IMPACTS OF INSECT DEFOLIATION IN COTTONWOOD PLANTATIONS IN MISSISSIPPI

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Abstract—In spring 2001, a notodontid moth, *Gluphisia septentrionis* Wlkr., defoliated about 2,000 acres of 9- and 10-year-old eastern cottonwood (*Populus deltoides* Bartr.) trees in west-central Mississippi. The farm manager had never seen cottonwood defoliated by that species of moth, because it was not considered a pest in Mississippi. When the trees leafed out again, cottonwood leaf beetles (*Chrysomela scripta* F.) attacked them. In order to avoid two defoliations by mid-season, the manager applied an insecticide. Cottonwood leaf beetles commonly attack young *Populus* but seldom require treatment in trees > 2 years old. However, this defoliation by the *Gluphisia* moth caused a flush of leaves in mid-season when cottonwood leaf beetle populations were high. Cottonwood growth is indeterminate, so the timing of insect defoliations can have a variety of effects on growth and energy storage. In spring 2002, *G. septentrionis* larvae were present in the same stands and again caused defoliation. This paper considers tree mortality and growth after 2 years of defoliation, as well as some associated economic effects.

INTRODUCTION

In mid-May 2001, partial defoliation of eastern cottonwood (*Populus deltoides* Bartr.) trees occurred in 9- and 10-year-old plantations that are part of a 15,000-acre tract in Issaquena County, MS, which is used for recreation and industrial production of cottonwood fiber. Trees were being defoliated from the top down, and after the felling of several trees, many larvae were discovered of the notodontid moth *Gluphisia septentrionis*. Surveys were begun, but within 2 weeks approximately 2,000 acres in the northern part of the tract had been completely defoliated. The farm manager reported she had not seen cottonwood defoliated previously by *Gluphisia* and wanted to know if this was a single event or if there would be successive generations that might require management. *G. septentrionis* was not considered a common pest in Mississippi (Morris and Oliveria 1976, Morris and others 1975); the literature suggested that two generations were possible (Baker 1972). The manager decided to set out a light trap and evaluate the next generation of adults. A few days later, we observed several small wasps ovipositing into large *Gluphisia* larvae. Inspecting a freshly felled tree, we found 14 clusters of pupae of the parasitoid *Eulophus orgyiae* within a few minutes. Would the parasitoid control the next generation of *Gluphisia*? Unfortunately, that question would remain unanswered, because when the trees refoliated that season, cottonwood leaf beetles (*Chrysomela scripta* F.) attacked them, and the manager opted for chemical control rather than suffer two defoliations by mid-season. The cottonwood leaf beetle is a common pest of young *Populus,* but trees > 2 years old seldom require treatment. In this case, we believe the defoliation by *Gluphisia* caused the growth of new, attractive leaves in mid-season, when cottonwood leaf beetle populations were quite high. Although it was not present later in 2001, *G. septentrionis* reappeared in the same stands in May 2002. It again caused nearly complete defoliation of the cottonwoods but did not appear to have spread to neighboring stands. The farm manager did not apply chemical control but accelerated harvest in some of the affected stands as a result of her concerns about increased mortality and loss of growth after 2 years of defoliation.

The common *Gluphisi*a feeds on various poplars, especially trembling aspen (*P. tremuloides* Michx.) (Baker 1972, Wagner and others 1997). Adult moths emerge in June and have a wingspan of about 1.25 inches. The front wings are gray with irregularly shaped beige and dark gray bands; the hind wings are uniformly light gray (Ives and Wong 1988). Mature larvae are about 1.5 inches long, pale green with yellow subdorsal stripes, and have pinkish-to-reddish spots on the back (Baker 1972, Wagner and others 1997). The common *Gluphisia* was reported by Baker (1972) to occur in Southeastern Canada and parts of the Northeastern United States. An Internet search revealed a wider distribution within the continental United States, as reported by the U.S. Geological Survey, Northern Prairie Wildlife Research Center at www.npwrc.usgs.gov/resource/distr/lepid/moths/usa/694.htm. The distribution map at this Web site shows *G. septentrionis* as sporadically distributed from Maine to South Carolina in the East and from Oregon to California in the West, with occurrences in most other States. South Carolina and Louisiana each had confirmed records from one county, Arkansas had reports from two counties, and Mississippi had reports from six counties, including Warren County, which borders Issaquena County to the south. Another Web site listed the common *Gluphisia's* range from Nova Scotia to Florida and west to Texas, and recorded a collection in Georgia (Adams 2002). While Baker's book (1972) focused on insects in forests of the Eastern United States, it appears either that he was unaware of records outside the Northeast, or that the range of *G. septentrionis* has expanded over the last 30 years. Regardless, we undertook the present study to document occurrence of this defoliator on cottonwood trees in Mississippi, and to determine if complete defoliations in

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consecutive years would affect cottonwood growth and mortality.

METHODS

In fall 2002, we selected three stands within the estimated 2,000-acre area affected by *G. septentrionis* defoliations in spring 2001 and 2002. Our intent was to estimate mortality and collect increment cores for the purpose of measuring annual growth. Stands averaging in size from 50 to 80 acres were planted in 1992 or 1993, making them either 9 or 10 years old during the first defoliation in 2001. Cottonwood trees had been planted at 12- by 12-foot spacing. A tree in two stands was completely defoliated in 2001 and 2002, and in one defoliated stand every other row of trees was removed in 2000, resulting in a spacing of 12 by 24 feet. The third stand was not defoliated in either 2001 or 2002. We sampled tree condition (either alive or dead) in each stand by evaluating 50 trees per row in each of 10 rows. Sample rows were systematically selected and equally distributed throughout each stand. A special category of live trees, those with live stems but dead crowns, was counted in all stands. Missing trees were not tallied, but the next standing tree in the row was. As many as five different clones of eastern cottonwood may have been planted in each of the three stands, and different clones would have been randomly mixed throughout each (Personal communication. 2003. Jackie Henne-Kerr, Manager, Vicksburg Procurement, Tembec U.S.A. LLC, Vicksburg, MS 39183). It was impossible to measure the effect of defoliation on different cottonwood clones because they were mixed in the stand. The average number of dead trees and trees with dead stems and live crowns were compared between site types using chi-square tests (Ott 1977).

We measured tree growth on 1 increment core removed from each of 23 trees per stand type using a Swedish increment borer. Sample trees were cored at the same time tree conditions were evaluated. Sample trees were selected systematically so that they were equally distributed throughout each stand. Increment cores were glued into grooves in wooden blocks, and growth-ring surfaces were prepared for measurement by sanding them with progressively finer grain sand paper. Annual increments for each of 9 or 10 years were measured to the nearest 0.001 mm using a dendrochronometer. Annual growth averages were calculated from the cores collected for each stand type, plotted against time, and examined for differences in growth rates. Each tree from which an increment core was removed was measured for total height and diameter at breast height (d.b.h.). Heights were measured to the nearest 0.1 foot with the aid of a digital hypsometer; diameters were measured to the nearest 0.1 inch using a metal diameter tape. T-tests were used to compare average heights and diameters among site types.

RESULTS AND DISCUSSION

About 2,000 acres of cottonwoods had been defoliated by *G. septentrionis* in the spring of 2001 and again in spring 2002. Large numbers of parasitoids, *E. orygiae*, were documented following the *Gluphisia* population in spring 2001. Presumably, they might have controlled the *Gluphisia,* as in standard predator-prey models. The *Gluphisia* defoliation forced the trees to produce new leaves during the summer, which were attractive to the cottonwood leaf beetle (*C. scripta*). Rather than suffer two or more defoliations in one growing season, the manager chose to treat the leaf beetle infestation with an insecticide. Her decision to spray the insecticide followed consideration of the many biological and economic factors involved. The decision to spray probably was not economically sound, although she had an obligation to keep her company's paper mill supplied with wood chips. For a large corporation with a mill, losses due to a pesticide application might be recovered through sales of paper products, but this probably will not be the case for an owner of a small tree farm whose only source of income is the narrow profit margin from selling cut trees, as the following example will show.

There were no economic injury levels or thresholds for treatment to consult for *Gluphisia* in cottonwood plantations. In the South, *Gluphisia* has multiple generations, and the trees were defoliated early in the season. Parasitoids were observed but could not be relied on to suppress the population. The first economic question was, How much does a treatment cost? This plantation included a nursery that was treated with insecticides on a regular basis, so it was determined the trees could be sprayed for $8.00 per acre. The second question was, Is $8.00 per acre economically feasible? To answer that question, the value of the crop had to be considered. Cottonwood is one of the fastest growing hardwood trees in North America. In the South, it is grown for pulp and normally harvested after about 10 years. An excellent yield is 60 tons per acre, and the product sells today for $10.00 per ton. On this site the expected yields were between 35 and 40 tons per acre, or $350 to $400. Plantation establishment and silvicultural practices cost about 50 percent of the harvested value ($175 to $200 per acre), over and above the land or rental cost (Stanturf and Portwood 1999). Eight dollars per acre is 40 percent of the profit for 1 year, but such cost should be considered in terms of the tree growth that will result from the treatment. Although the manager decided to spray before she considered growth and survival, she did evaluate those variables after the second defoliation in spring 2002.

Dead trees occurred at a rate of 7.3 percent in the two stands that were defoliated in 2001 and 2002, while 6.8 percent occurred in the nondefoliated stand (table 1). We could not determine the cause of death for each tree. Trees in both defoliated and nondefoliated stands had been killed or damaged by insects other than *G. septentrionis* or *C. scripta*, namely the poplar borer, *Saperda calcarata*. Chi-square tests showed no differences in the numbers of dead trees, or trees with live stems and dead crowns, between stands that were defoliated or not defoliated. In stands that were defoliated in 2001 and 2002, average height and d.b.h. were significantly greater than in the stand that was not defoliated either year (table 2). While an exhaustive survey and analysis of soil types was not done in the three stands, height and diameter growth of trees generally are known to be strongly influenced by soil texture and concentrations of nutrient elements. Stands that were defoliated presumably had higher growth rates because they were growing on more productive soils. These stands

Table 1—Numbers of live and dead cottonwood trees in samples taken within stands defoliated or not defoliated by *Gluphisia septentrionis* in 2001 and 2002 in Issaquena County, MS

Stand type		Trees		Live trunk/
		Live	Dead	dead crown
	no.			
Not defoliated	500	466	34	3
Defoliated/50% cut	500	456	44	4
Defoliated	499	470	29	6
Total	1,499	1,392	107	13

Table 2—Average heights and diameters at breast height of cottonwood trees in samples taken within stands defoliated or not defoliated by *Gluphisia septentrionis* in 2001 and 2002 in Issaquena County, MS

Stand type		Average	
		Height[a]	Diameter[a]
	no.	*feet*	*inches*
Not defoliated	50	47.1 ± 1.15b	5.6 ± 0.18b
Defoliated/50% cut	50	56.0 ± 0.73a	7.4 ± 0.19a
Defoliated	50	56.9 ± 1.24a	6.8 ± 0.20a

[a] Different lowercase letters indicate results of T-tests ($P = 0.05$) showing differences in average heights and diameters between defoliated and nondefoliated cottonwoods.

all are within 5 to 10 miles of the Mississippi River, and the texture of soils there is highly variable. Figure 1 shows similar patterns of annual growth for the three stands, each of which had rapid growth during the first 5 years (about 8 mm or more per year) and much smaller growth (2 mm or less per year) for each of the last 3 years. Tree growth apparently was not influenced adversely by the *G. septentrionis* defoliation, because in 2001 and 2002 there were few differences in the average annual increments for defoliated and nondefoliated trees.

The similar growth rates indicate that two complete defoliations by *G. septentrionis* did not adversely affect tree physiology enough to reduce cottonwood growth. One reason for this is that *G. septentrionis* defoliated trees early in the growing season, thus allowing the trees sufficient time to produce a second set of leaves and replenish the storage chemicals used to make those leaves. Cottonwood in the Lower Mississippi Alluvial delta typically breaks bud in early April and holds its leaves into late October or early November. Complete defoliation by the common *Gluphisia* had occurred by the end of May in both years, which left at least 5 months per growing season for trees to replenish their carbon stores. In the Delta Experimental Forest near Stoneville, MS, and the Delta National Forest, near Rolling Fork, MS, Leininger and Solomon (1994) found a similar response to 3 years of heavy defoliation by the forest tent caterpillar (*Malacosoma disstria* Hübner) in sweetgum (*Liquidambar styraciflua* L.), green ash (*Fraxinus*

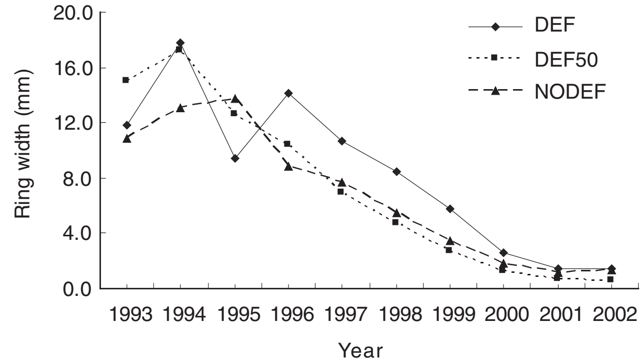

Figure 1—Average ring widths of cottonwood trees collected from stands that were defoliated (DEF) and nondefoliated (NODEF). A second stand with defoliated trees (DEF50) had every other row of trees harvested prior to defoliation. Annual averages are from the cores of 23 trees.

pennsylvanica Marsh.), water oak (*Quercus nigra* L.), overcup oak (*Q. lyrata* Walt.), Nuttall oak (*Q. nuttallii* Palmer), and willow oak (*Q. phellos* L.). While Leininger and Solomon reported small differences in ring widths and basal area indices for Nuttall and water oaks, they concluded that growth rates of all species damaged by the forest tent caterpillar recovered rapidly after an outbreak, and that individual tree crowns had recovered completely by the end of each growing season.

CONCLUSIONS

The farm manager decided to treat cottonwood plantations that had been defoliated by the common *Gluphisia* and the cottonwood leaf beetle during the first year of two consecutive defoliations. Although she chose to spray the affected stands, the presence of neither insect alone warranted treatment, nor was it necessarily economical. During the long Mississippi delta growing season, the cottonwood trees we studied did not suffer increased mortality or growth loss following successive early spring defoliations.

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