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Research Note

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION
OGDEN UTAH

No. 47

June 1957

THE YELLOW WITCHES' BROOM OF SUBALPINE FIR IN THE INTERMOUNTAIN REGION

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The yellow witches' broom disease of true firs is caused by the rust fungus Melampsorella caryophyllacearum Schroet. This fungus is native to North America (1) and also Europe and Asia (5). It has been known in Europe for about 150 years and approximately half that long in this country (1).

The pathogen is not particularly destructive in Europe (5, 3), and there is no record in the literature of it causing serious damage and losses in any of the true fir species in North America. The purpose of the present paper is to report an epidemic of the rust in subalpine fir (Abies lasiocarpa (Hook.) Nutt.) on several areas in the southern portion of the Intermountain Region.

RANGE OF THE RUST

In North America, Melampsorella caryophyllacearum is known from Labrador and Newfoundland west to Alaska; south through Canada to the northern United States, and still farther south in the western United States to California and Mexico (2). It has been reported on Abies spp. in all of the western states except Arizona and Nevada (1).

HOSTS

The fungus is one of the heteroecious rusts, i.e., it evidently requires an alternate host for the completion of its life cycle (3, 5, 9, 10). The alternate hosts are species of Cerastium and Stellaria (2), commonly called chickweeds in this region. Some species within each genus are annual and the others perennial.

Aecial hosts of the parasite are the true or balsam firs. In the Intermountain Region the rust is known on white fir (Abies concolor (Gord. & Glend.) Lindl.), grand fir (A. grandis (Dougl.) Lindl.), and subalpine fir. The latter is by far the most common host of the three.

LIFE HISTORY OF THE RUST

The fungus is systemic and perennial not only on firs, but also on those alternate host plants that are perennial species (7, 10.).

Spores (aeciospores) are produced during the summer and early fall in small yellowish-orange sacs (aecia) on the needles that are borne on the witches' brooms. The aeciospores are wind disseminated and infect the leaves of chickweeds (3). Small orange-red pustules (uredia) soon develop and release urediospores which serve only to infect other chickweeds, thus intensifying the fungus on that host. The uredial stage is followed by the formation of teliospores. These spores form within the leaf cells where they overwinter (10). Teliospore germination and infection of firs occurs the following spring (3).

DESCRIPTION OF THE DISEASE ON FIRS

The outstanding characteristic of this disease is the witches' broom caused by it. The brooms are particularly conspicuous from midsummer to late fall, for it is then that their yellowish-orange color is at the peak of intensity and stands out in striking contrast to the normal dark green foliage. Aeciospore production, which is then in progress on the diseased needles, contributes to this color. Witches' brooms are upright, typically compact with a dense growth of many small and shortened branches, and rarely exceed a diameter of 3 feet. The diseased needles are greatly shortened and thickened.

In winter the brooms appear to be dead because the infected needles shrivel and become dark in color. Shortly prior to the advent of spring these needles drop leaving the brooms bare until new growth starts. The new needles are a yellowish-green color until midsummer.

Witches' brooms occur on trunks and branches, but are most common on the latter. Swellings commonly develop on both branches and trunks in association with the brooms.

Twenty years ago Garrett (4) reported that in Utah the yellow witches' brooms are often mistaken for some kind of "mistletoe." Even though no mistletoes have ever been reported on subalpine fir in Region 4, this mistaken identity as to the cause of these brooms still exists to a large extent. Mistletoes are seed-producing plants; Melampsorella caryophyllacearum is a fungus and therefore reproduces by means of spores.

A similar appearing witches' broom is present in this region on Engelmann spruce, but it is caused by another rust fungus, Peridermium coloradense (Diet.) Arth. & Kern (6, 7, 8, 9, 10). It is not certain yet that this rust has an alternate host (2).

DAMAGE

Heavily infected trees are noticeably reduced in growth rate, and as the disease continues to intensify within them they are eventually killed. Trees of all ages are susceptible to the parasite. The disease is particularly destructive to seedlings and saplings and considerable mortality has occurred on some areas.

No systematic survey has yet been made to appraise accurately the prevalence of this disease and the damage caused by it. Based on observations, however, heavily diseased stands of subalpine fir are known to be present on three of the national forests in Region 4 and more lightly infected stands have been noted on most of the other forests.

In heavily diseased stands trees containing 30 to 50 or more brooms are common. Many large trees have hundreds of infections. In such cases almost every branch has one or more brooms. Estimates made in some of the more severely diseased stands ranged from 80 percent to 90 percent of the trees infected.

EPIDEMIOLOGY

It is inconceivable that subalpine fir would be present as a species on certain of the diseased areas today if the intensity of infection by this native rust had always been as great in the past as it is at the present time. If the fungus remains uncontrolled and continues at its present destructive rate the end result will be either greatly reduced stocking of the fir or probable elimination of the tree from some areas. The great abundance of young brooms, ranging from one to several years or more of age, provides adequate evidence that intensification of the disease has been occurring at a rapid rate. Literally dozens of such brooms may be observed in many trees.

Some factor, or factors, not yet determined has been responsible for the increased intensification of the disease and infection of the firs to a degree far surpassing that of any case hitherto reported in this country. Moisture during the growing season is needed for infection of both the alternate hosts and the firs. General observations indicate that the epidemic has been in progress for about 25 years, perhaps longer in some cases. Very favorable climatic conditions (a series of moist summers) during this period could account for the present behavior of the pathogen. However, weather records do not support this possibility. Furthermore, weather

conditions alone do not provide the full answer because moist years or periods, favorable for intensification and spread of the fungus, certainly must have occurred in the past.

Evidently the fungus cannot perpetuate itself without the presence of the alternate host. Accordingly, the epidemic may be accounted for by a marked increase, perhaps an invasion, of chickweeds on areas adjacent to and within the affected fir stands. At least two of our common and well-known chickweeds, Stellaria media and Cerastium vulgatum, are exotics that now occur over most of North America. These two plants are present on many of our mountain range lands. Changes have occurred in the composition of forage plants on such lands and it is entirely possible that chickweeds are now more common than they were in the past.

ECOLOGY OF CHICKWEEDS

No special studies have ever been conducted on the ecology of chickweeds. The available information on these plants is based largely on observation. According to the Range Plant Handbook (11), chickweeds are common and are found on a wide variety of sites, but the majority of the species occur in moist or wet places. They also often concentrate in shaded or partially shaded places. Stellaria jamesiana is a native perennial species ranging over most of the West (11). It is a common plant in this region, occurring in the aspen and the fir-spruce belts. This species has tuberous rootstocks which enable it to propagate vegetatively as well as from seed. For the most part chickweeds are small, sparse in stand, and relatively unimportant as range plants (11). Grazing animals, therefore, probably interfere little with the normal reproduction of these plants.

CONTROL

No attempt has been made to control the disease because it has never been regarded as serious enough to warrant special attention. Eradication of chickweed from the vicinity of the firs would ultimately eliminate the disease, but chickweed is so abundant that this is considered as not feasible in either this country (3) or Europe (5). However, the plants probably could be killed with some of the present-day herbicides.

Tests are now under way with fungicides applied to the witches' brooms. If these materials should prove effective it probably would be feasible to apply them on high value areas such as summer homesites, campgrounds, and around ranger stations. Cutting the brooms from branches in young trees might provide some measure of control of the disease locally. A test of this kind is under way.

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