ARMILLARIA MELLEA: AN OPPORTUNIST[1]

by Philip M. Wargo

An opportunist takes advantage of the slightest change of circumstance in his favor, and *Armillaria mellea,* the shoestring root rot fungus, does this very well. *Armillaria* always seems to be in the right place at the right time. The fungus is found throughout the world in both temperate and tropical climates. Its host list is enormous and ranges from a variety of herbaceous hosts and shrubs to trees, both forest and fruit. To paraphrase Will Rogers, *A. mellea* hasn't met a tree it didn't like.

The fungus can take advantage of nearly every stress that affects trees. Attack by the fungus has been associated with poor cultural practices such as too deep planting, transplant shock, and off-site planting; environmental effects such as drought, flooding, ice damage, defoliation by insects from fire, wind, and lightning; and poor site conditions such as nutrient-deficient soils, soil compaction, and poorly drained soils. In short, any thing that disrupts a tree's normal physiological functions favors attack by *A. mellea* (Fig. 1).

Fig. 1. *A. mellea* existing as a parasite colonizing living tissues between the bark and the wood and killing the root system.

The fungus is called a secondary organism or pathogen because it usually attacks stressed trees, but the fungus is secondary only in time, not in importance, since the fungus is responsible for the death of many trees that would have tolerated the stress. But stress is not necessary in some cases; among some tree species, especially conifers, the fungus can attack and kill healthy trees; this fungus is versatile.

Life habits. The main reason this fungus is so versatile is its capacity to live as a parasite able to attack living tissues and as a saprophyte able to live as a decay fungus on the tissues that have died (Fig. 2). This saprophytic ability enables the fungus to live in the soil in an active stage for many years where it spreads to other trees and, in a sense, waits for the next stress to weaken these trees so it can attack.

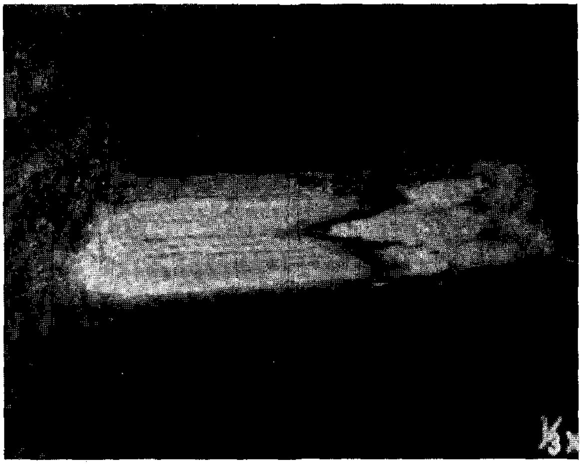

Fig. 2. *A. mellea* existing as a decay organism on white oak root. The black margin indicates the leading edge of decay.

To take advantage of the changes in a tree caused by stress requires that the fungus be in the right place at the right time. *A. mellea* has a unique system for doing this which is called a rhizomorph system (Fig. 3). A rhizomorph is an

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aggregation of hyphae organized into a rootlike structure that offers significant advantages to the fungus. The rhizomorph is much less fragile than the thin-wall single hyphal strands, and its toughness enables the fungus to tolerate a range of moisture and temperature conditions and the gamut of growing sites.

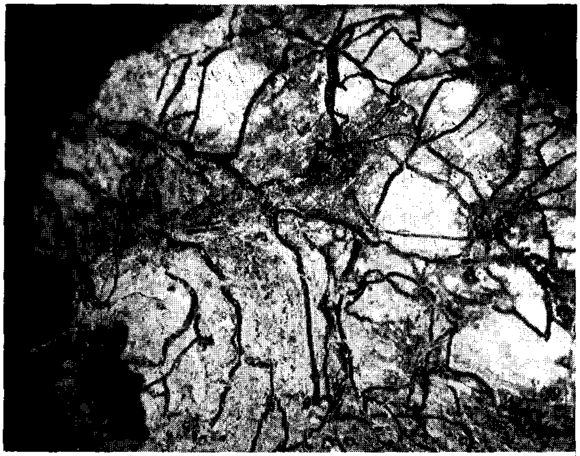

Fig. 3. Rhizomorphs of *A. mellea* on the outer bark of a white oak root.

Rhizomorphs enable *A. mellea* to spread from tree to tree, sometimes at great distances, by growing from an infected tree through the soil to an uninfected tree. Once in contact with the roots of the uninfected tree, the rhizomorphs continue growth and spread over the surface of the roots, colonizing the surface of most major roots. This puts the fungus in the right place awaiting the right time when stress-caused changes allow the fungus to penetrate through the bark and begin to grow, killing the inner bark and wood tissues of the tree.

The fungus is not limited to rhizomorphs to spread. In some soils, such as those in Africa where rhizomorphs are found infrequently or not at all, the fungus spreads from tree to tree via root contacts. *A. mellea* also produces mushrooms at the base of colonized trees (Fig. 4). The mushrooms, in turn, produce spores that are wind disseminated, which possibly results in spreading the fungus even greater distances.

Food requirements. The fungus is very adaptable when it comes to food. *A. mellea* can utilize a wide variety of energy sources, but it does best when glucose, or compounds made up of glucose molecules such as maltose (2 glucoses) and starch (many glucoses), is the source. For protein production it can use many nitrogen sources, and when grown in a lab, it requires only one vitamin, thiamine. When all the free or easily soluble sugars have been used, it can produce enzymes that can break down bark tissues into sugars it can use. This adaptability is what enables the fungus to exist in two lifestyles, parasite and decayer. A most interesting feature is that *A. mellea* utilizes food better and grows faster when ethanol is present.

Fig. 4. Fruiting bodies (mushrooms) of *A. mellea* at the base of a recently killed black oak.

This fungus also has the capacity to tolerate many compounds that inhibit other decay fungi. Not only can the fungus tolerate inhibiting phenolic compounds such as tannins, gallic acid, chlorogenic acid, and quercitrin, but it is actually stimulated by some of them, especially in the presence of a rich sugar source.

How the fungus takes advantage. We have already noted that in many instances the fungus is already in place on the root system via its rhizomorphs. The fungus has probably already penetrated through the outer bark into the inner bark and wood tissues; but, because the tree is healthy, the fungus cannot spread any further. The fungus is held in check by some physiological process in the tree, possibly from an enzyme breakdown of its thin-walled hyphae, or the lack of a rich sugar source or ethanol needed for rapid growth. But *Armillaria mellea* is in a position to take advantage should a change occur! When a tree is stressed by defoliation for example, all sorts of changes take place, but important to *A. mellea* are changes that occur in the roots: the amount of glucose increases, probably from starch breakdown, and amino acids that are good nitrogen sources also increase. These provide rich food sources for the fungus and, coupled with other changes in the root which are yet to be understood, the fungus takes advantage and attacks the tree — an opportunist par excellence.

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ABSTRACTS

Good, J.M. 1980. **Can IPM succeed?** Agrichemical Age 24(2): 18-20, 36.

To be desirable to farmers, IPM must produce expected, dependable results. It must be practical and must help farmers maximize profits. Otherwise, IPM practices will not be adopted by farmers without financial incentives from government. Regulated IPM practices must be precise enough to be enforceable. They must be socially acceptable and cost effective to both the public and to the user. Good IPM programs will be accepted by the innovators. There are several ways of reaching these IPM users. There cannot be an agricultural IPM program in the broadest sense, only alternative, multiple choice pest management systems that are designed for individual user groups. Too often the term IPM is equated with biological control or nonchemical control. In most instances, farmers do not accept this because their experience proves otherwise. Certainly there are a few pests that can be adequately or completely controlled with biological methods. Resistant plant varieties and animal breeds can be effective in controlling a few pests. Cultural practices including crop rotation are partial aids, but pesticides have proved to be effective against the greatest array of pests. Therefore, use of pesticides will remain the cornerstone of most but not all IPM programs for many years.

Skirvin, R.M. and M.C. Chu. 1979. **Ginkgo: a beautiful tree with edible seeds.** Illinois Research 21(4): 10-11.

During the age of the dinosaur millions of years ago, ginkgoes grew throughout the temperate areas of the world. Today only one member of the entire Ginkgoaceae family survives: *Ginkgo biloba* Linn., which strictly speaking is not closely related to any other living plant species. Landscapers are particularly interested in these trees because they do not seem to have any serious insect or fungal pests. The ginkgo also appears to be insensitive to several forms of air pollution and to adverse soil conditions. Hence ginkgoes are often used as street trees either alone or in groups. The ginkgo has a very long life span. In the gardens of certain Chinese and Japanese temples some specimens are reputed to be more than 1,000 years old. Because of its long life, the Chinese call the ginkgo "kung Sun Soo," which means "grandpa grandson tree." The fruit of the female resembles an apricot in size and color. But the similarity ends there; when the fruit begins to decompose, it gives off a highly offensive odor. Despite the unpleasant qualities of the fruit, the nut or seed inside is good to eat and is used in oriental dishes or as a snack food. The seeds can be purchased canned in water at oriental food stores, or the fruit can be gathered fresh as it ripens in autumn. When gathering the fruit, however, people who are allergic to it should wear rubber gloves to prevent a rash.