A FOREST TENT CATERPILLAR OUTBREAK IN THE MISSISSIPPI DELTA: HOST PREFERENCE AND GROWTH EFFECTS[1]

T.D. Leininger and J.D. Solomon[2]

Abstract-An outbreak of forest tent caterpillars (FTC) began in spring, 1989 and lasted three years. This is the first recorded epidemic of FTC in the Mississippi Delta. Species fed upon and defoliated, or nearly defoliated, include: willow oak, water oak, nuttall oak, overcup oak, green ash, and sweetgum. Water hickory, and sugarberry were not fed upon. Tree crowns recovered to near normal condition by the end of each *growing season* during the epidemic, and showed few effects of defoliation at Delta National Forest (DNF) and Delta Experimental Forest. Slight growth decreases in nuttall, willow, and water oaks occurred during the outbreak at the DNF.

INTRODUCTION

A forest tent caterpillar, ***Malacosoma disstria* Hübner,** infestation began in the **Delta National** Forest, near Rolling Fork, MS in the spring of 1989. It became an epidemic in 1990 and spread to surrounding **areas** in the Mississippi Delta (MD), including the Delta Experimental Forest (DEF), near Stoneville, MS, where the infestation was less intense than that on the DNF. Solomon estimated that about 30,000 acres were completely defoliated in the DNF in 1990 (Layton 1991). Following the 1991 growing season, in which defoliation was lighter in some areas, but heavier in others, the population collapsed. This is the first recorded epidemic of the FTC in the MD.

The FTC is a well known hardwood defoliator in other parts of the country where epidemics are either more or less continuous (flooded tupelo stands in Louisiana and Alabama) or cyclic and predictable (northern and eastern states) with epidemics occurring at 6 to 16 year intervals (**Batzer** and Morris 1978, **Ciesla** and Drake 1969). Tree species infested in mixed deciduous stands in south Louisiana include: sweetgum, *Liquidambar* ***styraciflua*** L.; tupelo gum, Nyssa ***aquatica*** L.; swamp blackgum, Nyssa ***sylvatica*** var. biiora (Walt.) Sarg.; black willow, ***Salix*** nigra Marsh; water oak, Quercus *nigra* L.; willow oak, Quercus ***phellos*** L.; cherrybark oak, *Quercus* ***falcata*** var. pagodaefolia **Ell.;** swamp chestnut oak, ***Quercus*** *michauxii Nut;* and pecan ***Carya*** spp. (Oliver 1964).

The effects of insect defoliation on tree health have been reported for upland forests in the North and East (Kulman 1971, **Wargo 1981),** but are poorly documented for species on bottomland sites **in the South. The** DNF and DEF are bottomland hardwood forests subject to seasonal flooding during winter and spring. In studies by Crow and Hicks (1990) of upland oaks and other species in an Appalachian forest of West Virginia, mortality, after **1, 2,** and 3 consecutive years of defoliation, averaged 27, 37, and 33 percent, respectively. Basal area of aspen in Minnesota was reduced **an** average 58 percent in a three year period including two years of heavy defoliation and a year of recovery (Duncan and **Hodson** 1958). In bottomland gums in the South, heavy defoliation can cause considerable **dieback** and **mortality,** and can cause severe loss of annual growth (USDA 1985). Heavy defoliation to sugar maple orchards in the Northeast can severely weaken trees and reduce the amount and **quality** of sap (USDA 1985). Efforts to document the effects of insect defoliation on tree health often **utilize** an analysis of annual growth rings (Swetnam **et al**. 1985, Swetnam and Lynch 1993).

Changes in climate may adversely affect tree health and favor pest populations (Anderson 1990, Wagner **1990),** and insect outbreaks may be provoked by climatic events such as drought (Mattson and **Haack** 1987 **a,b)**. Since there is no history of an FTC epidemic in the MD the question arises, "did changes in climate **and/or** other conditions trigger the epidemic"? **It** was not possible to answer that question with this study, but it was possible to examine FTC host preferences, as well as crown recovery and growth effects of southern bottomland oaks and associated species following FTC defoliation **in the MD. Determining the role of climate change in FTC outbreaks, even by simple correlation, would require subsequent epidemics.**

[1]Paper presented at the Eighth Biennial Southern Silvicuitural Research Conference, Auburn, AL, Nov. l-3, 1994.

[2]Project Leader and Research Entomologist (retired), respectively, Southern Forest Experiment Station, U.S. Department of Agriculture, Forest Service, Stoneville, MS.

EXPERIMENTAL APPROACH

Crown Health

In June 1990, the percentage of tree crowns defoliated by the FTC was estimated for 18 trees of 8 species at the DNF. Species selected were: sweetgum; green ash, *Fraxinus pennsylvanica* Marsh.; water oak; overcup oak, *Quercus lyrata* Walt.; willow oak; nuttall oak, Quercus nuttallii Palmer; water hickory, *Carya aquatica* (Michx f.) Nutt.; and sugarberry, *Celtis laevigata* Willd. Sample trees were growing in compartments 2, 3, 8 and 17 in the northern one third of the DNF. The following June, on the DEF, percent defoliation by FTC was estimated for 18 trees of the same species, except for water oak of which 4 trees were sampled. Trees were growing in compartments 69, 70, 81, and 82 of the DEF. Differences in defoliation between species were determined by performing a one-way analysis of variance test on the arcsine-transformed percent defoliation values. Crown condition (volume of healthy crown as percent of total crown volume) and sparseness indices (amount of foliage area as a percent of normal foliage area) were estimated at the DNF in mid September 1990, early October 1991, mid September 1992, and early October 1993; and were estimated at the DEF in mid September 1991, early November 1992, and mid October 1993. Crown condition and sparseness indices were compared between species for each separate year for the two forests by analyzing arcsine transformations of recorded percentages using one-way analysis of variance.

Tree Growth

Increments cores were taken from each tree on the DEF in May 1994, and from each tree on the DNF in August 1994. Cores were taken early at the DEF due to an February 1994 ice storm which broke tops out of most trees and introduced another variable. Growth was measured using a dendrochronograph (Fred Henson Co., Mission Viejo, Ca). Growth, as radial growth, and basal area increment (BAI), prior to the outbreak (1969 to 1988) was compared to growth during (1989 to 1991) and after (1992 to 1994) the outbreak using analysis of covariance, with average annual precipitation as the covariate. The covariate was applied across the three treatment periods without regard to treatment, and was applied within individual treatment periods in an effort to detect interactions between growth and precipitation within individual treatment periods. Measuring annual growth of sweetgum (even when cores were stained) proved too difficult because growth rings are diiuse porous.

RESULTS AND DISCUSSION

Crown Defoliation

Average defoliation as estimated for each species at the DNF in June 1990 was as follows: sweetgum, 100 percent; green ash, 98 percent; water oak, 97 percent; willow oak, 94 percent; overcup oak, 92 percent; nuttall oak, 88 percent; water hickory, 9 percent; and sugarberry, 1 percent. Percent defoliation for water hickory and sugarberry are significantly different ($p=0.05$) from those of the other six species. Average defoliation as estimated for each species at the DEF in June 1991 were as follows: overcup oak, 94 percent; sweetgum, 91 percent; nuttall oak, 83 percent; green ash, 78 percent; willow oak, 76 percent; water hickory, 0 percent; and sugarberry, 0 percent Percent defoliation for water hickory and sugarberry are significantly different ($p=0.05$) from those of the other five species. Clearly, water hickory and sugarberry are not preferred by the FTC. Red maple, *Acer rubrum* L., and boxelder, *Acernegundo* L., (not part of the study) were present in the stands but were not fed upon by the caterpillars.

Crown Recovery

Crown condition (Figure 1) values for DNF at the end of the 1990 and 1991 growing seasons, the second and third years of the epidemic, are similar to each other and are similar to those of 1992 and 1993, the years immediately following the epidemic. Sparseness index values follow this same pattern (Figure 2). These findings indicate that crowns recovered to a near normal condition by the end of the growing season following severe defoliation. The fact that crown condition and sparseness index of all species, including the non-host species sugarberry and water hickory, had fairly consistent values and rankings from 1990 to 1993 suggest that FTC feeding had little effect on crown health. In light of these similarities, significant means separations which were intended to detect differences in recovery between species are not particularly meaningful. However, means separations do suggest that crown condition and sparseness index for a given species are somewhat characteristic and repeatable from year to year. Crown condition (Figure 3) data for the DEF indicate a rapid recovery of crown health following the severe defoliation in spring 1991. Crown condition and sparseness index (Figure 4) data for 1992 and 1993 provide additional examples of the range of normal crown health for these species. Recovery of crowns by the end of each growing season is likely due to the fact that FTC feeding occurs before leaves are fully expanded, a condition that would leave trees with some energy reserves for refoliating crowns. Additionally, the long growing season (average Autumn frost date is November 8) in the Mississippi Delta allows trees time to develop crowns and store energy for the next year in spite of severe defoliation in spring.

Mortality

One water oak, two nuttall oaks, and one water hickory died during the study on the DNF, but these deaths appeared to be due to root or bole rot fungi and not

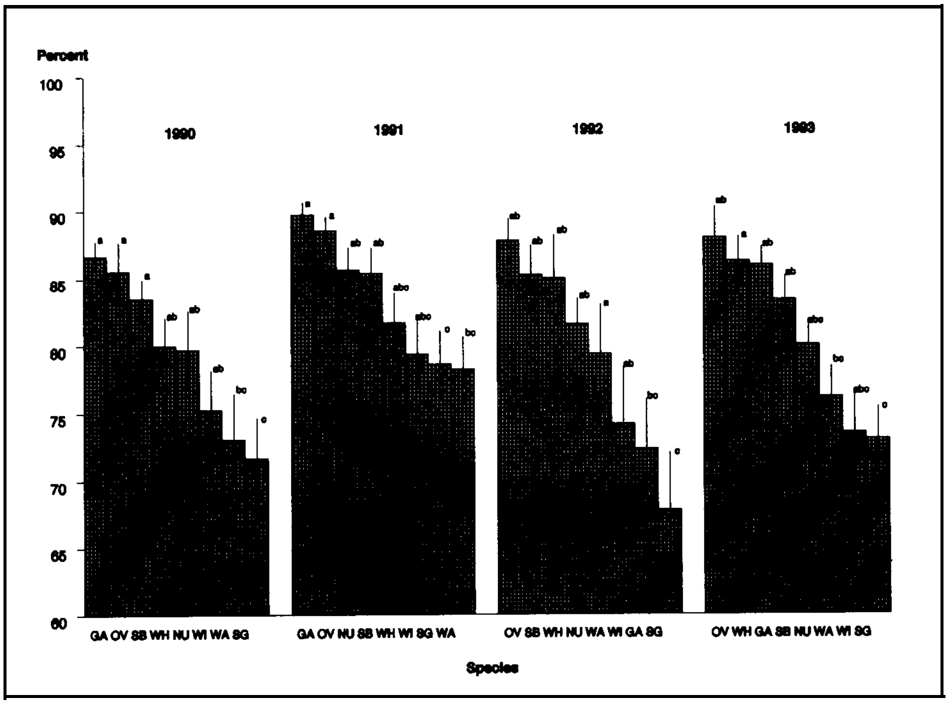

Figure 1- Average percent crown condition of eight species from 1990 to 1993 at the Delta National Forest, near Rolling Fork, Ms. Means separations between species within years, as determined by Duncan's Multiple Range Tests, are indicated by diierent lower case letters. Species codes are as follows: GA= green ash, NU= nuttall oak, OV= overcup oak, SB= sugarberry, SG= sweetgum, WA= water oak, WH= water hickory, WI= willow oak.

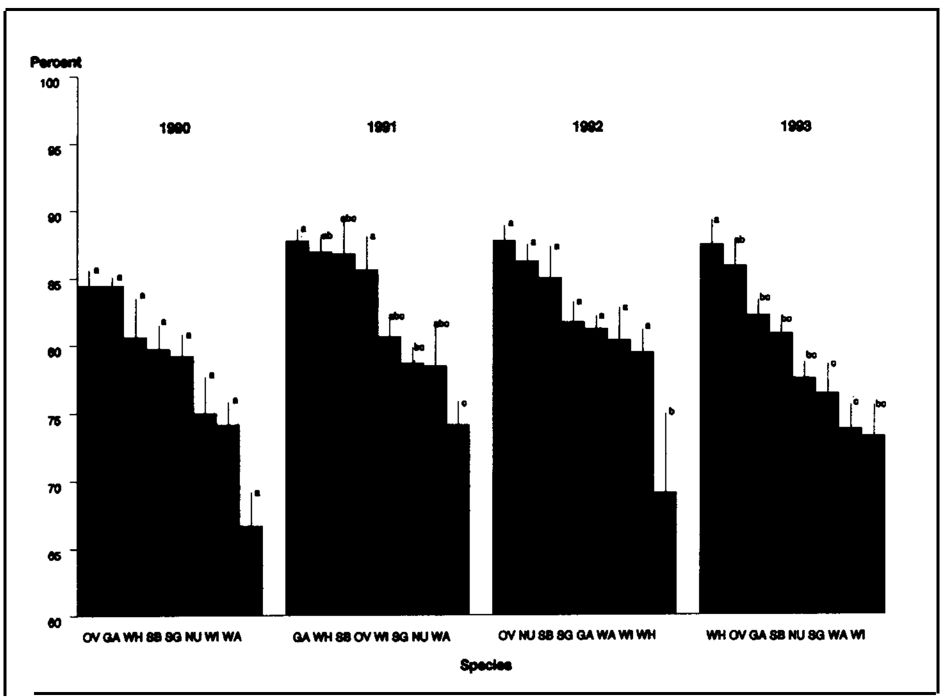

Figure 2– Average percent sparseness index of eight species from 1990 to 1993 at the Delta National Forest, near Rolling Fork, Ms. Means separations between species within years, as determined by Duncan's Multiple Range Tests, are indicated by diierent lower case letters. Species codes are as follows: GA= green ash, NU= nuttall oak, OV= overcup oak, SB= sugarberry, SG= sweetgum, WA= water oak, WH= water hickory, WI= willow oak.

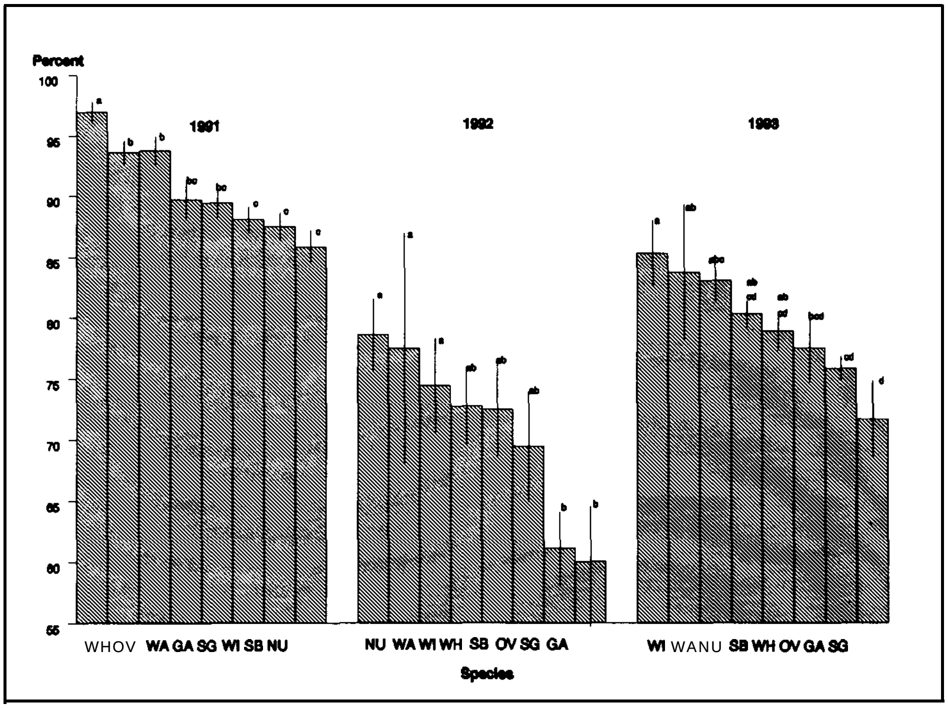

Figure 3-- Average percent crown condition of eight species from 1991 to 1993 at the Delta Experimental Forest, near Stoneville, Ms. Means separations between species within years, as determined by Duncan's Multiple Range Tests, are indicated by different lower case letters. Species codes are as follows: GA= green ash, NU= nuttall oak, OV= overcup oak, SB= sugarberry, SG= sweetgum, WA= water oak, WH= water hickory, WI= willow oak.

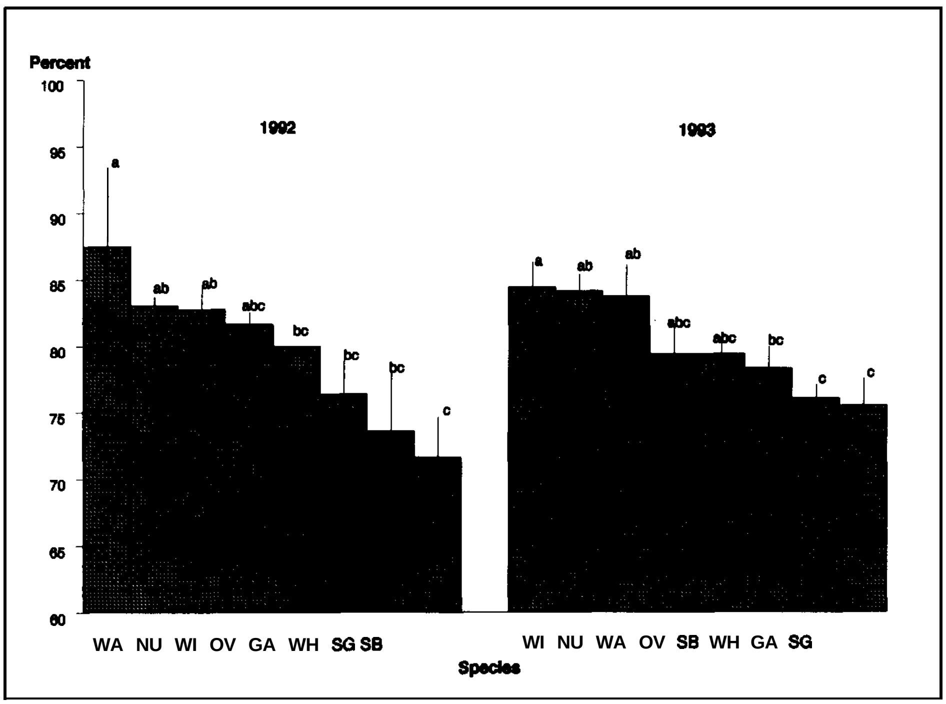

Figure 4-- Average percent sparseness index of eight species from 1991 to 1993 at the Delta Experimental Forest, near Stoneville, Ms. Means separations between species within years, as determined by Duncan's Multiple Range Tests, are indicated by diiierent lower case letters. Species codes are as follows: GA= green ash, NU= nuttall oak, OV= overcup oak, SB= sugarberry, SG= sweetgum, WA= water oak, WH= water hickory, WI= willow oak.

due to FTC feeding. One sugarberry died as a result of the February 1994 ice storm on the DEF.

Growth Effects

Average annual BAI and average annual ring width of **nuttall** oak were less **(p=0.05)** during the epidemic than before and after the epidemic (Table 1) indicating a temporary decline in growth due to FTC feeding. Average annual BAI and average annual ring width of willow oak and water oak were less **(p=0.05)** during the epidemic than before the epidemic, and tended to increase after the epidemic. Precipitation interacted **(p=0.01)** with treatments for water oak **BAI.** Increased growth of **overcup** oak during the post-epidemic period compared to the previous periods is not consistent with FTC feeding. **Other** biotic or environmental factors are likely responsible for **differences** in growth across treatments of the non-host species, sugarberry and water hickory. None of the differences in growth between treatments for any species of the DEF are consistent with FTC feeding (Table 2); that is, a decrease during the epidemic followed by an increase after the epidemic. **These** results are consistent with the initial assessment that the epidemic had a lesser impact on host trees of the DEF. Precipitation interacted **(p=0.02)** with treatments for **overcup** oak **BAI.**

SUMMARY

This report documents the first known occurrence of a forest tent caterpillar outbreak in the Mississippi Delta beginning in 1989 and ending in 1991 as recorded for two forested sites. There is no history of epidemic cycling in the MD as occurs in many parts of the country. The question arises; have conditions of climate, stand structure or usage, seasonal flooding, or natural enemies changed to a degree that signals future epidemic defoliation cycles?

Sweetgum, green ash, water oak, **overcup** oak, **nuttall** oak, and willow oak are fed upon readily. Sugarberry and water hickory are not fed upon. Crowns of preferred species at both sites recovered rapidly by the end of the growing season from 100 percent, or near 100 percent, defoliation in the spring, and showed no apparent negative **effects** in post-epidemic years. Rapid recovery may be due in part to a long growing season in the Mississippi Delta. **Three** years of FTC feeding (two years, light to moderate and one year, heavy) at DNF resulted in slight reductions in the growth of **nuttall,** willow, and water oaks followed by a recovery after the epidemic. Two years of defoliation at DEF did not result in apparent growth loss.

Table 1. Growth, as average annual basal area increment and average annual ring width, during pm-epidemic, epidemic, and post-epidemic periods for Delta National Forest

	BAI (cm^2)			Rina Width (cm)		
·	Pre	Epi	Post	Pre	Epi	Post
GA	39	44	36	**.32**	**.30**	**.29**
NU	47 **A**[b]	32 B	44A	**.27** A	**.16** C	**.22** B
0 0	41 B	46 B	58A	**.29** B	**.27** B	**.34** A
WI	36 A	24 B	26 B	**.21** A	**.12** B	**.14** B
SB	25 B	30 AB	22A	**.20**	**.21**	**.22**
WH	20	17	17	**.15 A**	**.12** B	**.13 AB**
WA[c]	A7 A	?A **B**	**36** AR	**.32** A	**.21 B**	**.25 B**

[a] Species codes are as follows: GA= green ash, NU= **nuttall** oak, OV= **overcup** oak, SB= sugarberry, SG= sweetgum, WA= water oak, WH= water hickory, WI= willow oak.
[b] Separations of growth variable means by Duncan's multiple range tests for species are indicated by diierent upper-case letters **(p=0.05)**.
[c] The covariate, precipitation, was significant **(p=0.01)** across the three treatments.

Table 2. Growth, as average annual basal area increment and average annual ring width, during pm-epidemic, epidemic, and post-epidemic periods for Delta Experimental Forest

	BAI (cm^2)			Ring Width (cm)		
·	Pre	Epi	Post	Pre	Epi	Post
GA	**10**	10	10	**.18 A**	**.14** B	**.12**
NU	27 **B**[b]	37A	24 B	**.21** A	**.23** A	**.14** B
OO[c]	24 B	34A	**39 A**	**.23**	**.22**	**.26**
WI	31 B	58A	56A	**.26**	**.31**	**.29**
SB	11 B	21 A	20A	**.16**	**.18**	**.16**
WH	12	12	13	**.12**	**.11**	**.12**

[a] Species codes are as follows: GA= green ash, NU= **nuttall** oak, OV= **overcup** oak, SB= sugarberry, SG= sweetgum, WH= water hickory, WI= willow oak.
[b] Separations of growth variable means by Duncan's multiple range tests for species are indicated by different upper-case letters **(p=0.05).**
[c] The covariate, precipitation, was significant **(p=0.02)** across the three treatments.

ACKNOWLEDGEMENTS

The authors thank **Jobe Maynor** and Carey Hammett for their heip in the field and with computer graphics; Don Lester for performing statistical analyses; and Lonnie **Newsome** and Wayne **McDuff** for monitoring crown conditions.

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