INSECT DAMAGE TO OAKS

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ABSTRACT. In terms of mortality caused by insects, defoliators are the most serious enemies of oaks at the present time. An oak leaf tier, *Croesia semipurpurana*, is one of the principal defoliators of trees in the red oak group. Oak leaf rollers, primarily *Archips semiferana*, have been responsible for widespread mortality in white and chestnut oaks. Defoliation by the gypsy moth, *Porthetria dispar*, could become the major insect problem in the Appalachian Region and possibly throughout the Eastern United States. Economically, wood borers may be the most important at present.

INSECTS ARE the most numerous animals living in a forest, and more than a thousand different insect species feed on oaks *(Metcalf and Flint 1962)*. However, we are interested only in those that cause important damage. Only a few groups of insects have a significant impact on the oak resource: the leaf feeders (defoliators, skeletonizers, and miners); the borers (bark, phloem, wood, root, twig, shoot, and acorn borers); the sucking insects; and those insects that cause indirect damage, such as vectors of disease-inducing organisms.

The discussion will center on damage and impact by the most important defoliators and borers affecting the five upland oaks. Present and future needs for control of these insects will be discussed from both a forester's and entomologist's viewpoint.

DEFOLIATORS

In mortality caused by insects, defoliators are the most serious enemies of the oaks at present. An oak leaf tier (*Croesia semipurpurana* [*Kearf*]) is one of the principal defoliators of trees in the red oak group (fig. 1 and fig. 2). It has intensified during the past 10 years and is now one of the primary factors causing mortality or initiating decline in oak stands.

Staley *(1965)* concluded that defoliation by *C. semipurpurana* was the primary causal factor in the decline of red and scarlet oaks in Pennsylvania, Virginia, and West Virginia during the 1950's. This insect has been collected in many states from the East Coast to Texas and Minnesota, and it probably occurs throughout the range of the upland oaks.

Beckwith *(1963)* described its stages and seasonal development in Connecticut. It overwinters in the egg stage on small branches of the host tree. Larvae hatch about mid-April and migrate to expanding buds. They feed on the foliage until late May. Pupation occurs primarily in the litter beneath the trees, and adults can be seen in early June. There is one generation per year.

In areas of Pennsylvania and West Virginia where oak mortality is caused by insect defoliation, *C. semipurpurana* com-

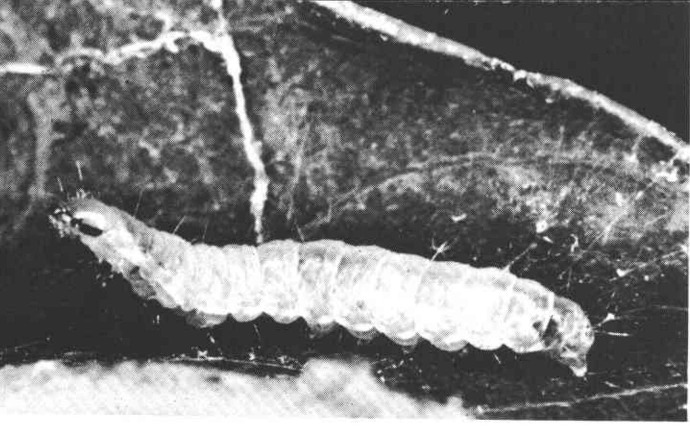

Figure 1.—An oak leaf tier larva *(Croesia semipurpurana)*.

monly causes 60 to 90 percent of the total defoliation. Several species of leaf rollers normally found associated with this oak leaf tier occasionally contribute substantially to defoliation.

Oak leaf rollers, primarily *Archips semiferana* (Wlk.), have been responsible for high mortality of white and chestnut oaks. In 1968-70, *A. semiferana* was responsible for mortality ranging from 5 to 98 percent in oak stands on 175,000 acres in Pennsylvania *(Nichols 1970)*. The oak leaf rollers have life cycles similar to that of the oak leaf tier *C. semipurpurana*. However, leaf roller damage is limited to higher elevations while the oak leaf tier does most of its damage at lower elevations and in river drainages.

The gypsy moth (*Porthetria dispar* L.) could become the major insect problem in the Appalachian Region and possibly throughout the Eastern United States. Oaks

Figure 2.—Larval webbing and feeding by the oak leaf tier.

are among its favored food plants. It has one generation a year, and its life cycle is similar to that of the oak leaf tier. It over-winters as eggs are deposited on almost any object. The larvae hatch in late April and early May and feed on foliage until late June or early July. Adults are present from early July to late August.

About 8,000 acres of oak and other tree species were completely defoliated by the gypsy moth in Pennsylvania in 1970 *(Nichols 1970)*. Estimates are that 1 million acres of forest land in Pennsylvania are infested by the gypsy moth. In New Jersey, in 1968-71, over 1 million oaks were killed on 18,000 acres as a direct result of gypsy moth defoliation *(Kegg 1970)*.

IMPACT OF DEFOLIATION

The effects of defoliation are obvious because the leaves synthesize the food needed by the plant for sustenance and growth. The degree to which an oak is injured depends on the extent of defoliation, the season of year, and the frequency of successive defoliations. Severe defoliation reduces the production of wood, especially when it occurs early in the growing season. Successive annual defoliations cause branch dying and tree mortality.

Results of studies by Nichols *(1968)* on oak mortality in Pennsylvania show the effects of defoliation. He found that 2 consecutive years of 60- to 100-percent spring defoliation caused mortality. Only rarely did mortality result from one heavy stripping preceded by several years of moderate defoliation. Continuous moderate defoliation did not kill trees, but it started their decline. A year of moderate defoliation reduced radial growth by 20 to 30 percent. But 1 year of heavy spring defoliation resulted in a 40- to 70-percent growth reduction.

Widespread mortality of tree species in the red oak group has occurred on nearly 500,000 acres in Pennsylvania and West Virginia since 1953, and sawtimber losses have ranged from 3,000 to 7,000 board feet per acre. Areas of mortality have ranged in size from 30 to 15,000 acres.

W. P. House *(1955)* appraised damage caused by the gypsy moth in New England from 1933 to 1952. He found that, on the average, every acre of oak type reported as 75 or 100 percent defoliated suffered mortality of 19 percent of the volume.

During a 10-year period (1912-21), Baker *(1941)* found that there was 30 percent mortality of oaks where defoliation by gypsy moth averaged 37 percent. Growth increment among oaks 81 to 100 percent defoliated was about half that of normal.

In appraising the effects of defoliation, the secondary barkmining insects are important factors in determining the ultimate damage to the stand.

WOOD BORERS

Although the borers are listed here as the second important group of insects affecting the oaks, economically, they may be the most important. At least 30 species attack living or recently killed oaks in the Appalachians. Perhaps the most important species damaging the upland oaks are the *Goes* borers, the Columbian timber beetle (*Corthylus columbianus* Hopk.), the red oak borer (*Enaphalodes rufulus* [Hald.]), and the carpenterworm (*Prionoxystus robiniae* [Peck]).

The injuries in wood ordinarily are not extensive enough to produce mass symptoms in a forest. Only rarely are there external signs of attack on a tree or log. On individual trees, evidence of insect attack consists of dead areas that become open cavities, small holes, distortions in the bark pattern and cracks exuding sap and extruded wood fibers. Observations normally must be made on split, sawed, or peeled portions of the wood.

IMPACT OF BORERS

Wood-boring insects are responsible for a large portion of the poor-quality timber in our hardwood stands (fig. 3). Direct damage results from their boring and associated stains; indirect damage is done by wood-decaying fungi gaining entrance through the borings. Loss of growth has not been determined, and mortality is rare. Accurate appraisals of damage to the value and quality of lumber and veneer are at present lacking. The insects responsible for the red oak group should be reduced to a minor component of the stand. Red and black oaks should be left in preference to scarlet oak. Depending on other management considerations, clearcutting is probably the best treatment for large areas of mortality, especially where scarlet oak predominates. White pine and white oak should be encouraged.

Silvicultural control also shows promise for reducing future damage by wood borers. Preliminary results of recent studies suggest that modified cutting practices can significantly affect wood borer populations.

THE FUTURE

We should consider not only the problems we face today, but also our needs for the future. We, as forest entomologists, often think of the study of insects in terms of a zoological science and forget that it is a forestry science as well. The ultimate objective of the forest entomologist should be to discover how to prevent insects from causing economic damage to forests. Control prescriptions must be developed for prevention rather than cure.

Too many entomologists have become detached from the problems of forest management. There must be more integration of entomological principles into oak management programs. Management guidelines for our upland oaks should be developed through the cooperative efforts of practicing foresters, research foresters, entomologists, pathologists, and economists.

At present, the full biological and ecological impact of insects on oak forests is not known. When we have an insect outbreak, too often the decision for direct control is based on the abundance of the insect pest that will apparently cause the death of a large volume of timber. But it is not enough to look at the insect and host alone—we must look at the entire forest.

Enlightened insect control, to be both effective and lasting, will require a thorough understanding of the biology of the pest. In addition, comprehensive damage and hazard appraisals will be needed, including evaluation of pest impact on stand composition, release, succession, age distribution, and other factors of stand ecology.

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