Needlecasts of Pines in Florida[1]

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Fig. 1. Symptoms of needlecast on pines in Florida. A) Healthy (left) and diseased (right) slash pines. B) Severely infected slash pine. C) Severely infected loblolly pine. Note concentration of symptoms in lower portion of tree crown. D) Severely infected Christmas trees. (Photography credit: E.L. Barnard)

INTRODUCTION: Needlecasts (also written needle casts) are common, yet complex, and often poorly understood fungal diseases of conifers. Collectively, the term needlecast refers to distinct foliage infections which are considered different from needle blights on the basis or bases of symptoms produced, disease cycles and modes of resulting epidemics, and/or specific causal agents. Merrill (1990) discusses foliage **blight** (including conifer needle blight) as sudden and rapid foliage death resulting from direct foliage infection. He points out that blight infections have short incubation periods (time from infection to symptom expression) and repeating cycles (infectious spore to infectious spore); e.g., as little as a few days. The results are "compound interest diseases" and potentially explosive epidemics. Needle blights are caused by a variety of pathogenic fungi, the repeating infection cycles of which are often initiated by asexual spores (conidia). Conversely, Merrill (1990) urges that **needlecast** be applied more restrictively to "loss of leaves caused by *spp. of Hypoderma*, *Lophodermium*, *Rhabdocline*, or other Rhytismatales" *(sensu* Hawksworth *et al.* 1995) "with few exceptions." According to Merrill, needlecasts are "simple interest diseases" with only one infection cycle per year, typically initiated by sexually produced ascospores. Stone (1997a) suggests that needlecast refers to "a disease that causes premature needle abscission but has also been used more generally to refer to foliage diseases caused by the so-called needle cast fungi, the genera of ascomycetes that comprise an ecologically similar, closely related group of conifer needle parasites originally included in Hypodermataceae *sensu* Darker" (1932, 1967).

NEEDLECAST FUNGI: Needlecast fungi, *sensu stricto*, are currently classified as members of the family Rhytismataceae in the ascomycetous order Rhytismatales [formerly, Hypodermataceae, Hysteriales *sensu* Darker 1932; or otherwise according to taxonomic schemes popular at various times (Merrill 1990)]. Species known or reported on pines in Florida include three species of *Lophodermium [L. australe* Dearn., *L. molitoris* Minter, and *L. pinastri* (Schrad.: Fr.) Chev.]; two species of *Ploioderma [P. lethale* (Dearn.) Darker, and P. *hedgcockii* (Dearn.) Darker], and *Lophodermella cerina* (Darker) Darker (Alfieri *et al.* 1994). Needlecast fungi reproduce by means

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of characteristic ascospores (Fig. 3) produced in distinct ascomata called hysterothecia (sing.; hysterothecium). Hysterothecia of certain species of needlecast fungi are produced on necrotic needle tissues while others develop on green tissues (Stone 1997b). Sometimes conidiomata of the anamorphs (asexual stages) of certain needlecast fungi are produced prior to and/or coincident with, and sometimes more abundantly than the hysterothecia (Fig. 2). The so-called "conidia" of most needlecast fungi (belonging to the Deuteromycete form-genus *Leptostroma* for most species of *Lophodermium;* Minter1981) apparently serve only spermatial or male gamete functions in the life cycles of the organisms (Merrill 1990; Minter 1981; Sinclair *et al.*

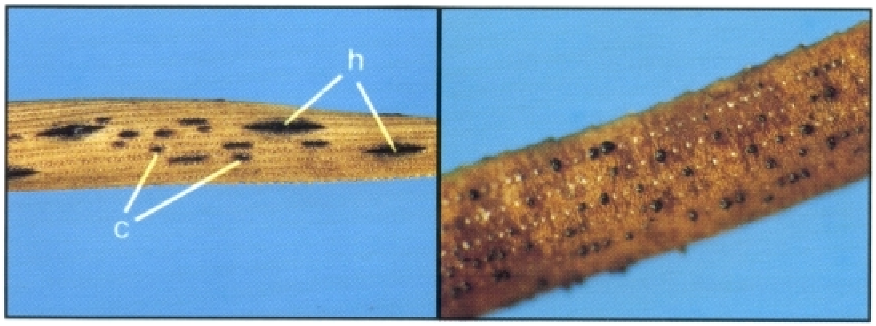

Fig. 2. Fructifications of needlecast fungi on necrotic pine needles. A) Hysterothecia (h) and conidiomata (c) typical of members of the Rhytismataceae family. B) Conidiomata of *Rhizosphaera kalkhoffii* Bubak (Deuteromycetes, Coelomycetes) emerging from stomatal pores. This fungus, a pathogen of *Picea* spp. and other conifers (Diamandis and Minter 1980), is often seen on necrotic pine needles in Florida, but its role remains uncertain. (Photography credit: Jeff Lotz, DPI Photo File 90006 and 90031)

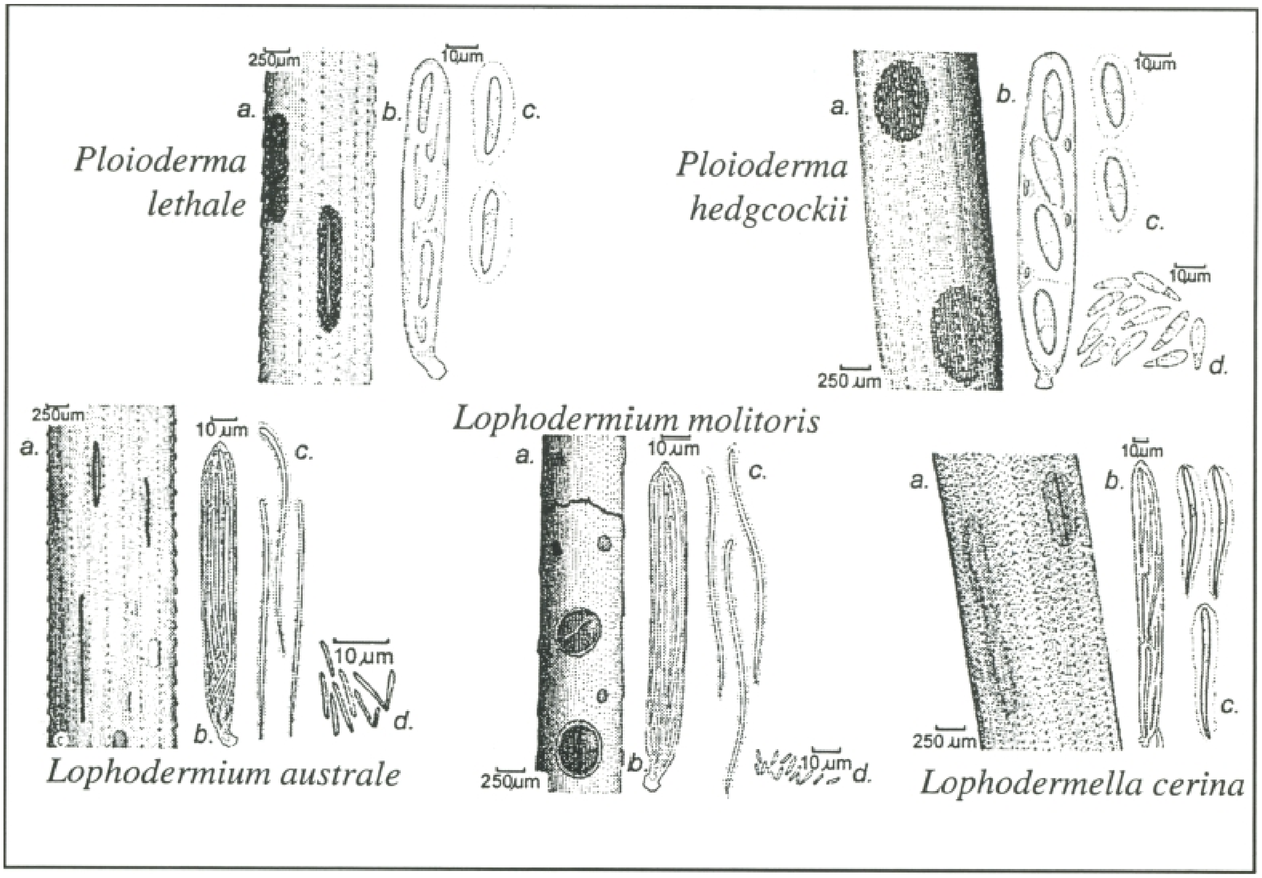

Fig. 3. Key identifying characteristics of needlecast fungi common on pines in Florida. a) Ascomata (hysterothecia) on infected needles; both ascomata and conidiomata shown for *L. australe.* b) Asci containing ascospores. c) Ascospores with characteristic gelatinous sheaths. d) Conidia. (Line drawings reproduced with permission of Dr. David Minter, CABI Bioscience, Egham, Surrey, UK.)

1987; Stone 1997a), while ascospores provide the inoculum for new infections. Ascospores are forcibly discharged through medial slits in sufficiently hydrated and mature ascomata at times related to the particular phenologies of the pathogens (which can be coincident with or following peak symptom expression and, in some cases, not until after infected needles are "cast"). New infections are apparently aided by sticky, gelatinous or mucoid ascospore sheaths (Fig. 3) which presumably facilitate adhesion of the airborne propagules to host needle tissues (Boyce 1961; Minter 1981; Sinclair *et al.* 1987).

SYMPTOMS: Needlecast infections are usually initiated on young current-year needles, but definitive symptoms of infection are not evident until the following winter or spring. Early symptoms may include subtle yellow to red-brown to grayish spots, bands, or mottling on otherwise green tissues. More characteristically, however, needlecast infections are recognized by the seasonal occurrence (below) of red-brown foliage giving infected trees a "fire-scorched" appearance (Fig. 1). Infections result in the death of all or sometimes only the distal portions of infected needles which are then prematurely "cast", sometimes leaving new current-year foliage tufted at branch ends (Boyce 1954; Kraus and Hunt 1971; Sinclair *et al.* 1987).

OCCURRENCE: In general, needlecasts are late winter-early spring events in Florida. However, depending upon the year, local environmental conditions, the host pines, and the particular fungal pathogen(s), the distribution, severity, and timing of needlecast symptoms will vary. For example, Boyce (1954) described symptoms caused by *Ploioderma lethale (=Hypoderma lethale* Dearn.) in the South as most prevalent in late winter or early spring prior to new needle development. Sinclair *et al.* (1987) discuss symptoms caused by *Lophodermium* spp. as most conspicuous in April and May. Others (Czabator *et al.* 1971; Snow 1986; 1990) have noted that a needlecast of slash pine *(Pinus elliottii* Engelm.) caused by *L. cerina,* perhaps in concert with P. *lethale* and P. *hedgcockii*, hard freezes, and possibly air pollutants, occurred in early December. We have observed needlecast-like symptoms on young loblolly pines *(P. taeda* L.) in November and on Christmas trees *[P. clausa* (Chapm.) Vasey, and P. *virginiana* Mill.] during the summer growing season. Observations suggest that needlecast symptoms in southern Florida may typically precede those in the northern portions of the state. It is not uncommon for severely infected trees to occur in close proximity to disease-free trees (Fig. 1).

IMPACT: While hard data regarding the biological or economic impact of needlecasts on pines are scarce, the visual impact in Florida can be impressive (Fig. 1). Needlecasts rarely, if ever, result in tree mortality. However, reduced growth of trees following severe needlecast infections has long been presumed (Boyce 1958; Boyce 1961), and limited data appear to support the presumption (Van Deusen and Snow 1991). There is no reason to assume that needlecast infections would impact trees much differently than crown scorch from wildfires or prescribed bums, i.e., reduced diameter growth resulting from severe needle damage or loss (Chambers *et al.* 1986; Johansen and Wade 1987; Lilieholm and Shih-Chang Hu 1987). We have monitored growth of young (3 to 6-year-old) loblolly pine in one northern Florida plantation and recorded an apparent inverse relationship between tree growth and severity of needlecast-like symptoms (unpublished). Boyce (1958) speculated that severe cases of needlecasts could predispose trees to attack by bark beetles. The impact of severe needlecast epidemics in Christmas tree plantations is obvious (Fig. 1) and at times catastrophic. Remote sensing techniques may prove useful in enhancing future evaluations of disease occurrence, distribution, and impact (Carter *et al.* 1996).

CONTROL: Sophisticated fungicidal control programs have been developed for certain needlecast diseases (Nichols and Skilling 1974), and the University of Florida - Cooperative Extension Service's Plant Disease Management Guide (Simone *et al.* 1998) lists fungicides registered for control of certain needlecasts in Florida. However, limitations with respect to treatment efficacies and cost-effectiveness may be anticipated due to deficiencies in our understanding of specific details regarding needlecast etiology and epidemiology in the state. The use of chemicals in forest or shade tree settings is likely cost-prohibitive and perhaps environmentally unsound. Forest managers interested in promoting wood production in managed plantations may have an "ace-in-the-hole" through genetic selection and tree improvement programs since susceptibility/resistance to needlecasts is apparently highly heritable (Kraus and Hunt 1971).

SURVEY AND DETECTION: Look for red-brown to grayish-colored foliage, often appearing in the late winter or spring, giving pines a "fire-scorched" appearance (Fig. 1). In many cases, only distal portions of infected needles become necrotic while needle bases remain green. Occurrence of typical ascomata and/or conidiomata on dead needle tissues (Fig. 2) may provide helpful confirmation.

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