



Biotic Diseases

YELLOW WITCHES' BROOM OF FIR

Melampsorella

Pls. 152–154

caryophyllacearum

HOSTS: Grand fir, red fir, subalpine fir, and white fir. Alternate hosts are species in the family Caryophyllaceae, including chickweed (*Stellaria media*) and mouse-ear chickweed (*Cerastium vulgatum*).

DISTRIBUTION: Throughout most forests in California containing true firs. It is most common in the predominantly true fir stands of the Sierra Nevada and southern Cascade Mountains.

SYMPTOMS AND SIGNS: Yellowish, often large, broomed branches on true firs are the clearest symptom of this disease. The brooms are compact and made up of many short branches bearing short, stubby, yellowish needles. Small tubules are often seen protruding from the surface of these infected needles. Pronounced swelling of the main portion of the broomed branch is also common. Yellowing is most conspicuous in mid-summer and fall. On the alternate host, yellowish spore masses are the most easily recognized sign of the disease. These occur on the leaves, flowers, and stems and are most pronounced in summer, when the host is at the peak of maturation (pl. 152).

LIFE CYCLE: Yellow witches' broom of fir is caused by a rust fungus that requires two unrelated host species to complete its life cycle. The rust on fir causes a perennial infection resulting in large witches' brooms and stem swellings. Spores are produced in summer in structures on infected needles. These spores are wind-borne and infect nearby alternate hosts. A spore stage develops on the surface of the infected alternate host, and the spores are carried by wind to adjacent firs, where infection occurs. Hosts and



Plate 152. *Melampsorella caryophyllacearum*, causal agent of yellow witches' broom of fir, on red fir.



Plate 153. Spore-producing structures (light colored) of *Melampsorella caryophyllacearum* on red fir foliage.



Plate 154. Spore-producing structures of *Melampsorella caryophyllacearum* on the alternate host.

alternate hosts need to be near one another for the rust to complete its life cycle. Outbreaks of the disease are infrequent and apparently regulated by highly specific weather conditions (pl. 153)(pl. 154).

SIGNIFICANCE: True firs of all ages and sizes are susceptible to yellow witches' broom. Broomed branches on young trees often stunt top growth, resulting in deformed and dead trees. Larger trees are seldom killed, but growth reduction, spike tops, trunk swellings, and open wounds leading to stem decay are the usual damage caused by this rust fungus. Large, persistent branches caused by brooms result in large knots and reduced lumber value.

SIMILAR PESTS: With the possible exception of white fir mistletoe, *Phoradendron pauciflorum*, there are no pests in California that could be confused with the disease caused by yellow witches' broom of fir. The yellowish, broomed branches are the distinctive symptom of this disease.

MANAGEMENT OPTIONS: Little has been done to manage yellow witches' broom of fir, for several reasons: the disease usually causes little damage in fir forests, infection occurs only sporadically, and



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little is known about the epidemiology of the disease. The best way to manage yellow witches' broom of fir at present is to avoid planting or favoring firs in stands where high levels of the rust are present, or where abundant populations of the alternate hosts grow.

For More Information

Peterson, R. S. 1963. *Effects of broom rust on spruce and fir*. Research Paper INT-8. Washington, D.C.: USDA Forest Service.

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WESTERN GALL RUST

Peridermium harknessii

Pls. 155–157

HOSTS: Nearly all native hard pine species in California; also many exotic hard pines.

DISTRIBUTION: Throughout California, in native forests and on planted trees. Western gall rust is particularly common on lodgepole pine, bishop pine, and shore pine throughout California in their native ranges, and on native and planted Monterey pines wherever they are grown. Exotic Aleppo pine may also be infected with this rust.

SYMPTOMS AND SIGNS: Round to pear-shaped, woody outgrowths, or galls, on branches of trees of all ages, or on the stems of small



Plate 155. *Peridermium harknessii*, causal agent of western gall rust, on lodgepole pine branches.

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trees, are the most obvious symptom of infection. These galls grow steadily, sometimes exceeding 30 cm (12 in.) in diameter. Older galls partially circling trunks or large branches sometimes die and become sunken, resinous cankers; those on trunks are called hip cankers. Some brooming or growth of lateral branches also results from infection. In spring and early summer spores are produced. Pustules filled with yellow-orange spore masses erupt from cracks in the galls, which lose their bark, or at the margins of older cankers. Dead branches and branch flagging, often caused by insects invading galls, are common on heavily infected trees (pl. 155)(pl. 156)(pl. 157).



Left: Plate 156. *Peridermium harknessii* infection on the stem of a young ponderosa pine.

Below: Plate 157. Hip canker caused by *Peridermium harknessii* in the trunk of a lodgepole pine.





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LIFE CYCLE: Unlike many other rust fungi, the western gall rust fungus does not require an alternate host to complete its life cycle; it is sometimes called pine-to-pine rust for this reason. In spring, spores produced from the galls intensify the disease on the original host, and spread to and infect other pines. Spores may be carried by wind for many miles. Young pines are infected when favorable, usually moist, conditions occur.

SIGNIFICANCE: Western gall rust is a damaging disease in California because it is widespread and common on many pine species. It is the most common native rust found in our pine forests. Young pines, especially those in nurseries and plantations, and pines grown for the Christmas tree market are particularly susceptible to infection and damage. Larger trees are usually severely weakened by numerous galls and killed outright by subsequent bark beetle attack. Larger trees with trunk cankers often break at the canker site, posing a hazard in developed areas.

SIMILAR PESTS: Several other species of rust fungi also infect the hard pines of California. None produce the conspicuous spherical galls of western gall rust, but some produce open cankers on older trunks and stems. On older pines, trunk cankers caused by dwarf mistletoe, *Arceuthobium* spp., could also be confused with those caused by rust fungi.

MANAGEMENT OPTIONS: Management of native pine forests to reduce the impact of western gall rust has been somewhat successful. Favoring nonhost species and controlling stand density may reduce infection and damage in some cases. In highly valued pine stands grown as Christmas trees and in nurseries, managers have had limited success with chemical sprays to prevent infection.

For More Information

- Allen, E. A., P. V. Blenis, and Y. Hiratsuka. 1990. Early symptom development in lodgepole pine seedlings infected with *Endocronartium harknessii*. *Canadian Journal of Botany* 68:270–77.
- Vogler, D. R., and T. D. Bruns. 1998. Phylogenetic relationships among the pine stem rust fungi (*Cronartium* and *Peridermium* spp.). *Mycologia* 90:244–57.
- Vogler, D. R., B. B. Kinloch, F. W. Cobb, and T. L. Popenuck. 1991. Isozyme structure of *Peridermium harknessii* in the western United States. *Canadian Journal of Botany* 69:2434–41.