

Insects and Diseases of Longleaf Pine in the Context of Longleaf Ecosystem Restoration

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Abstract

Restoration and management of the longleaf pine (*P. palustris*) ecosystem are important forestry issues in the southeastern coastal plain of the United States. When compared to loblolly, shortleaf and slash pines (*P. taeda*, *P. echinata*, and *P. elliottii*), longleaf pine is generally regarded as resistant to the “poster children” of southern forest pest management, i.e., the southern pine beetle (*Dendroctonus frontalis*) and fusiform rust (caused by *Cronartium quercuum* f. sp. *fusiforme*). Consequently, and partially due to staffing and funding realities, little attention has been given to damaging pests of longleaf pine in recent years. This paper reviews historical elements of longleaf pine/pest interactions and considers what those interactions might look like in a “restored” longleaf pine ecosystem context. Focus will be given to pests of longleaf pine, especially fusiform rust, in an ecosystem considerably different from that of the species’ past and opportunities to minimize potential impacts.

Keywords: pest management, fusiform rust, disease resistance, longleaf pine, tree improvement/genetics

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The presettlement range of longleaf pine (*Pinus palustris* Mill.) in the southern United States has been estimated at some 37 million hectares; 23 million hectares of which were dominated by the species. Today, as a result of historical land use, resource exploitation and forest practices the remnant of this once vast forest ecosystem occupies little more than perhaps an estimated 1 million hectares, c. 2.2% of the original (Frost 2006, Jose *et al.* 2006). For more than a decade now restoration of the longleaf pine ecosystem has been a key focus of state and federal conservation agencies, environmental groups, private landowners and others (Brockway *et al.* 2005, Gjerstad and Johnson 2002, MacMahon *et al.* 1998, Center for Longleaf Pine Ecosystems 2009, The Longleaf Alliance 2009). This emphasis has resulted in an impressive increase in longleaf pine seedling production (nearly 1 billion seedlings since 1996) with a major shift from bare root to containerized seedlings (c. 50% of total in 1996 to nearly 90% in 2008) (Mark Hains, Auburn University/Longleaf Alliance – personal communication) and a possible increase of 228,000 acres in longleaf pine acreage in the southern U.S. from 1996 to 2005 (U.S. Forest Service FIA data and Dean Gjerstad, Auburn University/Longleaf Alliance – personal communication). These statistics and the expectation that the push to restore longleaf pine ecosystems will continue (Reg. WG for America’s Longleaf 2009) provide an opportunity to take a proactive look at insect pests and diseases that could be issues in the restoration process and/or a “restored” ecosystem. In this paper we reflect on historical understandings of longleaf pine-pest interactions and consider interactions that could be issues in the future.

Historical Reflections

Longleaf pine has long been touted as resistant to many insects and diseases often problematic on other southern pine species (Barnett and Dennington 1992, Boyer 1990, Croker 1987, Hepting 1971, Maple 1977, Marcus 2009). For example, Hepting (1971) states that longleaf pine’s “high resistance to fire and fusiform rust have resulted in its surviving in the unmanaged forests of the past over large areas of the South where other pine species could not.” He further states “longleaf pine is so resistant to fusiform rust that this disease, destructive to loblolly and slash, is seldom a problem on longleaf either in the nursery or in the field.” Others have referred to longleaf pine’s “natural resistance to most insects and diseases” (Maple 1977) or stated 1) “it is highly resistant to ... tip moth, southern pine beetle, fusiform rust, *Fomes annosus* root rot, and most other diseases except brownspot” (Croker 1990) or 2) it is “resistant to, or at least tolerant of, all insects and diseases that are of major importance to other southern pines” (Snow *et al.* 1990). Indeed, Snow *et al.* (1990) suggested that “longleaf’s ‘immunity’ to tip moth attack may reflect an evolutionary adaption.” While there is a certain amount of evidence for such characterizations (Anderson and Walkinshaw 1986, Barnard and Van Loan 2003, Cordell – unpublished data via personal communication, Powers 1975, Snow *et al.* 1990), resistance is a relative variable that is influenced by environmental factors and may be unstable as new host genotypes appear, environmental conditions change, and insect pests and pathogens develop new strains or varieties over time (Duvick 1999).

Reality

Despite longleaf pine’s reputation as “resistant to most (if not all) common insects and diseases of southern pines” (often translated in field management situations as, “It doesn’t get _____.”), there are important observations and clarifying data. Boyer (1990) acknowledged

occasional problems with pitch canker (caused by *Fusarium circinatum* Nirenburg and O'Donnell) (Figure 1), annosum root disease caused by *Heterobasidion annosum* [Fr.:Fr]

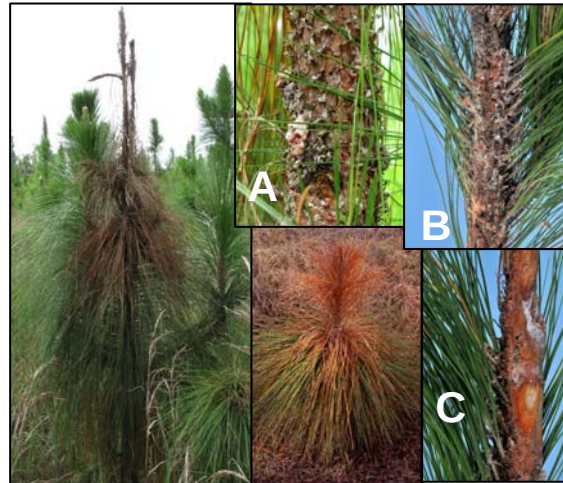


Figure 1. Longleaf pine shoot mortality associated with pitch canker and southern pine coneworm damage. A) Pitch mass typical of southern pine coneworm attack on main stem. B) External resinosus typical of pitch cankers. C) Internal pitch-soaking of xylem and possible coneworm gallery. (Photo credits – Greg Staten and Jeff Lotz)

Bref.) and southern cone rust (caused by *Cronartium strobilinum* [Arth.] Hedge & Hahn). He further noted that longleaf pine seedlings are vulnerable to pales weevil (*Hylobius pales* [Herbst]) and that injured or stressed longleaf pines are attacked by a variety of bark beetles. Doggett and Smith (1992) observed heavy mortality in longleaf pine seedlings due to tap root injury by pales weevils. Cram (1994) reported significant mortality in thinned longleaf stands associated with root pathogenic fungi, including *H. annosum* and Fraedrich and Dwinell (1997) demonstrated significant longleaf seed and nursery seedling issues attributable to the pitch canker pathogen. Additional seedling diseases capable of inducing serious losses in longleaf pine seedling crops (both bare root and containerized) include *Rhizoctonia* needle blight (English and Barnard 1989, English *et al.* 1986 – Figure 2) and *Calonectria* (anamorph *Cylindrocladium*) blight (Barnard 1997 – Figure 3).

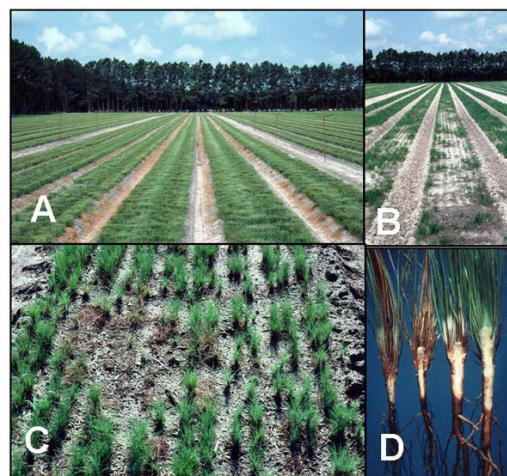


Figure 2. *Rhizoctonia* needle blight of longleaf pine. A) Desired crop. B) Heavily damaged seedbeds. C) Developing infection locus. D) Infected and healthy seedlings.

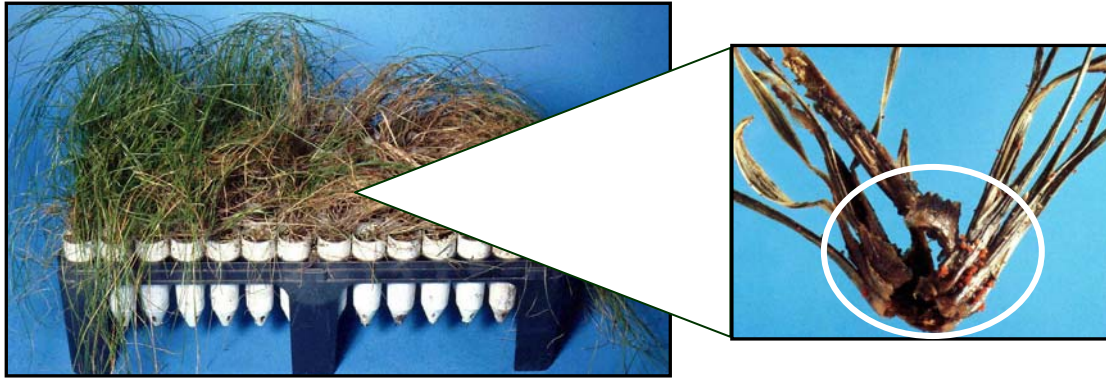


Figure 3. Impact of *Calonectria kyotensis* (anamorph *Cylindrocladium floridanum*) on containerized longleaf pine seedlings in a South Florida nursery. Callout shows perithecia of *C. kyotensis* at base of infected seedling (circled).

The redheaded pine sawfly (*Neodiprion lecontei* [Fitch]) (Figure 4), a common defoliator of hard pines (Wilson et al. 1992) occasionally causes defoliation heavy enough to result in



Figure 4. A longleaf pine stand heavily defoliated by the redheaded pine sawfly (*Neodiprion lecontei*) (larva in inset).

substantial longleaf mortality (particularly of young trees) on areas ranging from small patches to large acreages (Huber *et al.* 1984, Ghent and Hinchey 1996). Longleaf pine is also susceptible to a number of seed and cone insect, including cone feeding midges (Diptera: Cecidomyiidae), seedworms (*Laspeyresia ingens* Heinrich), seedbugs (*Leptoglossus corculus* [Say]) and various coneworm species (*Dioryctria* spp.) (Ebel *et al.* 1980). The southern pine coneworm (*Dioryctria amatella* [Hulst]) can infest elongating shoots of young longleaf pine resulting in terminal dieback (Meeker 1999, see Figure 1), and the Nantucket pine tip moth (*Rhyacionia frustrana* [Comstock]) and a closely related species (the subtropical pine tip moth, *Rhyacionia subtropica* Miller) (Figure 5) do occur on longleaf (McGraw 1975, Doggett *et al.* 1994, Asaro *et al.* 2003).



Figure 5. Damage to terminal shoots of young longleaf pine by subtropical pine tip moth (*Rhyacionia subtropica*).

Among the biggest “reality checks” with respect to longleaf pine’s long understood resistance to disease is its actual susceptibility to fusiform rust (caused by *Cronartium quercuum* [Berk.] Miyabe ex Shirai f. sp. *fusiforme* [Hedgc. & N. Hunt] Burdsall & G. Snow) (Figure 6).

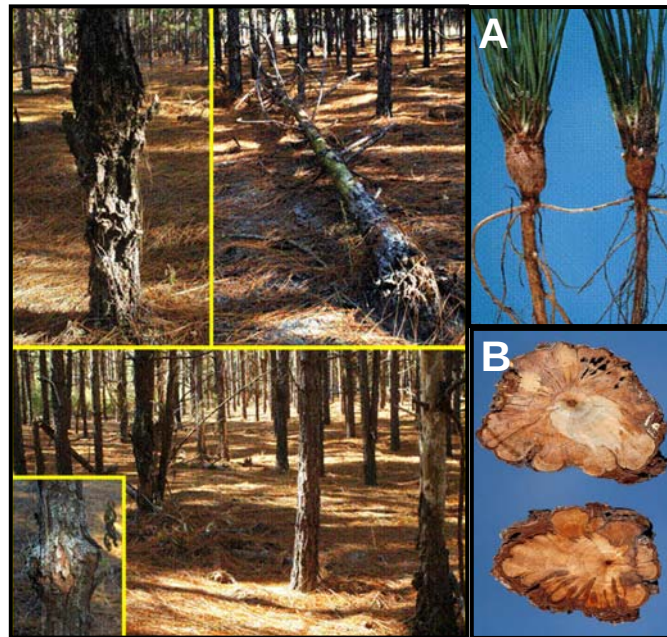


Figure 6. Fusiform rust on longleaf pine. Typical stem galls and impacts on plantation trees (collection at left). Galls on nursery seedlings (A) and cross sections of basal galls from 10-year-old trees possibly resulting from nursery infections (B).

Walkinshaw and Barnett (1992) reported significant rust infection in longleaf pines in Mississippi, Florida, Georgia, and Louisiana; $\geq 67\%$ stem galls at one Florida site. They further reported artificially infecting 34-52% of young longleaf pines in a study of seedlots from Louisiana and Texas. In at least one Georgia planting they observed 80% infection. Anderson and Walkinshaw (1985) reported incidence of rust infections ranging from 16-38% in artificially inoculated longleaf seedlings from various seedlots. A recent survey of 78 longleaf plantations in Florida revealed stem rust infections in ten plantations ranging from 10-30%. In three plantations stem infections exceeded 30% (Barnard and Van Loan 2003). And more recently, a west Florida landowner sustained substantial losses of 10-year-old longleaf pines to what may very well have been nursery-initiated infections, which are known to occur (Barnard – unpublished, see Figure 6).

The Future

While occasional problems may not concern some, it is prudent for foresters, nurserymen, and other natural resource managers to be aware of longleaf pine’s vulnerability to various insects and pathogens. The “occasional” problem is not inconsequential if your trees or seedling crops are among those affected. Preventive and integrated approaches to minimize damage/loss are available and should be implemented as needed. For example, losses to *Rhizoctonia* spp. in bare root nurseries can be minimized by sowing seed in the fall as opposed to spring, carefully managing seedbed mulching regimes, and possibly the judicious use of

fungicides (English and Barnard 1989, Gilly *et al.* 1985). *Calonectria/Cylindrocladium* blight can likely be prevented by careful management of irrigation and seedling spacing in containerized nurseries (Barnard 1997). Brown spot needle blight (caused by *Mycosphaerella dearnessii* Barr) can be controlled with fungicides (in nurseries and newly established plantings), genetics, and prescribed fire (Kais 1989, Snow *et al.* 1990, Snyder *et al.* 1977). When regenerating cutover pine stands with longleaf, pales weevil damage can be prevented by waiting one year beyond the harvest before planting new seedlings, or by planting insecticide-treated seedlings (Nord *et al.* 1982). Although sawfly activity can be difficult to predict or anticipate, management strategies for minimizing sawfly damage include establishing stands on sites appropriate for longleaf, reducing competing vegetation, promoting ecologically diverse stands, scouting for life stages on the foliage in the early spring, and appropriately-timed application of insecticides (Wilson *et al.* 1992).

Perhaps it is with respect to fusiform rust that the greatest opportunities lie. Current nursery practices in the South do not include fungicide programs for prevention of fusiform rust in longleaf pines (S. Enebak@Auburn University's Southern Forest Nursery Management Cooperative), likely a function of longleaf's reputed resistance to the disease. Nonetheless, nursery infections could be problematic carry-over issues (above, Figure 2). Many (Schmidtling and White 1990, Snow *et al.* 1990, Snyder *et al.* 1977, Snyder and Namkoong 1978, Wells and Wakeley 1970) have alluded to useful genetic variability within longleaf pine, in particular with respect to fusiform rust resistance. Such variability has been experimentally validated (Anderson and Walkinshaw 1986), but in practice it is not exploited. In light of the observed and reported rust infection levels mentioned above, several questions arise. Would it not be prudent to expand resistance screening within longleaf pine, if not for the identification of the "perfectly resistant genotype," then at least to identify highly susceptible seed sources which then could be culled from operational deployment? Why, if we have options, would we willingly deploy seedlots or genotypes we know to be highly susceptible?

Further, are we returning longleaf pine to the ecosystem from which it came? For example, U.S. Forest Service FIA (Forest Inventory and Analysis) data show some interesting changes in oak populations across much of longleaf pine's original range. In particular, and presumably a function of resource management practices including fire suppression, the data reflect a major and recent increase in populations of water oak (*Quercus nigra* L.) (Table 1). This could be a significant ecosystem change as water oak is perhaps the most important alternate host in the heteroecious life cycle of the fusiform rust pathogen (Schmidt 1998, Squillace and Wilhite 1977). Furthermore, could the establishment of even-aged, traditional-density, monoculture plantations of longleaf pine over greater and greater acreages result in a greater incidence of pests (e.g. sawflies, tip moths) than has been observed historically in a more "natural" longleaf ecosystem?

Table 1. Changes in oak populations in southeastern coastal plain states

State	Interval	% Change		Q. Nigra/Total Oks (%)	
		Quercus Spp.	Q. Nigra	State	End
Alabama	1972-2008	-7.3%	94.2%	19.5%	40.8%
Florida	1980-2007	-10.9%	24.2%	15.3%	21.3%
Georgia	1972-2008	6.5%	73.6%	26.3%	42.9%
Louisiana	1974-2005	-3.2%	131.0%	18.9%	45.1%
Mississippi	1977-2006	-2.8%	115.6%	20.8%	46.2%
North Carolina	1984-2006	-23.7%	24.6%	15.6%	25.5%
South Carolina	1986-2007	7.2%	59.9%	29.0%	43.0%
Texas	1975-2008	-1.2%	160.0%	13.7%	36.0%

From: FIA Data supplied by Jeff Turner. U.S. Forest Service

Given the foregoing and the existence of the U.S. Forest Service's Resistance screening Center in Asheville, NC, we think it expedient to initiate region-wide screening and cataloguing of longleaf pine seed sources for genetic resistance/susceptibility to fusiform rust. The technology and protocols exist and the necessary inputs are not exorbitant. Indeed, should such a region-wide initiative take hold, screening for resistance to the pitch canker pathogen might very well be incorporated into a more comprehensive effort. Development of even a rudimentary database of resistance vs. susceptible seed sources could result in an improved deployment strategy for seeds and seedlings and minimize management setbacks for landowners and resource managers.

In closing, we suggest that potential pest problems of longleaf pine be given proper consideration as the thrust toward longleaf restoration unfolds. Longleaf pine is not "immune" to many of the pests that have been considered non-issues in its management. As we strive to increase the acreage of longleaf within stand, forest, and ecosystem contexts that may differ substantially from those of the pre-settlement forest, we should be ready for the possibility that some insects and diseases may respond in new ways or with greater prominence.

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