A LEAF SKELETONIZER, *LOBESIA LIRIODENDRANA* (KEARFOTT), OLETHREUTIDAE, ON *MAGNOLIA GRANDIFLORA* IN FLORIDA

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On April 20, 1959, Mr. H. A. Denmark called the author's attention to the presence of a leaf skeletonizer producing considerable damage on two medium-sized trees of *Magnolia grandiflora* located on the University of Florida campus at Gainesville. The following are observations recorded on the biology of the insect and the type and extent of damage produced during 1959 and the spring of 1960.

DETERMINATION OF SPECIES: Infested leaves, possessing larvae and pupae in cocoons, were collected on April 20, 1959, and moths emerged on May 2, 1959. These were sent to Mr. C. P. Kimball for determination. He identified the moths to be *Lobesia liriodendrana* (Kearfott), a species of Olethreutidae. This insect was originally described from adults reared from larvae on *Magnolia virginiana*.

FOLIAGE INJURY: A single larva may produce a conspicuous, brown to silvery, elongated, irregular blotch on one half of a mature leaf which is more or less parallel with the midvein. The silvery blotch is the unbroken upper membrane of the leaf which the larva did not injure when it consumed the tissue on the lower surface. If two more or less parallel blotches occur on the upper surface, one on each side of the midvein, they were produced by two larvae, each living under its own web on one half of the leaf. Rarely will one find in the field more than two living larvae under enlarged webs on a single leaf. Occasionally one may see two or three empty mines or very small empty webs on a leaf.

The two magnolia trees mentioned in the introduction showed a far greater degree of infestation during 1959 than any other magnolia trees seen in Gainesville or other places in Florida. Many magnolia trees were examined. Some showed no signs of skeletonizer damage, while a few possessed an occasional injured leaf. Usually the number per tree was less than one per cent, but the damage on the two trees under observation was at least 25 per cent. On many branches, 10 to 20 per cent of the leaves were damaged, while others showed 50 per cent or more. Most of the observations included in this report were recorded from insects observed on the two heavily infested trees.

ADULTS: The over-all color of the small moth (Plate 1:1) is a mottled mixture of shades of brown, made up of light beige, medium to dark brown, and almost black scales grouped in irregular masses and lines. Each forewing is approximately 7 mm. in length and possesseses two irregular conspicuous dark areas, one near the proximal end and the other beyond the mid-region arising from the costal margin. The metathoracic wings are folded and located under the forewings when the insect is at rest. They are somewhat uniform in color, varying from a light beige near their bases

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[1] Contribution No. 11 from the Department of Entomology, State Plant Board of Florida, Gainesville.

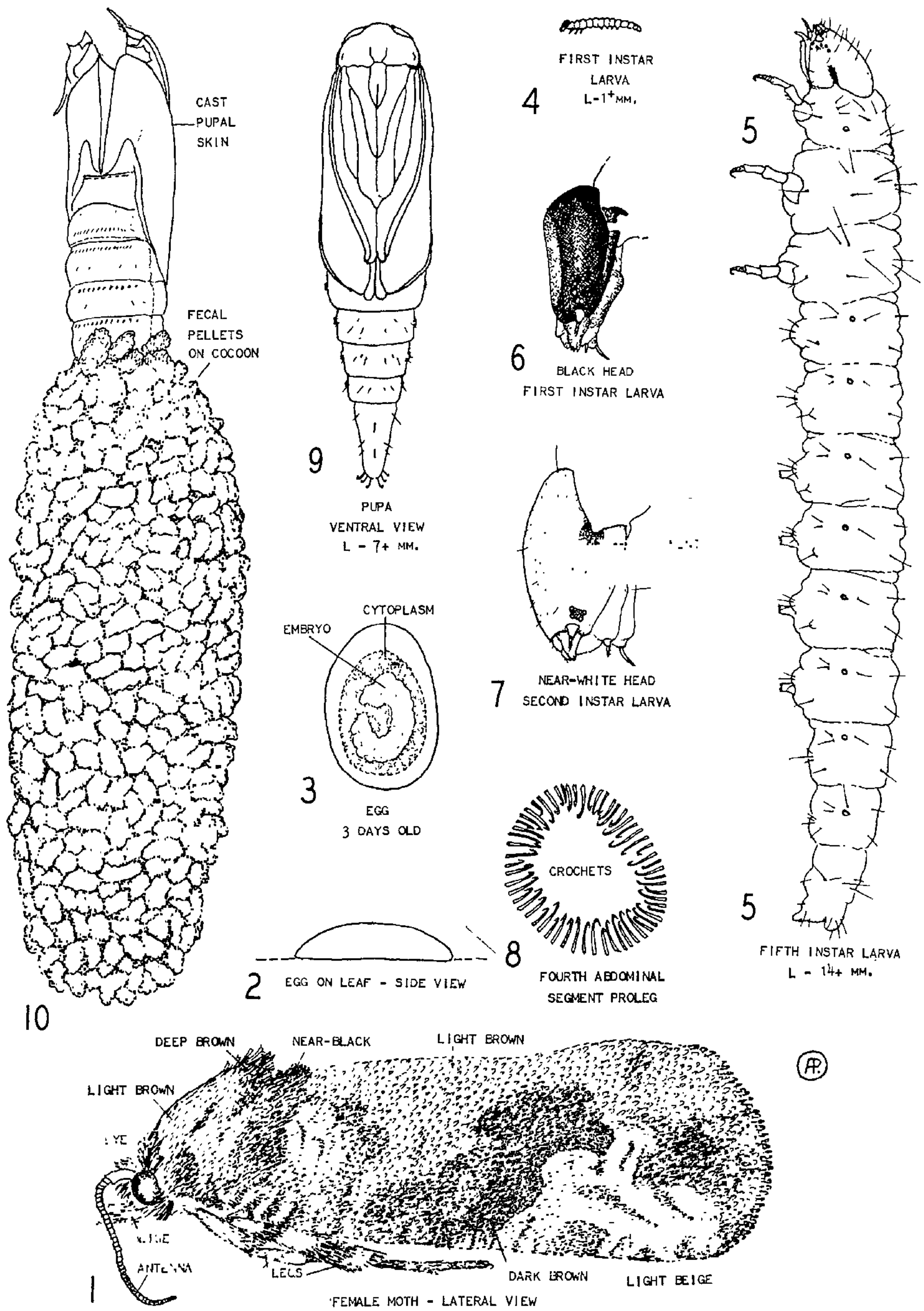

PLATE I

Life Stages of *Lobesia Liriodendrana* Kearfott to a distinct grey near the tip ends. Long, light-colored scales occur on the outer margins of these wings.

A conspicuous tuft or mass of erect dark-colored scales occurs on the rear portion of the dorsal aspect of the thorax. The many segmented antennae are light brown with the distal portions near-black. The fairly conspicuous dark-colored eyes are deep brown and surrounded with elongated beige-colored scales which arise from the head and palpi.

In the laboratory adult females lived for 3 to 8 days when they had access to water. They were most active from the late afternoon until total darkness. During this period of activity eggs were deposited.

OVIPOSITION: Under field conditions, the female moths deposit their eggs on the upper glossy surface of magnolia leaves. In the laboratory, repeated tests were made with a few to many adults in various kinds of cages in order to obtain eggs. Small screen cages, 12" x 12" x 12", glass jars and vials lined with polyethylene or paper, and small polyethylene bags containing magnolia leaves and a water source were tried. All told, the deposition of eggs under laboratory conditions was unsatisfactory. In a few tests, a small number of eggs were found on the foliage of polyethylene.

EGGS: Eggs of the magnolia leaf skeletonizer (Plate 1: 2-3) are very similar to the eggs of several species of the Olethreutidae. They are smooth, flat, disc- or scale-like objects measuring approximately one millimeter across when viewed from above. Also, they are translucent, and consequently, when deposited on green foliage, the green color of the leaf

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PLATE I

Explanation of Life Stages on Plate I,
Figures 4, 5, 9 and 10 drawn to same scale

Figure 1.—Lateral view of a female moth at rest.

Figure 2.—Outline of the lateral view of an egg.

Figure 3.—Top view of a three-day-old egg deposited on a clear substrate showing, by transmitted light, a u-shaped embryo within surrounded by yellowish cytoplasm.

Figure 4.—A first instar, 1 mm. larva with a black, flattened head and habits of a leaf miner.

Figure 5.—A nearly full-grown, green, fifth instar larva with a light-colored rounded, prognathous head with external leaf-skeletonizing habits.

Figure 6.—Lateral view of a black, flattened head of a first instar larva. Drawn to same scale as Figure 7.

Figure 7.—Lateral view of an almost colorless (yellowish-white), rounded head of a second instar larva showing a lateral pigment area which also occurs in succeeding instars.

Figure 8.—Enlarged ventral view of the crochets on one fourth abdominal proleg of a fifth instar larva.

Figure 9.—Ventral view of a light or dark brown pupa.

Figure 10.—Dorso-lateral view of a pupa showing the slit on the dorsomeson through which the adult emerged, also, the normal position of the pupa in relation to its black, fecal-pellet covered cocoon at the time of adult emergence.

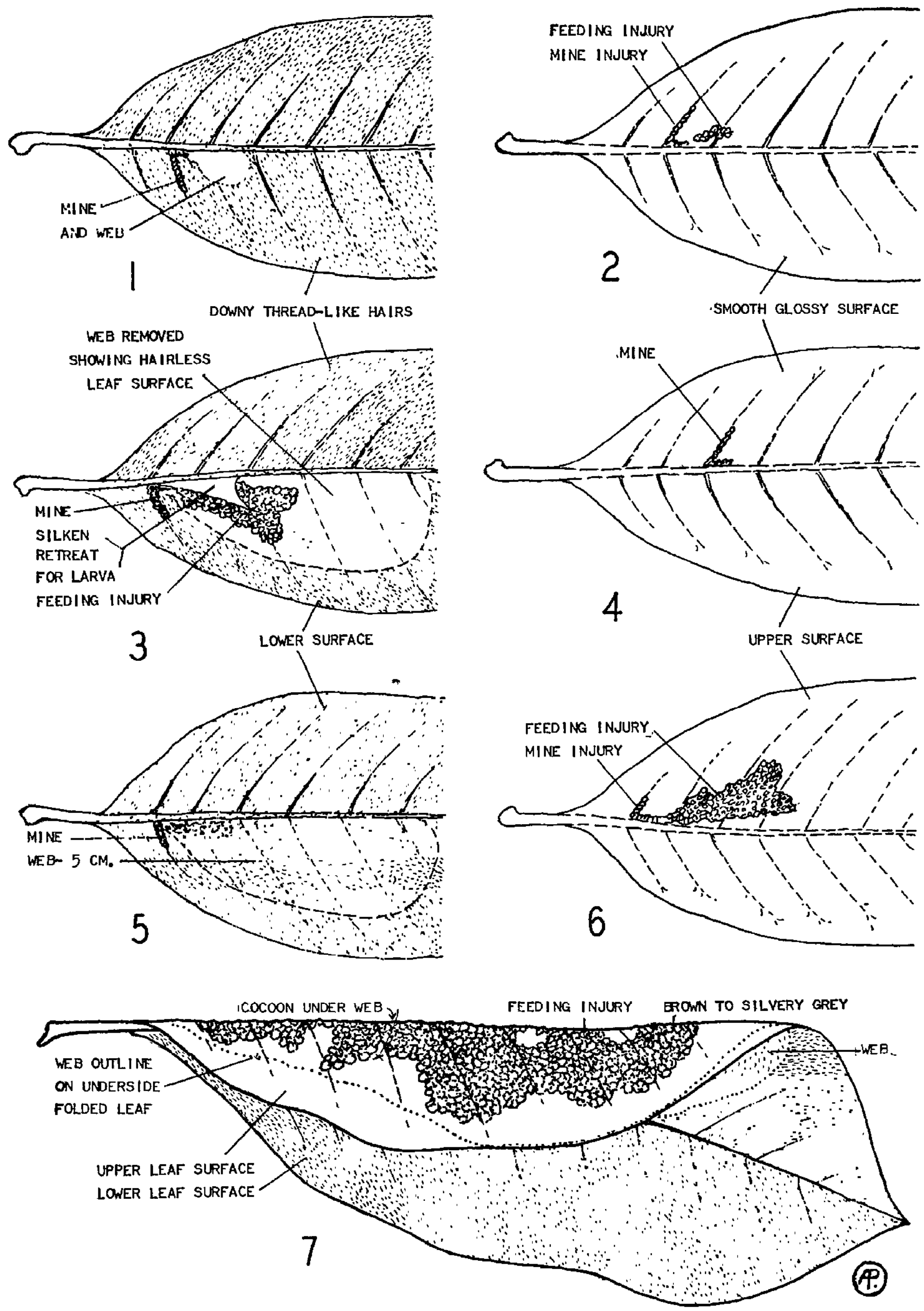

PLATE II

Leaf Injury Produced by *Lobesia Liriodendrana* Kearfott is visible through the egg. When eggs are deposited on glass or colorless polyethylene, they are almost without color except for the slightly yellowish cytoplasm surrounding the nearly transparent embryos. As an egg develops, the embryo takes on a u-shape. Before it completes its development, it inverts its position, momentarily assuming an s-shape. The changes in the embryo can be seen by light reflected through the egg from below.

The incubation period of the eggs during the summer was 4 to 6 days. About 24 hours previous to hatching, the black head of the first instar larva shows as a black spot through the egg covering. This black-spot condition of the egg, when it is ready to hatch, is typical of many eggs of the Olethreutidae, Tortricidae, Pyralidae and other Lepidoptera. In hatching, the larva chews an exit opening in the egg covering.

LARVAE: A newly-hatched first instar larva (Plate 1: 4 and 6) approximates one millimeter in length. It possesses a flattened, black head with ocelli present on the lateral aspects.

PLATE II

Figures 1-7.—Magnolia leaves injured by single larvae while feeding or constructing their mines and webs. Figures 1, 3 and 5 show mines and webbed areas on the lower surface. Figures 2, 4 and 6 show mines and feeding injury from the upper surface.

Figure 1.—Leaf showing mine produced by a larva during its first instar and a one centimeter silken web produced by a late first instar or a second instar larva.

Figure 2.—Same leaf as figure 1 showing a mine and feeding injury from the upper surface.

Figure 3.—An infested leaf showing a web five centimeters in length, similar to Figure 5. The webbing has been removed to show the behavior pattern of the larva. Under the web, the downy thread-like hairs have been cut off and deposited on the outer surface of the web by the larva as it enlarges its domicile. The larva then proceeds to consume a portion of the smooth, green denuded surface. The feeding extends to the epidermis of the leaf's upper surface, producing a dead, brown to silvery irregular area. In addition to the above behavior, the larva constructs a white, tough, silken funnel adjacent to the main vein of the leaf. It uses this as a retreat when disturbed or when it is inactive.

Figure 4.—Leaf showing a v-shaped mine from the upper surface produced by a first instar larva located on the lower surface.

Figure 5.—A five centimeter web constructed by a third instar larva on the lower surface of the leaf. It is always located on one half of the leaf and distad of the mined area. The outer surface of the web is covered with severed, downy, thread-like leaf hairs which are cut off by the larva and placed on the outer surface as it builds its web covering.

Figure 6.—Same leaf as Figure 5, showing the mine and feeding injury from the upper surface.

Figure 7.—The final stage of a 9 to 11 centimeter web constructed by a fifth (last) instar larva. In many cases the leaf is folded, often not as much as shown in this figure. Within and under the web the larva constructs a near-black cocoon attached to the leaf. The cocoon consists of white silk and is covered with near-black fecal pellets which, at this stage, are abundant under the web. When the adult is ready to emerge the pupa partially pushes its way out of the coccoon and splits its covering on the dorsum of the thorax. Upon emergence, the adult, when ready to fly, finds a hole in the web and escapes.

So far as observed, a newly-hatched larva on the upper surface of the leaf does not enter the leaf from this surface. Apparently, it wanders over the leaf (upper and lower surfaces) until it finds the mid-vein on the lower surface and usually enters the midvein not far from the petiole. A large majority of the mines produced by first instar larvae occur on the basal half of the leaf and almost invariably are adjacent to the midvein.

Upon entering a leaf, the larva constructs a small v-shaped mine (Plate 2:4) with one arm of the mine parallel with the midvein and the other portion parallel with a smaller lateral vein. This damage to the leaf is the work of a first instar larva.

About this time, the larva moults and produces a second instar larva which is an external feeder. It proceeds to build a web 1 or more centimeters in length. This V-shaped web starts at the V-shaped mine and, almost without exception, projects toward the tip end of the leaf adjacent to the midvein on one half of the leaf. A second instar larva averages 2 to 4 mm. in length and possesses a rounded, light-colored head (Plate 1:7) with a distinct pigment spot on each side adjacent to the caudo-lateral margins. Succeeding instars also have rounded, yellowish- to light-amber heads with pigment spots on the caudo-lateral margins (Plate 1:5).

After a small web is constructed, leaf feeding may begin under the web. Before a larva consumes the leaf tissue on the lower surface it cuts off the thread-like leaf hairs and deposits most of them on the outer surface of the webbing. This leaves a green area of plant tissue without obstructions when feeding occurs. A larva, in feeding, will consume all of the green plant cells at a given point until it reaches the epidermis of the leaf's glossy upper surface. This it does not destroy; consequently, when this surface dries and hardens, it appears as a grey or silvery membrane.

During the second instar and later, the larva constructs under its web and adjacent to the midvein an inner, elongated, firm white, silken, funnel-like retreat (Plate 2:3). When a larva is disturbed, it backs into this retreat. During the daytime, one seldom sees a larva feeding on the leaf as it is usually at rest in its retreat. It is probable that most feeding and web construction occurs at night.

As shown later, the larvae apparently passes through five instars. When the fifth instar larva is almost full grown, the webbing on the leaf may be 10 to 15 cm. in length and 3 to 5 cm. in width at its broad end. Occasionally, a full-grown larva will pull back the tip end of a leaf or pull over one edge (Plate 2:7) and anchor these parts with silk. Also, some larvae feeding on the area adjacent to a midvein will produce a distinct fold in the injured portion of the leaf under the web. Usually, the brown or light grey skeletonized dead tissue, seen best from the upper surface, does not exceed one-half of the area covered by the webbing on the lower surface.

A mature larva is 10 to 14 mm. in length and usually has a dull-green color. Before a cocoon is constructed, the larva produces a considerable amount of dark fecal pellets held together in loose masses by silken threads. Some of these masses may resemble cocoons except they are not compact and firm. Eventually the full-grown larva constructs a cocoon which it attaches to the midvein or some portion of the leaf. The cocoon is made of white silk and covered with dark fecal pellets.

LARVAL INSTARS: Dyar's idea, that the width of the head capsule of a lepidopterous larva is more or less constant for any instar of a given species, was used to determine the number of instars among larvae of *Lobesia liriodendrana* (Kearfott) feeding on the leaves of magnolia during the middle of June at Gainesville, Florida. About 200 infested leaves were collected and brought to the laboratory for study. Over 150 larvae were removed from the infested leaves, killed in a K.A.A. mixture, and preserved in 95 per cent ethyl alcohol. The head capsule widths were measured with a cross-hatched eyepiece located in one ocular of a stereoscopic microscope. Each square under a 10 X ocular and 7.5 X objective measured 0.13 x 0.13 mm.

Figure A shows the number of head capsules of a given width on the vertical lines. To obtain an over-all trend, a running-average, plotted line was constructed. Each point on the line is the average number of individuals of 5 sizes, 2 to the left and 2 to the right of the line on which the point is placed. Figure A shows 5 prominent vertical lines and 5 elevations in the running average line. These points and the elevations on the line indicate strongly that there are 5 instars.

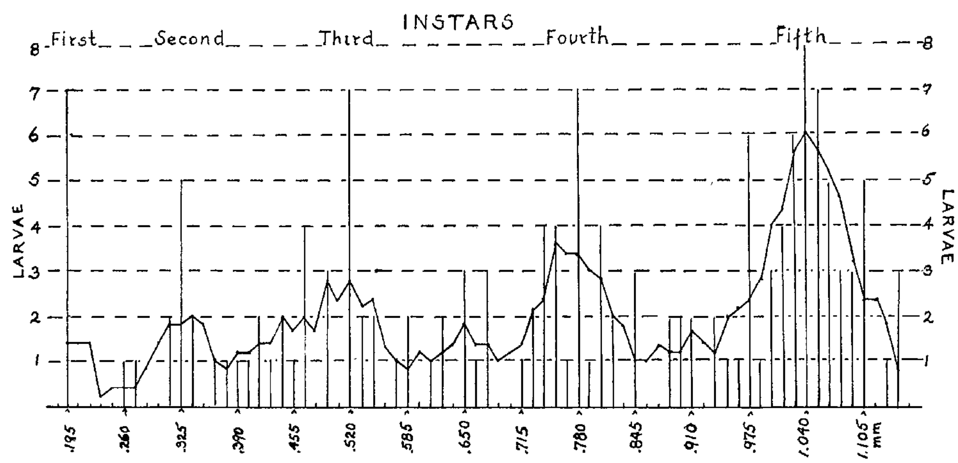

Figure A.—Larval Instars Determined by Widths of Head Capsules among 153 Larvae Collected at Random During June 1959 at Gainesville, Florida.

One might question the evidence for the second instar because the number is low. If the collection had been made late in May or early in June, the number of very small larvae probably would have been greater.

Dyar has also stated that the ratios of growth between the successive instars of a given species show a more or less regular geometric progression. If this idea is applied to the 153+ measured larvae of *Lobesia liriodendrana* (Kearfott), it will be noted that the ratios between the measurements, when it is assumed that there are 5 instars, are as follows: .60, .605, .66, and .75; while, if we assume that there are four instars, the ratios are .37, .66, and .75. In other words, the first series agrees much more closely with Dyar's idea of growth ratios than the second series.

In both series, the ratios between the last and next to the last instar are somewhat divergent from the previous ratios of .60, .605, and .66. This also holds for other species of lepidopterous larvae which the author has studied.

Until further study is made, it will be assumed that most larvae of this species pass through 5 larval instars.

LIFE CYCLES: When this investigation was started on April 20, 1959, all stages of the insect were found in the field. Consequently, the observations to date[2] do not reveal the complete life cycles of this insect for any single year.

As stated previously, eggs deposited on foliage during May to September required 4 to 6 days to hatch. Lower temperatures undoubtedly will increase the incubation period.

In order to determine the time required for a larva to complete its growth and transform into a pupa, two practices were pursued. In one procedure, close to 200 infested leaves were collected and brought into an air-conditioned laboratory. Some leaves were also placed in polyethylene bags in a screened insectary. The latter failed to produce results and all of the larvae died, probably due to the high temperature in the insectary and the excessive condensation in the containers where the leaves were kept.

During May, June and early July, leaves were brought into the air-conditioned laboratory, tagged individually and placed in polyethylene bags, 5 leaves per bag. The date of collection, size of the web, and other pertinent facts were recorded on the tags. The leaves were examined 3 times a week and all changes recorded on the tags. When the larvae started to construct a cocoon this was called the end of its growth period. As soon as a cocoon appeared, the leaf containing the cocoon was removed, cut down in size and placed in a separate polyethylene bag, and held for adult emergence. The above practice gave satisfactory results until early in July when it was noted that the picked leaves molded and turned dry before the larvae could complete their development. Another objection to this method of study is the fact that the leaves were kept in an air-conditioned room which differs decidedly from an outdoor environment. The 200 larvae used in these rearings gave the following results: larvae collected under webs 1 cm. in length, containing chiefly first or early second instar larvae, completed their growth in 10 to 21 days with an average close to 15 days, and the pupal period was 9 to 20 days.

The second practice pursued was the tagging of leaves on the tree, recording the development of the web once a week and the development of the insect a month or so after the leaves were tagged. When leaves were tagged, only those that showed normal, uninjured webs were chosen. For the most part, these were leaves with webs under 5 cm. in length.

Fifty leaves were tagged on June 10, examined twice a week and checked for final details on July 13th. This lot of tagged leaves had a total of 7 living larvae varying in size from 7 to 10 or more millimeters in length. All of the webs showed some tears. Most of these were badly riddled.

Fifty leaves tagged on June 18 and examined in detail on July 13th possessed eleven living larvae, mostly full grown, and two pupae in cocoons. Again, most of the webs were badly riddled and empty.

Another fifty leaves were tagged on July 14 and examined in detail on August 17. The results showed one full-grown larva, two empty pupal skins, two dead larvae in cocoons, and one dead parasite cocoon. All other webs were empty and torn, and, in most instances, badly riddled. This method for obtaining life cycle records was unsatisfactory, chiefly due to the

[2] The manuscript was submitted for publication in March, 1960.

fact that some predator entered the webs and destroyed the living larvae and pupae in the cocoons. The tagged leaves did show that some predator was responsible for the death of many larvae and pupae.

PUPAE IN COCOONS: When a full-grown larva is ready for pupation it spins a white cocoon which it covers with black fecal pellets (Plate 1:10). The cocoon is approximately 15 mm. long and 3 to 4 mm. in diameter. It is always under the webbing on the leaf and usually attached to the leaf adjacent to the midvein.

When emergence time for the adult approaches, the pupa pushes itself at least halfway out of the cocoon. At this point, the pupal covering splits along the dorsomeson and the adult emerges and escapes from the web via one or more holes found in most large webs.

The time the pupa spent in the cocoon during May to August varied from 9 to 20 days. Approximately two days of this time was spent in the prepupal stage. A newly formed pupa is light yellowish-brown but before emergence of the adult takes place, the color changes to a deep brown.

NATURAL ENEMIES: Natural enemies of the magnolia leaf skeletonizer are numerous, and, at times, appear to reduce the population decidedly.

Eggs were never plentiful or easy to find on the foliage. During the season approximately 50 eggs of *Lobesia* were seen. About one-half of these were parasitized by some species of *Trichogramma*. An egg, parasitized by *Trichogramma*, is black before and after the wasp has emerged.

Larvae and pupae of *Lobesia* are attacked by predators, hymenopterous parasites and disease pathogens. Early in the season chrysopid larvae were plentiful on the foliage. A few were seen feeding on small larvae of *Lobesia liriodendrana* (Kearfott).

Some predator, capable of tearing large holes in the webs, was fairly common early in the season. By midseason most of the webs showed some to excessive tears. It is evident that a predator larger than an average insect seeks and feeds on the larvae and pupae in cocoons under the webs. The author suspects birds. The only birds seen were mocking birds, cardinals and English sparrows. At no time did these species appear to be seeking larvae or pupae in the webs.

An occasional lizard of the genus *Anolis*, commonly referred to as a chameleon, was seen on the trees. It is suspected that they may feed on the larvae or pupae; however, it is known that these creatures usually attack objects that are in motion and not under a web.

An occasional parasite was found among the larvae collected. One was a species of *Macrocentrus*. Also, an occasional larva or pupa was found dead under the webbing covered with the mycelium of some unknown pathogen or secondary fungus.

In summarizing the information on the natural enemies of this host it is evident that predators play a decided role in the reduction of *Lobesia liriodendrana* (Kearfott), especially during the summer months.

During the months of October through December, there was a decided reduction in the activity of the predator which produced excessive tears in the webbing. On November 2, sixty-three leaves which appeared to be infested were collected. Only two of these were torn badly. Under the webs there were 33 living larvae, 9 pupae in cocoons, and 2 empty pupal skins. Again, on December 9, sixty-one leaves with normal webs were collected. Under these webs were found 10 living larvae, 14 pupae in cocoons, and 15 empty pupal skins. All told, these observations showed that 64 to 70 per cent of the webs collected in November and December possessed living larvae, pupae or empty pupal skins, while similar collections made during July and August showed that only 5 to 20 per cent of the webs possessed living larvae, pupae or empty pupal skins.