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Global Distribution of the Pitch Canker Fungus

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ABSTRACT

The pitch canker fungus, *Fusarium subglutinans* f. sp. *pini*, causes diseases of pines in the United States, Haiti, Japan, Mexico, Spain, and South Africa. Pitch canker was first reported in Virginia pine in North Carolina in 1946. Although the disease was reported in Haitian pine in 1953, pitch canker was generally considered a disease of pines in the southeastern U.S. until the mid-1980s. Since 1986, however, pitch canker has seriously damaged Monterey pine in coastal central California. By the late-1980's, pitch canker had also been reported in Japan and Mexico. In the 1990's, the pathogen was reported to induce a root rot of containerized *Pinus patula* seedlings in South Africa and the mortality of radiata pine seedlings in bare-root nurseries in Spain.

Fusarium subglutinans (Wollenw. and Reinking) Nelson, Toussoun, and Marasas f. sp. *pini*, the pitch canker fungus, causes a number of serious diseases in *Pinus* species. The pathogen infects a variety of vegetative and reproductive pine structures at different stages of maturity and produces a diversity of symptoms. In addition to producing resinous cankers on the woody vegetative structures of its pine host, the causal fungus causes the mortality of female flowers and mature cones, deteriorates seeds of several pine species, and can cause mortality of pine seedlings in nurseries (Dwinell 1998, Dwinell et al. 1985). In the last two decades, pitch canker has evolved from a regional disease, to one of national and international importance (Dwinell 1998, Dwinell et al. 1998).

The pathogen has gone through a number of name changes. When first described in 1946, the pitch canker fungus was referred to as a species of *Fusarium* belonging in the Section Liseola (Hepting and Roth 1946). Three years later, it was designated *F. lateritium* (Nees) emend. Snyder and Hansen f. sp. *pini* Hepting. In the 1970's, the most common isolates of *Fusarium* from pitch canker tissue were assigned to *Fusarium moniliforme* Sheldon var. *subglutinans* Wollenw. and Reinking (Dwinell 1998; Kuhlman et al. 1978). In 1983, the variety was raised to species level as *F. subglutinans*. In 1991, Correll et al. (1991) justified assigning strains of *F. subglutinans* pathogenic to pines to a specific forma specialis. Recently, Nirenberg and O'Donnell (1998) proposed ten new species in the *Gibberella fujikuroi* species complex and proposed renaming the pitch canker fungus *F. circinatum* Nirenberg et O'Donnell. Until the universality of the sterile coiled hyphae in the pitch canker fungus has been fully evaluated, I will continue to refer to the pitch canker fungus as *Fusarium subglutinans* f. sp. *pini*.

Pitch canker was first reported in 1946 on Virginia pine (*P. virginiana* Mill.) in North Carolina (Hepting and Roth 1946). The name of the disease is derived from the copious pitch flow associated with most cankers. The disease came to the forefront in 1974, when a shoot dieback caused by the pitch canker fungus reached epidemic proportions on planted slash pine (*P. elliottii* Engelm. var. *elliottii*) in Florida and on loblolly pine (*P. taeda* L.) in seed orchards in North Carolina and Mississippi (Dwinell et al. 1985). In 1986, pitch canker was a major cause of dieback and mortality of Monterey pine (*P. radiata* D. Don) in California (Correll et al. 1991). Pitch canker in the southeastern U.S. extends from Virginia to southern Florida and west to eastern Texas (Dwinell et al. 1985). In California, surveys have found that the disease extends from

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Mendocino County to San Diego; however, the disease is most severe in the central coastal region (Correll et al. 1991; Dwinell 1998).

During a disease survey of the Foret les Pins in Haiti 45 years ago, Hepting (Hepting 1953, Hepting and Roth 1953) observed pitch canker on *Pinus occidentalis*—a hard pine. The disease primarily affected the leaders and to a lesser extent the branches. According to Hepting (Hepting 1953), the disease appeared responsible for shoot dieback in the larger trees. A species of *Fusarium* was isolated from the cankers and Hepting concluded that the cultures were the pitch canker fungus (Hepting 1953).

In the mid-1980s, the pitch canker fungus had caused trunk cankers and dieback of Ryukyu pine (*P. luchuensis* Mayr.) on Amamiooshima and Okinawa islands of Japan (Muramoto and Dwinell 1990). Pitch canker is considered an endemic disease of Ryukyu pine in the subtropical zone of Japan. In a field inoculation study, Japanese red (*P. densiflora* Sieb. and Zucc.) and Japanese black (*P. thunbergii* Parl.) pines were moderately susceptible to the pitch canker fungus (Muramoto, personal communication).

In the late-1980s, Blanchette (1989) observed pitch canker on planted *P. halepensis* Mill. and in natural stands of *P. douglasiana* Mart. and *P. leiophylla* Schl. and Cham. In 1995, I observed pitch canker on *P. estevesi* (Mart.) Perry in a plantation and *P. arizonica* var. *stormiae* Mart. in a natural stand in the State of Nuevo Leon. The disease is also prevalent on planted P. radiata and in natural stands of *P. douglasiana, P. leiophylla, P. durangensis* Mart. and other pine species (Guerra-Santos 1995). Branch tip dieback appears to be more common on Mexican pines than bole or stem cankers. Pitch canker is now widespread in Mexico and has been documented in eight States (Sinaloa, Nayarit, Mexico, Nuevo Leon, Puebla, Michoacan, Jalisco, Durango and Tamaulipas) (Guerra-Santos 1995). Currently, pitch canker is considered a native disease of Mexico, and the apparent increase in incidence has been attributed to increased investigation.

In 1990, a forest nursery in the Eastern Transvaal province of South Africa reported heavy losses of containerized *P. patula* Sch. and Cham. seedlings. Viljoen et al. (1994) concluded that *F. subglutinans* f. sp. *pini* was causing a root rot of the pine seedlings. They also reported that *P. patula*, a native of Mexico that is widely planted in South Africa, is highly susceptible to infection by South African isolates of *F. subglutinans* f. sp. *pini*. However, pitch canker *per se* has not been reported in South Africa.

Pitch canker was first observed in Europe in 1997 in the autonomous community of País Vasco (Basque Country) in Northern Spain. The disease caused extensive mortality of radiata pine seedlings in bare-root nurseries (Dwinell et al. 1998). The disease, however, did not reappear in 1998 (Aquirre, personal communication). In nurseries pitch canker is typically an annual event that may or may not be repeated in subsequent years. The canker disease has not been confirmed in radiata pine plantations in País Vasco.

Since pitch canker was first described in 1946, the parameters of the disease have been constantly expanding (Dwinell 1998; Dwinell et al. 1985). From 1946 until 1974, the disease was defined largely as a canker on the trunk or branches of planted pines in the southeastern United States. In 1974, the disease manifested itself as shoot dieback on southern pines (Dwinell et al. 1985). The pathogen also infects reproductive structures causing mortality of female flowers, first-year strobili, and mature cones and deteriorates seeds of several pine species. The pitch canker fungus also causes pre- and post-emergence damping-off and root rot in bare-root and container nurseries (Dwinell 1998; Vilgoen et al. 1994). Finally, the disease now occurs in several countries in landscape plantings, plantations, seed orchards, nurseries, and natural stands (Dwinell 1998).

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Question and Answer

Mike Devey: It's interesting what you've mentioned about the politics and secrecy regarding the identification of pitch canker in Spain. I had written to several people in Spain and Portugal regarding this conference and never heard a word back from them.

Dave: A lot has to do with the relationship between the Plant Health Committee of the EU and Spain, and also I think the lack of expertise in dealing with the problem. I said the same thing, I sent Juan the information on the meeting because I thought it'd be good for him to come here.

Mike Wingfield: Dave do you have isolates from Spain from mature trees?

Dave: No just from the nursery.

Mike: You're calling that pitch canker which you've just told us is not acceptable to do, so you've got me confused.

Dave: Cankers on seedlings is pitch canker.

Mike: Well then pitch canker is in South Africa, very commonly.

Dave: Okay well you've reported a root rot, you haven't reported a cambial canker.

Mike: So you don't have isolates from mature trees from large trees?

Dave: No because like I say the people in these provinces don't recognise they have a problem. So the only isolates we have are from nursery material.

Mike: But they might not have a problem. It may be the same situation as you have in South Africa where large trees don't have symptoms. The picture you have shown there would be a very common picture as seen all over South Africa, all *Diplodia*. We have looked at thousands of trees.

Dave: It was originally sent to me as pitch canker, then they started waffling because of the politics between provinces. What I'm saying is there is a possibility that it is in plantations; they're supposed to be doing surveys to confirm that. But really the only thing we have now is in seedlings, above ground cankers in seedlings.

Mike: That will become quite an important issue as we go into discussion. What drives the disease here relative to these other countries?

Colin Matheson: It sounds as though there are at least three manifestations: in the root rot, and in the small seedlings which you might still call pitch canker, and that which is in mature trees where you have cankers and other things as well.

Dave: Basically you're talking about a seedling which has a cambial necrosis and that's pitch canker. If you have root rot, that's not pitch canker. If you do have a canker on an above ground surface that's pitch canker, as long as you have cambial necrosis.

Mike: Or at the root collar?

Dave: Right.

Dave Wood: You made a comment about *Ips* and *Dendroctonus* being decoupled from pitch canker in the South. That's blasphemous of course for bark beetle biologists.

Dave: I'm sorry but that's the way it is.

Dave Wood: I'd like to know what your evidence for this is.

Dave: Because southern pine beetle which is our primary *Dendroctonus* species attacks loblolly pine and other species totally independent of pitch canker. With engraver beetles it's primarily a thinning problem. So most of our southern pines, and George has seen this on slash pine, most of the southern pines that I've ever seen with pitch canker, there isn't a subsequent insect attack.

Dave Wood: This violates the natural law of bark beetles which says that as a tree grows weaker from whatever cause, it becomes colonised by bark beetles, like *Ips* and *Dendroctonus*. So it runs counter to all of our philosophies.

Dave: That's the way it is. Sorry.

Dave Wood: Can I say I don't believe you?

Dave: That's fine. What do you think George?

George Blakeslee: Well we did a study in one of the worst pitch canker slash pine stands that I've ever seen, up to that time. There was 25% tree mortality, these were trees 6–8 inches in diameter. Massively pitch canker infected, several 2 or 3 cankers per meter of stem length, which basically put the trees out of commission. When I first encountered these situations, I expected a nuclear detonation of bark beetles in the making. When you go into these places certainly there's *Ips* species all through, but they're all way late. It appears secondary, in that sense I agree with you. They are certainly not absent, but in some of these trees they have trouble finding a place to feed because of competition from the deodar weevil which breeds in these severely declining stands. They use up all the habitat where the bark beetles would normally go. You might get 400 to 600 weevil chip cacoons in a small pole size tree. So a lot of their habitat is displaced because of weevil competition.

Andrew: A follow up question on that, in trees that are infested with *Ips* and *Dendroctonus* or even weevils, to what extent have you emerged those insects to find out if they are carrying the disease?

George: In heavily infected stands where what happens is there is tremendous crown infection, you get bark beetle colonisation, and you get wood peckers going in after the beetles. Wood peckers love it of course. It's a really nice ecological system. You can look at bark slabs and see microconidia, solid sporulation, you get larval galleries. We haven't trapped the insects, but if they aren't carrying it, I didn't eat breakfast. No one has looked.

Andrew: Do you think there's a possibility they might vector it? We have data here where healthy trees are visited by beetles. They chew into the tree and reject it.

George: That could be, but to my knowledge that hasn't been pursued. In these bad epidemic areas you get plenty of bark beetles. You get fungus by the tons, which would normally be trapped underneath the bark except where the damn birds knock it off and it's exposed. So you have that element there too. I don't know, I haven't trapped any of the *Ips*, and I don't know of anyone who has.