STUDIES ON

CHRYSOBOTHRIS FEMORATA FAB. IN OKLAHOMA

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PREFACE

The flat-headed apple-tree borer, Chrysobothris femorata Fabricius, has been the most serious pest of orchard and shade trees in Oklahoma in recent years. The three years of drouth from 1934 to 1936 have weakened trees of all kinds and made them very susceptible to borer attack. In certain orchards in Oklahoma as high as 95 per cent loss has occurred in recently transplanted pecan and apple trees. The damage resulting from the larval feeding of this insect has been for many years a serious menace to recently transplanted trees in all sections of the United States.

Realizing the necessity of working out a more complete and detailed life cycle of this insect with the hope of finding an effective control, the work which is contained within this thesis was undertaken at Stillwater during the spring and summer of 1936. A few control materials were tested, but insufficient data were obtained to present in this thesis. Therefore most of the problem was confined to a study of the habits and life cycle.

At this time, I would like to express my appreciation to Dr. F. A. Fenton, Head of the Entomology Department, for his careful consideration and help in this problem; to Professor Frank B. Cross, Acting Head of Horticulture, for his helpful suggestions and use of materials; and to Professor G. A. Bieberdorf, of the Entomology Department, for his help in obtaining the photographs. I wish also to thank Josef N. Knull, of the Department of Zoology and Entomology at Ohio State University, Columbus, Ohio, for his help in determining the species of flat-headed borers. I am also greatly indebted to C. F. W. Meuesbeck, R. A.

Cushman and A. B. Gahan of the Bureau of Entomology and Plant Quarantine, Washington, D. C., for their identification of the parasitic hymenoptera.

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INTRODUCTION

Chrysobothris femorata was described first by Fabricius in 1798, and was referred to as a native insect of North America. It belongs to the order Coleoptera, family Buprestidae, the members of which are known as the metallic wood-boring beetles. The common name, "flat-headed apple-tree borer", was given this species due to the fact that the anterior or head region of the larva is very much enlarged and flattened dorso-ventrally, making it appear to have a flat head, and to the fact that it is very destructive to apple trees.

The problem of working out a detailed life cycle and studying the habits of this pest was assigned to the writer by Dr. F. A. Fenton because it was an issue of importance and many questions were being asked concerning life history details and control methods of the flat-headed apple-tree borer.

An abundance of material was available, as in many places one could see dead or dying trees which were heavily infested with the larvae of C. femorata. Material was collected at the time of year when larvae, which were in the resting stage, were present in the wood of the trees. This material was caged, and observations were made from time to time to study the activity and development of the borers. The observations and results of experiments conducted will be presented in the following pages.

REVIEW OF LITERATURE

A review of the literature available showed that, in the oldest entomological notes in the United States, occasional reference was made to the flat-headed apple-tree borer as being a pest in certain areas. However, the round-headed apple-tree borer, Saperda candida Fab., was a more serious pest than the flat-headed apple-tree borer, in the opinion of many authors.

The writer finds that very little progress was made in life history studies and control measures prior to 1890. A detailed discussion of the life history of this insect was not found in the literature, but a few facts concerning the habits and development were generally known at that time.

Beach (1), Gill (16), Rumsey and Brooks (27), Hillman (17), Stedman (29), Walker (30), Howard (19), Essig (11), Garman (15), Garcia (14), Bogue (4), Cordley (10), Washburn (31), and many others are well agreed upon the following facts: The eggs are laid by the females in the early spring, and are placed in such places as cracks and checks caused by sun-scald or mechanical injuries. The beetles and larvae are most commonly observed on the south and west sides of the trunk or lower limbs. The larvae feed on the outer sapwood until full grown, and the beetles emerge in the spring.

Beach (1), Walker (30), Garcia (14), Cordley (10), and others list the duration of the larval stage as from one to three years, while Gill (16), Hillman (17), Stedman (29), Howard (19), Smith (28), Chandler (8), Matz (22), and others state that the life cycle is completed in one year.

Chittenden (9), Essig (11), Rumsey and Brooks (27), Bogue (4), and Howard (19) each stated that when the borers were nearly full grown they ate deeper into the sapwood, and finally worked outward nearly through the bark where they formed large cells in which they transformed to the pupal stage. Other writers are of the opinion that pupation occurs deeper in the sapwood in the cell in which the larva passes the winter.

Hopkins (18) recommended one of the first repellents to prevent egg laying. It was merely placing fresh wood ashes around the roots of the trees in early spring and hanging rags or pieces of old carpet, saturated with soft soap, in the forks of the trees.

Washburn (31), Hillman (17), Stedman (29), Garman (15), Garcia (14), Rumsey and Brooks (27), and Essig (11) have recommended a repellent paint consisting of soft soap, washing soda, and a little carbolic acid to be painted on the tree trunks in early spring. Lime and Paris green could be added to increase the efficiency, according to Stedman (29).

Wright (33), in 1911, recommended painting the trunk with pure white lead and oil without turpentine or dryer. He claimed that this repellent was fairly effective. In 1912, Beach (1) recommended Portland cement mixed with skim milk to a creamy consistency, and worked well into the crevices of the bark. Murrill (23) recommended a white wash composed of stone lime, beef tallow, and salt.

In 1923, Pettit (25) reported on a repellent which was considered very effective. It was as follows: common laundry soap, 50 pounds; water, 3 gallons; flake napthalene, 25 pounds; and flour, 2 pounds.

Another compound was recommended by Lovett (21) in 1923, and reported to be particularly effective. The contents of this compound were rock lime, one-half bushel; rock salt, 2 quarts; rice (cooked to a thin paste), 3 pounds; casein, 2 pounds; napthalene flakes, 2 pounds.

Flint's (13) opinion on repellent paints is that, "No successful repellent wash or paint has been found."

The first larvacides were recommended by Walker (30) in 1907. He advocated the use of kerosene dropped into the burrows or carbon bisulphide injected into the larval chambers, and the holes plugged with grafting wax to confine the gas around the larvae. In 1931, Hutson (20) reported control of flat-heads from the following: 1. raw cottonseed oil and calcium cyanide used as a paste over the infested area, and 2. paradichlorobenzene and raw cottonseed oil also applied as a paint over the infested area.

Many authors claim that the best method of preventing serious damage and reducing the population of beetles is "worming". This is done by removing the larvae with a sharp knife or probe during the summer or early fall before the borers enter the heartwood.

Chandler (8), in 1912, recommended wood veneer wrappers placed upon the trunks of smaller trees to prevent the beetles from depositing eggs thereon. In 1923, Watson (32) recommended shading the tree trunks with a board set up in front of it or a wrap of burlap placed on the trunk to prevent injury. Flint (12), in 1936, reported good success in preventing injury by wrapping the tree trunks with a certain kind of paper.

GEOGRAPHIC DISTRIBUTION

C. femorata, being a native insect of North America, is found in nearly every state in the Union. Petch (24) in 1914 stated that the species is found in various districts of Quebec. Ruhmann (26) reported that this species had caused much loss in newly transplanted orchards in certain sections in British Columbia in 1923.

<u>C. femorata</u> has been collected from many counties in Oklahoma in widely separated parts of the state, as shown in Fig. I, indicating that this insect is abundant throughout the state. The data for this map were compiled from insect pest surveys in Oklahoma.

FOOD PLANTS

The list of plants attacked by <u>C. femorata</u> is extensive. Plants listed by Essig (11) are: apple, apricot, ash, mountain ash, beech, box elder, cherry, chestnut, currant, hickory, horse chestnut, linden, maple, oak, peach, pear, pecan, plum, prune, raspberry, rose, sycamore, and willow. Brooks (5) adds quince, walnut, California poplar, weeping willow, elm, hackberry, service berry, hawthorn, redbud, sugar maple, and Japanese persimmon to the list. Other writers list dogwood, basswood, and Carolina poplar. Blackman (2) has reported finding specimens in white pine. The original food plant of this insect is thought by many writers to be the oak.

The writer has observed the specimens in apple, peach, apricot, plum, pear, sweet cherry, sour cherry, walnut, pecan, native willow, weeping willow, oak, American elm, Chinese elm, redbud, soft maple, and rose bushes. The trees most seriously damaged by flat-heads in recent years in Oklahoma are apple, American elm, sweet cherry, sour cherry, pecan, plum, and soft maple. The borers have also been a very serious pest of rose bushes throughout the state.

NATURE OF INJURY

Flat-headed borer injury can easily be detected by the presence of sawdust castings packed tightly in the feeding galleries just beneath the bark. In many cases the bark will crack and peel off, making the feeding galleries visible, but if the bark is thick it may not crack but may appear darker and slightly raised or depressed over the tunnels.

The feeding galleries are very irregular and winding, and may completely girdle the smaller trees. In larger trees several borers may kill only a portion of the trunk or limb the first year, but in this case the feeding of many more borers the following year will kill the tree.

The tunnels are very narrow at first, gradually widening as the larva approaches maturity, and usually range from three to five inches in length. Lighter colored castings are found near the larger end of the tunnel. These castings are made when the larva starts into the sapwood to make the pupal cell. Large apple and elm trees 6 to 15 inches in diameter have been killed in Oklahoma by the borers (Plate VI, Fig. 1).

TECHNICAL DESCRIPTIONS

The Beetle

(Plate I, Figs. 1 and 2)

The description of the beetle as given by Blatchley (3) is as follows:

> "Oblong or elongate-oblong subdepressed. Color usually dark bronze, sometimes slightly brassy or cupreous; antennae greenish or cupreous, the third joint a little longer than the next two. Side margins of last ventral segment with fine teeth. Disk of thorax irregular, median line more or less sulcate, often with small elevations. Front tibiae of male curved and with numerous fine teeth on the inner edge; clypeus acutely notched at middle, semicircularly curved on each side. Thorax more than twice as wide as long, widest slightly behind the apex; disk irregular, with an indistinct median depression, and a deeper one each side behind and parallel with the apical margin, with other irregular ones near the sides; surface rather coarsely punctured, more densely on the sides. Elytra a little wider than thorax, sides nearly parallel, gradually narrowed on apical third, margin serrate, tips obtuse; sculpture of disk very variable, usually with first and second costae distinct near apex, and with two transverse depressions on each side, the first a little in front of middle, second one-third from apex, the basal depression rather feeble; surface coarsely and, on the sides, confluently punctured. Length 7-16 mm."

Measurements of the 100 specimens made by the writer varied from 7 to 15 mm.

The Egg

(Plate II, Figs. 3 and 4)

The egg of the beetle is deposited on the sunny side of limbs or the trunk of the tree in crevices caused by sun scald or mechanical injury, or in bud scars. It is slightly less than one millimeter in diameter, somewhat flattened, ribbed, and yellow in color. The nature of the crevice or crack in which the egg is deposited tends to determine its shape.

The Larva

(Plate III, Figs. 1 and 2)

The following description of the larva is somewhat similar to that given by Burke (7): Larva clublike, somewhat depressed dorso-ventrally, thorax broad three-segmented, abdomen slender ten-segmented. Prothorax with dorsal and ventral granulose, almost circular shields; the other segments whitish yellow without shield, fleshy, covered with extremely fine hairs and minute asperities. Length of mature larvae 15 to 25 mm., greatest width of prothorax about $5\frac{1}{2}$ mm. Head for the greater part retracted into the prothorax. Mouth frame and mouth parts dark and thickly chitinized.

The Pupa

(Plate IV, Figs. 1 to 4)

In transforming to the pupal stage the old larval skin is cast off and the pupal form is immediately assumed. The following description of the pupa is taken from Burke (7):

> "Flattened, elongate oval, . . . texture smooth and shiny, antennae, mouth parts, wings, and elytra folded against ventral surface; head, especially mouth parts, resting on prosternum; antennae extending obliquely caudad and resting closely against sides of prothorax; prothoracic and mesothoracic legs with femora and tibiae folded together and extending at right angles from the median line; . . . posterior femora extending at right angles to median line, posterior tibiae extending obliquely caudad along ventral surface of first abdominal segment, . . ."

Average length 11 to 12 mm. At first the pupa is very light yellow or creamy color in its entirety. Later the eyes darken. Then gradually the legs, antennae and sternum darken, and lastly, as the pupal skin is cast off the portions of the elytra and wings that were folded around the abdomen move to the back, and the elytra darken to the metallic grey color of the beetle.

TECHNIQUE

In starting the work on life history, infested material containing larvae was collected during the winter and spring of 1936, and placed in screen emergence cages on the campus of A. and M. College in Stillwater. The cages were placed in the open so that the material would be subjected to natural conditions so far as temperature and moisture were concerned.

As the beetles emerged they were removed from the cages daily and placed in feeding cages (Plate II, Fig. 1). These cages consisted of a lantern chimney placed on a six-inch flower pot which contained a four-ounce bottle of water. The pot was then filled with dirt to support the bottle of water. Young twigs of apple and elm were cut and placed in the feeding cages. Care was taken to have the fruit spurs or small lateral branches and leaves remain on the cuttings. A narrow strip of cellucotton was arranged around the twigs in such a manner as to prevent the beetles from falling into the water. Three females and three males were placed in each cage. The cages were then placed on a sunny bench in a greenhouse.

On May 28, a more satisfactory technique of feeding and handling the beetles had been developed, at which time cages A to I (Table I) were set up. The beetles in cage A emerged on May 23; B, May 24; C, May 25; D, May 26; E, May 27; F, May 27; G, May 28; H, May 29; and I, May 29. Cages J to M were set up on successive days as the beetles emerged. The cages were checked daily from May 29 to June 22, but because of the decreased number of beetles the cages were checked on alternate days from June 22 to July 10. The experiment was concluded on July 10 since the last beetles died on that date. The observations on number of eggs laid, mating and feeding habits, and preoviposition period were made and data recorded.

LIFE HISTORY AND HABITS

Pupal Chamber

Larvae were removed from the wood from time to time to check on their development and activity. The pupal cell was never found just beneath the bark but always deep in the sapwood of older trees or in the heartwood of smaller trees (Plate III, Fig. 3). The overwintered larvae, in no case, were found to become active and to feed in the spring, or even migrate from the pupal cell in which they had passed the winter.

The Pupal Stage

Several overwintered prepupal larvae were removed from the wood in March and placed in a constant temperature room at 80 degrees Fahrenheit. The specimens which were observed by the writer remained in the pupal stage from eight days to two weeks.

Several dead larvae, covered with a fungus growth, were found in the field. In the hope of obtaining information concerning this supposed parasitic fungus, six prepupal larvae were removed from wood and placed on moist cotton in petrie dishes in January 1937. Inoculations by several means were made from the spores and fungus mass surrounding the dead larvae. These petrie dishes were placed in an incubator at a temperature of 90 degrees Fahrenheit, or above, and in about two weeks the larvae had transformed into the pupal stage. They were then removed from the incubator and placed at ordinary room temperature, where they transformed into the adult stage nearly three weeks later.

Emergence of Beetles

The first adult beetles emerged at Stillwater on May 4. The rate of emergence of the beetles, as shown in Fig. II, steadily increased to a peak which occurred May 21. Then the rate gradually decreased until June 29, at which time a total of 669 beetles had emerged from the cages. No more beetles were found in the emergence cages after this date.

The rate of emergence was correlated very definitely with the maximum daily temperature up to, and a little past, the peak of emergence (Fig. II). No definite correlation could be observed after this point, but this is explained by the fact that there was a definite decrease in the supply of beetles remaining to emerge.

According to Gill (16),

> "The adults are found in orchards from May to November, but are especially abundant at two periods, namely, during May and from mid-August to mid-September."

Based upon the emergence records at Stillwater, the writer concludes that the beetles will be abundant at one period only, namely, during June and July. As a possible explanation of Gill's statement that the beetles would be abundant at two periods, there is a chance that during June and July they will be more active, thus more difficult to observe in the field.

Feeding Habits of Adults

(Frontispiece)

In searching the literature, the only information concerning the feeding of the adults was that of Burke (6) in which he stated:

> "Although the usual food of the adults is the foliage of the host plant, some are pollen feeders, and as has been determined recently by Mr. F. C. Craighead, some will feed on the spores of fungi."

In a later work by Burke (7) on the Pacific flat-headed borer, C. mali Horn, he found,

> "Although food probably is not necessary to sustain life in the beetle stage of this insect, the beetle does feed. It prefers leaves or the tender bark of young twigs, but will eat the older bark and wood or even paper or cotton. Beetles kept in cages appear to live as long without food as with it."

Certain supposed food materials were placed in the cages to study the feeding habits of the beetles, and observations were made on their reactions. The first material tested was pollen which was taken from a beehive. No feeding was observed upon the pollen. Then when a young twig of elm and a twig of apple with the leaves and fruit spurs remaining were cut and placed in the feeding cages with the adults, the beetles immediately started feeding upon the tender bark in crotches and around bud scars, (Plate II, Fig. 2). It was later found that they sometimes fed on the older bark, but showed a marked preference for the younger.

Beetles remaining in the cages without food lived only a few days while those that had access to plenty of food lived approximately 40 days (Table I). Two beetles were kept alive 44 days. The technique of handling the beetles was not perfected, thus the injury incurred in changing them from cage to cage no doubt decreased their longevity.

Mating Habits

An interesting observation made was that of the drumming habit of the male which was noted very commonly to take place about the second or third day after emergence. This sound made by the male was very audible especially as the glass chimney of the cage acted as a sort of sounding board. The drumming was very rapid and made by the male vibrating the abdomen up and down against the surface upon which he was resting. This drumming sound was apparently a mating call as the females were attracted by this action or sound. They would come up by the male and stop about one-half or three-fourths of an inch from him. Very shortly the male would turn and pursue the female, catching her within an inch or two, and copulation would occur. Sometimes the two remained in copulation for only a short time but most often five or ten minutes, or even longer. Copulation was observed several times during the life of a single female.

Preoviposition Period

No eggs were obtained from the beetles that had not been fed, while those in the feeding cages began depositing eggs after about four to eight days. The average preoviposition period of the series of beetles was 5.8 days, as calculated from Table I. A shortage of food during the first few days after emergence caused a longer preoviposition period.

Oviposition

The females seemed very selective in choosing a place to deposit their eggs. They were observed running up and down the sunny side of limbs, working their short ovipositors in and out over the surface, and would stop only when the ovipositor would strike an uneven surface such as cracks, sun scald checks, or other injuries in the bark which seemed suitable to the female for egg deposition. The first eggs would be laid in such places. It took about 10 to 30 seconds for the female to deposit the egg after a desirable place had been found.

Two small twigs less than half an inch in diameter and one large twig about three-fourths of an inch in diameter were placed in each feeding cage, and practically every egg found was on the larger cutting. A few eggs were found inserted into the cellucotton around the base of the twigs, and one egg was found on the side of the glass chimney.

As many as 24 eggs were obtained from a single female in one day. This was from a beetle in cage H on June 28. The total number of eggs obtained from individual females of the series over the entire egg laying period varied from 22 to 173 (Table I).

Since the first beetles emerged at Stillwater on May 4, and since the preoviposition period was eight days or more, egg laying therefore probably started about May 15, 1936. The last beetles emerged on June 29. As previously stated, the maximum period of longevity was found to be 44 days. Thus the last beetles that emerged would live until about August 15. From this information, it appears to the writer that the natural egg laying period of the beetles is from May 15 to August 15.

Incubation Period

Fresh cuttings were placed in the feeding cages daily, and the cutting upon which the eggs had been deposited was removed and placed in another bottle, and the incubation period of the egg observed. A total of 25 eggs was observed during the course of the experiment. The first egg hatched in eight days; others hatched in about six or seven days. The average incubation period, therefore, as estimated by the writer, is approximately seven days.

Growth and Feeding Habits of the Larva

The young larva could be seen moving within the egg for nearly two days before hatching. In hatching, the small larva ate directly through the side of the egg shell which was in contact with the wood. A small oval hole marked its exit. It then continued directly through the bark of the twig, and the sawdust castings and excrement left behind filled the egg shell.

The one-day old larvae measured 1 1/3 to 2 mm. in length. They had the same characteristic shape as the full grown larvae. The first thoracic segment measured more than twice as wide as the remaining portion of the thorax and abdomen. The enlarged segment of the thorax measured nearly one-third the entire length of the larva.

From observations made, it is believed that the larvae continue to feed on the living tissue in and surrounding the cambium layer until they are nearly full grown, at which time they eat into the sapwood or heartwood and form the pupal cells. This may occur at any time from the latter part of July until late September.

Total Development

The findings of the writer indicate that eggs are present in the field from May 15 to August; larvae in the cambium area from May 25 to September; mature larvae in the pupal cells from early August to the following May; and pupae from late April to June 20. Adults are found from early May to late September or even longer. Collection data for Oklahoma show that adults have been found in the field as late as October. The total developmental period of the flat-headed apple-tree borer from egg to adult is probably therefore one year.

PARASITES AND PREDATORS

About 6.9 per cent of all the flat-headed borers collected in the larval stage were parasitized by at least seven species of hymenoptera. Brooks (5) states that six hymenopterous parasites are known to attack _C. femorata_. They are _Bracon charus Riley_, _B. pectinatus Say_, _Spathius pallidus Ashm._, _Labena apicalis Cr._, _L. grallator Say_, and _Phasgonophora sulcata Westw._

Burke (7) lists six species of hymenopterous parasites of _C. mali_. The most important of these was the chalcid _Trigonura californica Rohwer_ which was noted in 29 of the 49 cases studied, and the next in importance a braconid which was noted in 18 cases. The others were of minor importance.

Essig (11) lists _Bracon charus Riley_, _Cryptus grallator Say_, and _Labena apicalis Cr._ as important hymenopterous parasites.

The seven species of parasitic hymenoptera taken from the emergence cages by the writer were sent to the Bureau of Entomology and Plant Quarantine, Washington, D. C., for identification. It was found that the two most important species of parasites in Oklahoma were _Labena grallator Say_ and a new species of the genus _Cryptoheleostizus_, which were determined by R. A. Cushman. Two other new species of the genus _Eusandalum_ were among the parasites sent for identification. These were determined by A. B. Gahan. The other species of less importance were _Phasgonophora sulcata Westwood_, _Heterospilus astigmus Ashm._, and _Atanycolus rugosiventris Ashm._

Another interesting observation on the natural enemies of the flat-headed borer was that of finding two coleopterous predators, _Chariessa pilosa Forst._ and _Chariessa pilosa onusta Say_, belonging to family Cleridae. Eight specimens of _C. pilosa_ and four of _C. pilosa onusta_ were taken. The larvae of these beetles were found feeding on the larvae of the flat-headed borers near the ground level. The adults of these predators were removed from the emergence cages about June 1, and before being removed were observed to be feeding on the adults of the flat-headed borer. Determinations of the above predators were made by the writer from Blatchley's _Coleoptera of Indiana._

CONTROL

Sustaining a vigorous growing condition of the trees was one of the first cultural methods recommended for combating the flat-headed apple-tree borer. This control practice is, no doubt, of great value where it is possible to carry it out. Many authors state that trees in a healthy, vigorous growing condition are not attacked by the borers, but that weakened and unhealthy trees are attractive to the beetles and that serious damage results.

From observations made during the course of experiments the writer finds that the female beetles needed only to find roughened bark, preferably in the bright sunshine, and eggs would be deposited. This condition may occur on healthy trees as well as unhealthy ones. An explanation of how a beetle can distinguish a healthy tree from one having less vitality could not be found in the literature.

Chittenden (9) states,

> "Observations lead us to have doubts as to the ability of young larvae to withstand the strong flowing sap of vigorous trees."

This seems very evident as the larva is an air-breathing form, and when totally submerged in the liquid sap would succumb.

As previously stated, most authors claim "worming" to be the most satisfactory means of controlling the borers. However this must be done before the borers mature and enter the sapwood. The writer tried killing the overwintered larvae by probing with a sharp wire and found that about three per cent were killed out of several hundred trials at probing.

The use of kerosene injected into the burrows of the borers by means of a medicine dropper or oil can has been recommended by several writers. Kerosene was injected by the writer into the burrows of about 25 overwintered larvae and the borers removed from time to time to observe their condition. They were found to be in excellent condition, apparently unharmed by the presence of the kerosene. Kerosene was also dropped directly on the borers in many cases, and no harmful effects resulted at the end of one day's observation. The writer realizes that this experiment was very limited and that better results might have been obtained had the borers been younger and more active.

Garman (15) in 1908 recommended the use of tree tanglefoot smeared on the trunks of trees and on trap wood to catch the adult beetles, and claimed that this method showed much promise.

In his work on the pecan and persimmon borers in 1923, Watson (32) stated that boards set up in front of the trees or a wrapping of burlap on the trunk would often prevent injury from C. femorata. Observations made by the writer tend to question the efficiency of burlap wrapping. In fact, it is thought that trees wrapped with burlap are more seriously damaged by borers than those plants not wrapped (Plate V). This conclusion is drawn from finding over 100 sour cherry trees in the vicinity of Chilocco, Oklahoma, which had been wrapped with burlap, killed from attacks of the borers. The finding seemed quite unusual as the sour cherry is considered a rather unfavorable host of the borer.

Many repellent paint formulae have been recommended by different writers since 1880. Flint (13) questions the efficiency of all paints and washes. In 1936, he stated that no successful repellent wash or paint for the flat-headed apple-tree borer had been found. Also in 1936, Flint (12) recommended the wrapping of tree trunks with certain heavy paper to prevent borer injury. On very limited experiments conducted by the writer, this method showed much promise. It is thought that this method (Plate VI, Fig. 3) will become the most practical means of preventing borer injury.

SUMMARY

The flat-headed apple-tree borer, Chrysobothris femorata Fab., is one of the most injurious pests of orchard and shade trees in Oklahoma. It belongs to the family Buprestidae, the members of which are known as the metallic wood borers. The larvae of this species have attacked and killed many thousands of trees in recent years by girdling the main trunk.

The flat-headed apple-tree borer is a native of North America, and is probably found in every state in the union, as well as in southern Canada.

The list of food plants of this insect includes at least 30 species, of which apple, elm, and pecan have been most seriously damaged in Oklahoma.

The larvae remain in pupal cells, located deep in the sapwood or heartwood, all winter and remain there to pupate the following spring. The first beetles emerged at Stillwater on May 4, 1936, and emergence continued until June 29.

It was found that the beetles fed very readily on the bark of one-year old apple and elm twigs. They seemed to prefer the bark in crotches and around bud scars. It was also found that it was necessary for the beetles to feed for an average of six days before egg laying started.

The number of eggs obtained from individual females varied from 22 to 173. An average of 69 eggs per female was obtained from the 39 females observed. The eggs hatched in about seven days and the young larvae ate directly to the cambium area, and continued to feed

on the live tissue until fully developed. They then ate deeper into the sapwood or heartwood and formed the pupal cells. The total life cycle was found to be completed in one year.

Seven species of hymenoptera were found parasitizing the larvae of _C. femorata_, three of which were new to science. Two of the species are frequently referred to in literature as parasites of the flat-headed apple-tree borer, and the other two species had never before been reported as parasites of _C. femorata_. Two coleopterous predators were found by the writer to feed on _C. femorata_ in both larval and adult stages.

Preliminary experiments indicate that the best method of preventing a tree from being attacked by the flat-headed apple-tree borer is to use paper wraps, or tree protectors, which keep the females from depositing their eggs on the bark of the main trunk. After the tree is attacked by the borers, the best method of saving it is to cut them out with a sharp knife before they enter the sapwood.

BIBLIOGRAPHY

(1) Beach, S. A. Spraying Practice for Orchard and Garden. Iowa Exp. Sta. Bul. 127, 1912.

(2) Blackman, M. W. "Notes on Forest Insects". Psyche, (August, 1919), pages 85-96.

(3) Blatchley, W. S. Coleoptera of Indiana.

(4) Bogue, E. E. Some Injurious Orchard Insects. Okla. Exp. Sta. Bul. 26, 1897.

(5) Brooks, F. E. The Flat-Headed Apple-Tree Borer. U. S. Dept. Agri., Farmers Bul. 1065, 1919.

(6) Burke, H. E. Flat-Headed Borers Affecting Forest Trees in the United States. U. S. Dept. Agri. Bul. 437, 1917.

(7) Burke, H. E. The Pacific Flathead Borer. U. S. Dept. Agri., Tech. Bul. 83, 1929.

(8) Chandler, W. H. Combating Orchard and Garden Enemies. Mo. Bul. 102, 1912.

(9) Chittenden, F. H. The Larger Apple-Tree Borers. U. S. Dept. Agri., Div. of Ento., Circ. 32, 1898, Rev. 1902.

(10) Cordley, A. B. Insects of the Prune. Ore. Exp. Sta. Bul. 45, 1879.

(11) Essig, E. O. Injurious and Beneficial Insects of California. Calif. State Comm. of Hort., 1915.

(12) Flint, W. P. Crop Protection Institute Circ., Vol. 10, 1936.

(13) Flint, W. P. News Letter. Ill. State Hort. Soc. No. 7, Oct. 1936, pages 3-4.

(14) Garcia, Fabian. Injurious Insects. N. M. Exp. Sta. Bul. 68, 1908.

(15) Garman, H. Spraying Apple Trees and Apple Orchard Pests in Kentucky. Ky. Exp. Sta. Bul. 133, 1908.

(16) Gill, John B. Important Pecan Insects and Their Control. U. S. Dept. Agri., Farmers Bul. 1364, 1924.

(17) Hillman, F. H. Some Common Injurious Insects of Nevada. Nev. Exp. Sta. Bul. 36, 1897.

(18) Hopkins, A. D. Report of Entomologist. W. Va. Sta., 3rd Annual Report, 1890, pages 45-180.

(19) Howard, W. L. The Apricot in California. Calif. Circ. 238, 1922.

(20) Hutson, R. Control Measures of the Flat-Headed Borers. 62nd Annual Report of Ento. Soc. of Ontario, 1931.

(21) Lovett, A. L. Tree Borers and Their Control. Ore. Exp. Sta. Circ. 39, 1923.

(22) Matz, J. Diseases and Insect Pests of the Pecan. Fla. Exp. Sta. Bul. 147, 1918.

(23) Murrill, A. W. Report of Entomologist. 7th Annual Report of Ariz. Comm. Agri. and Hort., 1915.

(24) Petch, C. E. Insects Injurious in Southern Quebec. 45th Annual Report of Ento. Soc. of Ontario, 1914.

(25) Pettit, R. H. A Repellent for Flat-Headed Borers. Mich. Agri. Col. Quar. Bul. 5, 1923.

(26) Ruhmann, M. H. Report of Assistant Entomologist. 18th Annual Report, Dept. Agri., British Columbia, 1923.

(27) Rumsey, W. E. and Brooks, F. E. Starting Young Orchards. W. Va. Bul. 116, 1908.

(28) Smith, R. I. Insects and Fungous Diseases of Apple and Pear. N. C. Bul. 206, 1910.

(29) Stedman, J. M. The Fruit Tree Bark Beetles. Mo. Exp. Sta. Bul. 44, 1900.

(30) Walker, Ernest. Suggestions Upon Care of Apple Orchards. Ark. Exp. Sta. Bul. 91, 1907.

(31) Washburn, F. L. Entomological Notes. Ore. Exp. Sta. Bul. 5, 1890.

(32) Watson, J. R. The Pecan and Persimmon Borer. Quar. Bul. State Plant Bd. of Fla. VIII, No. 1, 1923, pages 17-18.

(33) Wright, W. J. The Control of Insects and Diseases Affecting Horticultural Crops. Pa. Exp. Sta. Bul. 110, 1911.

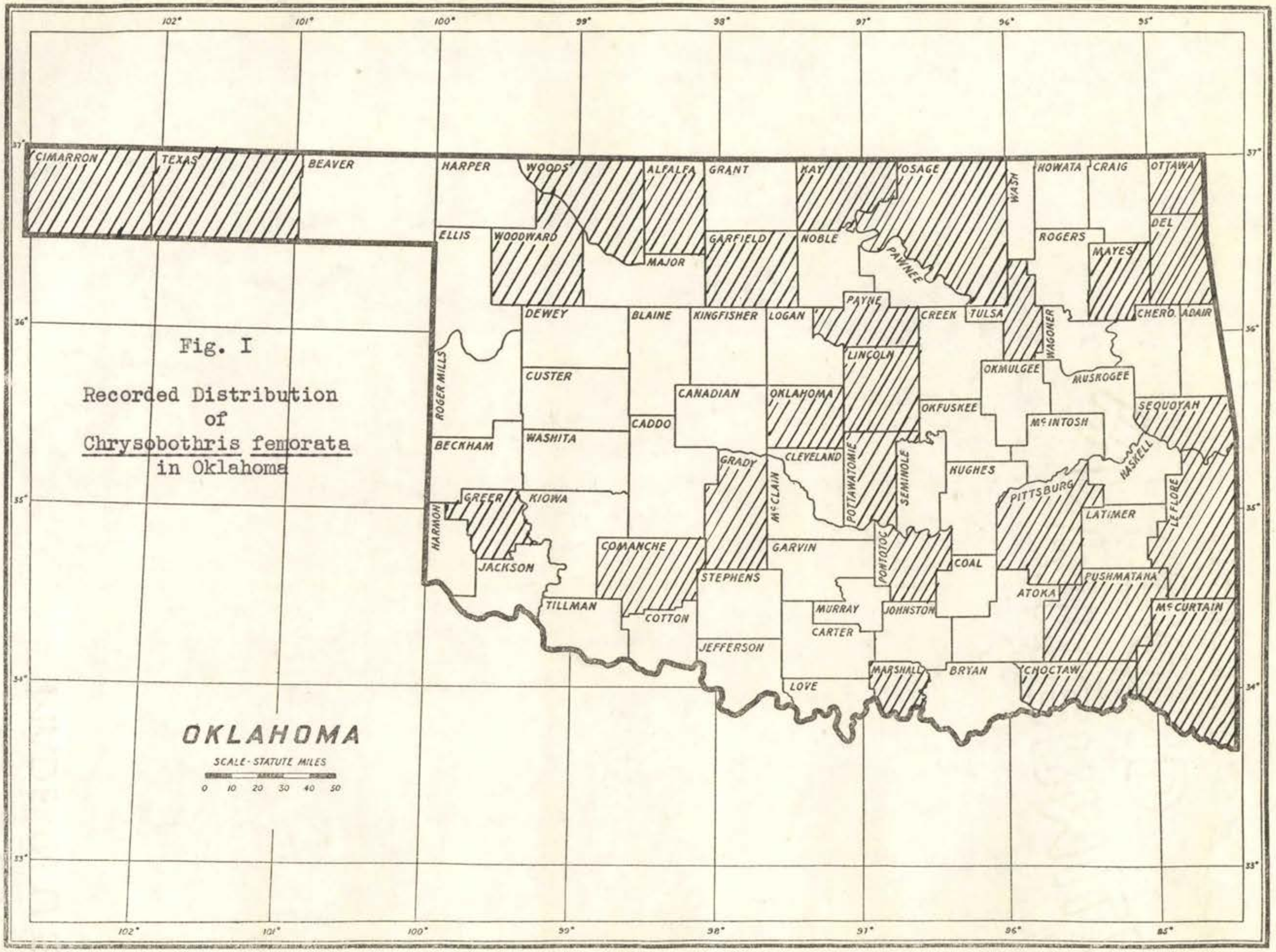
Fig. I
Recorded Distribution
of
Chrysobothris femorata
in Oklahoma
OKLAHOMA
SCALE - STATUTE MILES
0 10 20 30 40 50
CIMARRON
TEXAS
BEAVER
HARPER
WOODS
ALFALFA
GRANT
KAY
OSAGE
WASH
NOWATA
CRAIG
OTTAWA
ELLIS
WOODWARD
MAJOR
GARFIELD
NOBLE
PAWNEE
ROGERS
MAYES
DEL
DEWEY
BLAINE
KINGFISHER
LOGAN
PAYNE
CREEK
TULSA
WAGONER
CHERO.
ADAIR
ROGER MILLS
CUSTER
LINCOLN
OKMULGEE
MUSKOGEE
CANADIAN
OKLAHOMA
OKFUSKEE
SEQUOYAH
CADDO
McINTOSH
BECKHAM
WASHITA
CLEVELAND
GRADY
McCLAIN
POTTAWATOMIE
SEMINOLE
HUGHES
HASKELL
GREER
KIOWA
PITTSBURG
LATIMER
LE FLORE
HARMON
JACKSON
COMANCHE
GARVIN
PONTOTOC
COAL
STEPHENS
ATOKA
PUSHMATAHA
TILLMAN
COTTON
MURRAY
JOHNSTON
McCURTAIN
CARTER
JEFFERSON
MARSHALL
BRYAN
CHOCTAW
LOVE

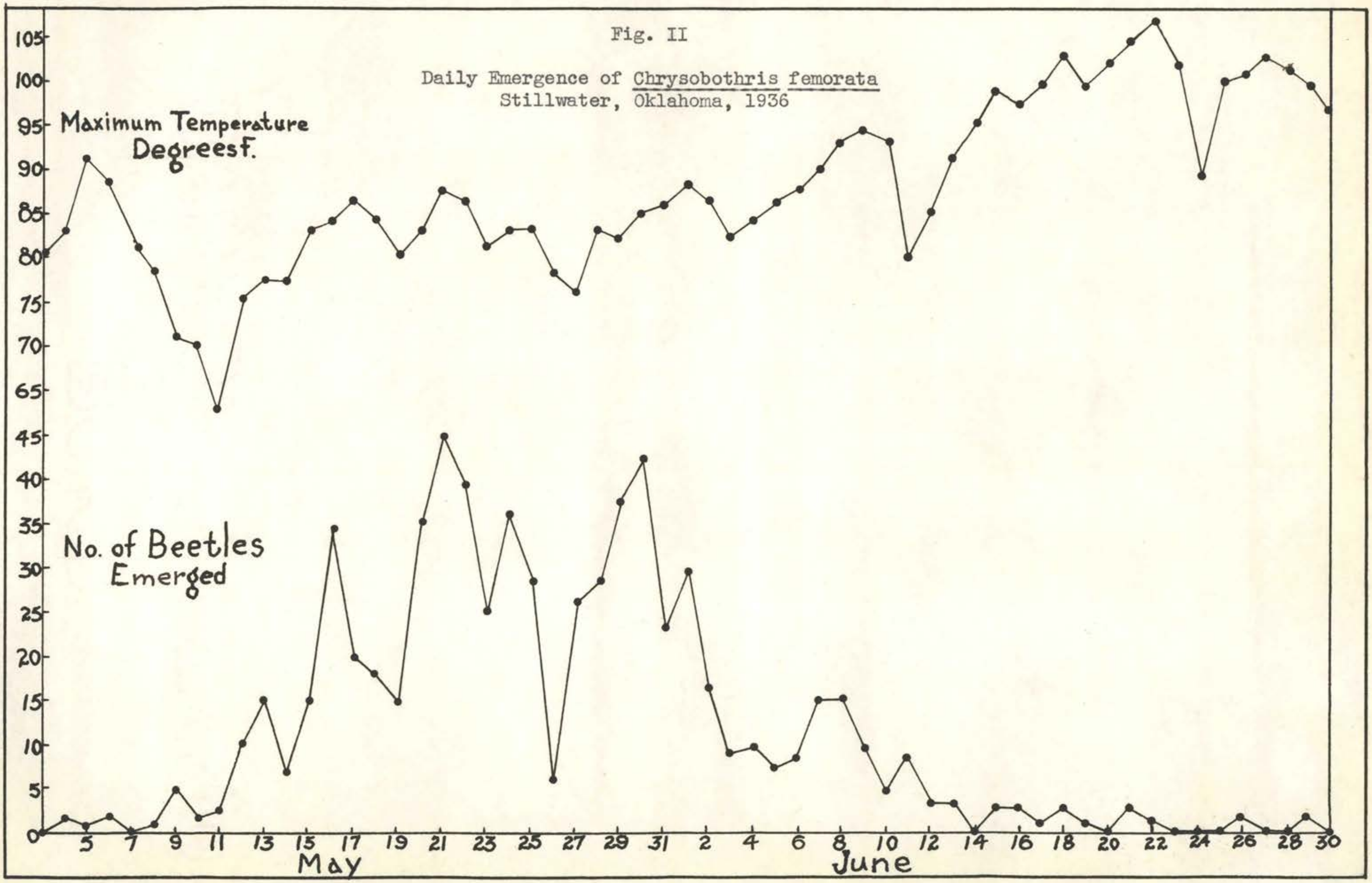

Fig. II

Daily Emergence of <u>Chrysobothris femorata</u>
Stillwater, Oklahoma, 1936

Table I

Daily Egg Record

Cage	May			June																							July					Total No. Eggs Per Cage	Total No. Eggs Per Female
	29	30	31	1	2	3	4	6	8	9	10	11	12	13	14	16	17	18	19	20	21	22	24	26	28	30	2	4	6	8	10		
A	5	12	12	4	6	0	3	11	13	*5	0	0	0	3	6	10	8	0	**0													98	38
B	0	0	3	2	10	6	3	3	*11	12	10	0	*0	11	1	9	6	4	4	0	2	4	0	*0								101	66
C	0	0	14	7	12	20	*4	9	7	2	*0	2	0	0	*0																	77	27
D	0	0	0	3	5	5	4	*4	11	12	2	0	5	0	0	2	1	6	5	*0	0	*0										65	30
E	0	0	0	12	25	15	4	14	11	21	10	0	1	11	16	16	7	2	0	0	*0	0	*0									165	59
F	0	0	0	7	8	11	2	7	11	*2	2	0	0	*2	3	17	2	9	2	1	3	4	1	3	7	*0						104	68
G	0	0	0	11	17	8	13	5	3	**9																						66	22
H	0	0	0	0	34	30	6	4	20	21	11	0	0	7	20	*23	11	10	7	5	*0	22	16	22	24	1	4	3	0	0	*2	303	173
I	0	0	0	0	8	1	14	9	3	*6	0	0	0	15	11	19	12	15	8	8	11	*3	4	4	7	4	1	*8				171	95
J		0	0	0	0	4	2	8	12	19	4	1	*3	22	10	13	9	10	5	4	6	7	10	40	*19	16	11	4	*0			239	136
K			0	0	0	0	0	0	3	2	2	0	1	*5	11	20	4	5	-	-	-	9	0	9	1	6	3	5	*3	*0		89	45
L				0	0	0	0	0	12	9	14	*0	2	29	19	25	5	33	-	-	-	14	10	*2	*4							177	86
M					0	0	0	0	17	11	2	0	0	17	3	3	*3	7	-	-	-	28	0	16	5	*4	5	*3				124	54

Total 1779

Average No. of Eggs Per Female. . . . 69

* One female dead.

PLATE I

Fig. 1. Dorsal view of beetle
(x 5.5).

Fig. 2. Ventral view of beetle
(x 5.5).

PLATE II

Fig. 1. Feeding cage used in studying adults.

Fig. 2. Showing injury resulting from adult feeding (x 2).

Fig. 3. C. femorata egg in bud scar (x 8).

Fig. 4. Eggs placed in crack caused by wound (x6).

PLATE III

Fig. 1. Ventral and dorsal view of mature larvae of C. femorata (x 2).

Fig. 2. Larva in heartwood.

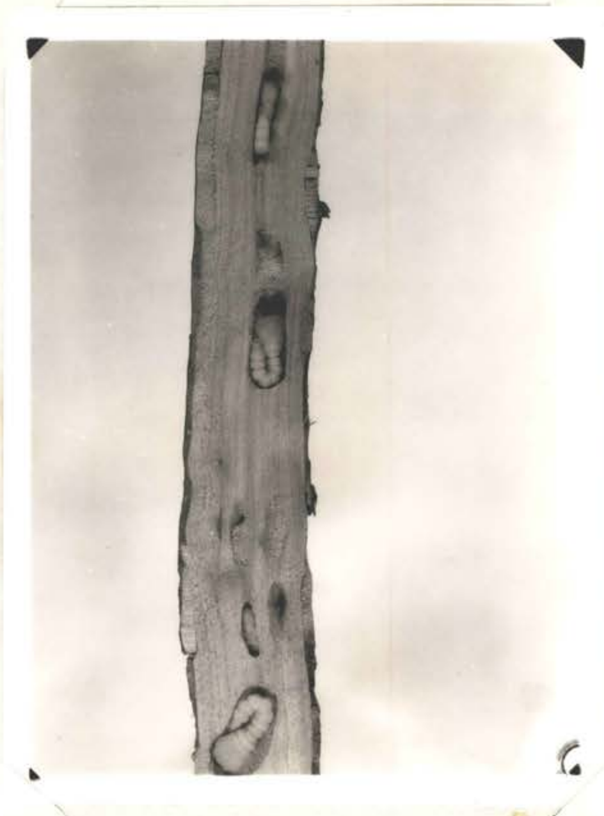

Fig. 3. Overwintered larvae in pupal cells.

PLATE IV

Fig. 1. Ventral view of pupa of C. femorata soon after transformation (x5.4).

Fig. 2. Dorsal view of pupa shown in Fig. 1 (x 5.4).

Fig. 3. Ventral view of pupa nearing maturity (x 5).

Fig. 4. Dorsal view of pupa shown in Fig. 3 (x 5).

PLATE V

Fig. 1. Damage resulting from larval feeding in tree trunk wrapped with burlap.

PLATE VI

Fig. 1. Large apple tree attacked and killed by larvae of C. femorata.

Fig. 2. Type of tree very susceptible to borer injury.

Fig. 3. Small apple tree wrapped with paper to prevent injury.

Typist--Thelma Holmes Maxwell
(Mrs. J. Myron)