The white light of the hydrogen bomb which glows over the horizon and threatens men's very survival, has seared into our consciousness the awareness that material progress is not enough, and that the uses of science depend, finally, on the moral precepts which form the ethical codes, which govern the affairs of men.

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THE ELM SPANWORM—PAST, PRESENT, AND FUTURE

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INTRODUCTION

Probably no forest insect in the Southeast has ever received so much publicity, aroused so much curiosity, and annoyed so many people as the now notorious elm spanworm which during the past five years has defoliated thousands of acres of hardwood forest in north Georgia and adjacent areas of North Carolina and Tennessee. In some 27 years of experience in forest entomology, 23 of them in the South, I have never known of a forest insect which received quite so much popular attention. There have been large-scale outbreaks of other leaf-eating insects before, there have been many outbreaks of pine bark beetles throughout the South which caused losses of millions of dollars, and there have been incalculable losses caused by inconspicuous insects insidious in their destruction of our forest resources. None have attained the prominence of the spanworm. By comparison, the damage caused by the elm spanworm has been rather light. This is not to minimize the losses caused by this insect. Indeed it has killed timber and caused deterioration and a reduction in growth that might well amount to many thousands of dollars if the total loss could be assessed. Also, it has inflicted less tangible damage such as adverse effects on the whole forest complex.

Why has this relatively unknown insect attracted so much public attention? Perhaps the answer will be revealed as I attempt to unfold the history and the general story of the elm spanwork outbreak. First it would be well to describe the insect, its life cycle, the damage it causes, and other characteristics.

LIFE HISTORY

The adult spanworm, once commonly called the snow-white linden moth, is a white, rather inconspicuous moth. It lays eggs in June on the branches and bark of the broadleaved trees such as oak, hickory, walnut maple, and many of the other species of the hardwood forest. The eggs remain on the trees until about the end of April of the following year, whereupon they begin hatching into larvae sometimes called loopers or measuring worms. These feed on the young foliage, and as the larvae grow in size and become more voracious, the damage becomes quite apparent. The larvae grow to a length of about two inches and vary in color from light green to brown. During this period they are frequently suspended on silken threads and are carried by wind currents from tree to tree. In heavy infestations a virtual curtain of threads is created. At the end of about six weeks the larvae go into a resting stage in crumpled, folded leaves or in strands of loosely spun silk. After about two weeks in this loosely spun cocoon, the new generation of moths emerge. Within a matter of days they begin to lay eggs, then die, thus completing the life cycle.

DAMAGE

Injury is caused by the severe defoliation of trees at a time when food has not yet been manufactured. When defoliation is heavy and is repeated the second, third, and sometimes the fourth year in a row, trees simply are unable to manufacture the food required to exist. There is a weakening effect, and subsequently the trees are attacked by wood-boring insects, particularly the two-lined chestnut borer, and eventually die. Where mortality does not occur, there is a considerable loss in annual increment in the tree. Generally the oaks and hickories are favored host species, but the larva feeds readily on most species of trees except yellow-poplar. While most of the damage occurs on ridge tops where timber is relatively poor, considerable injury takes place at lower elevations on sites supporting stands of well-formed high-quality trees.

BACKGROUND OF THE CURRENT OUTBREAK

So far as is known, the present outbreak of the elm spanworm originated around Potato Patch Mountain in Gilmer County. Apparently few trees were involved, and no insects were collected to make an identification. In 1955 the insect had spread over an area of about 1,500 acres and at that time was identified as the elm spanworm (fig. 1). By 1957 it covered an area of 200,000 acres and had spread into North Carolina and Tennessee. In terms of area covered, the peak was reached in 1960 when spanworm defoliation was spread over an area of about a million and a half acres. During the past year the overall area has declined to about 1.1 million acres, but defoliation was heavier than in any year in the past (fig. 2). Throughout the entire epidemic there has been a general spread toward the northeast, and this trend is still continuing.

The question might well be asked, "Why was the outbreak permitted to develop to its present proportions; why was it not nipped in the bud?" There is, of course, no assurance that complete control would have been possible even early in the outbreak, for small infestations might have been scattered throughout forest stands. However, there was no great concern by foresters or entomologists at the time the identity of the

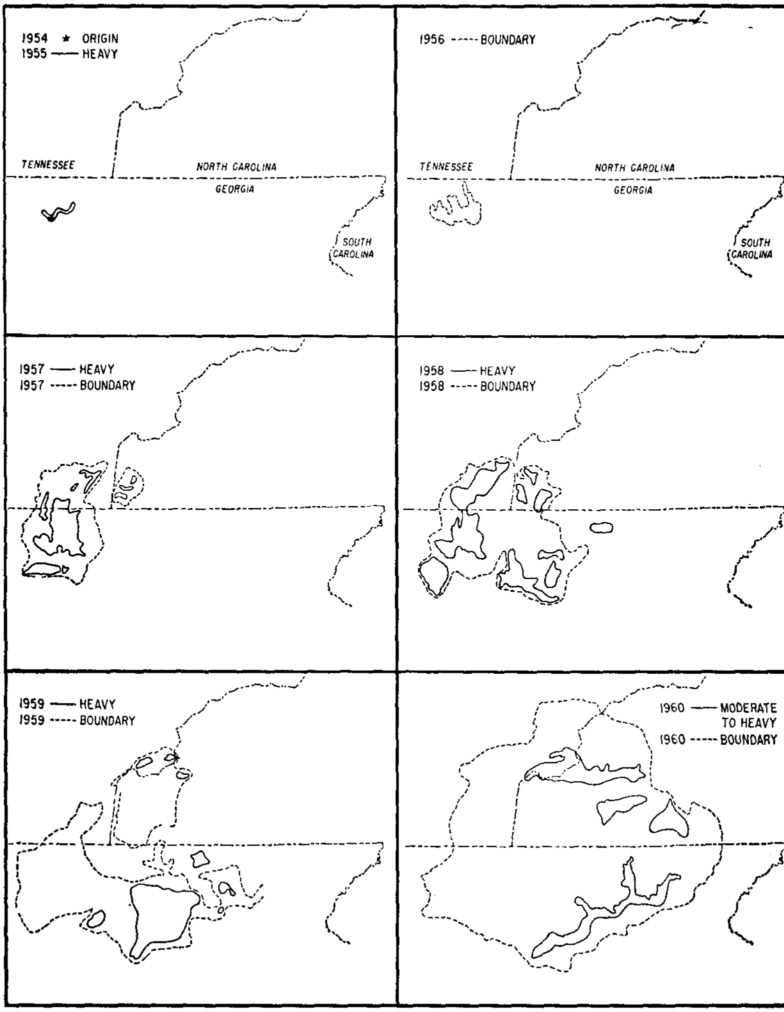

Figure 1. Series of maps showing the areas defoliated yearly from 1954 to date.

insect was learned because hardwood defoliators are very common and most of them rather innocuous. When the size of the defoliated area reached 51,000 acres in 1956, there was still no great concern because even the most economically important defoliators such as the forest tent caterpillar seldom persist more than about three years. A review of the available literature revealed that infestations of the spanworm had occurred in other parts of the East, and they suggested that no great importance was attached to the outbreaks and apparently little serious damage was reported. By 1957 the defoliated area reached some 200,000 acres, and it was apparent that no immediate decline was in prospect (fig 3). However, it was still difficult to justify control measures in view of the situation which existed: tree mortality was not yet evident, though deterioration was apparent; the complex landownership pattern precluded use of chemical controls; and interest was not strong.

However, questions regarding the insect and its potential importance were beginning to be asked. Was this an unusual outbreak? Was this a

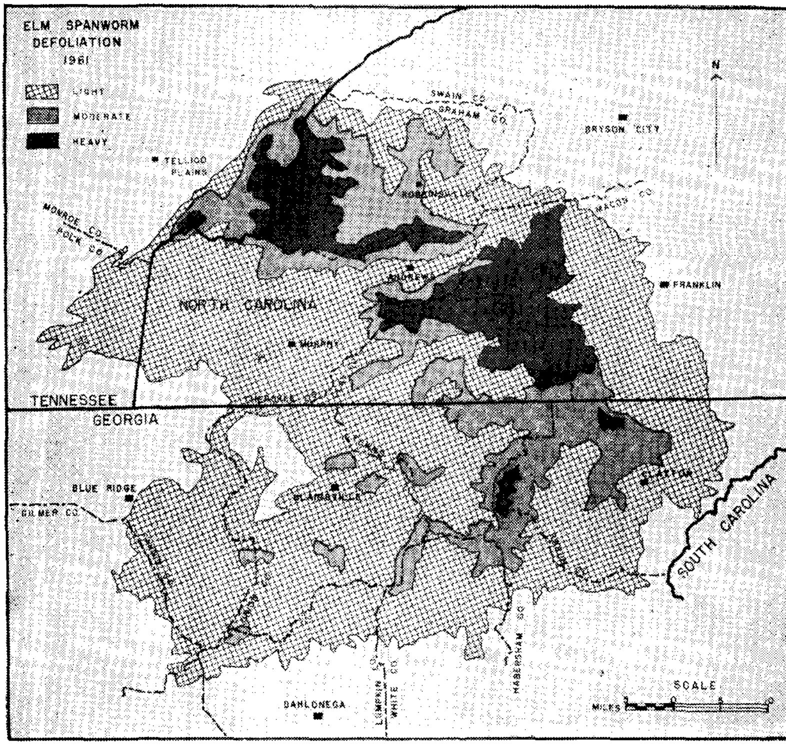

Figure 2. Elm spanworm defoliation, 1961.

native insect? Had it come into the South recently, and if so, when? How long might the epidemic continue? Would damaged timber die? What would be the effects on the total forest complex? It was at this *time that field studies were intensified to learn more about the insect* and its damage, and a more exhaustive search of the literature was begun.

HISTORY OF PAST OUTBREAKS

The search into the history of the spanworm outbreaks is a fascinating one. It has lead into the libraries, insect collections, and correspondence files of universities, State institutions, and public institutions throughout the country. The search is not yet complete. At the present time it appears that scientific recording of the spanworm was made in an unpublished folio by S. Abbot as far back as 1792; the insect was reported to be in the vicinity of Savannah, Ga. In 1823 Hubner, in his monograph on foreign Lepidoptera published and included illustrations of the elm spanworm. Since that time rather voluminous literature on the spanworm has appeared, but the history of the insect has been erratically and poorly traced. Accounts of past outbreaks are scanty, providing little information to evaluate the insect's importance. During the 1860's Brooklyn and Philadelphia suffered large infestations of the spanworm on shade trees. In the 1874 *Proceedings of the American* Association for the Advancement of Science a statement is made that the spanworm infestation in the Philadelphia area was exterminated by European sparrows introduced for that purpose. Around 1910 outbreaks occurred in the Catskill Mountains, defoliating beech and maple. In the late 1930's the spanworm was found in New Jersey in mixture with the fall and spring cankerworm. One of the most severe infestations in the Northeast occurred about 1940 in Massachusetts when red maple was severely injured. Thus far our investigation indicates that the insect has appeared in scattered areas from southeastern Canada and the

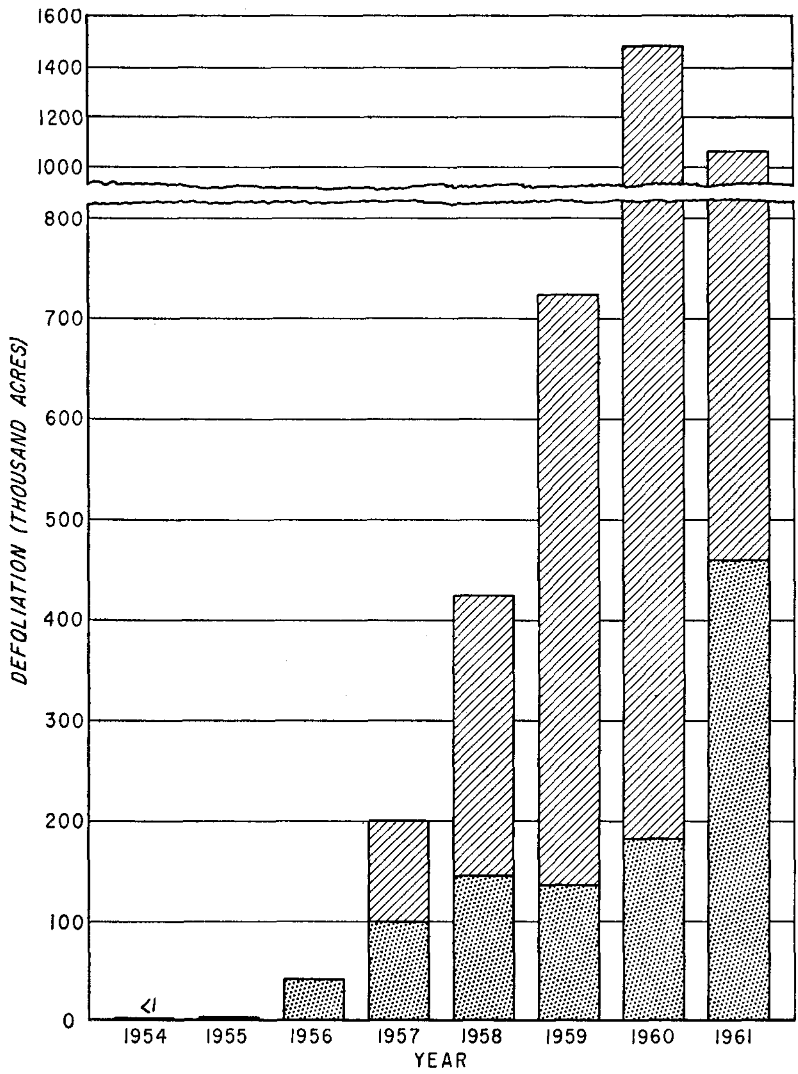

Figure 3. Annual elm spanworm defoliation, showing acreages of light (line shading) and moderate to heavy defoliation (dot shading).

Atlantic States, west into Iowa, and south possibly even to Texas. Probably the most startling revelation of this historical research was that as far back as 1878 an epidemic originated in Georgia in the same place as the current one and developed and spread over a similar area and acreage of forest land. In 1880 the renowned entomologist, J. H. Comstock, reported, "During the past summer specimens of this common northern geometrid were received from Mr. Davenport of Morganton, Fannin County, Georgia." In the accompanying letter Mr. Davenport stated that the insect had first been noticed in the country two years before and that they readily spread until they were now destroying forests of hickory and chestnut and were doing much damage to the fruit trees. In another report in 1882 in the Canadian Entomologist this information is found, ". . . it is stated that the worm made its appearance upon Rich Mountain, a spur of the Blue Ridge, about four

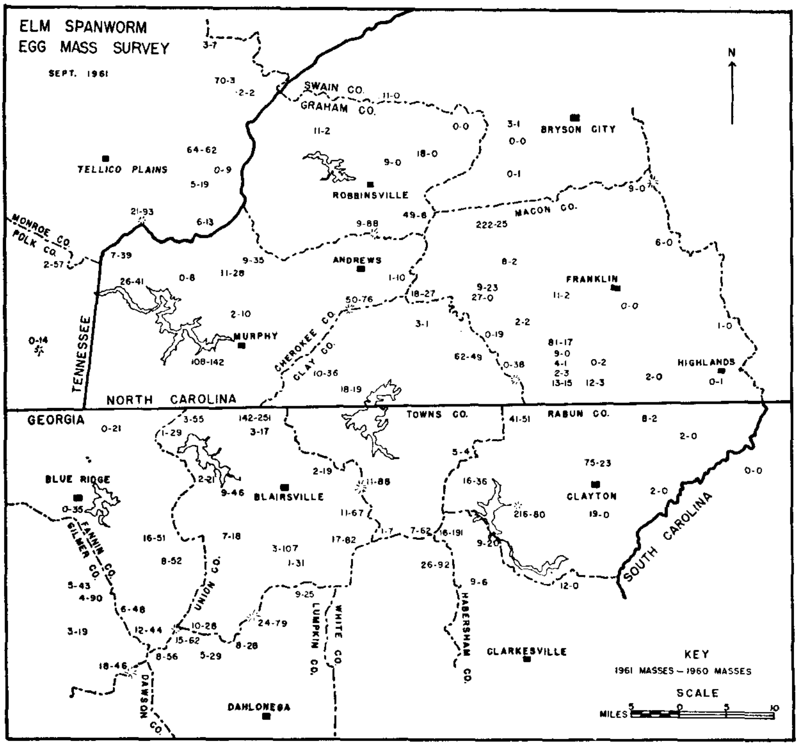

Figure 4. Elm spanworm egg mass survey showing the numbers of new and old masses on twenty-four 5-foot branch samples per station. This is double the sample size taken in 1960.

years ago, attacking the forest and fruit trees, and that it has since spread over a large area doing great damage." And ". . . it has been spreading in a northern semicircle at the rate of about 15 miles a year. The infested district in Georgia is not less than 60 miles long by 40 wide and embraces Union County on the east, Gilmer County on the west, and Polk County, Tennessee, on the north. They have been injurious two years, but in the summer of 1881 they were most destructive." It is difficult to interpret the words "injurious" and "destructive" but in any event it is estimated that defoliation in the 1881 season was approximately 1½ million acres in size. It is interesting that Rich Mountain referred to above lies in the southernmost corner of Fannin County, a straight line distance of less than 27 miles southeast from Potato Patch Mountain where the present outbreak was first sighted. It seems remarkable that an insect capable of reaching epidemic proportions should apparently go through a population depression for a period of over 80 years.

It is anticipated that within the year a publication presenting a complete review of all literature on the spanworm will be prepared by entomologists of the Southeastern Station.

RESEARCH

Because of the nature of the outbreak, the economics involved, and general financial consideration, there has been no intensive research on the elm spanworm. Life history studies have been conducted, however, to obtain the essential information in the event further studies might be needed. Biological evaluations have been made to determine trends in epidemics, and annual aerial surveys to determine the extent of defoliation and the spread of the insect. Egg mass surveys have been made annually in the fall or winter to provide the information for predicting intensity of defoliation and spanworm distribution for the coming year (fig. 4). Studies in 1956 and 1957 revealed that definite growth loss occurred in trees defoliated by the spanworm compared with those species not defoliated. About 1958 evidence began to appear that defoliation was causing deterioration and mortality of the trees. Thus, when it seemed likely that some measures of control might be needed, at least in restricted areas, a pilot test was conducted in the spring of the year to determine the value of DDT. The dosage of 1 pound per acre commonly used against related defoliators at that time was applied by fixed-wing aircraft on 50-acre plots in the Cohutta area in northeastern Georgia. The test revealed that the treatment was completely effective and that control of the insect could be attained at high and low elevations, where insect development varied, if proper flight procedures were followed. An attempt was made to assess the influence of the spray on fish and wildlife. Mr. Merkle of the Georgia Fish and Game Commission and Mr. Marvin Smith of the U.S. Fish and Wildlife Service checked streams in the spray plots. No effect on bottom feeders was observed, and no mortality of fish took place. These results were limited in their scope since the drainage areas involved in the test were rather small.

The results of this test have had restricted application. They have been employed primarily in recreation areas and where DDT has been applied by helicopter at a dosage of ½ pound per acre. No attempt has been made to completely control the insect in such areas, but rather to suppress it. During the past year a 4,500-acre area of the Coweeta Hydrologic Laboratory near Franklin, North Carolina, was sprayed with 1 pound of DDT per acre applied by fixed-wing aircraft. Here very high values in terms of many years of watershed studies were involved. Sound preliminary preparations were made relating to all aspects of the spray operation. Included in this was thorough investigation of all side effects of DDT, including the effect on bottom-feeding organisms, fish, wildlife, and on water purity. Representatives of State and Federal fish and wildlife agencies, public health agencies, and the Forest Service cooperated closely in this endeavor and formed a committee which will meet sometime before the end of the year to discuss the results of the study and consider their publication.

EFFECT OF SPANWORM DEFOLIATION ON WILDLIFE

No intensive studies have been conducted to determine the effect of spanworm defoliation on wildlife. However, numerous observations by wildlife and Forest Service personnel indicate that the decided reduction of mast has influenced animal populations. On October 15 of this year the Asheville Citizen carried an article on the effect of this season's mast failure on wildlife. Forest workers indicated that hunting would be poor in many areas because of mast failure due to elm spanworm damage as well as other causes.

NATURAL CONTROL OF THE SPANWORM

Since 1956 we have made observations on the natural control factors operating within the elm spanworm outbreak, in hopes that some factor or combination of factors could be detected which might indicate a downward trend in the epidemic or might be utilized as a control method. It was found that weather during the epidemic thus far had no adverse effect on the spanworm. Sudden and extreme low temperatures have had no effect on eggs. The sudden drop to below freezing in late spring of this year has little effect on the spanworm population. Efforts have been made to detect the evidence of a virulent disease organism which might be isolated, cultured, and used to control the spanworm. Thus far two viruses have been recovered from dead or dying larvae, but to date it has been impossible to evaluate their effectiveness. In a small-scale exploratory test a bacterial disease, *Bacillus thuringiensis,* was studied and found to be of little value.

We have made many collections of insect enemies of the spanworm. Different stages of the spanworm were reared in the laboratory to see if significant numbers of parasites could be recovered. None of the 15 species recovered occurred in sufficient quantities to indicate any promise as a method of control. Predators were likewise ineffective. It has been difficult for many individuals to understand why the large, formidable-looking *Calosoma* beetle could not control the spanworm. Actually the *Calosoma* is not a particularly effective predator because it is general in its feeding habits. Furthermore, it is sluggish and rather ineffective in searching for the spanworm.

No discussion of the spanworm could possibly be complete without some reference to "the huge, brown 'fly," "the big, gray fly," etc., about which so much has been said. While many stories have been written about the spanworm outbreak, probably no aspect of the problem has received the attention given to the big, gray fly. The most popular theme used to explain the presence of the flies is that they were natural enemies released to control the spanworm. Some have likened this effort to that of the U.S. Department of Agriculture which liberated sterilized male flies to control the screw-worm in the Southeast. One story suggested that bags of flies were dropped from low-flying planes. Actually the flies belong to several species of the family Sarcophagidae, commonly known as flesh flies. Many spanworms in different stages were collected to see if the Sarcophagids could be recovered. None at all were reared from 1956 collections, and only seven specimens were reared from the 1959 collections which included 1,166 larvae and 845 pupae of the spanworm. Why then are these noxious and annoying creatures so abundant? Actually, if one will observe closely, he can find them in rather large numbers in the forest at any time. However, when tremendous numbers of spanworms or any other defoliator of this type occur along with a multitude of associated species, their presence, their carcasses, and cast skins serve as a powerful attractant to the fly. The Sarcophagid feeds largely on decaying material and can thus thrive and multiply under conditions such as the spanworm creates.

WHAT OF THE FUTURE?

One can only speculate on the trend of the present epidemic of the spanworm. As previously indicated, the overall area of defoliation is in a downward trend, but there is a strong upward trend of heavy defoliation. We cannot predict what this change may mean. On the favorable side, it could mean that heavy concentrations of the spanworm will bring about starvation and greater susceptibility to natural control, particularly by diseases. This could be wishful thinking, but it is a phenomenon that sometimes develops in the presence of heavy population concentrations. Another possibility is that as the insect continues its northeastward spread, a new set of natural control factors may operate against it and bring about a decline in the epidemic.

Given sufficient support, it is possible that research might, with good fortune, develop a satisfactory method of controlling the spanworm during the current epidemic. Considerable knowledge about the insect and its associates has already been accumulated. Studies are now in progress to determine ways of breaking diapause or dormancy in the spanworm so that large numbers may be reared under laboratory conditions. Having these, it will then be possible to test various agents, whether they be biological or chemical, for the control of the spanworm. There is considerable promise and hope that the spanworm viruses recovered to date or new viruses may lead to a biological control method which can be applied rapidly by aircraft over large areas. This requires considerable research on the virus organisms themselves, as well as the host insect, to determine the conditions under which the virus is effective.

Paralleling this suggested research is the need for more intensive studies on the biology of the spanworm, its relationship to its environment, the cause of epidemics, and the factors which predispose stands to attack. Answers to these and other questions are a long time in coming and will do little good in relation to the present epidemic. However, only by attacking the problem now while the insect is with us will it be possible to predict, prevent, and control such epidemics in the future and thus avoid the loss, the confusion, and consternation that has characterized the current epidemic.