THE DECAY OF TIES IN STORAGE

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The present paper was prepared at the request of your association for an article dealing in as simple terms as possible with the more common fungi which attack ties in storage. As the fungi concerned in the decay of such timbers vary to a considerable extent with the region and also the kinds of wood under consideration, a paper covering the situation in any comprehensive manner would necessarily be quite extensive, and would involve a careful study over the entire country. For this reason it was considered advisable by the writer to limit the discussion to those fungi commonly found on hardwood and pine ties throughout the central† United States.

Several tie yards at Metropolis and Joppa, Ill., were selected as representative of this region. Ties are concentrated at these points in large numbers, coming in by rail or water from a wide tributary area. Upon arrival these ties are sorted and air seasoned and the obviously defective ones culled. These culls, running up into the hundreds of thousands, offered a very favorable field for study, as a large proportion had been culled for decay, much of which had developed before the ties reached the yards.

In the production of ties it is customary to yard them first locally near the point of cutting. Since many are rafted they are preferably yarded near the rivers, from which they can be reached at high water. Storage conditions at these local concentration points are usually very poor, and no particular care is taken to safeguard the stock from decay, hence many ties have to be rejected at these points by the buyers. Many others, however, find their way to the permanent yards, and when infected with fungi continue to deteriorate until fully air dried. It is only within comparatively recent years that the producers have even considered the use of many timber species known to be very susceptible to rot. At the present time, however, almost all species known to the local flora are acceptable if they otherwise conform to specifications. This has led to serious loss from decay, much of which is preventable.

In order to present the broader aspects of decay control I will digress at this point to indicate the fundamental factors involved in

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† Since the paper was originally prepared I have received request for another plate covering a few additional fungi most likely to be found on ties in the northern United States. Plate VIII has been included for this reason. Many of the fungi recorded for the more southern region, however, will likewise be found in the north.

the development and spread of wood-destroying fungi, to which we attribute all the primary decays with which we are concerned.

What Are Fungi?

Fungi are plants, just as much as trees, shrubs and herbs. They merely differ in their form, lack of green coloring matter, and methods of nutrition. A tree gets its nutriment from the soil and air through its root system and leaves; the fungus derives its nutriment from the substrate upon which it grows, namely, wood or other vegetable matter.

In the life cycle of wood-inhabiting fungi we recognize two essential stages in development: (1) The *mycelium* (vegetative stage), which consists of fine, cotton-like branched threads which penetrate the wood and may also develop on the surface if the surrounding air be moist; (2) the *fruiting stage*, which produces spores at the surface of the timber. These spores may be found directly on the exposed mycelium, as in the case of "molds," but more often they are produced on definite fruit-bodies which are nothing more than mycelium compacted into characteristic shapes representative of different fungi.

Many fungi are wood inhabiting, but these may not all necessarily be wood destroying. For practical purposes it is, therefore, necessary to discriminate between two broad groups, namely, molds or stains and wood destroyers.

Mycelium

The mycelium is the stage which penetrates the wood. It is the absorbing system of the fungus and in function is comparable to the root system of ordinary green plants. In the case of "molds" and "blue stains," it mainly enters the ducts or pith rays of the wood where it feeds on the starches, sugars and other easily digested organic compounds. In the case of these fungi it may also pass through the pits in the walls of the wood fibers, but rarely bores through the solid wood substance. For this reason the molds and blue stain do not affect the strength of the timber to any appreciable degree.

The mycelium of both wood destroyers and molds is in many cases colorless and rather fine when growing within the wood; that of the blue stain is brown and usually coarse. The main difference between the mycelium of wood destroyers, molds and blue stain, however, is its action on the wood fiber, the wood destroyers having the capacity to attack and disintegrate the wood substance itself while the molds and blue stain act only on the starches, sugars and other organic substances stored in the pith rays and ducts.

The chemistry of wood is rather complex, but the main constituents of the wood substance itself are cellulose and ligno-cellulose (often termed lignin), and any fungi which have the ability to feed on these substances are necessarily wood destroying. These compounds, as well as others in the wood, are acted on by specific ferments (enzymes)

which change them to simpler organic substances which can be absorbed by the fungus as food for its own growth.

Fruiting Stage

In order to propagate itself successfully every fungus must have a fruiting or spore-bearing stage. Spores are very minute bodies which in the case of molds are borne directly on the surface of superficial mycelium, and in the case of the blue stain fungi also in minute, black, flask-shaped fruit-bodies which appear as stiff bristles on the surface of the wood. The wood-destroying fungi, however, have conspicuous fruit-bodies whose shape, color and texture are quite characteristic for the different fungi. The spores are borne on or within these definite fruit-bodies.

Spores are entirely comparable in function to seeds. They are microscopic in size, extremely light, and appear in mass as a very fine powder, very often white, but the color may vary widely for the different fungi. Very often the spores from a single fruit body of the wood-destroying fungi will run up into the billions, most of them being capable under the right conditions of germinating to produce a new plant. With such an abundance of spores blowing about in the air and settling on new timber, it is seen that the chances for infection are very great, providing the conditions for their germination are favorable. The most important factor here concerned is moisture, both in the wood and in the atmosphere. The most active period for the casting of spores from the fruit bodies is during moist weather, which in turn is most favorable for germination and subsequent infection.

Conditions Necessary for the Growth of Fungi

The conditions necessary for the growth of fungi are: (1) The presence of an adequate food supply; (2) sufficient moisture; (3) at least a small amount of air; (4) a suitable temperature.

Food. This is furnished by the wood tissues and the more easily these tissues are attacked the more readily will the wood disintegrate. The sapwood of all the species of the region under consideration is non-resistant to fungus attack. The heartwood of the different woods, however, varies widely in this respect. The white oaks are highly resistant, as is also good red gum, while such species as beech, red oaks, medium grade yellow pine, hard maple and birch offer less resistance, and hackberry, elms, tupelo gum, cotton-woods, soft maple and low grade pines are easily rotted.

Moisture. A suitable amount of moisture is, without doubt, the most important factor in decay. The different fungi, however, appear to vary somewhat as to their water requirements. For infection and incipient decay a comparatively high moisture content of the wood and the surrounding air is highly favorable for all. After infection has once taken place, however, and the fungus has become established

in the wood, the rate of decay may vary considerably with different organisms, depending on the amount of moisture present. For instance, there are many fungi which thrive only under humid forest conditions and will not develop on partially seasoned timber in storage, while others can tolerate a considerable amount of drying and still continue to decay the wood. It is safe to say that most of the fungi which rot structural timbers are quite resistant to drying when once established in the wood.

The term "dry rot" should not be used indiscriminately, as is rapidly becoming the case among laymen. While the writer thinks the designation should be retained, it should be limited in its scope so as to apply only to the decay produced by *Merulius lachrymans* and its close relatives, which are mainly of economic importance in connection with the decay of timbers in buildings. Even in this case the term is more or less of a misnomer, as these organisms always start under moist conditions. They have the capacity, however, of developing porous water-conducting strands which may spread from the moister portions of a building to dry timbers, whose decay is furthered by the moisture which the fungus carries.

Air. A certain amount of air in the wood is absolutely necessary for decay to take place. The fungi require it in their growth. When wood is saturated the air in the wood cells is displaced by water and fungus growth is impossible.

The opinion widely prevalent among laymen that alternate wetting and drying is necessary for decay has developed through observation of the way wood decays in exposed situations. For instance, take the case of an infected railway tie partly embedded in soil. During a very dry season there may not be sufficient moisture in the wood to permit decay, and the fungus will remain dormant. On the advent of rains, if only sufficient moisture falls to put the tie in good moisture condition, it begins to rot rapidly again and will continue to do so as long as the moisture and temperature are favorable. If, on the other hand, the rainy period is long continued, the tie may become saturated and decay will be retarded again until the stick dries out sufficiently to admit the necessary amount of air. Thus, in the alternation of wet and dry conditions, there occurs at some point intermediate between the dry and wet ranges a condition at which decay is at its maximum. If the moisture were *held at this optimum point* it can readily be seen that the stick would decay much more quickly than under the alternating conditions. Therefore it is only under fluctuating climatic conditions that alternation becomes of advantage.

Temperature. In general, the fungi under consideration grow best between 75 degrees and 90 degrees F. They will all grow at much lower temperatures, but much more slowly. The most severe winter conditions do not kill them. They merely cease growth and remain in

a dormant condition. On the other hand, a rise of temperature of but a few degrees above the optimum has a greater influence on growth than a corresponding reduction. The practical purposes, however, we may say that nature so regulates temperature conditions that for the region under consideration the fungi find a very favorable environment over a considerable portion of the year.

Control of Decay in Stored Ties

With the foregoing considerations in mind relative to present commercial practices as coupled up with the fundamental conditions necessary for decay, it is seen that relief can only be secured by changing commercial practice as far as possible so as to eliminate infection and put the timber in a moisture condition unfavorable for subsequent decay.

Winter Cutting and Barking. The advantages in winter cutting lie in the fact that at this season both temperature and humidity are much less favorable for infection. It is true that air seasoning will be much slower at this season, but this can be increased by removal of the bark, which is also of advantage in controlling insect depredations. Slower seasoning is of particular value from a pathological standpoint, as it decreases the number and size of season checks which collect and retain moisture and thus offer favorable points for infection.

Proper Piling in Woods. At points of production ties should never be piled directly on the ground or allowed to lie about singly on the ground for more than a few days at most. Forest soil is full of living fungus, and being moist, infection is quickly carried over to timber in contact with it. In piling or yarding ties they should be placed on foundations well off the ground and amply ventilated beneath, the ties being spaced so as to allow as much ventilation as possible without undue checking. This preliminary seasoning in the woods is of very great importance, as apparently a large amount of subsequent decay is to be attributed to infection in the woods.

Transport of Ties. With partially seasoned ties rail transport would appear preferable to rafting from a pathological standpoint, but perhaps not from a practical, for every time a tie is wet it is put in a good condition for infection. The writer, however, does not wish to lay too much stress upon this point, as proper yarding and piling at destination will normally take care of the situation.

Yarding Ties at Destination. Inasmuch as ties may be stored for sometimes more than a year at terminal yards, careful attention must be given to piling them, particularly when they are rafted. Since many of the yards are on comparatively low ground, the first care must be given to drainage so that all rainfall or ground water may be immediately removed by seepage. A slag or cinder covering to a depth of 6 to 12 inches makes a very good surface which keeps the weeds down and allows rapid run off.