Root Disease of *Delonix regia* and Associated Tree Species in the Mariana Islands Caused by *Phellinus noxius*

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ABSTRACT

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A root and butt rot of flame tree, *Delonix regia*, in the Mariana Islands was found to be caused by the fungus *Phellinus noxius*. Several associated tree species, including *Albizia lebbek, Bauhinia* sp., *Casuarina* sp., *Citrus* sp., *Erythrina* sp., *Leucaena leucocephala,* and *Thespesia populnea*, were also infected by the fungus. The disease is characterized by slowly enlarging disease centers and a thick, dark brown mycelial sheath around the bases of infected trees. A serious root disease of breadfruit, *Artocarpus altilis*, previously reported from other island groups in the Western Pacific as caused by a *Corticium* sp., was found to be caused by *Phillinus noxius*.

In 1979, several dead and dying flame trees (*Delonix regia* (Bojer) Raf.) were observed on Saipan in the Northern Mariana Islands. Affected trees wilted rapidly, and leaves turned yellow and were shed within a few weeks. A brown fungal sheath was evident on the bases of affected trees. In 1980, trees with similar symptoms were noted in several areas on Rota, and we started a study to determine the cause of the problem. Flame tree is widely planted throughout the tropics as an ornamental in yards and along streets and highways. In the Northern Mariana Islands, it has become naturalized with dense, almost pure stands of small trees sometimes surrounding scattered old trees.

This paper reports the results of an investigation on the symptomatology and etiology of the root disease and describes the causal organism, *Phellinus noxius* (Corner) G. H. Cunningham.

Distribution and severity. Although the root disease was first observed on Saipan, it has apparently been present on Rota for a much longer time. On Rota, numerous infection centers—up to 0.1 ha each—were noted around the airport and between the airport and Songsong Village. Contiguous areas composed of several overlapping centers involved 1 ha or more with several hundred dead and infected trees. On Saipan, the disease occurred in much smaller and more widely scattered centers. Several centers were seen around Puerto Rico and Sadog Tassi on the east end of the island. Because much of the island is inaccessible, it is difficult to determine if the disease is present in other areas. The disease has not been observed to date in yard or roadside plantings.

While surveying plant diseases in the Northern Mariana Islands in 1980, G. Beaver of the University of Guam visited the infested area near the Rota Airport. On Guam, he found what was apparently the same disease on *Leucaena leucocephala* (Lam.) Dewit and received reports of its occurrence on several other hosts (G. Beaver, *personal communication*). One of us (first author) recently visited the infested area on Guam and confirmed the diagnosis. Although the extent of the infection on Guam is not known, infected trees of *L. leucocephala* and a *Bauhinia* sp. were seen.

Hosts. Several tree species are usually associated with flame tree in its naturalized state. Most of these also appear to be affected. The disease was verified in *Albizia lebbek* (L.) Benth., *Bauhinia* sp., *Casuarina* sp., *Citrus* sp., *Erythrina* sp., *L. leucocephala*, and *Thespesia populnea* (L.) Soland. The relative susceptibilities of these species are not known, but dead individuals of all species have been observed with the characteristic mycelial sheath at the base.

Symptomatology. In the early stage, the disease occurs in well-defined, more or less circular loci. A large dead flame tree, which appears to be the initial site of infection, is usually at the center of each locus. Smaller dead and living infected trees of one or more species surround the central tree. The most noticeable sign of the disease is a dark brown to blackish mycelial crust that covers the base of the stem and root collar of an infected tree (Figs. 1 and 2). The crust is hard and has a varnished appearance. On large trees (30–40 cm dbh), it may extend to 2 m above the root collar, but on smaller trees, it seldom extends higher than 80 cm. It often has alternating light and dark zones about 2 cm wide. During the rainy season (July to November), the advancing margin is white and covered with drops of brownish exudate.

When bark is removed from living trees, the height of the dead and discolored areas of cambium generally corresponds to that of the external mycelial crust (Fig. 3). A very thin white mycelium is present between the bark and wood. The brown external mycelial crust also occurs on the surfaces of infected roots, where it is somewhat obscured by adhering soil.

When small (4–10 cm dbh) flame trees are infected, colonization and decay apparently progress rapidly. Trees showing no foliar symptoms may have the entire root collar area decayed to the extent that the butt of the tree easily breaks. The decayed wood, which is white and brittle, easily fractures in a more or less straight line across the grain. Once foliar symptoms appear on small trees, they progress from slight yellowing to wilting, reddening, and leaf drop within a few weeks. On large trees, the symptoms progress much more slowly.

Although the advanced decay in other affected species is similar in appearance to that in flame tree, the wood is not so easily fractured. Large trees of all species with decaying root systems may be uprooted before death.

The pathogen apparently spreads by root contacts, which are frequent in dense, natural mixed stands of flame tree and other species. The very rapid death of some small trees is probably due to infection from contact with an infected root at or near the root collar (Fig. 4).

Identity of the pathogen. On the basis of typical sporophores and the prominent mycelial crust at the bases of infected trees, the fungus causing root rot of flame trees and other species on Saipan, Rota, and Guam is *P. noxius*.

Sporophores (Fig. 5) were common on large, dead, standing or fallen trees on Rota but were less common on Saipan. The sporophores are solitary and vary widely in size, usually from about 3 × 4 to

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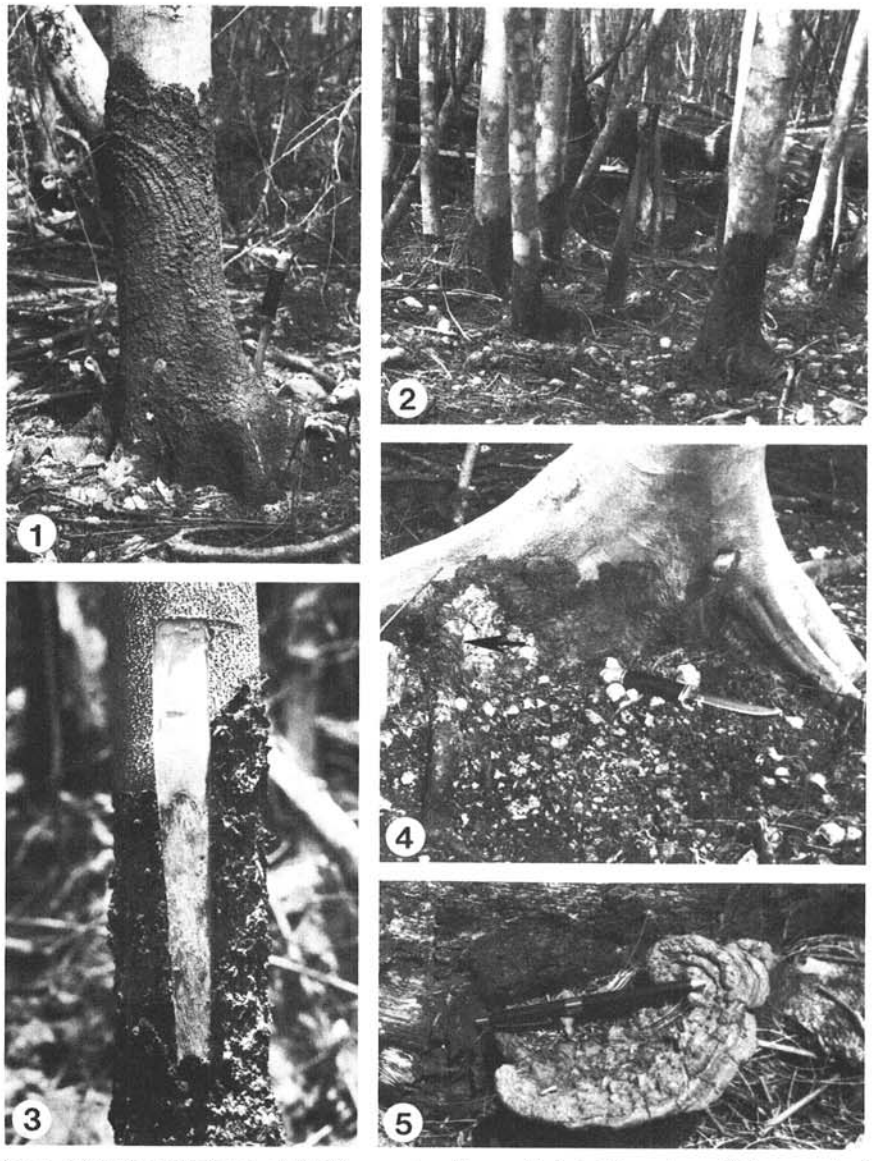
10 × 20 cm; however, one very large sporophore on a large, fallen flame tree was 40 × 75 cm. This was several times the usual maximum dimensions for this fungus (4). In contrast to most sporophores, which were reflexed, the large specimen was effused-reflexed with the reflexed portion up to 20 cm wide. The upper surface of sporophores was dark brown to almost black, crustose, glabrous, and narrowly but irregularly zonate. The pore surface was grayish brown to brown with six to nine pores per millimeter. Tubes were in one to four layers 1–3 mm long and similar in color to the pore surface. The color of the tubes contrasted sharply with the deep chocolate brown of the context. Spores were hyaline, broadly ellipsoid, and 3–3.5 × 3.5–4.5 μm. Microscopic and macroscopic characteristics of *P. noxius* were described by Corner (4) and Fidalgo (5).

DISCUSSION

P. noxius is a fungus of pantropical distribution (5), and like other Basidiomycetes that cause root rots of forest trees, it has a wide host range. The fungus often causes serious losses in plantation crops such as rubber, coffee, tea, cacao, and timber trees (3,5–7) and has been reported from Samoa, Fiji, and other islands in the South Pacific, but this is the first confirmed occurrence on islands of the North Pacific. In 1971, however, Trujillo (8) reported a crown rot disease of breadfruit (*Artocarpus altilis* (Parkins) Fosb.) on Ponape, Kosrae, American Samoa, Fiji, and Tahiti, and he tentatively identified the causal fungus as a *Corticium* sp. His descriptions and illustrations leave no doubt that the breadfruit disease is caused by *P. noxius*. Recent discussions with Trujillo further confirmed that diagnosis. According to Trujillo, the majority of breadfruit dieback in the above-named islands is due to *P. noxius*.

P. noxius is a natural component of many tropical forests. When such forests are cleared for cultivation of tree crops, the fungus survives in stumps, roots, and other logging debris and eventually passes to the plantation trees and spreads from tree to tree by root contact. New infections can also take place on freshly cut stumps or logging debris by airborne spores, with subsequent spread to living trees by root contact (1). Infection of trunk wounds, presumably by airborne basidiospores, has been reported on cacao (7) and rubber (2).

The infested stands on Rota occur on abandoned agricultural land, and those on Saipan are on areas devastated during World War II. It is thus unlikely that infected stumps or debris were the sources of infection. The infection centers on Rota were so large the original foci could not be identified. On Saipan, however, the foci are almost always large flame trees. It could not be determined how these trees became infected, but entrance through trunk or root wounds appears likely. Flame trees have numerous, large, superficial buttress roots that could easily be damaged, especially on shallow soils that overlie coral. Periodic typhoons may also account for trunk and root wounds.



Figs. 1–5. (1) Mycelial sheath of *Phellinus noxius* at base of infected flame tree. **(2)** Young mixed stand of flame tree and *Leucaena leucocephala* heavily infected with *P. noxius* (note basal mycelial sheaths). **(3)** Relation between cambial infection of flame tree by *P. noxius* and the external mycelial sheath. **(4)** New infection by *P. noxius* at root collar of flame tree originating from root contact (arrow). **(5)** Sporocarp of *P. noxius*.

Apparently, *P. noxius* was introduced fairly recently to Saipan and Rota. Trujillo (*personal communication*) did not observe the fungus on Saipan or Rota between 1969 and 1971. The largest and probably oldest infection centers on Rota are concentrated around the airport. It is possible that infested wood or an infected plant was introduced through this port of entry. Basidiospores produced on Rota could be carried by wind currents to Saipan and Guam.

Although not yet observed, the most potentially serious aspect of the root disease would be its establishment in street and roadside plantings, which have high aesthetic value for both residents and tourists. *P. noxius* is known to infect through pruning and other types of trunk wounds (2). Care should be taken to prevent damage to superficial roots during mowing or other cleaning activities.

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