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Life History and Outbreaks of an Oak Leafroller, Archips Semiferanus (Lepidoptera: Tortricidae), in Michigan

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LIFE HISTORY AND OUTBREAKS OF AN OAK LEAFROLLER, *ARCHIPS SEMIFERANUS* (LEPIDOPTERA: TORTRICIDAE), IN MICHIGAN

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In the late 1960's an outbreak of yellow-green tortricid larvae occurred over hundreds of thousands of acres of red oaks in northeastern Lower Michigan. At first the insect was thought to be the fruittree leafroller, *Archips argyrospilus* (Walker); adult specimens, however, were identified by Freeman[2] as *A. semiferanus* Walker. On forest lands oak or pine was the preferred cover type. In urban areas, the problem was acute where red oaks were the predominant shade tree.

In 1969 and 1970 I observed this insect to learn about its life history, habits, and distribution. Besides regular field collections, some cage studies and laboratory rearings were done.

RECENT OUTBREAKS

Freeman (1958) reports *A. semiferanus* feeding on *Quercus* spp. and *Pyrus malus,* and says it is widely distributed but restricted to the southern half of the North American continent. The principal host species in Michigan are northern pin oak, *Quercus ellipsoidalis* E. J. Hill, and northern red oak, *Q. rubra* L., and the major outbreaks have been in the northeastern part of Lower Michigan where these oaks are abundant. Oaks of all ages are attacked (Fig. 1).

The recent outbreak was first noticed in 1965 but aerial surveys made by the U.S.D.A. Forest Service were not able to detect defoliation that year. Heavy defoliation occurred in Oscoda County in 1966 and lesser defoliation occurred in surrounding counties. The outbreak reached its peak in 1968 when it extended over parts of Ogemaw, Oscoda, Montmorency, Crawford, Alcona, Iosco, and Roscommon Counties. The insect population declined in 1969 and collapsed in early summer of 1970.

The heaviest mortality occurred near the end of the outbreak in 1969 in areas where heavy leafroller defoliation had occurred for 2 to 4 consecutive years. One or two late frosts during June that year weakened the trees sufficiently that healthy-looking refoliated trees began dying from the top down in August. Another late frost in early June of 1970 appeared to be the major reason for the population collapse. The insects, then in the third and fourth instars, almost completely disappeared. Casual observations suggest that a sap borer, probably *Agrilus bilineatus* (Web.), may have killed some of the weakened trees as well.

The extent and degree of damage was never fully assessed but at least one-half million acres of oaks were attacked and considerable dieback and tree mortality occurred where oaks had been heavily and repeatedly defoliated. Mortality was highest in Roscommon, Oscoda, Alcona, and Iosco Counties.

A similar outbreak occurred over part of the same area from 1956 to 1958.[3] At that time it also was thought to be the fruittree leafroller, but there is good evidence that

[1]Office maintained in cooperation with Michigan State University.

[2]T. N. Freeman, Ottawa, Ontario, Canada.

[3]State and Federal insect situation reports, unpublished.

Fig. 1. Young oaks completely defoliated by *A. semiferanus* in 1968 in Oscoda County, Michigan, at peak of the outbreak.

it was *A. semiferanus* as in the 1965-70 outbreak. The population started to build up in 1955, and in 1956 the insect defoliated oaks on 214,500 acres in Crawford County. The infestation peaked in 1957 when it covered some 350,000 acres in parts of Crawford, Roscommon, Ogemaw, and Oscoda Counties. Branch mortality occurred that year. By

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1958 some trees had died--especially on the poorer oak sites. The drought that occurred from 1955 to 1959 undoubtedly contributed to the mortality. A severe frost that occurred when the leaves were several inches long may have been the major cause of the insect population collapse in 1958.

LIFE HISTORY

The oak leafroller in univoltine in Michigan and overwinters in the egg stage. The life history for Alcona County for 1969-1970 is depicted in Fig. 2.

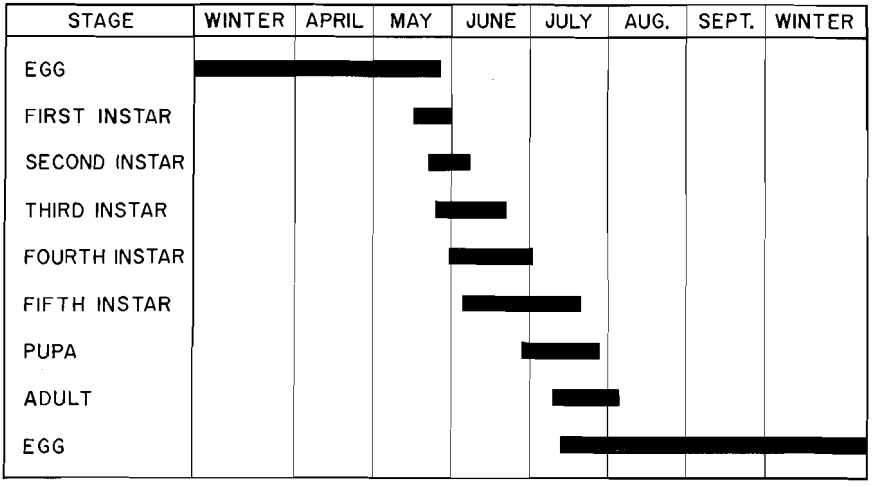

Fig. 2. Seasonal development of *A. semiferanus* on oak in Alcona County, Michigan.

Egg Stage

Female moths emerge and oviposit through most of July and early August. Eggs are laid in a compact mass on the bark usually to the side of or just below a twig crotch (Fig. 3B). The mass is oval and covered with erect or semi-erect tan scales from the female's abdomen (Fig. 3A). Old egg masses are grayish and frequently devoid of scales (Fig. 3B). Twenty-six egg masses examined in autumn of 1969 revealed a mean of 48 eggs/mass (range 15-125). Mean egg mass dimensions were 4.2 mm X 2.8 mm. The diameter of the twig at the oviposition site averaged 16 mm but varied from 5 mm to 25 mm. One twig collected had four egg masses around the same crotch with three together and overlapping. They appeared to be from three separate females.

All eggs, except parts of a few on the periphery, are well concealed beneath the scales on the egg mass. Eggs appear brown, probably from the adhesive coating them that holds the scales tightly. The eggs vary in shape and dimensions depending on their locality in the mass. Those on the periphery are flattened and oval and measure about 0.63 X 0.55 mm at the widest and narrowest diameters. Those in the center are "on edge" and if cut from above resemble the cells of a honeycomb. They measure about 0.35 mm wide by 0.69 mm deep.

Larval Stages

Five larval instars were indicated from a frequency histogram of 1,494 head capsule width measurements and by comparing living larvae with cast head capsules in

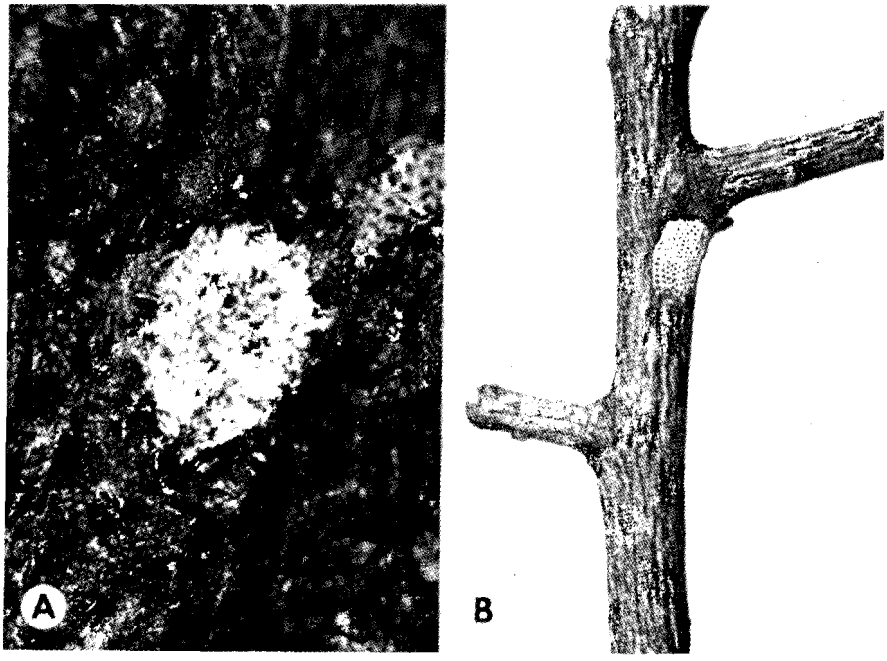

Fig. 3. Egg masses of *A. semiferanus:* (A) egg masses on oak bark covered with scales from female moth; (B) hatched egg mass located below and to the side of twig crotch of oak.

their leafrolls. First-instar measurements were made on larvae emerging from egg masses that were placed in jars in the field in autumn and brought into the laboratory in the spring. Behavior and development observations were made on two young oaks caged in the field, and one small sapling potted in the laboratory. Mean and range (in mm) of head capsule measurements for the 1,494 larvae for the five instars were:

Instar	No. head capsules	Mean width and S.D.	Range
I	37	0.272 ± .010	0.267 - 0.298
II	193	0.464 ± .033	0.393 - 0.565
III	239	0.719 ± .075	0.581 - 0.864
IV	305	1.075 ± .099	0.879 - 1.319
V	720	1.734 ± .123	1.366 - 2.010

The first-instar larva ecloses in mid-May by chewing an exit hole in the upper side (or end) of the egg. The newly emerged larva is greenish-yellow with a shiny black head. First eclosion appears to be synchronized closely with bud-break of oak; the leaves are about 1.2 mm or shorter at emergence time. The larva seeks out these emerging leaf clusters. It then spins a web within the protective concealing folds of the leaves (Fig. 4A) and skeletonizes small patches of the upper leaf surfaces within the webbed area. The leaf edges may be nibbled on as well. Later the larva moves to new leaves or leaf clusters as

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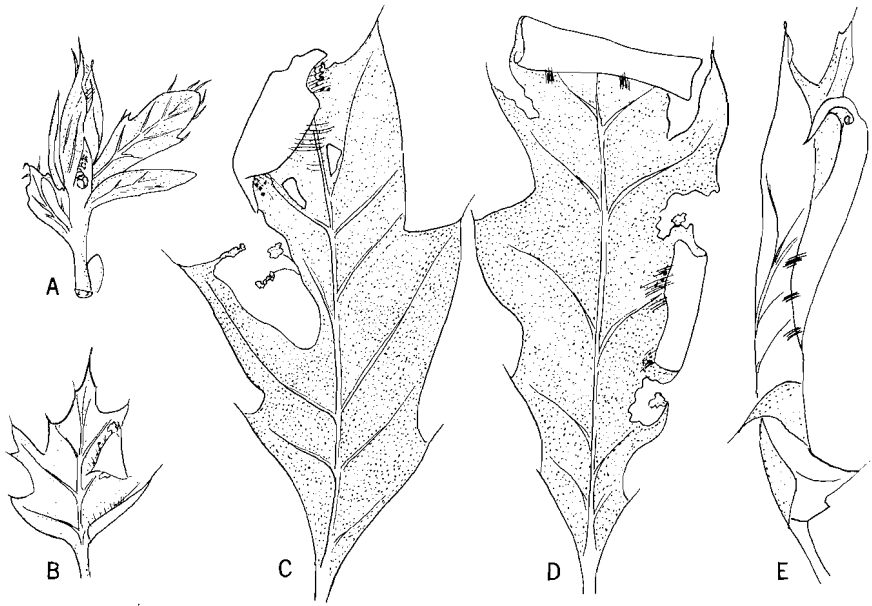

Fig. 4. Some leaf webbing and rolling habits of *A. semiferanus*: (A) first-instar larva webbing in folds of young leaf cluster; (B) webbing and folding of leaf of late-emerging first-instar larva; (C,D) leafrolling, webbing, and feeding patterns of third- to fifth-instar larvae; (E) tightly rolled leaf of last-instar larva (occasionally encountered).

the food supply is consumed or dies. A late-eclosing larva encounters leaves that are further advanced in development and thus webs two or more touching leaf surfaces together, or it rolls the leaf edge to form a partly closed fold or cylinder (Fig. 4B). Several young larvae may occupy the same leaf or leaf cluster at this time.

The second-instar larva appears about the third week in May. The cast first-instar head capsule often remains in the webbing. During this stadium the leaf is rolled more, or new leaves are added as they are needed for shelter and food. Free feeding occurs along the edges and between the large veins during the second and remaining stadia. The leaf or leaf cluster may be rolled lengthwise, crosswise, or just along one side to form a cylindrical cavity. Typical habits are depicted in Figures 4C, D, E, and Figure 5. Within the leafrolls, only one side is lined with silk; the other side has at most a few strands. Outside, a few compact bundles of silk strands maintain the roll structure (Figs. 4C, D, E). Both the leafroll cavity and webbing are relatively free from debris with only an occasional frass particle or head capsule.

Mature larvae exhibit typical torticid behavior when disturbed. They retreat rapidly in reverse and drop down on their silk threads. Those dropping over water attract trout and other fish. Some fishermen who noticed the activity of this "greeny-worm", as they called them, tied trout flies to imitate them during the outbreak.

Pupa and Adult Stages

The pupa appears in the leafroll in late June. It is firmly attached to the webbing

Fig. 5. Typical leafrolling of last two instar larvae of *A. semiferanus*.

by several terminal abdominal hooks. In early July the adult ecloses and vacates the leafroll through either end of the cavity. Moths were occasionally observed on the foliage during the day and were only seen in flight when disturbed. Oviposition behavior was not observed. Freeman (1958) notes that the large brush of closely packed, corrugated scales on the undersurface of the female is likely the group used to cover the eggs.

DISCUSSION

Outbreaks of *A. semiferanus* appear to be short-lived, seldom lasting more than 5 years in Michigan. Frost and drought contribute both to oak mortality and leafroller decline. A current outbreak of this insect in Pennsylvania,[4] which erupted in 1967, continued through 1971 but showed signs of decline by 1972 from parasites and predators. Degree and extent of mortality are not known for Michigan, but the Pennsylvania outbreak, which is probably twice as devastating, covered over 1 million acres by 1971; losses totaling $56 million in stumpage value alone are predicted by the end of 1972.

It is more difficult to assign an economic loss for Michigan. On forest lands some of the oak killed is scrub oak that is occasionally underplanted with red pine. Where management plans included release of the pine simply by killing the oak, the mortality of oak here perhaps constituted an economic gain. Other plans included commercially harvesting the oak for pulpwood. From the wildlife standpoint the oak provided acorns. In urban areas such as in and near the town of Mio, which relies heavily on tourism, the

[4]Pennsylvania Forest Pest Reporter 49 (1972).

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insect denuded and killed many of the predominant shade trees. Dead oaks along roadsides were aesthetically unpleasing to residents and tourists alike.

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