperatures.

Alternaria solani Collar Rot of tomato, also fruit rot and early blight, general on tomato with the collar rot stage most frequent in the South. ► Blights.

Alternaria zinniae Stem Rot on *Ageratum*.

Alternaria sp. Flower Rot of Vanda orchids, causing infection in transit along with *Botrytis*.

Alternaria sp. On Schefflera in Florida.

Alternaria sp. Calyx-End Rot on apple.

Amphobotrys

► Cankers and Diebacks.

Amphobotrys ricini Stem Rot and Wilt of poinsettia.

Aphanomyces

Phycomycetes, Saprolegniales

Thallus composed of cylindrical branching hyphae without definite constrictions; sporangium cylindrical, threadlike, swarm spores arranged in a single row and encysting at the mouth; saprophytic or parasitic, living in the soil and causing root rots or damping-off.

Aphanomyces cladogamus Causing rootlet necrosis of tomato, pepper, spinach, and a severe root rot of pansy.

Aphaomyces cochlioides A seedling disease of sugar and table beets, part of the complex called black root; causing tip rot, a wilting of tops. Crop rotation and proper fertilization are helpful.

Aphanomyces euteiches Pea Root Rot, also on bean, sweet pea and perennial pea. The fungus is also a weak parasite in roots of many nonlegumes. First described in 1925, the fungus probably existed earlier in various root disease complexes and was responsible for giving up land formerly devoted to canning peas. Considered the most important of the pea root rots, found in every district, it is particularly destructive in eastern and central states.

The fungus is parasitic on subterranean parts, causing root and stem rot in peas of all ages, symptoms and crop yield varying with the time of infection. If the root system is invaded when only three or four nodes are formed, the plant may wilt and die suddenly; later invasion results in dwarfing and drying out of foliage from the ground upward. When seedlings are pulled out of the ground, the roots do not break off but come out as a fibrous string or vascular cylinder freed from cortex. The fungus invades only the cortex or roots and base of stem, causing softening and rapid decay of tissue. Large numbers of thick-walled oospores are formed in the cortex; these may remain viable in the soil more than one season.

It is a novel root pathogen on alfalfa in Canada.

Control A well-drained soil with low moisture content decreases rot. When soil moisture is at 45 % of saturation, there is no disease; at 75 % there may be more than 70 % infection. Nitrogenous fertilizers are helpful.

Aphanomyces raphani Radish Black Root and Damping-Off, wide-spread; more important on long-rooted icicle varieties. Also on Abyssinian mustard, cabbage, Chinese cabbage, Chinese kale, honesty, mustard green, rape, rocuet salad,

sea-kale, Spanish mustard, wild radish and *Brassica robertiana*. Small, steel-gray to black areas appear around point of emergence of secondary roots. Enlarging roots are constricted and turn black. Rotation is essential for control. Choose globe rather than long varieties.

Armillaria

Basidiomycetes, Agaricales

One of the mushrooms, cap-shaped on a stalk with an annulus or ring butno volva (cup) at the base; gills attached to the stem; spores white (see Fig. 1).

Fig. 1 Mushroom Root-Rot Fungus, *Armillaria mellea*

Armillaria mellea Mushroom Root Rot of trees and shrubs, also known as Armillaria root rot or toadstool disease, first described in America in 1887, known in Europe a hundred years earlier. The fungus is called honey mushroom, honey agaric, oak fungus and shoestring fungus. Although the honey-colored toadstools are often seen in the East around rotting tree stumps and may occasionally cause death to weak ornamental trees, the chief damage is west of the Rocky Mountains, especially in California, where most fruit and nut crops and ornamental trees and shrubs are menaced.

The decay is of the roots and root crown. Sheets of tough, fan-shaped mycelium are found between bark and wood, the latter changing to light tan, becoming soft and watery in texture. Clumps of toadstools are often found at the base of dead or dying trees, especially in autumn, but do not always appear in dry seasons. They are honey-colored or light tan, with a stalk 4 to 6 inches or more high and a cap 2 to 4 inches across, often dotted with brown scales. Basidiospores formed along the gills are wind-borne. They can establish themselves in old stumps and dead trees but cannot infect healthy trees. The latter are infected in the ground by means of black or brown cordlike rhizomorphs, the "shoestrings," which grow out from infected roots a short distance through the soil. On meeting and penetrating a healthy root, the fungus progresses along the cambium layer, working up to and girdling the root crown. Leaves are dwarfed, turn yellow or fall prematurely; on small trees all foliage may die simultaneously. On conifers, particularly pines, there is an abnormal flow of resin from the root collar.

Trees subnormal in vigor and suffering from drought are most injured. Orchards of citrus and other fruits on lands recently cleared of oaks are liable to enormous damage unless resistant rootstocks are used. The rot is found less often on dry hillsides than in valleys near streambeds, where flood waters deposit soil and infected debris around root crowns, or in places kept too wet by artificial watering. Ornamental trees and shrubs are often injured when extra soil is added in grading and terracing, and are then kept too wet by watering the lawn frequently.

The list of susceptible plants is far too long to be given in entirety. A representative selection includes almond, apple, apricot, avocado, cherry, citrus, currant, grape, incense cedar, peach, pear, plum and raspberry, hickory, filbert and walnut, California pepper-tree; oaks, pines, spruce and sycamore; azalea, rhododendron, boxwood and rose; (root, crown, and stem rot on) African daisy and (stem rot on) sunflower; and sometimes other herbaceous plants such as begonia, carnation, dahlia, narcissus, peony, rhubarb, and strawberry.

Control Use resistant plants where possible. Of fruits, only French pear, Northern California black walnut, fig and persimmon are sufficiently resistant to grow safely on infested soil. Some plants can be grafted onto resistant rootstock such as Myrobalan 29. The University of California has prepared a list of resistant or moderately resistant ornamental shrubs. Some on the list are *Acacia decurrens* var. *mollis, A. verticillata, Buxus semipervirens, Ilex aquifolium, Lonicera nitida, Prunus ilicifolia* (hollyleaf cherry), *P. lyoni* (Catalina cherry), *Pyracantha coccinea* and var. *lalandii* but not *P. angustifolia*, which is susceptible.

Moderately resistant shrubs include *Abelia grandiflora*, Darwin, Japanese, and Mrs. Wilson barberry, Mexican orange (*Choisya*), *Elaeagnus argentea, Euonymus japonica*, Japanese privet, *Myrtus communis, Pittosporum tobira* and *Spiraea prunifolia*.

Mechanical measures are often helpful. Excavate and expose the root crown; remove diseased portions of bark and affected small roots. Paint wounds with a pruning wound compound. Leave the treated roots exposed until cool weather in autumn. Trenching or digging a ditch around a plot will restrict the disease temporarily, but roots will grow through the ditch in time.

Carbon disulfide is still recommended as a soil disinfectant, applied in staggered rows, in holes 18 inches apart each way, which should be immediately closed by tamping. Hand applicators are available for injecting the disulfide 6 to 7 inches deep. This treatment is for land where valuable trees have been removed; one cannot go closer to a healthy tree than the edge of the branch spread. After treatment, the land should remain fallow for at least 60 days, and then be ploughed before planting.

Ascochyta

► Blights.

Ascochyta pinodes Foot Rot of peas. Of the three species that make up the Ascochyta blight complex, this one produces most definitely a foot rot, with infection at the root crown or base of stem.

Aspergillus

Deuteromycetes, Coelomycetes

Conidiophores have a round head at the top, with radially arranged bottle-shaped sterigmata that bear conidia in chains; spores are one-celled, globose to ellipsoid, hyaline. Bread molds are in this genus. When, rarely, a sexual fruiting body (cleistothecium) is formed, the species is placed in the order Eurotiales.

Aspergillus alliaceus Cladode Rot, Stem and Branch Rot on *Cereus* and *Opuntia* cacti. This is a high temperature species. Spores are yellow in mass.

Aspergillus fumigatus Wound Rot (storage) on beet.

Aspergillus niger Calyx-End Rot of dates, Fig Smut, Bunch Mold of grapes, Pomegranate Rot, Black Mold of peach. Crown Rot of peanut; also market and storage rot of shallot, onion, apple and potatoes. The fungus is a weakly parasitic black mold invading ripe tissue through wounds. In dates, the interior of the fruit is filled with a black dusty mass of spores, spread to a large extent by the dried-fruit beetle. Practice orchard sanitation; keep decaying fruits cleaned up so insects cannot carry spores.

Aspergillus niger var. **floridanus** Wound parasite on *Dracaena*. Lower stem black, rotted, with dark brown spore masses.

Aspergillus spp. Green and yellow molds causing secondary rots of many fruits and some vegetables in storage.

Lasiodiplodia (Botryodiplodia)

► Blights.

Botryodiplodia theobromae (see ►*Lasiodiplodia theobromae*). Root Rot on apple

Lasiodiplodia theobromae (formerly *Botryodiplodia theobromae*). Root Rot on apple.

Botryosphaeria

► Blights.

Botryosphaeria dothidea Fruit Rot of peach and grape.

Botryosphaeria obtusa Fruit Rot of peach, Black Root Rot of apple.

Botryosphaeria rhodina Fruit Rot of peach.

Botryosphaeria ribis (Anamorph, *Dothiorella gregaria*) Dothiorella Rot of avocado and citrus, Black Fruit Rot of apple and pear, Nut Rot of tung oil. On avocado this is a soft rapidly spreading surface rot, starting from small spots when fruit begins to soften. The fruit may be covered with decay spots by the time it is usable. The fungus winters in dead twigs, in tip-burned leaves, and enters the avocado while it is still on the tree. Two sprays, mid-September and early October, using bordeaux mixture, have given fairly good control. Remove dead wood from trees, to reduce source of inoculum, and pick fruit early.

On lemons and other citrus fruits the rot starts as a discoloration around the button, becoming a brown, leathery but pliable decay. When fruit is entirely involved it becomes olivaceous black. On tung, brown lesions appear on green fruit, which drops prematurely. See further under ► Cankers and Diebacks.

Botryotinia

► Blights.

Botryotinia convoluta Botrytis Crown Rot of iris, Gray Mold Rot on rhizomatous iris, first recorded in Canada in 1928 and apothecia later produced in culture. The chief diagnostic character is the presence of many shining black sclerotia, much convoluted and agglomerated into large clusters on rotting rhizomes. These are often found in spring on plants that started into the winter apparently healthy, for the fungus is active in cool, wet weather. Conidiophores are brown, formed in fascicles, and bear dense clusters of light brown ovate or slightly pyriform conidia. They appear in spring growing from or near sclerotia. Affected plants do not start spring growth.

Botrytis

► Blights.

Botrytis aclada Gray Mold Neck Rot of onion, also shallot and garlic; widespread. This is usually found on bulbs after harvest, infection taking place through neck tissue and scales appearing sunken and "cooked." Sclerotia are first white, then dark, 2 to 4 mm across. Conidiophores and conidia forming the gray mold are produced directly from mycelium in tissue or from sclerotia. Artificially cure bulbs after harvest to cause rapid dessication of neck tissue; store at low temperature. Colored varieties keep better than white.

Botrytis byssoidea Mycelial Neck Rot of Onion. The fungus is much like *B. aclada* but produces more mycelium and less profuse gray mold.

Botrytis cinerea Gray Mold Fruit Rot, Cosmopolitan on peach, cherry, plum, pomegranate, quince, pear, grape, strawberry, pepper, tomato and eggplant. Also causing a leaf rot of hothouse rhubarb and a rot of carrot, lettuce, celery and onion. See further under ► Blights.

Botrytis gladiolorum Botrytis Neck Rot, Corm Rot, Blight of gladiolus.

► Blights.

Botrytis porri Seedborne causing natural infection.

Botrytis squamosa (Teleomorph, *Botryotinia*) Small Sclerotial Neck Rot of onion. Elliptical leaf lesions with withering of tips.

Botrytis tulipae Bulb Rot of Vidalia sweet onion.

Brachysporium

Deuteromycetes, Hyphomycetes

Conidiophores brown, erect, usually solitary, septate; conidia dark, unequally two-or more-septate; attached to apical cell of conidiophore by a short narrow cell; saprophytic.

Brachysporium tomato Fruit Rot of tomato.

Calonectria

See ►*Cylindrocladium* under Blights.
Calonectria crotalariae Basal Stem Rot of oleander.
Calonectria sp. (Anamorph, *Cylindrocladium*) Crown and Collar Rot on papaya.

Catenularia

Deuteromycetes, Hyphomycetes

Hyphae dark; conidophores simple or sparingly branched, with terminal chains of conidia; spores dark, one-celled.
Catenularia fuliginea Fruit Rot of date.

Mycocentrospora

Deuteromycetes, Coelomycetes

Spores hyaline, filiform, with long, whiplike tapering beaks, several cross walls and a swordlike appendage from basal cell; mycelium dark.
Centrospora acerina (see ►*Mycocentrospora acerina*). Black Crown Rot of celery, Storage Rot of carrot.
Mycocentrospora acerina (formerly *Centrospora acerina*). Black Crown Rot of celery, Storage Rot of carrot (see Fig. 2). On celery the disease appears 7 or 8 weeks after stock has been placed in cold storage with pale, ochraceous lesions at the crown end, gradually turning black, sometimes reddish. The fungus lives in the soil; use infested fields for early celery to be marketed without storage. The same species also causes leaf spot of pansy.

Cephalosporium

► Leaf Spots.
Cephalosporium carpogenum Fruit Rot on apple in storage, reported from Washington and Pennsylvania.

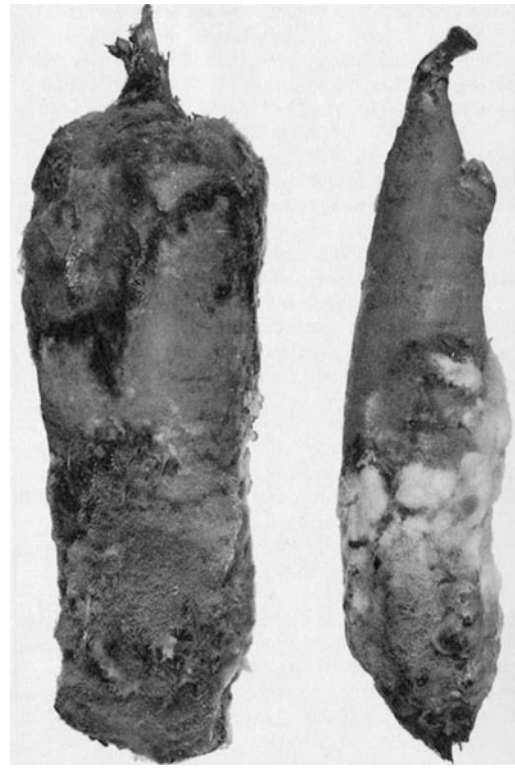

Fig. 2 Storage Rot on Carrot

Cephalosporium gregatum (see ►*Phialophora gregata*). Brown Stem Rot of soybean.
Phialophora gregata (formerly *Cephalosporium gregatum*). Brown Stem Rot of soybean.

A vascular disease of major importance in the Midwest, also present in Florida, North Carolina and Virginia. It has been controlled with a long rotation −5 years corn, 1 year soybeans.

Ceratocystis

► Cankers and Diebacks.
Ceratocystis fimbriata (*Endoconidiophora fimbriata*) Sweet Potato Black Rot, found wherever sweet potatoes are grown, most destructive in storage but present also in seedbed and field. Round, blackish spots extend into vascular ring or deeper; sprouts are sickly with black cankers

below ground or are killed. The fungus winters in storage houses, on wild morning-glory and other weeds near the field and in soil, where it remains viable for several years. Spores are spread by the sweet potato weevil and in wash water if potatoes are washed before storing. This fungus also infects *Jacquemontia*.

Control Standard treatment has been disinfection of planting stock in a solution of borax. Using pulled sprouts provides plants free from black rot. Plan a 4-year rotation; sort carefully before storage; cure quickly at high temperature and humidity. Yellow Jersey is highly susceptible; some varieties are quite resistant.

A strain of this fungus is reported causing Black Cane Rot in propagating bed of *Syngonium auritum* (*Philodendron trifoliatum*) in a California nursery. Brown to black water-soaked girdling cankers, often on parts in contact with the soil, cause yellowing and death of foliage. The fungus can be eradicated by treating canes with hot water, 120 °F for 30 min.

Ceratocystis wageneri (see ►*Ophiostoma wageneri*). Root Rot of lodgepole pine and ponderosa pine.

Ophiostoma wageneri (formerly *Ceratocystis wageneri*). Root Rot of lodgepole pine and ponderosa pine.

Apostrasseria (Ceuthospora)

Deuteromycetes, Coelomycetes

Pycnidia in a valsoid stroma; conidia oblong to bacillar, extruded in tendrils; conidiophores obsolete or none.

Apostrasseria lunata (formerly *Ceuthospora lunata*). Black Rot of cranberry, developing in berries after picking. The fruit turns dark and soft. The disease is more important in Washington and Oregon. Spraying for other cranberry diseases largely controls this rot. Pick berries when dry; avoid bruises; keep them cool.

Ceuthospora lunata (see ►*Apostrasseria lunata*). Black Rot of cranberry, developing in berries after picking.

Chalara (Chalaropsis)

► Molds.

Chalara thielaviopsis (formerly *Chalaropsis thielaviopsis*). Root Rot on poinsettia.

Chalaropsis thielaviopsis (see ►*Chalara thielaviopsis*). Root Rot on poinsettia.

Armillaria (Clitocybe)

Basidiomycetes, Agaricales

One of the mushrooms, with gills typically decurrent (running down the stem), cap homogenous and confluent with fleshy stripe, which has neither ring nor cup; spores white or very lightly colored.

Armillaria tabescens (formerly *Clitocybe monadelpha*). On privet, apple.

Armillaria tabescens (formerly *Clitocybe tabescens*). Mushroom Root Rot, Clitocybe Root Rot of citrus, pecan and other fruits and many ornamentals. This root rot is as devastating in Florida as Armillaria rot is in California and very similar (some say the pathogen is identical). It is important in the decline of citrus groves, on orange, grapefruit, lemon, tangerine and lime on rough lemon stock; is very destructive to Australian-pine (*Casuarina*); and has been reported on more than 200 species in 59 plant families, including *Acalypha*, avocado, arborvitae, apricot, camellia, castor-bean, cherry-laurel, crape-myrtle, cotoneaster, cypress, dogwood, *Eugenia*, eucalyptus, grape, guava, glorybush, *Hamelia*, holly, *Ligustrum*, juniper, jasmine, loquat, oleander, poinciana, pomegranate, pear, *Parkinsonia*, rose, viburnum and wax-myrtle. In recent years Clitocybe root rot has become economically important on Georgia peach trees and has killed many lychee trees in Florida. It is said to account for 75 % of rose mortality in some sections.

Symptoms of decline do not ordinarily develop until the pathogen has been working a number of years and has killed a large part of the root system. Often mushrooms are present

at the base of trees before the tops show more than a slight yellowing or lack of vigor; but if soil is removed from the root crown, many lateral roots are found dead, and often the taproot is also gone. Infection starts at some point on the lateral roots, spreads to the base of the tree, and then to other roots. Sometimes there is gumming at the crown extending upward on the trunk. Mycelial fans or sheets are present between bark and wood; the clusters of mushrooms developing at the base are similar to those of *Armillaria*, but the black shoestring rhizomorphs are lacking. Instead, there are sometimes black, hard stromatic outgrowths from fissures in bark of infected roots. The fruiting clusters develop in fall, from mid-September to December. The caps are light tan to honey-colored, 2 to 3 1/2 inches in diameter. The rot is most prevalent on land cleared of oaks and other hardwoods, also on sandy, well-drained land subject to drought.

Control Citrus trees on sour orange stock are quite resistant. Surgical treatment for fruits and ornamental trees is often quite successful. Remove the soil at least 2 or 3 feet from the trunk, working carefully to avoid injuring healthy roots. Cut off all dead roots, flush with the root crown and remove any infected oak or foreign roots in the vicinity. Cut out dead and infected bark at the root crown or the base of the trunk, being sure to collect all chips (on heavy paper placed under exposed roots) for burning. Paint all exposed surfaces with a pruning wound compound and fill in partially, disinfesting the soil with bordeaux mixture. The root crown can be left exposed to aeration and drying or, if too large a proportion of the root system has been lost, new roots can be stimulated by mounding the soil around the base to a height of several inches above the partial girdle. The new roots will come from callus formed at the margin of living bark.

Trenches 2 or 3 feet deep will aid in preventing spread to healthy trees. Fallow soil can be treated with carbon disulfide; ►*Armillaria mellea*.

Clitocybe monadelpha (see ►*Armillaria tabescens*). On privet, apple.

Clitocybe tabescens (see ►*Armillaria tabescens*). Mushroom Root Rot, Clitocybe Root Rot of citrus, pecan and other fruits and many ornamentals.

Colletotrichum

► Anthracnose.

Colletotrichum acutatum Bitter Rot of apple fruit; fruit rot of grape.

Colletotrichum capsici Ripe Rot of pepper, Boll Rot of Cotton.

Colletotrichum circinans Onion Smudge, surface rot, also on shallot, garlic and leek. Bulb or neck has a dark green or black smudge, often covered with stiff bristles of the acervuli of the fungus. Smudge is more prominent in white onions; it is confined to the neck of colored bulbs. The fungus winters on mature onions, on sets or in soil. It develops in the field at a fairly high temperature and soil moisture with most of the damage just before harvest. Cure rapidly after harvest; rotate crops; clean up debris; change to colored onions if the rot is too serious on white.

Colletotrichum coccodes Root Rot and Wilt of greenhouse tomato.

Colletotrichum gloeosporioides Fruit Rot of grape and pepper.

Colletotrichum gloeosporioides (formerly *Colletotrichum nigrum*). Fruit Rot of pepper, probably general on pepper in South and East. The fungus is a wound parasite on pepper pods. The spots are irregular, indefinite, depressed, blackish. Numerous acervuli with stout setae are scattered over spots.

Colletotrichum lilii Black Scale Rot of Easter lily, Brown Scale. First noticed in Louisiana in 1937, the rot immediately threatened the lily industry in that section. Bulbs are brown to nearly black when dug, with outer scales most affected. Young lesions start as irregular light brown areas, then become black and sunken owing to collapse of epidermal cells and subepidermal layers. Oldest lesions are nearly black, with tissue dry and shriveled. Stems and roots are not affected. The acervuli are

small, gregarious, with many dark brown setae and continuous hyaline conidia.
Colletotrichum nigrum (see ▶*Colletotrichum gloeosporioides*). Fruit Rot of pepper, probably general on pepper in South and East. The fungus is a wound parasite on pepper pods. The spots are irregular, indefinite, depressed, blackish. Numerous acervuli with stout setae are scattered over spots.

Frammulina (Collybia)

Basidiomycetes, Agaricales

Margin of young cap turned in; gills not decurrent; stipe central; no annulus or volva; spores white or light; causing wood rots.
Collybia velutipes (see ▶*Frammulina velutipes*). Heart Rot, White Sapwood Rot of hardwoods.
Frammulina velutipes (formerly *Collybia velutipes*). Heart Rot, White Sapwood Rot of hardwoods. The fungus is a small toadstool with central stem, base covered with dark brown velvety hairs, cap yellowish or brownish. The disease is a soft spongy white rot of sapwood of living hardwoods, particularly basswood, horsechestnut, American elm and on catalpa. The toadstools are formed in clusters at wounds.

Coniophora

Basidiomycetes, Aphyllophorales

Pileus resupinate, effuse; hymenium with one layer, cystidia lacking; spores dark; wood-destroying.
Coniophora puteana Brown Cubical Rot of conifers and sometimes hardwoods – on slash, building timbers, and sometimes living trees. The crustlike fleshy fruiting bodies are a little over 2 inches in diameter, olive to brown with whitish margins and smooth to slightly waxy surface.
Coniophora corrugis (see ▶*Cylindrobasidium corrugum*). Sapwood Rot of alpine fir.
Cylindrobasidium corrugum (formerly *Coniophora corrugis*). Sapwood Rot of alpine fir.

Coniella (Coniothyrium)

▶ Cankers and Diebacks.
Coniella diplodiella (formerly *Coniothyrium diplodiella*). White Rot of grapes, appearing spasmodically on grapes but not one of the more important diseases. Small pycnidia appear on outside of fruit cuticle as shiny, rosy points, also on leaves. Infection is usually through wounds. Spots on ripe grapes are grayish, with brown borders.
Coniothyrium diplodiella (see ▶*Coniella diplodiella*). White Rot of grapes, appearing spasmodically on grapes but not one of the more important diseases.

Coprinus

Basidiomycetes, Agaricales

Inky cap mushrooms; hymenium lining gills; gills deliquesce into a black, inky liquid.
Coprinus urticicola Fruit Rot of pear.

Corticium

Basidiomycetes, Aphyllophorales

Pileus resupinate, effuse; hymenium with one layer, cystidia lacking; spores hyaline. *Corticium vagum* and other species with a thin film of mycelium with short, broad cells on substratum have been transferred to *Pellicularia*. Species with cystidia have been placed in *Peniophora*. See also ▶*Corticium* under Blights.
Butlerelfia eustacei (formerly *Corticium centrifugum*). Fisheye Fruit Rot of apple, generally distributed. A dry, spongy rot often following scab.
Corticium centrifugum (see ▶*Butlerelfia eustacei*). Fisheye Fruit Rot of apple, generally distributed.
Corticium fuciforme (see ▶*Laetisaria fuciformis*). Pink Patch of turf, red thread.

Corticium galactinum (see ►*Scytinostroma galactinum*). White Root Rot of apple, also recorded on blackberry, dewberry, wineberry, peach and many ornamentals – baptisia, dogwood, holly, flowering almond, flowering plum, iris, winter jasmine, kalmia, pearl bush, peony, spirea, sumac, viburnum and white campion.
Corticium radiosum (see ►*Vesiculomyces citrinus*). White Butt Rot on sub alpine fir in Colorado.
Laetisaria fuciformis (formerly *Corticium fuciforme*). Pink Patch of turf; red thread. Grass is first water-soaked, then dead, in isolated patches, 2 to 15 inches in diameter, with pinkish red gelatinous strands of the fungus matting the blades together and growing into coral red horns, 1/8 to 2 inches long. These turn brittle, break into pieces to spread the pathogen. Velvet bent grasses are more susceptible than colonial and creeping bents. Cadmium compounds will control if applied as protectants before the disease appears.
Scytinostroma galactinum (formerly *Corticium galactinum*). White Root Rot of apple, also recorded on blackberry, dewberry, wineberry, peach and many ornamentals – baptisia, dogwood, holly, flowering almond, flowering plum, iris, winter jasmine, kalmia, pearl bush, peony, spirea, sumac, viburnum and white campion. The fungus also causes a root rot of white pine and a decay of firs, affecting also western white cedar and spruce. The disease starts at the collar or on larger roots and advances rapidly outward on smaller roots. The collar may be girdled and killed while distal portions are still alive. A dense weft of white mycelium covers roots and penetrates to wood, causing the white rot. The disease is prevalent on lands recently cleared of oaks.
Vesiculomyces citrinus (formerly *Corticium radiosum*). White Butt Rot on subalpine fir in Colorado.

Corynespora

► Leaf Spots.
Corynespora cassiicola Root Rot on soybean.

Cryptochaete

Basidiomycetes, Aphyllophorales

Basidocarp cartilaginous or coriaceous, erumpent, at first tuberculiform; gloecystidia yellowish or hyaline; cystidia present or lacking; spores hyaline, curved-cylindrical to allantoid, smooth.
Cryptochaete (Corticium) polygonia (see ►*Peniophora polygonia*). White Rot on aspen in Colorado.
Peniophora polygonia (formerly *Cryptochaete* (*Corticium*) *polygonia*). White Rot on aspen in Colorado.

Cylindrocarpon

Deuteromycetes, Coelomycetes

Conidia on sporodochia; spores with several cells, like *Fusarium* but more nearly cylindrical with rounded ends; cosmopolitan in soil, occasionally pathogenic.
Cylindrocarpon liriodendri Root Rot of tulip poplar.
Cylindrocarpon destructans Sometimes listed as cause of Scale-Tip Rot of Easter lily in Pacific Northwest, but probably secondary. True cause of rot unknown.

Cylindrocladium

► Blights.
Cylindrocladium clavatum Root Rot on Norfolk-island-pine.
Cylindrocladium crotalariae (Teleomorph, *Calonectria crotalariae*). Cylindrocladium Black Rot on peanut, and Root Rot on tulip tree and kiwi. Red crown rot; on soybean.
Cylindrocladium scoparium Root Rot on peach and tulip-tree.
Cylindrocladium heptaseptatum Postharvest Decay on leatherleaf fern.

Cylindrocladium pauciramosum Root and Crown Rot on heath.
Cylindrocladium parasiticum Black Rot of hoary-tick clover and on peanut.
Cylindrocladium pteridis Postharvest Decay on leatherleaf fern.
Cylindrocladium scorparium Root Rot on pine, sweet gum and tulip-tree.

Daedalea

Basidiomycetes, Aphyllophorales

Pileus dimidiate to caplike and stipitate; pores waved, mazelike or somewhat resembling gills; without cystidia; hymenium labyrinthine.
Cerrena unicolor (formerly *Daedalea unicolor*). Heart Rot, Canker of maples and other living hardwoods, including alder, ailanthus, amelanchier, birch, chestnut and hackberry. Decayed wood is yellow at first, later white and soft. Conks are small, corky, often occuring in clusters, varying from brown to gray.
Daedalea confragosa (see ►*Daedaleopsis confragosa*). White Mottled Wound Rot of hardwoods, also on fir.
Daedalea quercina Brown Cubical Rot of dead timber; Heart Rot of living trees in immediate vicinity of butt wounds, usually on oak, chestnut, sometimes on maple, birch and hickory. In advanced stages the wood is reduced to a yellow-brown friable mass, with a tendency to break into small cubes. Conks are corky and shelf-shaped, up to 7 inches wide, grayish to almost black with smooth upper surface and cream to brownish under-surface. Mouths are large, elongated, irregular. The conks are more or less perennial.
Daedalea unicolor (see ►*Cerrena unicolor*). Heart Rot, Canker of maples and other living hardwoods, including alder, ailanthus, amelanchier, birch, chestnut and hackberry.
Daedaleopsis confragosa (formerly *Daedalea confragosa*). White Mottled Wound Rot of hardwoods, also on fir. This is a white soft rot, a slash destroyer in eastern hardwood forests but sometimes on living trees, especially willows, near wounds. Annual leathery to rigid conks (sporophores) are shelf-shaped, up to 6 inches wide, and may occasionally encircle a small, dead stem. The upper surface is gray to brown, smooth, concentrically zoned. Mouths of tubes on undersurface are elongated, wavy in outline.

Daldinia

Ascomycetes, Xylariaceae

Perithecia in a globoid to pulvinate, concentrically zoned stroma, carbonaceous to leathery, 3 to 5 cm across; spores one-celled; dark.
Daldinia concentrica Wood Rot of ash, beech, various hardwoods and occasionally citrus. There is a superficial white rot on dead parts of living trees. On English ash the decay is called calico wood and is strikingly marked with irregular brown to black bands. Stroma containing perithecia are hemispherical, black, carbonaceous.

Diaporthe

► Blights.
Diaporthe phaseolorum Sweet Potato Dry Rot. If diseased potatoes are planted, the sprouts are affected, but the disease shows little in the field. The roots, infected at the stem end, continue to rot in storage. They are shrunken, often mummified, covered with papillae, which are pycnidia under the skin massed in a coal-black stroma. Optimum temperature for the fungus is 75° to 90 °F. Use cool storage.
Diaporthe citri Phomopsis Stem End Rot, Melanose, general on citrus; Stem Rot of mango. The rot on fruits is a leathery, pliable, buff to brown area at the button end. The melanose is a superficial marking of fruits with yellow or brown, scabby, waxy dots or crusts, on leaves, twigs and fruit, often in streaks. On lemon trees, especially variety

Eureka, there is a condition known as decorticosis or shell bark. The outer bark dies, loosens, peels off in longitudinal strips. New bark forms below this, and the tree may recover only to develop the disease again in 4 or 5 years. Some leaves and twigs die; the fungus winters in dead wood.

Control A single copper spray, bordeaux or a neutral copper, applied within 1 to 3 weeks after fruit is set, controls melanose. Copper applied in summer induces excessive cork formation in the melanose lesions, a condition known as star melanose. Applied early, it is noninjurious.

Diaporthe phaseolorum Fruit Rot of pepper and tomato, also pod blight of lima bean. ► Blights.

Dichotomophthora

► Cankers and Diebacks.

Dichotomophthora portulacae Black Stem Rot on common purslane.

Diplodia

► Blights.

Diplodia natalensis (see ►*Lasiodiplodia theobromae*). Diplodia Collar and Root Rot, Fruit Rot, Gummosis, general on citrus, sometimes peach, mango and avocado.

Diplodia opuntia Cladode Rot of cactus.

Diplodia phoenicum Leaf and Stalk Rot of date palms, Fruit Rot. The disease is sometimes fatal to transplanted offshoots. Leaves decay and die prematurely; spores are produced in great abundance. Infection is through wounds. Remove diseased tissue as far as possible and apply copper-lime dust.

Diplodia pinastri Collar Rot of pine.

Diplodia theobromae (see ►*Lasiodiplodia theobromae*). Sometimes considered a synonym of *D. natalensis*.

Diplodia tubericola (see ►*Lasiodiplodia theobromae*). Java Black Rot, general on sweet potatoes, especially in the South.

Diplodia zeae (see ►*Stenocarpella maydis*). Diplodia Corn Ear Rot, Root and Stalk Rot, seedling blight.

Lasiodiplodia theobromae (formerly *Diplodia natalensis*). Diplodia Collar and Root Rot; Fruit Rot, Gummosis, general on citrus, sometimes peach, mango and avocado. On fruit, the rot resembles Phomopsis rot in being a leathery pliable decay of the stem end. It can be prevented by spraying with bordeaux mixture, adding 1 % oil to check the increase in scale insects after the copper kills entomogenous fungi keeping them in check. The collar rot may girdle young trees and produce some gumming. Trees affected with root rot seldom recover and should be removed.

Lasiodiplodia theobromae (formerly *Diplodia theobromae*). Sometimes considered a synonym of *D. natalensis* but differentiated by pycnidia developed in a stroma instead of on a subiculum and by darker spores. Causing rots of tropical fruits, stem-end rot of avocado and collar rot of peanuts. The peanut rot appears in Georgia, Florida and Alabama. Runners and central stem are invaded; they are brown at first, then black with pycnidia.

Lasiodiplodia theobromae (formerly *Diplodia tubericola*). Java Black Rot, general on sweet potatoes, especially in the South. So named because the first diseased specimens came from Java; this is strictly a storage rot. The inner part of the tuber is black and brittle; innumerable pycnidia are produced under the skin, giving it a pimply appearance. The potato is finally mummified. Use care in handling so skins are not broken or bruised; cure properly after harvest; have suitable temperature in the storage house.

Stenocarpella maydis (formerly *Diplodia zeae*). Diplodia Corn Ear Rot, Root and Stalk Rot, seedling blight. This is one of several fungi commonly causing ear rot in corn. The rot is dry, varying from a slight discoloration of kernels to complete rotting of the ear. Seedlings and inner stalks have a dry, brown decay. Another species (*D. macrospora*) is similar but less common, found in more humid, warmer regions. The rot is greater in smutted plants. Treat seed before planting with Spergon.

Diplodina

► Leaf Spots.

Diplodina persicae Fruit Rot of peach, found in Louisiana in 1952, affecting stem and leaves as well as fruit. All varieties are susceptible.

Epicoccum

► Leaf Spots.

Epicoccum nigrum Postharvest Decay on cantaloupe.

Echinodontium

Basidiomycetes, Aphyllophorales

Hymenium in the form of teeth with spiny serrate margins; pileus caplike to crustose.

Echinodontium tinctorium The Indian paint fungus causes Brown Stringy Rot, Heartwood Rot of living conifers –balsam fir, hemlock, Engelmann spruce, larch, and Douglas-fir –- chiefly in the West, often with large losses in forest stands. Light brown to tan spots are produced in heartwood accompanied by small radial burrows resembling insect galleries. Rusty streaks follow the grain. In older trees rot can extend entire length of heartwood and into roots. External signs of decay are hard, woody, hoof-shaped perennial conks, the upper surface dull black, cracked, the undersurface gray, covered with coarse teeth, the interior rust are brick red with a pigment used by the Indians for paint. Even one fruiting body is indicative of extensive decay.

Polyporus (Favolus)

Basidiomycetes, Aphyllophorales

Pileus usually stipitate; lamellae forking irregularly to form elongate, rhomboidal pores.

Favolus alveolaris (see ►*Polyporus mori*). Heart Rot of hickory.

Polyporus mori (formerly *Favolus alveolaris*). Heart Rot of hickory.

Fomes

Basidiomycetes, Aphyllophorales

Pileus woody, perennial, with tubes in layers; common cause of wood decay. Spores hyaline to brown to nearly black.

Fomes annosus (see ►*Heterobasidion annosum*). Heart Rot, Root and Butt Rot, Spongy Sap Rot of conifers, sometimes hardwoods; also Root Rot on juniper and rhododendron.

Fomes applanatus ►*Ganoderma applanatum.*

Fomes connatus White Spongy Rot of heartwood of living hardwoods, most prevalent on maples, especially red and sugar maples. Entrance is through wounds or branch stubs, but fruiting is usually on basal stems or scars. Conks appear annually but are perennial, small, less than 6 inches wide, hoof-shaped, corky to woody, white to yellowish, the upper surface covered with moss or algal growth. There is usually a limited area of decay.

Fomes everhartii (see ►*Phellinus everhartii*). Yellow Flaky Heart Rot of living hardwoods, including birch and beech and especially oaks.

Fomes fomentarius White Mottled Rot of birch, beech, poplar, maple, and other hardwoods. This fungus mostly decays dead timber; sometimes it attacks living trees. The wood is brownish, firm in early stages of decay, but in advanced stages is yellowish white, soft, spongy, with narrow dark zone lines and small radial cracks filled with yellow mycelium, giving a mottled effect. Decay starts in upper part of the bole and progresses downward. Conks are profuse on dead trees. They are hard, perennial, hoof-shaped, up to 8 inches wide, with a smooth concentrically zoned upper surface, gray to brown undersurface. The interior is brown, punky, with tubes encrusted with white.

Fomes fraxinophilus (see ►*Perenniporia fraxinophila*). White Mottled Rot of ash, a heartwood rot most common on white ash, also on green ash and willow.

Fomes igniarius (see ►*Phellinus igniarius*). White Spongy Rot, White Trunk Rot, Heart Rot, on a wide variety of hardwoods but not on conifers.

Fomes officinalis (**Fomitopsis officinalis**) (see ►*Fomitopsis officinalis*). Brown Trunk Rot of conifers infecting heartwood of living larch and other trees.

Fomes pini (**Trametes pini**) (see ►*Phellinus pini*). Red Ring Rot, white pocket rot, of conifers, especially Douglas-fir, larch, pine and spruce, causing heavy forest losses.

Fomes pinicola (see ►*Fomitopsis pinicola*). Brown Crumbly Rot of many conifers and some hardwoods – maple, birch, beech, hickory, peach – usually on dead trees, occasionally in heartwood of living trees.

Fomes rimosus (see ►*Phellinus robiniae*). Heart Rot on locust.

Fomes robustus (see ►*Phellinus robustus*). Heart Rot of cacti and other desert plants; of oak, fir, juniper, in different strains.

Fomes roseus (see ►*Fomitopsis rosea*). Brown Pocket Rot, cubical rot of heartwood of living conifers, particularly Douglas-fir.

Fomitopsis officinalis (formerly *Fomes officinalis* (*Fomitopsis officinalis*)). Brown Trunk Rot of conifers infecting heartwood of living larch and other trees. Intensely white spore surface; very bitter, known as the quinine fungus.

Fomitopsis pinicola (formerly *Fomes pinicola*). Brown Crumbly Rot of many conifers and some hardwoods – maple, birch, beech, hickory, peach – usually on dead trees, occasionally in heartwood of living trees. Sporophores are shelf-to hoof-shaped, 2 to 10 inches across, sometimes up to 2 feet, upper surface gray to black, often with a red margin, underside white to yellow when fresh.

Fomitopsis rosea (formerly *Fomes roseus*). Brown Pocket Rot, cubical rot of heartwood of living conifers, particularly Douglas-fir. Decay originates in upper part of bole. Wood is yellow to reddish brown, soft, breaking into irregular cubes. Woody bracket conks, up to 6 inches wide, have black tops and rose undersurface. Infection is through dead branch stubs and broken tree tops.

Heterobasidion annosum (formerly *Fomes annosus*). Heart Rot, Root and Butt Rot, Spongy Sap Rot of conifers, sometimes hardwoods; also Root Rot on juniper and rhododendron. Infection is through wounds. Tissue thin, mycelial felts are formed between bark and wood, which is pinkish to violet in incipient states. In advanced stages white pockets are formed in wood. Perennial conks are bracket-shaped to flat layers, upper surface zonate, light to dark grayish brown, undersurface beige with small pores. Infection is sometimes through dead roots from mycelium growing through soil, sometimes by spores washed by rain or carried by rodents.

Perenniporia fraxinophila (formerly *Fomes fraxinophilus*). White Mottled Rot of ash, a heartwood rot most common on white ash, also on green ash and willow. Conks are up to a foot wide, with dark, rough upper surface, brownish underneath, appearing first when wood has decayed only a short distance. Infection is usually through branch stubs.

Phellinus everhartii (formerly *Fomes everhartii*). Yellow Flaky Heart Rot of living hardwoods, including birch and beech and especially oaks. Infection is usually limited to the lower trunk, and the flaky character is because the decay is more rapid between rays. There are narrow, dark brown zone lines. Gnarled swellings on the trunk indicate sapwood invasion. The conks are perennial, hard, woody, shelf-shaped, up to a foot wide, with the yellow-brown upper surface becoming black, charred, rough, concentrically grooved with age. The undersurface is reddish brown.

Phellinus ingiarius (formerly *Fomes igniarius* (*Phellinus igniarius*)). White Spongy Rot, white trunk rot, heart rot, on a wide variety of hardwoods but not on conifers. Aspen and birch are particularly susceptible. Decay is mostly confined to heartwood, but in yellow birch living sapwood is killed, causing cankers on the trunk. In an advanced stage the decay is soft, whitish, with fine black lines running through it. The conks are perennial, hard, woody, thick, usually hoof-shaped, up to 8 inches wide, the upper surface gray to black, becoming rough and cracked with age; undersurface is brown and the interior

rusty brown with many layers of tubes, the oldest stuffed with white. Infection is through branch stubs and open wounds. A single conk may indicate 15 linear feet of rot in heartwood.

Phellinus pini (formerly *Fomes pini* (*Trametes pini*)). Red Ring Rot, white pocket rot, of conifers, especially Douglas-fir, larch, pine and spruce, causing heavy forest losses. Decay starts as a purplish or red discoloration of the heartwood, but in an advanced stage there are many soft, white fibrous pockets separated by sound wood. Sporophores vary from shelf-to bracket-to hoof-shaped, averaging 4 to 8 inches across, rough gray to brownish black with light brown margin on upper surface and gray to brown underneath. Tube mouths are circular to irregular. On living trees conks are formed at knots or branch stubs.

Phellinus robiniae (formerly *Fomes rimosus*) Heart Rot on locust.

Phellinus robustus (formerly *Fomes robustus*). Heart Rot of cacti and other desert plants; of oak, fir, juniper, in different strains. Context of sporophores bright yellow-brown; spores hyaline.

Fusarium

Deuteromycetes, Coelomycetes

Mycelium and spores generally bright in color. Macroconidia fusoid-curved, septate, on branched conidia in slimy masses, sporodochia; smaller microconidia with one or two cells; resting spores, chlamydospores, common. Teleomorph state when known usually in Hypocreales, *Nectria* or *Gibberella*. Cause of many important rots, wilts, and yellows diseases. Classification difficult, with different systems and synonyms, many forms and races. (see Fig. 3)

Fusarium acuminatum Fruit Rot of squash and pumpkin.

Fusarium avenaceum Crown Rot of Eustoma. Associated with cereal diseases, fruit and storage rots, but now included in *F. roseum* by many pathologists. Fruit Rot of squash and pumpkins.

Fusarium culmorum Also on cereals, included in *F. roseum* by many pathologists. Fruit Rot of squash and pumpkins, also Root and Basal Rot of leak.

Fusarium equiseti Fruit Rot of squash and pumpkin.

Fusarium moniliforme (Teleomorph, *Gibberella fujikuroi*). Ripe Rot of figs, carried by the pollinating fig wasp; Root, Stalk, Pink Kernel Rot of corn. The rotted kernels are pink to reddish brown; the stalks have brown lesions, may break over or ripen prematurely.

Fusarium oxysporum Reported as causing a new disease of soybean in Missouri and Iowa. Root rot, with rapid wilting and drying of leaves; most severe on seedlings.

Fusarium oxysporum Root Rot on apple and sage; tomato hypocotyl rot on sugar pine, red and white firs; stem rot on zygocactus; and rot of stone plant. This pathogen may also be seedborne

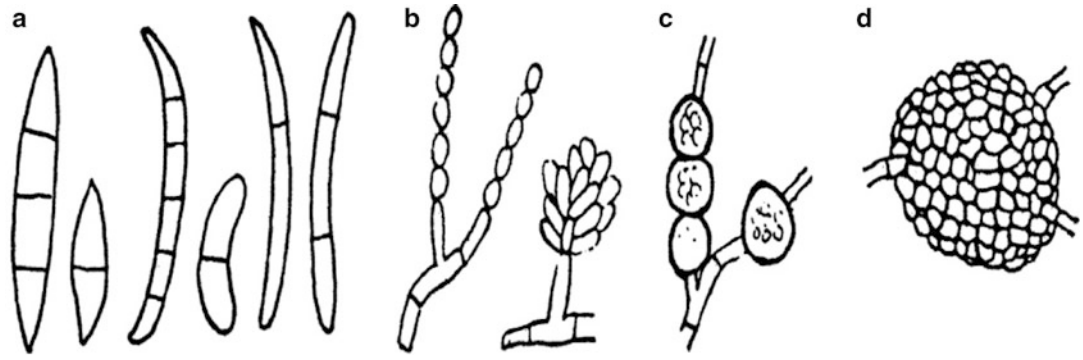

Fig. 3 Forms of *Fusarium*. (**a**) septate macroconidia; (**b**) micoconidia in chains or a head; (**c**) clamydospores; (**d**) sclerotium

and pathogenic on Douglas-fir. Root and crown rot; of leafy spurge.

Fusarium oxysporum Iris Basal Rot on bulbous varieties of iris. Plants fail to emerge, or turn yellow, wilt and die. Roots are few or none. The bulb is infected at the base, which shrinks; the husk adheres firmly, sometimes with a white or reddish mass of mycelium. The rot is more serious in warm climates and on yellow rather than blue varieties. De Wit is very susceptible; Wedgewood is quite resistant.

Control Avoid bruising bulbs in digging; sort and discard diseased bulbs right after digging; dry bulbs rapidly.

Fusarium oxysporum Tulip Basal Rot. Leaves growing from diseased bulbs turn red, wilt and die; roots are few or none. Bases of bulbs have a rather firm rot with white or pink felty masses of spores. The diseased area usually turns chalky. This is primarily a storage disease in bulb sheds and warehouses.

Fusarium oxysporum f. sp. **batatas** Sweet Potato Stem Rot, a widespread field disease, destroying more than 50 % of plants in some fields. This fungus also infects *Jacquemontia*. The stem rot is conspicuous about 2 weeks after sprouts are set. Sprouts are yellow or dead, and the vines brown or black, often split near the ground. Some plants develop new roots above the decayed section and so survive. Sweet potatoes from infected plants are small, decayed at the stem end, with vascular tissues brown. The fungi winter in stored roots and can live indefinitely in soil. Varieties Big Stem Jersey, Little Stem Jersey, Maryland Golden and Nancy Hall are very susceptible; Porto Rico is intermediate; Southern Queen, Triumph, and Yellow Strassburg are quite resistant.

Fusarium oxysporum f. sp. **cepae** Bulb Rot, Basal Rot of onion, shallot and garlic. In the field there is progressive yellowing and dying back from tips, the roots commonly turning pink and gradually decaying. The rot is often associated with wounds of maggots and other insects. In storage the rot is most active at room temperature or above.

Fusarium oxysporum f. sp. **chrysanthemi** - Fusarium Wilt of chrysanthemum.

Fusarium oxysporum f. sp. **gladioli** (*F. orthoceras* var. *gladioli*). Fusarium Brown Rot, Yellows of gladiolus, a major disease in some sections. Most infection takes place in the field, but subsequent decay appears in storage. Corm lesions are first small, reddish brown, more often on lower half of corm. They enlarge in storage to irregular to circular, sometimes zonate brown areas, which do not infrequently advance until the whole corm is a hard, dry, brownish black mummy. Infection comes from old corms, the fungus penetrating through the basal plate and the center of the new corm. The latter may be entirely decayed in storage, with the fungus advancing from the center to the outside, causing brown to black surface lesions.

Symptoms of yellows, a vascular disease, include bending of young leaf stalks, cupping of leaf stalks in older plants, crooked flower stems, often greener than normal and a curving of growth away from the side of the corm showing rot. There is gradual yellowing and dying of foliage, starting with the oldest leaves. Picardy and Spotlight varieties are particularly susceptible. Nitrogenous fertilizers and manures, especially where phosphorus is low, increase corm rot.

Control Cure immediately after digging at 95 °F to develop wound periderm and cuticle resistant to the fungus; use resistant varieties where possible or a 3-to 4-year rotation.

Fusarium oxysporum f. sp. **lilii**. Basal Rot of lily, on bulbs, roots, stems of garden and native lilies; Corm Rot of crocus, also on freesia and cactus (*Cereus*). A chocolate rot at base of scales next to the basal plate progresses until the scales fall away. The disease is more destructive to Madonna and some other garden lilies; it is seldom a problem with Easter lilies grown in the Northwest. Keep bulbs cool in storage, and plant in cool soil. Infection comes from contaminated soil as well as diseased bulbs.

Fusarium oxysporum f. sp. **narcissi** (*F. bulbigenum*). Narcissus Basal Rot, general on hardy varieties, rare on polyanthus varieties. Rot begins at the root plate at base of bulbs and spreads through central portions first, extension of the rot being more rapid in affected scales than

across to adjacent healthy scales. Rotted tissue is chocolate or purplish brown, the mycelium a delicate weft of white or pink threads. The rot is dry, spongy, with little external evidence; it is primarily a storage or transit disease, but it may occur in the field late in the season. When lightly infected bulbs are planted, there is no root development, and plants are stunted. Basal rot is spread in hot-water treatment for nematodes. It is more prevalent where soil temperatures are above 65 °F and on large trumpet varieties. Golden Harvest is much more susceptible than King Alfred.

Control Discard all bulbs showing rot, or that are soft when pressed; if disease has occurred previously, plant in a new location.

Fusarium oxysporum f. sp. **radicis-lycopersici** Root and Crown Rot of tomato.

Fusarium oxysporum var. **redolens** Root Lesions of pine.

Fusarium poae Carnation Bud Rot, Silver Spike Disease of bluegrass. The interior of carnation buds is brown or pink, decayed, moldy and often infested with grass mites, which have introduced the spores. The disease is favored by excessive dampness. Pick and destroy diseased buds; control mites.

On bent grasses, fescues and especially Kentucky bluegrass, seed heads wither before they are fully expanded, appearing silvery. Seeds are aborted, and in moist weather copious mycelium grows from decayed areas in culms. The pathogen is disseminated and grass inoculated by the grass mite (*Siteroptes graminum*). Burning over dead grass is a practical means of control.

Fusarium proliferatum Root Rot and Stem Wilt on asparagus in CT. Root Rot and Crown Rot of clovers and leafy spurge, Bulb Rot of onions.

Fusarium roseum Peppermint Root and Rhizome Rot. Reported from Oregon as part of a complex with *Rhizoctonia solani* and *Pythium* sp. Necrotic lesions girdle rhizomes; new shoots damp-off. Fall-plowed mint gave stronger stands. This pathogen also causes seedling stem rot on Douglas-fir.

Fusarium cerealis Stem Rot of carnation and cereals. Roots and stems of cuttings and young plants rot; in older stock the diseased tissue turns brownish red or crimson. Infection is only through injured, weak or old tissue.

Fusarium semitectum Corky Dry Rot on cantaloupe.

Fusarium solani Tuber Rot on caladium and Stem Rot on chrysanthemum, Fraser fir, Douglas-fir, dieffenbachia (cutting rot), and sweet potato (root rot); shefflera is susceptible with no symptoms. Root rot; this pathogen also causes root rot of apple. Root and Crown Rot of leafy spurge.

Fusarium solani (Teleomorph, *Nectria haematococca*). Stem Rot and Wilt of *Exacum*.

Fusarium solanif. sp. **cucurbitae** (Teleomorph, *Hypomyces solani*). Fusarium Root Rot of cucurbits, primarily pumpkin and squash, occasionally muskmelon, watermelon and cucumber. The fungus usually girdles the plant at ground level with a soft dark decay, resulting in a striking wilt of the entire vine. Fruits on the ground may be rotted and the fungus carried on seed to infest clean soil. Do not plant cucurbits in land known to be contaminated.

Fusarium solani f. sp. **phaseoli** Dry Root Rot of bean and lima bean, common but most important in New York, Idaho and other areas intensively cropped for many years. Indefinite reddish lesions or streaks on taproot and subterranean stem turn dark brown to black. Lateral roots are reduced and plants stunted. This is a late season disease favored by warm soil. The fungus winters in crop refuse and soil and may be carried in dust on seed. The best control is a long rotation between crops.

Fusarium solani f. sp. **pisi** Root Rot on chickpea, spruce, pine, fir, and hemlock.

Fusarium subgutinans Collar Rot and Foliar Blight on Chinese evergreen.

Fusarium sp. Root and Seed Rot of bird-of-paradise (*Strelitizia*), part of a fungus complex. Controlled by treating seed in hot water, 135 °F for 30 min, and immediately cooling in cold water and treating planting medium with methyl bromide or steam.

Fusarium sp. Dill Root Rot, Wilt, discovered in Ohio in 1949. Symptoms include browning of roots, necrosis of vascular system, yellowing, wilting and death. Young plants are most

susceptible. Seed treatment did not give satisfactory control.
Fusarium sp. Root Rot of sweet peas, reported as prevalent in Montana. Plants turn yellow when in bloom with necrosis of vascular system which leads to drying up of plant.

Gaeumannomyces

Gaeumannomyces graminis var. **graminis**. Blight of centipede grass and Bermudagrass. Root rot; of St. Augustinegrass. Leaf yellowing and root mass reduction; of Zoysia.

Ganoderma

Basidiomycetes, Aphyllophorales

Differing from *Fomes* in having spores truncated at one end and two-layered, the spines of the brown endospore projecting into hyaline exospore. Sporophore has a hard crust, formed by a layer of thick-walled, elongated cells.
Ganoderma applanatum (Syn. *Fomes applanatus*). White Mottle Rot, widely distributed on hardwoods, maple, beech, alder, acacia, birch, horse-chestnut, hawthorn and hickory, and sometimes on conifers. The rot is ordinarily on dead timber, but the fungus can attack living trees through wounds and destroy heartwood for a few feet. In early stages the wood is somewhat bleached, surrounded by a dark brown band. This shelf fungus is called artists' conk because the white undersurface immediately turns brown when bruised and can be used for writing or etching pictures. The upper surface is smooth, zoned, gray or gray-black; up to 2 feet wide.
Ganoderma curtisii (see ►*Ganoderma lucidum*). Perennial, with several layers of pores.
Ganoderma lucidum (formerly *Ganoderma curtisii*). Perennial, with several layers of pores.
Ganoderma lucidum (Syn. Polyporus lucidus). The varnish or lacquer fungus causes Heart Rot of eastern hardwoods and conifers, especially hemlock, reported also on boxwood, hackberry, sassafras, maples and citrus. This fungus may be an important facultative parasite on city shade trees. The rot is white, spongy, with black spots scattered throughout. The conks are annual, with a reddish, shiny, lacquered upper surface and a short, thick lateral stalk; common on logs, stumps, standing or fallen trees.
Ganoderma zonatum Butt Rot of queen palms, Florida.
Ganoderma zonatum On mesquite, in Texas.

Greeneria

Deuteromycetes, Coelomycetes

Greeneria uvicola Bitter Rot of grape.

Gibberella

► Blights.
Gibberella zeae (Anamorph, *Fusarium graminearum*). Corn Root Rot, Stalk Rot, Ear Rot, also Fusarium Head Blight or Scab of cereals and grasses. Corn is attacked at all ages, with both roots and kernels rotted. Conidia are pinkish in mass; black perithecia are numerous on overwintered corn stalks and residues. Hybrid corn with loose husks exposing the ear tip or varieties with upright ears retaining water are more apt to be infected. Rotation and clean plowing aid in control.

Gilbertella

Zygomycetes, Mucorales

Gilbertella persicaria Fruit Rot on peach.

Gloeosporium

► Anthracnose.
Colletotrichum gloeosporioides (formerly *Gloeosporium foliicolum*). (*Glomerella cingulata*). Fruit Rot on citrus fruits.

Gloeosporium foliicolum (see ►*Colletotrichum gloeosporioides*). (*Glomerella cingulata*). Fruit Rot on citrus fruits.

Gloeotinia

Gloeotinia granigera (formerly *Gloeotinia temulenta*). Blind Seed Rot on grass.
Gloeotinia temulenta (see ►*Gloeotinia granigera*). Blind Seed Rot on grass.

Glomerella

► Anthracnose.
Glomerella cingulata Bitter Rot of apple and pear, Fruit Rot of peach, also Stem Rot, Canker, Dieback of many fruits and ornamentals, Ripe Rot of grapes. Bitter rot is a late season disease of apple, often destructive in central and southern states. The fruits have light brown circular spots, which gradually enlarge; they cover rotting flesh, which has a bitter taste. Lesions become concave and have concentric rings of pink to dark spore pustules in sticky masses. Spores are splashed by rain or carried by flies and other insects. Eventually apples turn into dry, shriveled mummies, in which the fungus overwinters and where the ascospore stage is produced. Large limbs have oval, roughened, sunken cankers. The disease is favored by hot muggy weather.

Apple varieties vary greatly in resistance, and some, like Yellow Newtown, are resistant to the canker but susceptible to fruit rotting. Varieties somewhat resistant include Delicious, Rome Beauty, Stayman Winesap, Winesap and York Imperial. Ripe rot starts on grapes as they mature and gives a bitter taste to the pulp. To control disease remove mummies from trees and prune out dead twigs and cankers.
Glomerella cingulata var. **vaccinii** Cranberry Bitter Rot, a field and storage rot. A soft brownish yellow discoloration develops on fruit late in the season, most serious in a hot July and August.

Godronia

Ascomycetes, Helotiales

Apothecia coriacious, pitcher-shaped; spores filiform, hyaline.
Godronia cassandrae (*Fusicoccum putrefaciens*). Cranberry End Rot, general on cranberry, with the ascospore stage also found on dead branches of leatherleaf (*Cassandra*). The rot appears late, often after picking and packing, and is enhanced by injuries during harvesting and screening. It starts at either blossom or stem end of the berry; the fruit becomes soft and light-colored.
Godronia cassandrae f. sp. **vaccinii** On blueberry.

Guignardia

► Blackleg.
Botryosphaeria vaccinii (formerly *Guignardia vaccinii*). Cranberry Early Rot, Scald, Blast, general on cranberry and sometimes on huckleberry. All aerial plant parts are attacked, but the disease is more destructive to the fruit. Young fruit may blast and shrivel, but more often rot starts as a light-colored soft spot when fruit is half grown. The berry mummifies, turns black and is covered with small pycnidia. Leaves have reddish brown spots, sometimes drop prematurely.
Guignardia bidwellii Black Rot of grapes, widespread, principal cause of failure of European grapes in eastern United States, causing more loss than all other grape diseases combined. All parts of the vine are attacked. On leaves, reddish brown dead spots are sprinkled with black pycnidia. Rot starts on half-grown fruit as a pale spot, soon turning brown and involving the entire berry, which shrivels into a black wrinkled mummy, dropping or remaining in the cluster (see Fig. 4). Some berries shatter if attacked early. Ovoid conidia and sometimes microconidia (spermatia) are formed on leaves, berries and canes. Ascospores are produced in

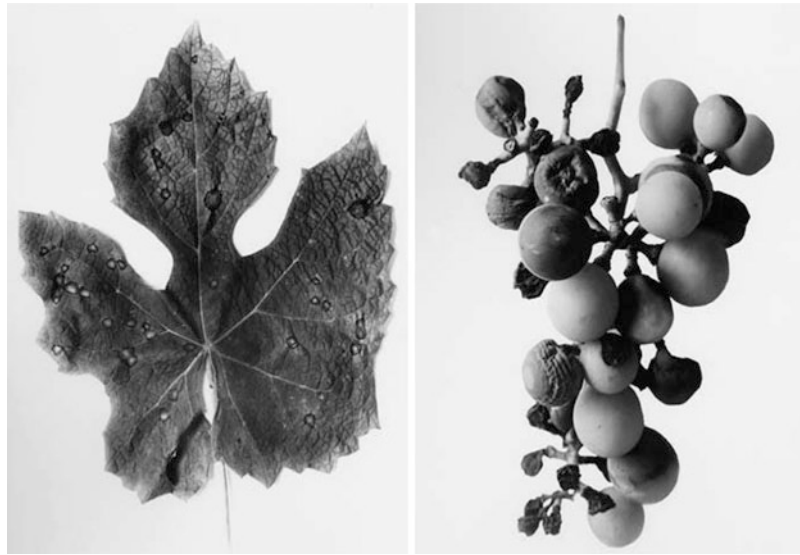

Fig. 4 Black Rot of Grapes

overwintered mummied berries. Primary infection in spring comes from either spore form.

Thecaphora deformans Seed Smut of lupine.

Control If mildew is also a problem, use a fixed copper. Cultivate in early spring so as to cover old mummies with soil and so eliminate that source of inoculum.

Guignardia vaccinii (see ►*Botryosphaeria vaccinii*). Cranberry Early Rot, Scald, Blast, general on cranberry and sometimes on huckleberry.

Helicobasidium

Basidiomycetes, Septobasidiales

An exposed cottony hymenium or fruiting layer; basidia transversely septate; spores coiled like a watch spring.

Helicobasidium corticioides Brown Pocket Rot on subalpine fir, in Colorado.

Helicobasidium brebissonii (Anamorph, *Rhizoctonia crocorum*). Violet Root Rot of potato, sweet potato, asparagus, beet, carrot and some ornamentals – ash, catalpa, chinaberry, crocus, elm, mulberry, parthenocissus and western soapberry. The fungus invades roots from the soil, turning them reddish or violet. The disease is confined to underground parts unless continuously wet weather allows the reddish-purple mycelium to grow up the stem. Small, darker sclerotia are embedded in this purplish mat, which turns brown with age.

Helminthosporium

► Blights.

Bipolaris cactivora (formerly *Helminthosporium cactivorum*). Stem Rot of cacti, Basal or Top Rot of seedling cacti, which turn into a shrunken brown mummy covered with spores. Initial symptoms are yellow lesions; rotting may be complete in 2 to 4 days.

Exserohilum turcicum (formerly *Helminthosporium turcicum*). Crown Rot of sweet corn, Leaf Blight. ► Blights.

Helminthosporium cactivorum (see ►*Bipolaris cactivora*). Stem Rot of cacti, Basal or Top Rot of seedling cacti.

Helminthosporium sesami Stem Rot on sesame in Texas.

Helminthosporium turcicum (see ►*Exserohilum turcicum*). Crown Rot of sweet corn, Leaf Blight.

Hericium

Basidiomycetes, Aphyllophorales

Fleshy, branched or unbranched, with subulate spines long and pendant; spores spherical or subspherical, staining blue with iodine. Like *Hydnum* but sporophore formed on wood, not on the ground.
Hericium erinaceus (Syn. *Hydnum erinaceus*), hedgehog fungus. White Heart Rot, occasional on living oak, maple and other trees. The soft white spongy rot may entirely decompose the tissue, leaving large hollows lined with yellowish mycelium. Sporophores are annual; soft, white, browning with age, globular with a hairy top and long slender teeth on the lower surface.

Grandinia (Hyphodontia)

Basidiomycetes, Aphyllophorales

Grandinia granulosa (formerly *Hyphodontia aspera*). Root and Butt Rot of spruce.

Hypholoma

Basidimycetes, Agaricales

Margin of cap with a curtainlike veil; stipe with incomplete or vanishing ring; spores purple.
Hypholoma sublateritium Root Rot of currant.

Idriella

Deuteromycetes, Hyphomycetes

Mycelium hyaline to brown; conidophores brown, simple, nonseptate, narrowed above, with prominent spore scars; conidia (sympodulospores) lunate to falcate, with pointed ends, produced in clusters near apex of the conidiophore; aleuriospores brown, several-celled.
Idriella lunata Root Rot on strawberry.

Inonotus

Inonotus tomentosus (Syn. **Polyporus tomentosa**). Root Rot of spruce.

Irpex

Basidiomycetes, Aphyllophorales

Resupinate, effused-reflexed, or shelf-like; younger parts of hymenophore are poroid; with increasing age produce flattened teeth.
Irpex lacteus Wood Rot and Decline of apple.

Gliocladium (Isaria)

Deuteromycetes, Hyphomycetes

Conidiophores equally distributed on a synnema, erect fascicle of hyphae; conidia hyaline, one-celled, ovoid; some species in insects.
Gliocladium roseum (formerly *Isaria clonostachoides*). Isaria Rot of tomato. Fruits are partly covered with cottony mycelium, white turning pink or orange and becoming granular, but rot remaining firm. Reported from around Washington, D. C.
Isaria clonostachoides (see ►*Gliocladium roseum*). Isaria Rot of tomato.

Kluyveromyces

Ascomycetes, Saccharomycetaceae

Kluyveromyces marxianus var. **marxianus** Soft Rot of onion caused by a true yeast on bulbs.

Lasiodiplodia

Deuteromycetes, Coelomycetes

Lasiodiplodia theobromae Collar Rot on peanut.

Lentinus

Basidiomycetes, Agaricales

Gills are notched or serrate at edge, decurrent, stipe often lateral or lacking cap, tough-fleshy to leathery; spores white.

Lentinus lepideus (see ►*Neolentinus lepideus*). Scaly Cap, causing a brown cubial rot of coniferous wood and sometimes decaying heartwood of living pines.

Lentinus tigrinus Sapwood Rot, white mottled butt rot of living hardwoods, commonly associated with fire scars and one of the most important decay fungi in the Mississippi Delta. Fruiting body is white with cap depressed in center, more or less covered with blackish brown hairy scales, rarely developing on living trees.

Neolentinus lepideus (formerly *Lentinus lepideus*). Scaly Cap, causing a brown cubial rot of coniferous wood and sometimes decaying heartwood of living pines.

Lenzites

Basidiomycetes, Aphyllophorales

Pores elongated radially to resemble gills; pileus shelflike; woolly and zonate above.

Gloeophyllum sepiarium (formerly *Lenzites saepiaria*). Timber Rot, Brown Pocket Rot, usually of dead sapwood, occasionally a heart rot, rarely on living trees. This is the common destroyer of coniferous slash; it is found on telephone poles and other timber. Fruiting bodies are long narrow shelves coming from cracks, the upper surface a yellow red to dark reddish brown.

Lenzites betulina Heart Rot of birch and cypress.

Lenzites saepiaria (see ►*Gloeophyllum sepiarum*). Timber Rot, Brown Pocket Rot, usually of dead sapwood, occasionally a heart rot, rarely on living trees.

Leptosphaeria

► Blights.

Leptosphaeria korrae Root and Crown Rot of turf grasses (necrotic ring spot).

Macrophoma

► Cankers and Diebacks.

Macrophoma sp. Fruit Rot of grape.

Macrophomina

Deuteromycetes, Coelomycetes

Spores hyaline, one-celled, in pycnidia.

Macrophomina phaseolina (Anamorph, *Sclerotium* or *Rhizoctonia bataticola*). Charcoal Rot, Ashy Stem Blight, on many plants in warm climates and sometimes in temperate zones. The name for the sterile stage comes from sweet potato, and the term charcoal rot is used because the interior of the potato becomes jet black.

The fungus lives in the soil, is particularly prevalent in warm soils and attacks roots and stems of a varied list of hosts, including bean, lima bean, soybean, beet, corn, cowpea, cabbage, eggplant, garlic, gourds, pepper, strawberry and watermelon; also chrysanthemum, dahlia, garden mallow, mountain-laurel, marigold and zinnia. In most cases the pycnidial stage is not formed. The mycelium spreads through the soil, and very small black sclerotia are formed in great abundance on or in lower stems and roots. On beans, black sunken cankers appear just below the cotylendonary node, and the lesion may extend up the stem, ashy gray in the center. Stems may break over, or the growing point may be killed. In sweet potatoes the disease is a storage rot, the tissue becoming a dark red-brown with the outer zone black from the formation of myriads of sclerotia. The decay is spongy, then hard,

mummified. The fungus is spread in irrigation water, crop debris, imported soil and on seed. *Control* Use bean seed grown in western disease-free regions. Keep plants growing vigorously with proper food and water; practice general sanitation.

Macrophomina phaseolina Charcoal Rot on soybean, sunflower, *Amaranthus, Euphorbia* spp., *Ipomea, Sonchus* and *Tidestrominia*; root rot on caper spurge.

Magnaporthe

Ascomycetes, Diaporthales

This is characterized by the production of perithecial ascocarps produced in a stroma of fungal and substrate tissues or directly from somatic hyphae on the substrate.

Magnaporthe poae Summer patch and large brown patch on grass.

Melanconium

► Leaf Spots.

Greeneria uvicola (formerly *Melanconium fuligineum*). Bitter Rot of grapes, widespread but especially serious on Muscadine grapes in Georgia. Decayed berry pulp has a bitter taste; up to 30 % of fruit is reduced to dry, hollow shells. Spray with bordeaux mixture three times at 14-day intervals beginning after fruit is set. The later sprays for black rot should control bitter rot.

Melanconium fuligineum (see ►*Greeneria uvicola*). Bitter Rot of grapes, widespread but especially serious on Muscadine grapes in Georgia.

Mycocentrospora

Deuteromycetes, Hyphomycetes

Mycocentrospora acerina Dry Rot of carrot.

Monilinia

► Blights.

Monilinia fructicola (Syn. *Sclerotinia fructicola*). Brown Rot of stone fruits, blossom blight, general on peach, plum and cherry, also on apricot, almond, beach-plum, Japanese quince, and, rarely, apple and pear. The fungus is distinct from the species in Europe (*Sclerotinia fructigena*) causing brown rot of stone fruits and also a serious apple rot. In the United States, brown rot is our most destructive stone-fruit disease, causing an annual peach loss of over $5 million. *Monilina fructicola* is the usual causative agent east of the Rocky Mountains; *M. laxa* causes a similar rot and blossom blight on the Pacific Coast. See also ► Blights.

Flowers turn brown prematurely, rot in moist weather; the calyx cup is blackened, and the discoloration may extend down into the pedicels. Infrequently there is a leaf and twig blight; cankers are formed on the larger limbs, with exudation of gum. The fruit rot is the familiar stage seen in any backyard with a fruit tree and usually in baskets of peaches, plums or cherries purchased for preserving and held over to the next day. The rot starts as a small, circular brown spot but spreads rapidly to take in the entire fruit, with the rotted surface covered with gray to light brown spore tufts or cushions (sporodochia), sometimes in concentric rings (see Fig. 5). Conidia are formed in chains on the sporodochia. The fruit finally shrinks and mummifies and either falls to the ground or remains clinging to the tree.

The fungus and decayed tissue together form a stroma that acts as a sclerotium; in spring, if the mummy has been kept moist and partially or wholly covered with soil, cup-shaped brown apothecia are produced. Primary infection is from ascospores, forcibly ejected and carried up to blossoms by air currents or from a new crop of conidia formed on mummies hanging on trees. Secondary infection is from conidia wind-borne from blossom to blossom and later from fruit to fruit.

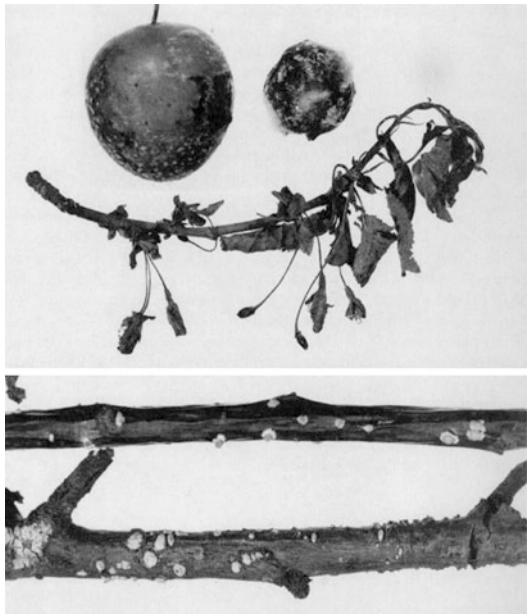

Fig. 5 Brown Rot of Plums

Entrance is often through wounds made by the plum curculio, oriental fruit moth and other insects. Rotting and conidial production continue after picking.

The rot is favored by wet weather, conidia germinating only in a film of water. Acid soil is said to increase apothecial production from mummies on the ground. In a normal season reduction from blossom blight is not important because some thinning is advantageous; but if blossom blight is not prevented, inoculum is provided for the fruit rot that causes such enormous losses.

Control Sanitary measures are important. In the small garden rake up and burn or bury deeply the fallen mummies; pick mummies from trees; cut out twigs showing gum; in summer remove infected fruit before conidia form. Standard control has been wettable sulfur sprays or sulfur dust, applied: every 3 or 4 days during bloom to control blossom blight; when shucks are falling; 2 or 3 weeks after shuck fall; and 2 to 4 weeks before fruit ripens. In some instances the newer organic fungicides are preferred to sulfur, and sometimes they are used with it. Control of the plum curculio is very important. For one or two trees in a home garden one of the all-purpose fruit sprays or dusts now available under various trade names may be satisfactory. Consult your county agent for the schedule right for your locality.

Monilinia laxa (Syn. *Sclerotinia laxa*). Brown Rot, green and ripe fruit rot, blossom blight, on almond, apple, apricot, cherry, peach, plum, pear, nectarine, quince and Japanese quince in Washington, Oregon and California; also reported from Wisconsin and Michigan. Although this disease is similar to that caused by *M. fructicola*, the blossom and twig blight phase is more important than the brown rot. Sulfur, which can be used in later sprays for most stone fruits, may injure apricots.

Monilinia oxycocci (Syn. *Sclerotinia oxycocci*). Cranberry Hard Rot, Tip Blight in Pacific Northwest and Wisconsin. Young growing tips wilt and dry just before blossoming; grayish spores tufts are formed on tips. Fruit is attacked through blossoms or wounds. The berries are yellowish white, firm, leathery, cottony inside, turning dark and mummifying late in the season. The disease is too erratic to justify cost of regular spraying; clean harvest will prevent overwintering.

Monilinia urnula (Syn. *Sclerotinia vaccinii-corymbosi*). Blueberry Brown Rot, Mummy Berry, Twig Blight of high bush blueberry, similar to hard rot of cranberry. Varieties differ in susceptibility, with June and Rancocas often showing severe primary infection.

Monilochaetes

Deuteromycetes, Hyphomycetes

Conidiophores dark, erect, slender, usually simple; septate; conidia hyaline or becoming pigmented in age, borne singly at apex or produced in chains under conditions of high humidity.

Monilochaetes infuscans Root Rot of weed species of genus *Ipomoea*.

Monosporascus

Ascomycetes, Sordariales

Monosporascus cannonballus Root Rot on cantaloupe and watermelon.

Mucor

Zygomycetes, Mucorales

Mycelium profusely developed. Sporangiophores erect, simple or branched, all branches terminated by sporangia which are globose to pyriform with a columella and thin wall; gametangia essentially alike, suspensors without definite outgrowths; hyaline chlamydospores sometimes formed.

Mucor mucedo Postharvest Rot of tomato.

Mucor piriformis Postharvest Rot of tomato. Fruit Rot of cherry.

Mucor racemosus Storage Rot of sweet potato, occasional after chilling;

Fruit Rot of citrus. Control with low temperatures and dry atmosphere in the storage house.

Mycoleptodiscus

Mycoleptodiscus terrestris Root and Stem Rot of soybean and birdsfoot trefoil.

Myrothecium

► Leaf Spots.

Myrothecium roridum Ring Rot of tomato, Crown Rot of snapdragon and pansy. Crowns of greenhouse snapdragons appear water-soaked, then covered with a thin white mycelium and numerous black sporodochia. Irregular brown spots on tomato fruits are surrounded by slight depressions. Also causes root rot of red clover and alfalfa.

Myrothecium sp. On Bells of Ireland, causing crown necrosis. Stems are girdled at ground level; tops wilt; basal branches die.

Nematospora

Ascomycetes, Saccharomycetales

This is a yeast or budding fungus, following after insect injury; asci, with 8 to 16 spores, derived directly from vegetative mycelial cells; spores elongate, fusiform to needle-shaped, flagellate.

Nematospora coryli Yeast Spot of soybean, Dry Rot of pomegranate, citrus, Pod Spot of pepper, bean and soybean, Cloudy Spot of tomato, Kernel Spot of pecan. The yeast is almost always associated with plant bug injury. The western leaf-footed plant bug carries the fungus from pomegranate to citrus. On pomegranates depressed light spots in flesh around seeds are followed by general browning and collapse. In citrus, the juice sacs just inside the rind dry out with a brownish to reddish stain. Cloudy spot on tomato fruit is associated with pumpkin bugs and leaf-footed plant bugs. Brown areas are formed on pecan kernels.

Nematospora phaseoli Yeast Spot of lima bean, a seed disease, destructive from Maryland southward. Infection follows puncture of pods by the southern green stinkbug and possibly other insects. The seed lesions are dark brown, sunken, wrinkled.

Neurospora

Ascomycetes, Sordariales

Perithecia flask-shaped, membranous; ascospores dark, one-celled with gelatinous coating; conidial stage monilioid

Neurospora sitophila Ripe Rot of pear. The fungus is the same one causing pink bakery mold on bread. There is a luxuriant pink growth over fruit; conidia are formed in chains.

Nigrospora

Deuteromycetes, Hyphomycetes

All hyphae more or less creeping, hyaline; conidiophores short, dark, cells somewhat inflated; conidia black, one-celled, situated on a flattened, hyaline vesicle at top of the conidiophore.

Nigrospora oryzae Ripe Fruit Rot of tomato, Nigrospora Cob Rot of corn. Corn cobs are shredded, with the pith completely disintegrated; kernels are filled with masses of black spores. Corn on poor soil is more susceptible; stalks break over at any point. Rapid drying checks infection of seed corn.

Olpidium

Chytridiomycetes, Spizellomycetales

Endobiotic, living in host cells or tissues, living or dead.

Olpidium brassicae Sometimes found in outer cells of rootlets of cabbage and other crucifers, tomato, lettuce and other plants, producing zoosporangia and resting spores in the cells. The effect on the host is usually merely a slight unthriftiness. Olpidium has been found associated with a disease of lettuce, Big Vein, now thought due to a virus.

Omphalia

Basidomycetes, Agaricales

Gills decurrent, cap sunken in center, somewhat funnel-shaped; central cartilaginous stem; spores white.

Marasmiellus pigmentatus (formerly *Omphalia pigmentata*). **Omphalia tralucida**. Decline Disease of date palms. Growth is retarded; roots decay; leaves die prematurely; fruit is worthless. Deglet Noor variety is most susceptible. Select thrifty offshoots from healthy plants for new date gardens. Soil can be treated with carbon disulfide, as for Armillaria rot.

Omphalia pigmentata (**Omphalia tralucida**) (see ▶*Marasmiellus pigmentatus*). Decline Disease of date palms.

Oospora (Geotrichum)

Deuteromycetes, Hyphomycetes

Slender branched or unbranched mycelium breaking up into ellipsoidal or spherical hyaline or light-colored conidia called "oidia."

Geotrichum citriaurantii (formerly *Oospora citri-aurantii*). Sour Rot of citrus. This is a soft, putrid slimy rot of fruit, mostly of stored lemons, where it is spread by contact. The mycelium forms a thin, compact, somewhat wrinkled layer over the surface. Fruitflies help to spread the spores. Fruit should be stored as short a time as possible and frequent inspections made during storage.

Geotrichum candidum (formerly *Oospora lactis*). Sour Rot, Watery Fruit Rot of tomato, common in transit and market, especially on fruit from the South. There is a velvety or granular coating over the surface or a fluffy growth along the margin of cracks, and a disagreeable odor and flavor. The rot is common on ripe fruit touching the ground, occasional on green fruit. The fungus is a weak parasite, entering through wounds.

Oospora citri-aurantii (see ▶*Geotrichum citriaurantii*). Sour Rot of citrus.

Oospora lacti (see ▶*Geotrichum candidum*). Sour Rot, Watery Fruit Rot of tomato, common in transit and market, especially on fruit from the South.

Ophiosphaerella

Deuteromycetes, Hyphomycetes

Ophiosphaerella sp. Large Brown Patch Rot on bermudagrass and creeping bentgrass.

Paecilomyces

Deuteromycetes, Hyphomycetes

Conidiophores and branches more divergent than in *Penicillium*; conidia (phialospores) in dry basipetal chains, one-celled, ovoid to fusoid, hyaline.

Paecilomyces buxi (see ►*Sesquicillium buxi*). Root Rot and Decline on boxwood.

Sesquicillium buxi (formerly *Paecilomyces buxi*). Root Rot and Decline on boxwood.

Pellicularia

► Blights.

Thanatephorus cucumeris (Syn. *Pellicularia filamentosa*) (considered by some *Botryobasidium*). Rhizoctoniose, Black Scurf of potatoes, stem canker and soil rot of beans (see under ► Blights for Web Blight of beans and other plants); Rhizoctonia Dry Rot Canker of Beets, Crown and Crater Rot of Carrots; Rhizoctonia Disease of Celery, Crucifers, Cucurbits; Bottom Rot of Lettuce; Damping-Off of Pepper and Eggplant; Root Rot of Onion; Root and Basal Stem Rot of Pea; Crown Rot of Rhubarb. The sterile state of this fungus, *Rhizoctonia solani*, was first named in 1858 in a German textbook and is still the most familiar term for a fungus with many pathogenic strains causing many types of diseases.

Any cook has seen signs of the pathogen on potato tubers – small brown to black hard flecks, sclerotia, on the skin. They look like particles of dirt but do not scrub off when potatoes are washed. There may be only one or two sclerotia, or they may nearly cover the whole surface of the tuber. When such potatoes are planted, the growing point may be killed. Some sprouts renew growth after being girdled, which may be repeated until they die. Larger plants have stems decayed just below the soil line, interrupting the downward transfer of food and resulting in a cluster of green or reddish aerial tubers. Roots may be killed back extensively. Most of the tubers are small, often with a brown jelly rot at the stem end.

Under moist conditions a white cobwebby weft of mycelium is formed at the base of potato stems, and the basidial stage is produced as a powdery crust on this weft. The fungus winters as mycelium or sclerotia in soil or tubers. The mycelium can grow saprophytically long distances in the soil independent of any plant. Infection is favored by cool temperatures; the disease is most serious in wet seasons on heavy soils. The average yearly loss for the country is about 10 million bushels, 2 to 3 %, but individual losses may be from 5 to 50 %. For control use healthy tubers for seed.

Thanatephorus cucumeris (Syn. *Pellicularia filamentosa* (Anamorph, *Rhizoctonia solani*)). Brown Patch of turf, Root and Leaf Rot of lawn grasses, wheat grass, bentgrass, fescues, ryegrass, Kentucky bluegrass (infrequently on Canada bluegrass), St. Augustine grass, and Bermuda grass. Brown or blackish patches on the turf resemble sunscald or chinch bug injury. The areas are roughly circular, from an inch to 3 feet across, sometimes up to 20 feet. The fungus works outward with a "smoke ring" of grayish black mycelium at the advancing margin. The leaves are first water-soaked, black, then collapsed, dry and light brown, but the roots are seldom killed. The disease develops most rapidly during warm humid periods and with an excess of nitrogen.

Thanatephorus cucumeris (Syn. *Pellicularia filamentosa* (Anamorph, *Rhizoctonia solani*)). Root and Stem Rot, Damping-Off of ornamentals. In wet weather cobwebby mycelium develops on lower portions of stems; the lower leaves rot and upper portions of plants wilt and die. Seedlings and older plants so rotted include *Aconitum*, abelia, *Achillea, Ageratum*, aster, artichoke, begonia, calendula, campanula, carnation, endive, dahlia, delphinium, geranium, iris, lettuce, lupine, orchids, platycodon, poinsettia, salsify, sunflower and tulip. For control avoid excessive use of manure.

Penicillium

► Cankers and Diebacks.

Various species cause blue, green, occasionally pink molds, including the common blue-green mold on jellies. Some produce antibiotics, *Penicillium notatum* being the one used for production of penicillin.

Gliocladium roseum (formerly *Penicillium roseum*). Fruit Rot of citrus and of dates. A pink mold, found on lemons but not oranges.

Gliocladium vermoeseni (formerly ***Penicillium vermoeseni***). Bud Rot of palms. The terminal bud is killed and base of leaf stalks rotted. Affected trees of very susceptible *Washingtonia filifera* should be replaced with resistant *Washingtonia robusta*, Mexican fan palm. Also ► Cankers and Diebacks.

Penicillium aurantiogriseum Crown Rot of asparagus, a seedling disease recently prevalent in Washington, following freezing injury. Bright blue spore masses appear on diseased crowns. Protect seedlings for winter by slight hilling in fall; avoid mechanical injury in harvesting; prevent drying out of crowns between digging and replanting.

Penicillium digitatum Green Mold of citrus fruit, Clove Rot of garlic. On lemons and other citrus, olive-green powdery spore masses, forming a dust cloud when disturbed, cover fruit except for a band of white mycelium outside the green area. Garlic plants are yellow and stunted. Avoid injury in harvesting and packing. Commercial growers use chemicals in the wash water to prevent decay.

Penicillium expansum Blue Mold Rot of many fruits; Soft Rot of apple, pear, avocado, pomegranate, Japanese persimmon, quince and feijoa. The decay on avocados is slow, and often the affected portions can be trimmed off. This fungus causes 80 to 90 % of the decay of storage apples. The rotted portions are light-colored, soft, watery, with a disagreeable moldy taste and odor. A few rotted apples spoil all the others in a container. Use great care in harvesting and grading to avoid wounds; keep temperature as low as possible.

Penicillium gladioli Blue Mold Rot, Penicillium Dry Rot of gladiolus, also found in imported bulbs – scilla, tritonia (montbretia). This is a storage rot. Light to dark brown sunken lesions appear on any part of corms with border of the decayed area water-soaked and greenish. Small grayish sclerotia are formed, and under moist conditions masses of blue mold. Dry rapidly after harvest, 80 °F for 10 to 14 days, then store at low temperature; avoid wounds and bruises; sort before planting.

Penicillium italicum Blue Contact Mold of citrus, Fruit Rot. The mold is blue in the older portion but powdery white at margins. It spreads readily from fruit to fruit by contact, through uninjured skin.

Penicillium roseum (see ►*Gliocladium roseum*). Fruit Rot of citrus and of dates. A pink mold, found on lemons but not oranges.

Penicillium vermoeseni (see ►*Gliocladium vermoeseni*). Bud Rot of palms.

Peniophora

Basidiomycetes, Aphyllophorales

Like *Corticium* but with cystidia.

Chaetoderma luna (formerly *Peniophora luna*). Brown Rot in lodgepole pine, Rocky Mountain area.

Peniophora luna (see ►*Chaetoderma luna*). Brown Rot in lodgepole pine, Rocky Mountain area.

Pestalotia

► Blights.

Pestalotia longisetula Root, Stolon, and Petiole Rot on strawberry.

Phaeoacromonium

► Blights.

Phaeoacremonium aleophilum Decline of grape.

Phaeoacremonium chlamydosporum Decline of grape.
Phaeoacremonium inflatipes Decline of grape.

Phialophora

Deuteromycetes, Hyphomycetes

Conidiophores dark, short, single or clustered; phialides broader near middle, tapering toward ends, producing conidia endogenously, spores subhyaline to dark, one-celled.
Phialophora malorum Storage Rot of apples.

Phlebia

Basidiomycetes, Aphyllophorales

Basidiocarp effuse, typically monomitic; spores even in general outline, hyaline or pale in color, typically nonamyloid.
Phlebia chrysocrea Heart Rot on oak.

Pholiota

Basidomycetes, Agaricales

Spores ochre yellow to rusty brown; gills attached to stipe, which has an annulus but no cup at the base.
Pholiota adiposa Brown Mottled Heart Rot of maple and other living hardwoods – basswood, birches, poplars and more rarely conifers. The wood has brown mottled streaks. The sporophores are formed in clusters on trunks and stumps – mushrooms with yellow central stems and caps, sticky yellow slightly scaly upper surface, yellow to brown gills.

Phoma

► Blackleg.
Phoma apiicola Phoma Root Rot of celery, occasionally serious, especially in Golden Self Blanching, also on carrot, parsnip, parsley and caraway. The disease appears first in the seedbed, a black rot of the crown or base of leafstalks. Plants are stunted, outer leaves or entire plant killed, falling over as roots rot off. Spores are produced in tendrils from black pycnidia and spread in rains and irrigation water. Use clean seed, grown in California, where the disease is rare; sterilize seedbed soil or use a fresh location.
Phoma betae (Teleomorph, *Pleospora betae*). Phoma Rot of beets, causing black root of seedlings, necrotic streaks on seedstalks, brown spots on old leaves and rot of fleshy roots. The fungus is seed-borne and winters in roots carried over for seed production and in debris. Crop rotation is essential.
Phoma destructiva Phoma Rot of tomato, pepper, nearly general, especially in the South, but not in North Central States. Small, irregular dark spots appear on leaves in great numbers; zonate markings are similar to those of early blight. Severely infected leaves turn yellow, wither. Fruit spots in field are small, 1/8 inch, slightly depressed, with numerous tiny black pycnidia. After harvest, spots enlarge to 1/2 to 1 1/2 inches and become black, leathery, with minute pustules. The fungus winters in decaying refuse in soil; seedbed infection is common, and the disease reaches the field via infected seedlings. Masses of spores produced on leaves are washed to fruits by rain or spread by workers and are distributed during harvesting and packing.
Control Locate seedbeds away from land that has previously grown tomatoes; spray as for early blight; do not harvest when wet.
Phoma macdonaldii (Teleomorph, *Leptosphaeria lindquistii*). Stem Rot on sunflower.
Phoma terrestris on sweet corn.
Phoma sp. Crown and Root Rot on bugleweed.

Phomopsis

► Blights.
Phomopsis amygdali Fruit Rot on almond.
Phomopsis mali Fruit and Core Rot (Postharvest) on apple.

Phomopsis vaccinii Fruit Rot on blueberry.
Phomopsis sp. Fruit Rot on peach.

Phymatotrichopsis (Phymatotrichum)

Deuteromycetes, Hypohomycetes

Conidiophores stout with inflated tips bearing loose heads of conidia; spores hyaline; one-celled, produced on surface of soil.

Phymatotrichopsis omnivors (formerly *Phymatotrichum omnivorum*). Texas Root Rot, Phymatotrichum Root Rot, Cotton Root Rot. This is the most destructive plant disease in Texas, a limiting factor in gardening and crop production. It occurs in the Red River counties of Oklahoma, the southwestern half of Arizona, the southeastern edge of Nevada and California, the southeastern corner of Arkansas and Utah, the northwestern corner of Louisiana and in most of Texas except the Panhandle.

The list of susceptible plants flowers, vegetables, fruits, field crops and trees – is much longer than that of plants resistant to this omnivorous fungus, so aptly named. At least 1700 plant species are attacked, more than by any other known pathogen. Because of the wide host range and destructiveness, the economic losses are enormous, $100 million a year in Texas alone, with perhaps $50 million in adjacent states.

Crops that either are resistant or escape the disease are the cereals and grasses, annuals grown in winter only, and sweet alyssum, amaranth, sweet basil, beauty-berry, bee-balm, collinsia, diosma, calceolaria, calla lily, California-poppy, candytuft, canna, chicory, cranberry, cucumber, currant, cyclamen, daffodil, dahoon, deutzia, dill, fenner, fern, staghorn, foxglove, freesia, goldentuft, mustang grape, gypsophila, hackberry, hoarhound, hyacinth, iris, lily, nigella, marsh-marigold, mignonette, mints, mimulus, muskmelon, mustard, nasturtium, oak, osage-orange, oxalis, Indian paint-brush, palms, pansy, petunia, phlox, Chinese pink, pitcher-plant, pomegranate, poppy, portulaca, primrose, pumpkin, red-cedar, sage, scarlet-brush, snapdragon, snowdrop, stock, strawberry, strawflower, tuberose, valerian, verbena, violet, wallflower, wandering jew, water cress, watermelon, yaupon, yucca and zinnia.

Phymatotrichum root rot occurs from July until frost. It kills plants in more or less circular spots, ranging from a few yards to an acre or more. Death may come within a few days of first wilt symptoms, and just preceding the wilt plants actually run a fever, with a higher than normal temperature. If plants next to the wilted ones are pulled out, these apparently healthy plants will often be found to be covered with yellow to buff mats of mycelium, and under moist conditions spore mats appear on the surface of the soil around diseased plants. Such mats are 2 to 12 inches in diameter, first snow white and cottony, later tan and powdery from spores produced in quantities. The fungus spreads through the soil by means of rhizomorphs, smooth, dark brown strands. The rate of spread may be 2 to 8 feet a month in an alfalfa field, 5 to 30 feet a season in a cotton field, or around fruit trees.

Sclerotia are formed along the mycelial strands. They are small, roundish, light at first, then dark and warty. The fungus winters either as sclerotia in soil, persisting several years in the absence of live hosts, or as dormant mycelium in living roots. The disease is most common and severe on heavy, alkaline soils. Abundant organic material reduces rot by favoring antagonistic soil saprophytes.

Control In ornamental plantings replace diseased plants with some of those given in the resistant list. Monocotyledons are generally resistant. In locating new orchards, make sure that root rot has not been present previously by growing an indicator crop of cotton for a year. Grow immune crops in rotation with susceptible crops, and grow susceptible annuals in winter rather than summer. Try heavy manuring.

Ammonium sulfate can sometimes save a valuable ornamental tree or shrubs already infected with root rot. Prune back the top, make a circular ridge about the plant at the edge of the branch spread, and work ammonium sulfate into the soil within the ridge then fill the basin with water to a depth of 4 inches. The chemical treatment and watering is repeated in 5 to 10 days,

then no more chemical the same season. Follow through with frequent watering.

Phymatotrichum omnivorum (see ►*Phymatotrichopsis omnivors*). Texas Root Rot, Phymatotrichum Root Rot, Cotton Root Rot.

Physalospora

► Cankers and Diebacks.

Botryosphaeria stevensii (formerly *Physalospora mutila*). Black Rot of apple, in the West, similar to disease by *P. obtusa* in the East.

Botryosphaeria obtusa (formerly *Physalospora obtusa*). Black Rot of apple, New York Apple Tree Canker, Frog-Eye Leaf Spot, general on apple and crabapple, from Atlantic Coast to the Great Plains; also widespread on pear, mountain-ash, peach, quince, currant and various woody species. The fungus, in its anamorph state (*Sphaeropsis malorum*), was first reported as causing apple rot in 1879.

The lesions start as small brown spots, frequently at a wormhole, but they darken and turn black as they expand. There is usually one lesion to an apple, often at the calyx end, with concentric zones of black and brown, and minute black pycnidia. The rot eventually takes in the whole fruit, which is shriveled and wrinkled and finally mummifies. The pycnidia are black, carbonaceous, and may contrain three types of spores – large one-celled brown spores, large hyaline spores, and two-celled colored spores. Perithecia, sometimes formed in cankers or on twigs, apparently play little part in the life history, the fungus wintering as dormant mycelium or in the pycnidial state. Conidia, entering through wounds, start primary infection in spring on leaves with the small "frog-eye" leaf spots.

Control Use the same spray schedule as for apple scab, starting with the petal-fall application. Clean up mummied apples; avoid bruising; cut out cankers.

Botryosphaeria rhodina (formerly *Physalospora rhodina*). Diplodia Rot of citrus, fig, rubber-tree and pear, possibly apple. The conidial stage is a *Diplodia*, probably *D. natalensis*, with dark, two-celled spores.

Physalospora mutila (see ►*Botryosphaeria stevensii*). Black Rot of apple, in the West, similar to disease by *P. obtusa* in the East.

Physalospora obtusa (see ►*Botryosphaeria obtusa*). Black Rot of apple, New York Apple Tree Canker, Frog-Eye Leaf Spot, general on apple and crabapple, from Atlantic Coast to the Great Plains; also widespread on pear, mountain-ash, peach, quince, currant and various woody species.

Physalospora rhodina (see ►*Botryosphaeria rhodina*). Diplodia Rot of citrus, fig, rubber-tree and pear, possibly apple.

Phytophthora

► Blights.

Phytophthora cactorum Stem Rot, Foot Rot of lily, *Photinia*, tulip, *Hydrastis*, blue laceflower, baby's breath, *Centaurea*, peony, clarkia, rhubarb and tomato; leather rot of strawberries; collar rot of dogwood, walnut, apple and pear; crown rot of Euonymus and strawberry; root rot of boxwood and vinca, and crown rot of peach and Cannan fir; kernel and shuck rot of pecan. With foot rot, lilies suddenly fall over, wilt and die; the lower part of the stem is shrunken. Plant only healthy bulbs and where the disease has not occurred previously.

Strawberry leather rot occurs when berries come in contact with soil, starting with a brown rotted area on green fruit and a discoloration of vascular bundles. Ripe fruit has a bitter taste. Crown rot of rhubarb starts with slightly sunken lesions at base of petiole, which enlarge until the entire leaf collapses. Spraying crowns with bordeaux mixture is helpful. Start new beds with healthy plants. Collar rot on English walnut is a bark disease starting below the ground with irregular dark brown or black cankers and soft, spongy areas at the crown, a black fluid in cambial cavities. Trees are stunted, with sparse yellow-green top growth. There may be an unusually heavy crop of nuts, but the tree dies the next season. Grow walnuts grafted on Persian or Paradox rootstocks. See under ► Cankers and Diebacks for symptoms on apple and dogwood.

Stem rot and wilt of snapdragon starts with water-soaked lesions on the stem; these turn yellow, brown, enlarge to girdle the stem; plant wilts. Sterilize soil before planting.

Phytophthora capsici One of the species causing buckeye rot of tomato. See under ▶ Blights for pepper rot and blight.

Phytophthora cinnamomi Avocado Root Rot, Pine Little Leaf, Collar Rot of hardwoods and conifers, seedling root rot, on more than 100 hosts, including firs, cedars, cypress, juniper, Japanese umbrella tree, larch, pine, spruce, arborvitae, heaths, heather, azalea, Heuchera, cranberry, highbrush blueberry, rhododendron, camellia, birch, western swordfern, manzanita, walnut, oak, locust, yew, venus-flytrap and gold-dust plant. In conifers root rot is dry with resin flow; needles gradually lose color. Infected tissue of hardwoods turns reddish brown except in black walnut, where it is black; seedlings die. The disease is aggravated in pine by poor aeration and low fertility.

Root rot is the most serious avocado disease in California, present also in Florida and Texas. It occurs on soils with poor drainage, excess moisture being necessary. As the roots rot, leaves become light-colored and wilt even if soil is moist; trees decline over a period of years. The fungus can be spread with seed if fruit is allowed to lie on the ground. Treat suspected seed with hot water, 120° to 125 °F for 30 min; use nursery stock grown in fumigated soil; prevent movement of soil water from infested areas; plant on well-drained soil; water trees individually to avoid excess moisture.

Phytophthora citricola Root Rot of pine, hemlock and Fraser fir seedlings in Christmas tree plantings; also fruit rot of avocado.

Phytophthora citrophthora Root and Crown Rot of Penstemon.

Phytophthora citrophthora Brown Rot, Gummosis, Foot Rot of citrus. Masses of amber gum break out from the trunk near crown; the bark is killed above and below ground; foliage turns yellow; trees may die. The disease is prevalent where excess water stands around the tree after irrigation or where there is poor drainage. Brown rot of fruit is a decay with no visible surface mold, except in moist air, but a slightly rancid, penetrating odor. Lemons and oranges may be affected on the tree, on branches near the ground, and there is much loss in storage. The fungus lives in the soil; spores are splashed up in rainy weather and are spread in the washing tank. Lemons are most susceptible to gummosis, then lime, pumelo, grapefruit, sweet orange and finally sour and trifoliate oranges. The latter two are used as fairly resistant understocks.

Control Plant susceptible trees high, with lateral roots barely covered; expose the root crown of infected trees with a basin 6 inches deep and 4 feet across. Once a year cover crown and lower trunk with bordeaux paste. To control fruit rot, spray ground and lower branches, up to 3 feet, with bordeaux mixture just before rains begin. If fumigation is to be practiced, substitute a copper-zinc-lime spray for the bordeaux.

Phytophthora colocasiae Root Rot of ginseng.

Phytophthora cryptogea Collar Rot of rhododendron, China aster, marigold, gloxinia and zinnia; root, crown, and stem rot on watercress, juniper, African daisy, chicory, beet, globe thistle, lettuce, parsley, peach, sage, spruce, and ice plant; stem rot on sunflower, pink rot of potato. Stems and roots appear water-soaked, then black from a soft rot. Sterilize soil.

Phytophthora cryptogea var. **richardiae** Root Rot of calla. The feeder roots rot from tips back to rhizomes, leaving the epidermis a hollow tuber. New roots sent out from the rhizome rot in turn. Leaves turn yellow and drop, starting with outer leaves; plants do not flower, or the tips of blossoms turn brown. Rot in the rhizome is dry and spongy, not wet and slimy. Clean old rhizomes thoroughly; cut out rotted spots. Grow in sterilized pots rather than benches.

Phytophthora drechsleri Root Rot on fir, basil, blackberry, columbine, juniper, sage, linden, pine, and spruce. Sometimes associated with tomato buckeye rot, basal decay of sugar beets, tuber rot of potato, root rot of safflower.

Phytophthora erythroseptica Pink Watery Rot of potato, Rot of calla lily and golden calla, Crown and Root Rot of wild rice. The rot starts at stem end of potatoes; affected tissues exude

water under pressure. When tubers are cut, flesh turns pink or red, then black. The fungus can exist in soil 4 years.

Phytophthora fragariae Strawberry Red Stele Disease, Brown Core Rot, a very serious strawberry disease, first noticed in Illinois in 1930, now widespread in northern strawberry sections and in California. A strain of this pathogen causes root rot of loganberry. The fungus attacks roots only, destroying fine feeding roots first, then invading the central cylinder, stele, which turns dark red. New spring leaves on badly affected plants are small, bluish, have short petioles; large leaves from the previous season dry up; little or no fruit is produced; plants die in the first dry period or are stunted.

The fungus is most active in cold, wet soil, in rainy periods in late fall, winter, and early spring except when ground is frozen. Zoospores produced on roots are spread by water; resting spores formed in the red stele carry the pathogen in a dormant state through the heat of summer. There are at least three physiological races, and once the fungus infests a field it is worthless for strawberries for 10 years.

Control Buy clean, certified plants. Aberdeen and Stelemaster varieties are resistant; Temple, Sparkle, Fairland, Redcrop, and Pathfinder, fairly so.

Phytophthora lateralis Cypress Root Rot on Lawson cypress (*Chamaecyparis lawsoniana*) often called Port Orford cedar, and Hinoki cypress (*C. obtusa*), killing thousands of trees in Oregon nurseries and landscape plantings. It is found on juniper and azalea in North Carolina. It is also reported on mountain-laurel and *Photinia* in NC and on cypress from Washington and apparently native to the Northwest. The fungus enters through the roots and spreads to lower part of main trunk killing the tissues. Blue cypress changes to purple, green, finally tan and dies. The color changes take several months in cool, damp weather, only 2 or 3 weeks in hot, dry weather. There is no practical chemical control, and Lawson cypress seems to be incompatible with resistant rootstocks. Grow disease-free propagating stock in new soil. Avoid large plantings of Lawson cypress such as windbreaks or hedges. Remove and destroy infected plants, getting the entire root system.

Phytophthora megasperma Root Rot, occasional on cabbage, cauliflower, brussel sprouts, carrot, artichoke, stock, citrus, soybean and wallflower. Diseased plants wilt suddenly; leaves turn red to purple; underground stems and roots rot. The disease is more prevalent in winter plantings in California and in low, poorly drained areas. Level ground properly before planting to avoid waterlogged spots. Root and crown rot on peach.

Phytophthora megasperma f. sp. **glycinea** Root and Stem Rot on soybean.

Phytophthora nicotianae var. **nicotianae** Crown Rot, Root Rot, and Stem Canker on flannel bush.

Phytophthora nicotianae var. **parasitica** Syn. *Phytophthora parasitica* (*P. terrestris*). Brown Rot of citrus, in Florida; Buckeye Rot of tomato, also on lily roselle, sempervivum, potato (tuber rot), zebra plant (stem rot), sage (root rot), and Christmas cactus (root rot). The disease appears on the lowest tomato fruits, where water stands after rains. The lesions have concentric narrow dark brown bands alternating with wide light brown bands. The decay is rapid and the internal tissue semi-watery, though the exterior is firm. Control by staking tomatoes; avoid poorly drained soil or plant on ridges. This species is often present with *P. citrophthora* in cases of citrus foot or collar rot.

Phytophthora nicotianae var. **parasitica** Crown Rot on petunia and poinsettia (stem rot).

Phytophthora palmivora Palm Bud Rot, Leaf Drop, Wilt of coconut, *Washingtonia*, and queen palm, root and crown rot of mango; also root rot on English ivy. The fungus is an omnivorous tropical species, presumably the one causing stem rot of dieffenbachia and peperomia. It has been prevented in nurseries by using cuttings from healthy plants in pasteurized soil.

Phytophthora parasitica var. **nicotianae** (Syn. *P. nicotianae* var. *parasitica*). Root Rot on pine.

Phytophthora porri Head Rot on cabbage.

Phytophthora sojae (Syn. *P. megasperma* f. sp. *glycinea*). Root and Stem Rot of soybean, a relatively new disease reported from Illinois,

Indiana, Missouri, North and South Carolina and Ohio. Serious in cool rainy weather, causing pre- and post-emergence damping-off.
Phytophthora syringae Root Rot on shore juniper and Photinia.
Phytophthora torulosum Root Rot and Damping-off on soybean.

Plectospira

Oomycetes, Saprolegniales

Sporangium with much inflated branching; swarm spores are formed in basal portion and cut out into a single row in an elongate filamentous apical portion, which acts as an exit tube. Swarm spores encyst at the mouth as in *Aphanomyces*. Oogonium terminal or intercalary, accompanied by up to 65 antheridia.
Plectospira myriandra Rootlet Necrosis on tomato. The fungus is weakly parasitic on roots.

Plenodomus

Deuteromycetes, Coelomycetes

Pycnidia coriaceous or carbonaceous, more or less sclerotoid. Condiophores obsolete or none; conidia one-celled, hyaline.
Plenodomus destruens Foot Rot of sweet potato, one of the more important field diseases and sometimes a storage rot. The base of the stem turns brown from just under the soil surface to 4 or 5 inches above; leaves turn yellow and drop off; vines wilt unless adventitious roots are put out; pycnidia are numerous. The root has a firm brown rot, not affecting the whole potato but enough to make it worthless for food. The fungus winters in old plant refuse but not in soil. Use clean seed potatoes; rotate crops. This fungus also infects *Jacquemontia*.

Pleospora

► Leaf Spots.

Pleospora herbarum Fruit Rot of tomato. A firm dark rot develops in fruit after picking, starting from infections through cracks near stem end of fruit. Progress is most rapid at 65° to 70 °F and is checked by storage at 45 °F.

Pleurotus

Basidiomycetes, Agaricales

Stipe off center or lacking; cap sometimes inverted; gills more or less fleshy and separable into two layers, edges acute; spores white.
Hypsizygus ulmarius (formerly *Pleurotus ulmarius*). Brown Heart Rot sapwood wound rot of elm, maple, and other living hardwoods. Rot starting in heartwood may extend into sapwood; infected wood separates along annual rings. Annual sporophores have a long excentric stalk, and white to yellow to brown smooth upper surface. They issue from crotches and pruning wounds.

Pleurotus ostreatus, oyster cap. White Flaky Sapwood Rot of maple and other hardwoods, sometimes on living trees. A light-colored decay is surrounded by a narrow brown zone. Fleshy annual conks are shelving, sessile, or with a short, stout excentric stalk. The upper surface is smooth, white or grayish, gills extending onto the stalk, an edible fungus. Infection is through open wounds. Wood Rot of grape.
Pleurotus ulmarius (see ►*Hypsizygus ulmarius*). Brown Heart Rot sapwood wound rot of elm, maple, and other living hardwoods.

Polyporus

Basidiomycetes, Aphyllophorales

Pileus tough, thick, with a stipe, or as a shelf; pores rounded, small, tubes crowded.
Dichomitus squalens (formerly *Polyporus anceps*). Red Ray Rot on western conifers, causing heart rot of living trees but beneficial as a cause of rapid decay of slash in forests. Fruiting bodies rarely develop on living trees.

Ganoderma lucidum (formerly *Polyporus lucidus*). Root Rot on redbud.

Inonotus dryadeus (formerly *Polyporus dryadeus*). White Root Rot, occasional in oaks and conifers in the West. Roots are killed; tree dies. Decayed wood is white to cream; bark is loosened and shredded.

Inonotus hispidus (formerly *Polyporus hispidus*). White Spongy Heart Rot of living trees of black ash, oak, maple and birch; does not decay dead trees. Heartwood in upper portion of trunk is reduced to soft spongy yellow or white mass. Shelf sporophores, up to 10 inches wide, have dark brown, coarse, velvety to hairy upper surface and golden brown undersurface, turning dark brown with age. They are formed at branch stubs, frost cracks, or trunk cankers.

Inonotus tomentosus (formerly *Polyporus tomentosus* var. *circinatus* Syn. *Inonotus circinatus*). Root Rot of sand pine.

Laetiporus sulphureus (formerly *Polyporus sulphureus* Syn. *Laetiporus sulphureus*), sulphur fungus. Red Brown Heart Rot, Brown Cubical Rot in heartwood of maple and other living hardwoods and conifers, widespread on oak, balsam, Douglas-fir and spruce. The annual, shelflike fruiting bodies are most conspicuous – soft, fleshy, moist when fresh, with bright orange-red upper surface and brilliant yellow underneath, formed in overlapping clusters. When old they are hard, brittle, dirty white (see Fig. 6). Infection is through dead branch stubs and wounds.

Phaeolus schweinitzii (formerly *Polyporus schweinitzii*) Root Rot on pine.

Phellinus gilvus (formerly *Polyporus gilvus*). White Sapwood Rot, prevalent on dead trees, occasional on living trees. Small, annual, yellow to red, brown leathery to corky sporophores, developed in profusion.

Pitoporus betulinus (formerly *Polyporus betulinus* Syn. *Piptoporus betulinus*). Brown Cubical Rot of dead or dying gray and paper birches. Conks have smooth grayish upper surface with incurved margin.

Polyporus abietinus Syn. Hirshioporus abietinus (see ▶*Trichaptum abietinum*). Pitted Sap Rot, Hollow Pocket, White Pocket Rot on fir.

Fig. 6 Shelf Fungus (*Laetiporus sulphureus*) on Oak

Polyporus anceps (see ▶*Dichomitus squalens*). Red Ray Rot on western conifers.

Polyporus balsameus (see ▶*Postia balsamea*). Balsam Butt Rot of living balsam fir, eastern hem lock, northern white-cedar, western red-cedar, also prevalent on dead trees.

Polyporus betulinus Syn. **Piptoporus betulinus** (see ▶*Piptoporus betulinus*). Brown Cubical Rot of dead or dying gray and paper birches.

Polyporus dryadeus (see ▶*Inonotus dryadeus*). White Root Rot, occasional in oaks and conifers in the West.

Polyporus gilvus (see ▶*Phellinus gilvus*). White Sapwood Rot, prevalent on dead trees, occasional on living trees.

Polyporus hispidus (see ▶*Inonotus hispidus*). White Spongy Heart Rot of living trees of black ash, oak, maple and birch; does not decay dead trees.

Polyporus lucidus (see ▶*Ganoderma lucidum*). Root Rot on redbud.

Polyporus pargamenus White Pocket Rot of dead sapwood in eastern United States but sometimes on living maple and other hardwoods.

Polyporus sulphureus Syn. **Laetiporus sulphureus** (see ►*Laetiporus sulphureus*), sulphur fungus. Red Brown Heart Rot, Brown Cubical Rot in heartwood of maple and other living hardwoods and conifers, widespread on oak, balsam, Douglas-fir and spruce.

Polyporus schweinitzii (see ►*Phaeolus schweinitzii*). Root Rot on pine.

Polyporus squamosus White Mottled Heart Rot on maple, buckeye, birch and occasional on living trees near wounds. Conks are annual, fleshy, white to dingy yellow with a short, thick lateral stalk, upper surface with broad appressed scales, up to 18 inches wide.

Polyporus tomentosus var. **circinatus** Syn. **Inonotus circinatus** (see ►*Inonotus tomentosus*). Root Rot of sand pine.

Polyporus versicolor Syn. Coriolus versicolor (see ►*Trametes versicolor*), rainbow conk. Sapwood Rot.

Postia balsamea (formerly *Polyporus balsameus*). Balsam Butt Rot of living balsam fir, eastern hemlock, northern white-cedar, western red-cedar, also prevalent on dead trees. Advanced decay is brown, brittle, breaking into large cubes, easily crushed to a clay-colored powder. In living trees the rot column is usually only 3 or 4 feet from ground. Sporophores are shelving, up to 2 inches wide, with pale brown upper surface with concentric zones, white underneath.

Trametes versicolor (formerly *Polyporus versicolor* Syn. *Coriolus versi-color*), rainbow conk. Sapwood Rot. This is the most common fungus on hardwood slash in woods and sometimes on conifers. The rot is soft, white spongy. Heartwood of living catalpa may be decayed, the fungus entering through wounds and dead branches. The conks are thin, tough, leathery, annual, up to 2 inches wide with a hairy or velvety surface multicolored white, yellow, brown, gray, and black. The undersurface is yellow or white. This pathogen also causes wood decay and decline of apple and has been reported as *Trametes versicolor*.

Trichaptum abietinum (formerly *Polyporus abietinus* Syn. *Hirshioporus abietinus*). Pitted Sap Rot, Hollow Pocket, White Pocket Rot on fir. May attack dead sapwood in wounds of living trees.

Poria

Basidiomycetes, Aphyllophorales

Pileus resupinate, thin, membranous; tubes wartlike, separate.

Junghuhnia luteoalba (formerly *Poria luteoalba*). Brown Rot of coniferous wood.

Perenniporia subacida (formerly *Poria prunicola*). White Rot of cherry and other *Prunus* spp.

Phellinus laevigatus (formerly *Poria laevigata*). Red Mottle Rot on *Prunus* spp.

Phellinus weirii (formerly *Poria weirii*). Douglas-Fir Root Rot. The disease is most destructive to trees 70 to 150 years old, which are killed in groups. The fungus can persist in dead roots for a century. Less susceptible conifers should be planted with judicious cutting of infected stands.

Poria cocos (see ►*Wolfiporia cocos*). Root Rot on roots of various trees, especially pine, in southeastern United States.

Poria luteoalba (see ►*Junghuhnia luteoalba*). Brown Rot of coniferous wood.

Poria prunicola (see ►*Perenniporia subacida*). White Rot of cherry and other *Prunus* spp.

Poria laevigata (see ►*Phellinus laevigatus*). Red Mottle Rot, on *Prunus* spp.

Poria subacida Feather Rot, Spongy Root Rot, String Butt Rot of living conifers and dead hardwood. Decay rarely extends more than 6 to 10 feet in the trunk. Irregular pockets run together forming masses of white fibers; annual rings separate readily. Sporophores are white to straw-colored to cinnamon-buff crusts forming sheets several feet long on underside of fallen trunks or on underside of root crotches or exposed roots of living trees.

Poria weirii (see ►*Phellinus weirii*). Douglas-Fir Root Rot.

Wolfiporia cocos (formerly *Poria cocos*). Root Rot on roots of various trees, especially pine, in southeastern United States. Huge sclerotia, weighing up to 2 pounds, are formed; this stage is known as *Pachyma cocos*.

Pyrenochaeta

► Blights.

Phoma terrestris (formerly *Pyrenochaeta terrestris*). Pink Root of onions, widespread on onions, garlic and shallot; also on grasses. Roots of affected plants shrivel and turn pink. New roots replacing the old are infected in turn; plants are stunted, bulbs small. The fungus persists indefinitely in the soil and is distributed on onion sets and transplants. Yellow Bermuda is the most resistant of commercial onion varieties. The green Beltsville Bunching onion, Nebuka strain of Welsh onion, Evergreen variety of shallot, and leaks and chives are resistant. In Arizona, Granex gives a better yield than other onions despite pink root.

Pyrenochaeta lycopersici Root Rot on tomato.

Pyrenochaeta terrestris (see ►*Phoma terrestris*). Pink Root of onions, wide spread on onions, garlic and shallot; also on grasses.

Pythium

Oomycetes, Peronosporales

Wall of sporangium smooth; dischargings warm spores in imperfectly formed state into thin-walled vesicle, which later ruptures to allow spores to escape. Sporangia terminal or intercalary. Species live in moist soil causing damping-off and root rots.

Pythium acanthicum; **P. myriotylum**; **P. periplocum** Causing rot of watermelon fruit.

Pythium aphanidermatum Leak, Root Rot. Damping-off of muskmelon, cucumber, squash, also papaya, bean, radish, spinach, sugar beet, guayule, caper spurge, and ice plant. There is a watery decay with a yellow brown liquid leaking out when fruit is pressed. Lesions are brown and wrinkled. The fungus lives in the soil; primary infection is in the field, secondary from contact in transit or storage. Sort carefully before packing. Refrigerate at 45° to 50 °F in transit.

Pythium aristosporum Root Rot of bean.

Pythium arrhenomanes Root Rot on tomato, broadleaf signalgrass, large crabgrass, barnyardgrass, nutsedge, goosegrass, itchgrass and johnsongrass.

Pythium carolinianum Root and Stem Rot of parrotfeather (*Myrio-phyllum*).

Pythium catenulatum Root Rot of bean.

Pythium debaryanum Damping-Off of seedlings. Watery Leak of potatoes. Leak starts as a brown discoloration around a wound and soon spreads to include the whole potato, which is soft, easily crushed, and drips a brown liquid with the slightest pressure. Entrance to the tuber is usually through harvest wounds. *Pythium* hyphae grow through the soil in great profusion and can enter seedlings through either stomata or unbroken epidermis. See ►Damping-Off, for rot of seedlings.

Pythium dissotocum Root Rot of bean, and spinach.

Pythium irregulare Associated with Melon Root Rot and Fruit Rots of other cucurbits in cool weather and Seed Decay of corn. Root Rot and Crown Rots of clovers and basil.

Pythium mastophorum Damping-off on celery.

Pythium myriotylum Root Rot on tomato.

Pythium paroecandrum Stem, Crown and Root Rot on lupine.

Pythium polymastum Bottom Rot and Damping-off on cabbage.

Pythium splendens On Chinese evergreen, peperomia, and philodendron.

Pythium ultimum Fruit Rot of muskmelon, often with luxuriant white fungus growth; Damping-Off, Root Rot of many seedlings in greenhouse and field. Root Rot and Crown Rot of clovers. Crown Rot of impatiens. Root Rot of kiwi.

Pythium uncinulatum Stunt and Leaf Yellowing on lettuce.

Pythium spp. Most soils contain several species of *Pythium* ready to perform at optimum moisture

Fig. 7 *Pythium* Blackleg on Geranium

and temperature. Exact determination is not always practical. Nematode wounds often dispose plants to rot. Diseases include African-violet rot, aloe root rot, black rot of orchids, begonia root rot, coleus black leg, geranium cutting rot (see Fig. 7), bean and parsley root rot, rhubarb crown rot, mottle necrosis of sweet potato, and other rots. Some plants can be treated with hot water, 115 °F for 30 min. Sterilize soil before use; avoid excessive watering. See ► Damping-Off, for seedling rots.

Rhizina

Ascomycetes, Pezizales

Cup-shaped apothecia with rhizoids underneath; asci operculate, opening with a lid, eight-spored; spores fusoid, spindle-shaped, paraphyses present.
Rhizina undulata Seedling Root Rot, Damping-Off. Coniferous seedlings in the Pacific Northwest are sometimes killed in isolated circular patches 2 to 4 feet in diameter, particularly in burned areas. Infected roots are matted together with white mycelium. More or less resinous annual fructifications are formed on the ground. They are irregular, an undulating brown upper surface with narrow white margin, 2 to 3 inches across. There is no control, but the disease is minor.

Rhizoctonia

Deuteromycetes, Hyphomycetes

Sclerotial form of *Pellicularia, Corticium, Macrophomina, and Helicobasidium*. Young mycelium colorless; branches constricted at points of origin from main axis; older mycelium colored, wefts of brownish yellow to brown strands, organized into dense groups of hyphae, sclerotia, made up of short, irregular, angular or somewhat barrel-shaped cells (see Fig. 8).
Rhizoctonia sp. Postharvest Decay on leather-leaf fern.
Rhizoctonia bataticola Charcoal Rot. ►*Macrophomina phaseoli*
Rhizoctonia crocorum Violet Root Rot. ►*Helicobasidium purpureum*.
Rhizoctonia solani Black Scurf of potatoes, Brown Patch of turf. ►*Pellicularia filamentosa* Root Rot and Crown Rot of clovers.
Rhizoctonia solani Root and Stem Rot of poinsettia and other ornamental plants, including basil, begonia, camellia, calla, carnation, chrysanthemum, coleus, cornflower, geranium, gloxinia, impatiens, lily, pansy, pothos, peperomia, primrose, ragweed, rosemary, caper spurge, and sainfoin (crown rot). Although *Pythium* flourishes best in the low oxygen content of poorly drained soils, *Rhizoctonia*, causing similar root rots, is serious in well-drained soils. On poinsettia, dark brown lesions at or above soil level are often covered with brown mycelium; the leaves turn yellow and drop, the roots rot, and the plant dies. Web Blight and Stem Canker on alfalfa. Damping-off and Bottom Rot on Cichorum (endive, escarole and witloof chicory) and Nicotiana.
Rhizoctonia tuliparum Gray Bulb Rot of tulips, in northeastern and Pacific states. The most conspicuous sign of this disease is a bare patch in

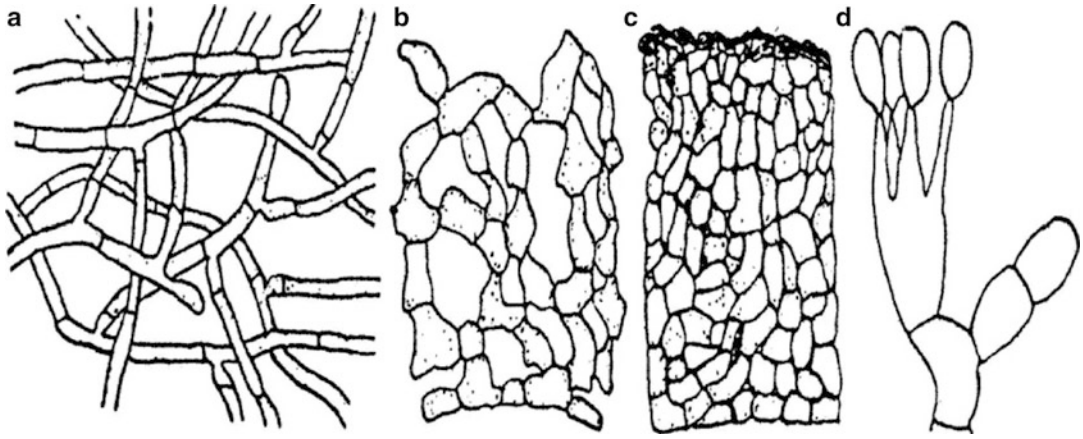

Fig. 8 Forms of *Rhizoctonia solani* . (**a**) young mycelium, constricted at branches; (**b**) loosely formed angular to barrel-shaped colored cells; (**c**) section through sclerotium formed from aggregation of cells in **b**; (**d**) basidium and spores of *Pellicularia*, teleomorph state of *R. solani*

spring where tulip shoots should be showing. Occasionally an infected bulb will produce some above-ground growth, but the plants are slow and often wither and die before flowering. Bulbs rot from the top down; mycelium forms felty masses between scales; on bulbs and in surrounding soil are masses of brown to black, flattened sclerotia, composed of the yellow-brown, thin-walled irregular cells typical of *Rhizoctonia*. These can survive in soil for years, germinating to infect bulbs after planting or in very early spring. Occasionally sclerotia are transported on bulbs, but the bulbs are usually so noticeably diseased that they are not sold.

Control Remove soil and plants from affected area and for at least 6 inches beyond. Destroy all infected bulbs at harvest. Use a 4-to 5-year rotation.

Rhizopus

Zygomyetes, Mucorales

Sporangium large, globose, multispored, with a columella and a thin wall; sporangiola and conidia lacking. Sporangiophores arise in fascicles from aerial arching stolons, which develop rhizoids at point of contact with substratum (Fig. 2, chapter ▶ Fungi).

Rhizopus arrhizus Soft Rot on gladiolus corms, light brown and on beet.

Rhizopus arrhizus (formerly *Rhizopus oryzae*). Head Rot on sunflower.

Rhizopus nigricans (Syn. *R. stolonifer*), the common black bread mold. Soft Rot of sweet potato and other vegetables; Rhizopus Rot, **"Whiskers,"** Leak of peach, strawberry, and other fruits. This is one of the more serious storage rots of sweet potato, soft, watery, progressing rapidly, with rotting complete inside 5 days after visible infection. The tuber is brownish within, covered with a coarse whiskery mycelial growth; there is a mild odor. Cucurbits, crucifers, carrots, beans, lima beans, onions, peanuts, potatoes, Jerusalem artichoke, and guava are susceptible to this black mold. Nancy Hall and Southern Queen are among the more resistant varieties of sweet potato. To prevent rot, cure at 80° to 85 °F for 10 to 14 days, at high humidity, to permit rapid corking over of wounds; then store at 55 °F.

The fungus is a weak parasite on ripe fruit –peach, fig, strawberry, citrus, persimmon, pear, avocado and melons. A coarse cottony mold appearing in wounds and over the surface is covered with sporangia, white when young, black at maturity. A watery fluid with an offensive odor leaks from the soft fruit. Avoid wounding in harvesting; do not pack overripe fruit; keep at

low temperature in transit and market. Amaryllis, lily, and tulip bulbs may be infected.
Rhizopus oryzae (see ►*Rhizopus arrhizus*). Head Rot on sunflower.
Rhizopus stolonifer Soft Rot of *Euphorbia trigona*.

Roesleria

Ascomycetes, Helotiales

Mycelium inconspicuous; apothecia cup-shaped, opening more or less completely; asci disappearing early, leaving a persistent mass of spores and paraphyses. Spores hyaline, one-celled, globose.
Roesleria hypogaea Root-Rot of grape.

Rosellinia

Ascomycetes, Xylariales

Perithecia smooth, ostiole simple or with a low papilla; with a subicle under the fruiting layer; paraphyses present; spores olive to brown, one-celled.
Rosellinia necatrix (Syn. *Dematophora*). White Root Rot of fig, grape, avocado, apricot, cherry, apple, pear, peach, walnut, holly osmanthus, privet and poplar. This is like Armillaria root rot in that all trees in a certain area are killed, but there are no rhizomorphs or toadstools formed. A white mycelial growth on surface of affected roots turns black and cobwebby. During wet weather a delicate mold forms on surface of bark and on soil around base of tree. Foliage is sparse and wilting, growth slow or none. Crabapples are quite resistant. Plums and apricots can be grown on resistant understock.

Schizophyllum

Basidiomycetes, Aphyllophorales

Pileus leathery; stipe lateral or none; edge of gills split; spores white.
Schizophyllum commune Wound Rot, common on dead parts of living trees– maple, boxelder, almond, acacia, ailanthus, birch, catalpa, hickory, peach, pecan and citrus, fig. Fruiting bodies are small, thin, sometimes lobed, up to 2 inches wide, fan-shaped with gray-white downy upper surface, brownish forked gills on underside, common on fruit trees. This pathogen also causes wood decay and decline of apple.

Sclerotinia

► Blights.
Botryotinia narcissicola (formerly *Sclerotinia narcissicola*). Narcissus Smoulder. Perhaps the fungus should be transferred to *Botryotinia*, since there is a conidial stage. The disease is a decay of stored narcissus bulbs, also known on snowdrop, and a rot of foliage and flowers in the open, especially during cold wet seasons. Leaves are distorted, stuck together as they emerge from soil. Sclerotia are small, black, flattened bodies, up to 1/2 inch long when several grow together, just below outer papery bulb scales. In prolonged storage there is a yellow-brown rot.
Control Remove and destroy diseased plants as soon as noticed; destroy weeds to provide air circulation; spray with bordeaux mixture; discard rotting bulbs at harvest; change location every year.
Sclerotinia homoeocarpa Dollar Spot. Small Brown Patch of turf on bent grasses, fescues and bluegrass. Spots are brown at first, then bleached and straw-colored, about 2 inches in diameter but coalescing to large irregular patches. While leaves are being killed, a fine white cobwebby growth of mycelium can be seen in early morning when dew is present.
Sclerotinia intermedia Stem Rot, market disease of celery, carrot and salsify.
Sclerotinia minor Stem Rot of lettuce, celery, carrot, cocklebur, Austrian winter pea, lana woolly pod vetch, phacelia and basil; also stem rot on fennel, root and crown rot on cabbage, crown rot and wilt on *Cichorium* (*radicchio*). Root and Pod Rot of peanut.

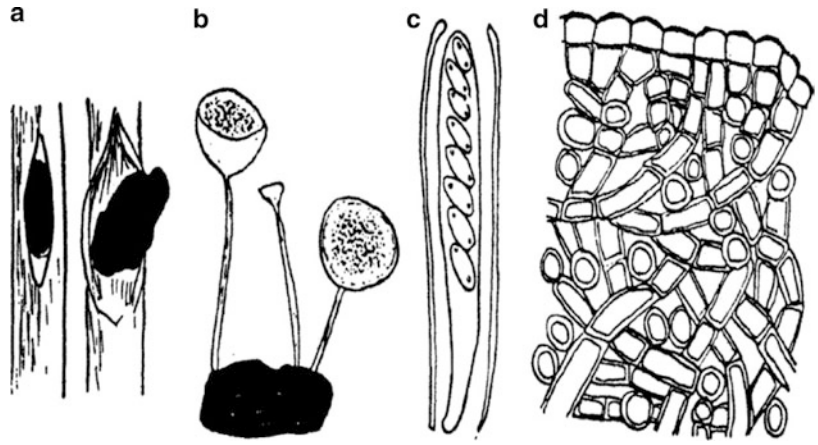

Fig. 9 *Sclerotinia sclerotiorum*. (**a**) sclerotium formed in pith of stem and one falling out from broken stem; (**b**) apothecia produced from sclerotium on ground; (**c**) ascus with paraphyses; (**d**), section through sclerotiorum, with colorless medulla and dark wall on rind cells

Resembles rot due to *S. sclerotiorum*, but sclerotia are much smaller. Crown Rot of pepper.

Sclerotinia narcissicola (see ►*Botryotinia narcissicola*). Narcissus Smoulder. Perhaps the fungus should be transferred to *Botryotinia*, since there is a conidial stage.

Sclerotinia sclerotiorum Black Rot of bulbous iris, hyacinth, narcissus and tulip. Iris fails to start growth, or plants turn yellow, wilt, and die, often in clumps. Bulbs are covered with thin gray masses of mold with black irregular sclerotia between scales. Tulip leaves develop reddish color early in spring, wilt and die; stems and bulbs are rotted into a crumbly mass of fragments and black sclerotia. This is a cool-temperature fungus that stops action about the time the heat-loving *Sclerotium rolfsii* starts in. Remove diseased plants and surrounding soil as soon as noticed. Discard all small bulbs at harvest; plant healthy bulbs in clean soil. The pathogen supposedly dies out after 2 years in soil without suitable host.

Sclerotinia sclerotiorum Calyx-End Rot on apple and Root and Pod Rot of peanut, Root and Stem Rot of alfalfa.

Sclerotinia sclerotiorum Green Fruit Rot of almond, peach, apricot, fig and strawberry; Rhizome Rot of ginseng. In almond, young shoots and fruits are killed and wither soon after petals fall. Infection takes place through jackets from apothecia produced under trees where weeds or crop plants have been previously infected with cottony rot. Losses are serious only when there is continuous wet weather during and after blooming. Spraying for brown rot helps to control green rot. Shaking or jarring trees after bloom to remove jackets from young fruits is suggested.

Sclerotinia sclerotiorum Leaf and Crown Necrosis of African daisy; Root Rot and Wilt of peanut. White Mold Rot of soybean.

Sclerotinia sclerotiorum (*S. libertiana*) Lettuce Drop, Watery Soft Rot of endive; Pink Rot of celery, Cottony Rot of bean, carrot, parsnip, cabbage, and other crucifers and cucurbits. In lettuce, older leaves wilt and fall flat on the ground, leaving center leaves erect, but these are soon invaded by mycelium and reduced to a slimy wet mass. In continued moisture a thick, white cottony mold is formed, bearing large black sclerotia up to the size of peas (see Fig. 9). They winter in the soil, send up groups of apothecia in spring. These are brown, cup-to saucer-shaped, up to an inch across, on a stalk. Ascospores are ejected in a veritable cloud; there is no known conidial stage.

Control In commercial celery fields deep plowing or flooding is used to inhibit apothecial production. Sterilize seedbed soil before planting.

Sclerotinia sclerotiorum Stem Rot of pepper, cocklebur, tomato, and many ornamentals – aconite, basil, calendula, chervil, canola, chrysanthemum, cynoglossum, dahlia, daisy, delphinium, Gaillardia, gazania, hollyhock, peony, purple coneflower, snapdragon,

sunflower, zinnia, and others. The same sort of cottony mold is formed on flower stems as on vegetables, but here the sclerotia are usually inside the pith and so are rather long and thin. You can feel them by running thumb and finger along the stem; sometimes the cottony mycelium, or cracks in the stem, or one or two external sclerotia indicate their presence. They are common in peony stems. When sclerotia are formed in flowers, the shape corresponds to floral parts. Sunflowers have large compound sclerotia.

Control Cut out and destroy affected parts, trying to keep sclerotia from falling out onto soil. Dusting with sulfur sometimes checks rapid spread of mycelium.

Sclerotinia trifoliorum Root Rot, Stem Rot of cocklebur and alfalfa.

Sclerotium

► Blights.

Sclerotium cepivorum White Rot of onion, shallot and garlic. Affected plants die from a rotting at the neck, at which point there is a surface crust of small black sclerotia and a thin weft of white mycelium. The sclerotia are smaller and rounder than those of *Botrytis*. Roots are often rotted off, and sometimes spots in a field covering several square yards are infested.

Sclerotium rolfsii (including *Sclerotium delphinii*). Crown Rot of delphinium, iris, ajuga, aconite, quinoa, sainfoin, kiwi, and many other ornamentals and vegetables, Root Rot and Wilt of peanut, Wet Scale Rot of narcissus, Southern Blight. For a full discussion see ►*Pellicularia rolfsii* under Blights.

Seaverinia

Ascomycetes, Helotiales

Apothecia shallow, cup-to disc-shaped; a stroma formed but no definite sclerotia; conidia botryose.

Seaverinia geranii (Syn. *Sclerotinia geranii*). Rhizome Rot on geranium.

Steccherinum

Basidiomycetes, Aphyllophorales

This genus has been separated off from *Hydnum*. The pileus is sessile or substipitate and laterally attached, on a woody substratum; spines are terete or flattened; cystidia present; spores white, smooth.

Climacoden septentrionalis (formerly *Steccherinum septentrionale* Syn. *Hydnum septentrionale*) White Spongy Rot of heartwood of living maples, beech, hickory, and other hardwoods. A zone of brown discolored wood is around the white rot area, and there are fine black zone lines. The fruiting bodies are large, soft, soggy, creamy white, in very large, bracket-shaped clusters on trunks.

Hericium obietis (formerly *Steccherinum abietis* Syn. *Hydnum abietis*). Brown Pocket Rot of heartwood of living firs and western hemlock in Pacific Northwest. Elongated pockets, empty or with white fibers, are separated by firm reddish brown wood. Sporophores are like coral, white to cream, up to 10 or 12 inches high and wide, usually on dead trees, sometimes in wounds of living trees.

Steccherinum abietis Syn. ***Hydnum abietis*** (see ►*Hericium obietis*). Brown Pocket Rot of heartwood of living firs and western hemlock in Pacific Northwest.

Steccherinum septentrionale Syn. **Hydnum septentrionale** (see ►*Climacoden septentrionalis*) White Spongy Rot of heartwood of living maples, beech, hickory, and other hardwoods.

Stereum

Basidiomycetes, Aphyllophorales

Effused-reflexed to stipitate; spore-bearing surface smooth, pale brown, upper surface with a velvety coating of hairs, formed in several distinct layers; gloeocystidia and cystidia present or lacking; spores smooth, colorless.

Chondrostereum purpureum (formerly *Stereum purpureum*). Silver Leaf, Sapwood Rot, common on plums and other fruit trees, sometimes important on apples, occasional on shade and ornamental trees, widespread but more serious in the Northwest. The fungus enters through wounds; grows first in heartwood, and then kills sapwood and bark; infected branches develop foliage with dull leaden or metallic luster. If the disease is not checked, the entire tree may be lost. The sporophores appear after death, resupinate to somewhat shelf-shaped, with purple undersurface.

Stereum fasciatum (Syn. *S. ostrea*). Brown Crumbly Rot, mostly on slash, sometimes on maple and birch. Thin, leathery grayish sporophores with undersurface light brown, smooth.

Stereum hirsutum Wood Rot, Sapwood Wound Rot, occasionally near wounds of living trees –birch, maple, hickory, mountain-mahogany, eucalyptus, peach, and others. Thin, leathery crustlike sporophores have hairy, buff to gray upper surface, smooth gray undersurface.

Control Remove branches and burn at first sign of silvering. Protect trees from wounds; paint pruned surface with bordeaux paste or other disinfectant; keep brush removed from orchard.

Stereum purpureum (see ►*Chondrostereum purpureum*). Silver Leaf, Sapwood Rot, common on plums and other fruit trees, sometimes important on apples, occasional on shade and ornamental trees, widespread but more serious in the Northwest.

Stereum sanguinolentum Red Heart Rot of slash and living conifers – firs and eastern white pine. Fruiting bodies are small, not over 2 inches wide; upper surface is a silky pale olive buff; lower surface "bleeds" readily when wounded, dries to grayish brown. Sporophores are produced in profusion on dead wood, occasionally on dead branches of living trees.

Streptomyces

Schizomycetes, Actinomycetales

Intermediate form between bacteria and fungi. Much-branched mycelium that does not fragment in bacillary or coccoid forms; conidia in chains on sporophores; primarily soil forms, some parasitic.

Streptomyces ipomoea (Syn. *Actinomyces ipomoea*) Soil Rot or Pox of sweet potatoes, general New Jersey to Florida and in the Southwest. This pathogen also infects *Jacquemontia*. Leaves are small, pale green to yellow; plants are dwarfed, make little or no vine growth, and may die before end of the season; the root system is poorly developed with most roots rotted off, or breaking off if plant is pulled from the soil. Small dark lesions are formed on stems below the soil line. Pits with jagged or roughened margins, often coalescing, are formed on mature roots. The rot is found in soils at pH 5.2 or above; and is worse in dry soils and seasons. Variety Porto Rico is very susceptible.

Control Apply sulfur to acidify soil to pH 5.0.

Stromatinia

Ascomycetes, Helotiales, Sclerotiniaceae

Apothecia arising from a thin, black, subcuticular, effuse sclerotium or stroma; small black sclerotia are borne free on mycelium, not giving rise to apothecia. There is no conidial stage; apothecia resemble those of *Sclerotinia*.

Stromatinia gladioli (Syn. *Sclerotinia gladioli*). Dry Rot of gladiolus, also found on crocus, freesia and tritonia. Lesions on corms start as reddish specks, with slightly elevated darker border; spots enlarge, and centers become sunken, dark brown to black with lighter raised edges; they grow together into irregular areas. On husks the lesions are tobacco brown. Very small black sclerotia are formed on husks, in corm lesions, and on dead stems. Plants in the field turn yellow and die prematurely owing to decay of leaf sheath. Corms may appear normal when dug, the rot developing in storage. The disease is more prevalent in heavy soils, and the fungus can survive several years in soil. Apothecia have been produced artificially by fertilizing receptive bodies on sclerotia with spermatia (microconidia).

They are densely crowded, 3 to 7 mm broad, on stipes 6 to l0 mm high.
Control Use soil with good drainage and a 4-year rotation. Removing husks before planting helps to reduce gladiolus rot diseases. Cure corms rapidly after harvest.
Stromatinia narcissi Large-scale speck fungus on narcissus and zephyranthes. Black, thin, round, flat sclerotia 1/2 to 1 mm, adhere firmly to outer scales. The fungus is mostly on bicolor varieties and seems to be saprophytic without causing a definite disease.

Thielaviopsis

Deuteromycetes, Hyphomycetes

Hyphae dark; two kinds of conidia-small, cylindrical, hyaline endogenous spores and large, ovate, dark brown exogenous spores, both formed in chains.
Thielaviopsis basicola Black Root Rot, seedling root rot of tobacco and many vegetables – bean, carrot, corn, chickpea, lentil, okra, onion, pea, tomato, corn-salad, vinca, and watermelon; and ornamentals – begonia, cyclamen, gerbera, elm, oxalis, lupine, pelargonium, peony, poinsettia, pansy, scindapsus, and others. There is blackening and decay of roots; young plants damp-off and die; older plants are stunted, with the decay proceeding until all roots are destroyed. Stem discoloration extends 2 to 3 inches above the soil line. The fungus lives in soil as a saprophyte, entering through nematode wounds. Hyaline conidia produced inside conidioles are forced out through hyphal tips. Chlamydospores are larger, dark, club-shaped, with several cells; they break up so that each pillbox acts as a spore. This disease is especially serious on poinsettia, dwarfing plants, causing misshapen leaves and flower bracts. The rot is most destructive in heavy, cold, slightly acid to alkaline soils well supplied with humus. Long wet periods after transplanting increase rot. Soils with pH lower than 5.6 or sandy soils low in organic matter are less conducive to disease.
Control Sterilize soil for seedbeds; use clean pots for poinsettias and other greenhouse plants; reduce pH with sulfur or by using half peat moss and half soil.

Trametes

Basidiomycetes, Aphyllophorales

Pileus without stipe, sessile to effuse-reflexed, firm; hymenium white or pallid, punky to corky, not friable when dry; tubes unequally sunken.
Trametes suaveolens White Wood Rot of willow and poplar, after wounding. A dry, corky decay with an anise odor begins in lower trunk and progresses upward. Leathery to corky sporophores 6 inches wide are white when young, gray to yellow with age.

Trichoderma

Deuteromycetes, Hyphomycetes

Conidia in heads on conidiophores divided into two or three tips, a single head on each tip; spores hyaline, one-celled.
Trichoderma viride Green Mold Rot, Cosmopolitan on narcissus, also on shallot, garlic, occasional on citrus, but saprophytic. This fungus has an antibiotic or antagonistic effect on *Rhizoctonia, Pythium*, and other damping-off fungi and is quite helpful in reducing Armillaria root rot and crown rot due to *Sclerotium rolfsii*.
Trichoderma harzianum Fruit Rot of apples in storage.

Trichothecium

Deuteromycetes, Hyphomycetes

Conidiophores long, unbranched; conidia two-celled, hyaline or bright, single, at apex of conidiophore; upper cell usually larger than basal cell; mostly saprophytic.

Trichothecium roseum Fruit, Storage Rot on tomato, fig, celery, carrot, occasional on quince and pear; a pink mold. Pink Mold Rot on plum, nectarine and peach.

Ustulina

Ascomycetes, Xylariales

Stroma globoid, cupulate to pulvinate; carbonaceous, black, somewhat hollow; spores dark, one-celled.

Ustulina deusta White Heart Rot, a brittle white rot with prominent black zones in butts of living hardwoods; prevalent on sugar maple sprouts. Black crusts appear on stumps, logs, and on flat cankered areas of American beech.

Valsa

► Cankers and Diebacks.

Valsa ambiens subsp. **leucostomoides** Causing decay around holes of tapped sugar maples.

Leptographium (Verticicladiella)

Deuteromycetes, Hyphomyceres

Conidiophores upright, tall, brown, branched only near apex, penicillate; conidia (sympodulospores) hyaline, one-celled, ovoid to clavate, often curved, apical on sympodially formed new growing points, in slime droplets.

Leptographium abietinum (formerly *Verticicladiella abietina*). Root Rot on white pine.

Leptographium penicillata (formerly *Verticicladiella penicillata*. Root Rot on white pine.

Leptographium procera (formerly *Verticicladiella procera*. Root Rot and Decline of eastern white pine, sand pine and red pine.

Leptographium wagenerii (formerly *Verticicladiell awagenerii*). Root Rot on fir and pine.

Verticicladiella abietina (see ►*Leptographium abietinum*) Root Rot on white pine.

Verticicladiella penicillata (see ►*Leptographium penicillata*). Root Rot on white pine.

Leptographium procera (see ►*Verticicladiella procera*). Root Rot and Decline of eastern white pine, sand pine and red pine.

Leptographium wagenerii (see ►*Verticicladiella wagenerii*). Root Rot on fir and pine.

Xylaria

Ascomycetes, Xylariales

Stroma is upright, simple or branched; perithecia, immersed laterally, are produced after conidia; spores dark, one-celled.

Xylaria hypoxylon Root Rot of hawthorn and gooseberry.

Xylaria mali Black Root Rot of apple, also honey locust. Wood is soft, spongy, dirty white, with narrow conspicuous black zones forming fantastic patterns. Roots are covered with thin compact white mycelium, which changes to black incrustations. Fruiting bodies are dark brown to black, club-shaped, 1 to several inches high, united at the base, extending upward like a fan. The disease is not common, and where it does occur, only a few trees are killed.

Xylaria polymorpha On decaying wood, identified by cylindrical thumblike fruiting bodies.