Life History With Methods of Control for the Peach Tree Borer in Oklahoma (Sanninoidea exitiosa)

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The eastern peach tree borer (S. exitiosa) has been the subject of upward of 200 pieces of literature, and the desire to know its life history and means of control has been the cause of much investigation and ingenious experiments.

Prior to the year 1749 we have no recorded ~~history~~ of the peach tree borer. The peach tree was introduced into the United States about the year 1680, or nearly a century before any record of the borer attacking this introduced plant. This insect is no doubt a native species. At least some stage of this pest has been known for 167 years; and during this period it has established a permanent record in the history of Economic Entomology of North America. The peach tree borer first came under the observation of fruit growers in New york in the year 1749, and 20 years later methods for preventing damage from this insect was being devised by Cooper in New Jersey. In 1801 the subject of the peach tree borer was presented to the Agricultural Society of Massachusetts, and 20 years later it became a common menance to peach growing in that state, and North Carolina, as well. By the year 1850 this insect had established itself through the peach growing area laying between the Atlantic Ocean and the Mississippi river.

Record is made of this insect in the "Canadian Entomoligist" as being present in Canada as early as 1871. In 1869, Riley speaks of this insect as being very common in Missouri, and it was reported as being present in Kansas in 1873. In 1896 this pest was injurious to peach trees in Texas. Records here in this Station state that the peach borer was a serious pest of the peach orchard in 1897, but no doubt it was present in Oklahoma before this date. Very likely the borer was introduced into this state during early settlement, when Oklahoma was made use of as a dumping ground for inferior and infested nursery stock from northern and eastern nurseries.

Geographical Distribution

The peach tree borer is now widly distributed thruout that portion of the United States laying east of the Rocky Mountains, together with southern Canada and Mexico. In this area wherever the peach tree grows conditions prove to be favorable for the development of the borer.

In Oklahoma there are very few peach orchards that do not suffer more or less from attacks of this insect. So far as present investigations direct the peach tree borer is established in the central and eastern portions of the state, in greater numbers than farther west.

Descriptive

The adult moth of the peach tree borer was first described by Say in 1823. The following original description, revised, is taken from Say Entomology, Vol. 1, p. 36: "Aegeria exitiosa.- Desc. male. Body steel-blue; antennae ciliated on the inner side, black, with a tinge of blue; palpi beneath, yellow; head with a band at base, both above and beneath, pale yellow; eyes black-brown; thorax with two pale yellow longitudinal lines, and a transverse one behind, interrupted above, and a spot of the same color, beneath the origin of the wings; wings hyaline nervures and margin steel-blue, which is more dilated on the costal margin, and on the anastomosing band of the superior wings; feet steel-blue, the coxae, two bands on the tibiae including the spines, incisures of the posterior tarsi, and anterior tarsi behind, pale yellow; abdomen with two very narrow pale yellow bands, one of which is near the base, and the other on the middle; tail fringed, the fringe margined, with white each side.

"Female. Body very dark steel-blue, with a tinge of purple; antennae destitute of ciliae; palpi beneath, black; thorax immaculate; superior wings steel-blue, without any hyaline spots; inferior wings hyaline, with an opaque margin and longitudinal line; the latter and costal margin are dilated; tergum with the fifth segment bright reddish-fulvous."

Later Beutenmuller placed the insect under the genus Sanninoidea and gave the following description: Sanninoidea Beutenmuller, Bull. Am. Mus. Nat. Hist., Vol. VIII, 1896, p. 126.

Palpi scarcely upturned, loosely scaled of first and second joints; third joint with oppressed scales. First joint very short; second joint three times as long as the first; third joint much thinner than the second, and about one-third as long. Antennae filiform, simple in the female, with fascicles of cilia in the male. Middle and hind leggs tufted at the joints anal, tufts of male wedge-shaped; female with a short tuft at each side, at the base of the last segment. Fore wings with eleven veins; 7-8 stalked. Hind wings with veins 3-4 on a short stalk, 2 from cell. Type, Aegeria exitiosa Say.

Synonomy

The following scientific names have been applied to the common peach tree borer:

Zygaena persicae	Barton, 1805
Aegeria exitiosa	Say, 1823
Apis persica	Thomas, 1824
Paranthrene pepsidiformis	Hubbner, 1825
Aegeria persicae	Harris, 1826
Sphinx exitiosa	Brown, 1832
Trochilum exitiosum	Fitch, 1856

Trochilum exitiosa	Morris, 1862
Sesia xiphiaeformis	Boisduval, 1874
Sannina exitiosa	Butler, 1874
Sanninoidea exitiosa	Beutenmuller, 1896

Varieties

Ageria exitiosa fitchii, female	Edwards, 1882
Sonnina exitiosa luminosa, male	Neumoegen, 1894
Sanninoidea exitiosa edwardsii, female	Beutenmuller, 1899

Harris stated in 1826 that Dr. Barton described this insect as Zygaena persicae in an essay which was published, in part, by Dr. Mease. Harris also claimed that the name imposed by Barton should have priority. But in his later writings Mr. Harris uses exitiosa. If Dr. Barton's description was ever published it was lost, however the name persicae was used by him but no description by that author has ever been found. Thomas Say first described this insect and gave it the specific name exitiosa, because of its destructive habits, and to-day this name is applied to the peach tree borer the world over.

Life History

The winter is passed in the larval stage, usually under the bark of the trees, where they hibernate during the colder weather,

Some winters in Oklahoma the larvae are active until the middle of December. The larvae awake in the warmer spring temperature and renew their destructive habits of tunneling the sapwood near or below the crown of the tree. When they become full grown they construct a cocoon in which they are protected and carried thru pupation. Shortly after pupation the adult moths begin to emerge and deposit eggs on the trunks of the trees which hatch into small dull white larvae. Larvae in most all stages of development may be found during the winter and because of this fact the moths continue to emerge thruout greater portions of the summer months. There is but one generation annually.

The sexes mate ordinarily within a few hours after emerging, and immediately the female begins to oviposit, the male living only a short time after copulation. The female, when confined to the exclusion of the male, will often deposit eggs without being fertilized, but under such conditions she will not lay her eggs nearly so soon after emerging, and in many cases will not oviposit at all.

The Egg. The eggs are brown, subellipsoidal, with a distinct oblong-oval concavity dorsally. They harmonize quite well with the bark of the tree on which they are deposited. The microphile end is concave and truncate. The shell is sculptured with a net-work of veins that form irregular polygons. The eggs are about 0.8 mm. long and 0.55 mm. wide. They are firmly cemented to their support and the chorion may adhere to the bark long after hatching, or the infertile

eggs may remain intact for a considerable time following oviposition. The average number of eggs deposited by a single female in the breeding cages was 142, the greatest number deposited by a single female was 244. The greatest number counted in one bunch was 22. E. N. Cory states that he counted 47 in one mass, and also that the majority of the eggs were laid on the foliage. In 1897 Prof. Smith dissected a female and counted 625 eggs in her body and found all but a few of them brown and of full size. Probably the greatest number counted in one female was given by "W. T.", Washington, D. C., 1820, as 678 eggs.

Prof. Smith writes: "The adult life is short, perhaps no more than a day or two, and the female is capable of laying 500 to 600 eggs in that time." The number of eggs deposited by the female peach borer is great, and if all the eggs deposited on our peach trees were fertile, and not subject to natural enemies the damage would certainly be more extensive. Fortunately, however, only 15 or 20% of the total number of eggs deposited ever hatch, and still a smaller per cent of those hatching ever give rise to borers that enter the tree and become mature insects.

In the breeding work by far the greater portion of the eggs were deposited on the main trunk of the tree and branches. The majority of eggs in nature seem to be placed singly and within a foot or two of the crown. The female appears to have little choice as to

the exact location of eggs, readily deposits them on smooth bark, in crevices, on branches, on leaves and sometimes the eggs are deposited on vegetation near the base of food plants. The incubation period of the egg is 10 to 14 days in Oklahoma.

The Larva. The newly hatched larvae are of a dull white color and not easily detected by the naked eye, being only 0.6 to 0.8 mm. long. The full grown larvae are from $\frac{3}{4}$ to 1 3/8 inches long (20 to 30 mm.) and 5 to 6 mm. at greatest width. The body, white or yellowish white; head reddish brown, with a triangular light spot on each epicranial lobe, mandibles strong and toothed, the teeth being darker. Body sparsely pubscent, hairs arising from tubercles. There are five pairs of prolegs armed with hooks.

During the course of growth the larvae molt five or six times, each instar representing a distinct stage in larval development. Immediatley after issuing from the egg the minute larvae enter the tree, usually thru a crevice, and begin to feed on the softer growing tissues just inside the bark or on the cambium layer, near the crown of the tree. As growth continues the borers start downward, eating and tunneling the white wood and growing dark as they go. The burrows often extend down into the roots, but it is an exception to find where a larva has burrowed toward the center of the tree. The channels are somewhat tortuous and irregular, usually extending from an inch or so above the soil downward to a distance of 4 to 6 inches. About eleven months

of the peach tree borer's existance is passed in the larval stage.

Most of the larvae hibernate over winter in their burrows just under the bark and below the surface of the soil. Some, however, never enter the tree to hibernate but remain on the exterior and hibernate in the gummy exudate and adjacent soil. When not well protected otherwise, the larva cinstructs for itself a silken hibernaculum, composed of bits of frass supported by silken threads in which to pass inclement weather. In the tunnels beneath the bark, below the surface, of the soil, the larvae seem to provide no such protection. The presence of the borer is indicated by the accumulation of waxy exudation about the base of the tree.

Pupa. The pupa is somewhat light in color when first formed, but later changes to dark brown, finally assuming the color of the adult. The naked pupa measures 9/16 to 6/8 inches in length. The female pupa is larger than the male and has but one row of spines dorsad of the seventh abdominal segment, while the male has twice that number of rows. Professor Slingerland states: "When nearly mature, the female pupae are also readily distinguished from the males by the fact that the fourth, or fourth and fifth, abdominal segment assumes a dark orange color; the orange-colored segment of the female developing the inside simply shows through the skin of the pupa." The pupal stage is ordinarily one of inaction, though wonderful changes take place in the transformation from larval to the pupal stage. Completely, changed, the pupa breaks open the end of cocoon and by constant twisting,

using the thoracic spines as aids, draws itself from the cocoon. With the tip of the abdomen remaining in the cocoon, the pupa case splits along the head and back, and the adult moth emerges. The duration of the pupal stage, after complete transformation, is 15 to 18 days in Oklahoma.

Cocoon

When mature the larvae set about to perform their last duty, which is the construction of a cocoon. When the larvae have reached maturity they move from the base of their burrows upward and drill a hole to the exterior. Thru this exit they pass frass, and excrement, and there is also an elimination of gum at this point. After having completed its work on the interior, the larva passes out thru the small hole, and envelopes his body in the exudate material. The cocoon is generally located on the outside of the tree and is composed of the frass and gum held together and lined with a thin layer of silk of the larva's own manufacture. The process of spinning the cocoon occupies about 4 days, there follows another period of 2 or 3 days before pupation is apparent, the latter period in which the larva is in a state of inaction. The cocoon is about 1 inch long; brown, rough, elongate-oval, slightly tapering from center to each end. The cocoon is often formed an inch or so below the surface of soil, and sometimes formed under the bark,

but usually it is located on the outside of the tree near the surface of the soil. In some instances the pupa, after emerging from the cocoon, passed thru several inches of sandy soil in order to reach the surface where the adult could emerge in the open. But we can say, with very few exceptions, that pupation occures in a location where the escape of the adult moth will not be handicapped.

Food Plants

The peach tree borer, although it has a decided preference for the peach tree, has been known to infest the following list of plants:

Peach
Cultivated plum
Cherry
Prune
Almond
Apricot
Nectarine
Azaleas

The oldest record claiming injury to the peach tree by this borer was made in 1749, by the Swedish scientist, Peter Kalm.

Dr. Fitch found the borer working in plum trees indigenous to North America and was led to believe that very likely the native

wild plum was its original plant food. Devereaux observed the borer subsisting on wild cherry and his discovery led him to suggest wild cherry as being originally the food plant of the peach tree borer. Japan plums when grafted on exotic stocks became badly infested with borers, but when budded on native stock of plums enjoyed perfect immunity (Virginia, G. E. M.). The fact that there seems to be no record of the borer ever having been found infesting our indigenous plum places the bulk of evidence in favor of the wild cherry as being the original food plant of this insect. In this connection Prof. Slingerland was led to state that "perhaps it originally fed upon both",--wild cherry and wild plum. Considering that either of these served as food for this borer prior to the introduction of the peach, we can understand how the borer could have only been waiting for a more suitable diet.

Emergence of Adults

In Oklahoma the adult moths begin to emerge the middle of June. The individuals, however, that come forth at this early date are very few. The rate of emergence gradually increases, reaching a maximum about August the 20th, and then gradually decreases until September 20th, when the emerging season closes.

In badly infested orchards, near Guthrie, the adults were emerging rapidly the first week in September. One tree yielded eleven pupae, and two adults emerged during the time required to gather the

eleven specimens. In several instances, adults would emerge from the pupa case while being transferred to a small box. The same conditions were found to exist in the eastern part of the state.

Sexes

In all the specimens collected males were in the majority. The differences in sexes of the peach tree borer are well marked in all stages with the exception of the eggs. The adult female differs from the male in being larger, and of more heavy build; posterior wings of female are transparent, the fore wings covered with scales. The wings of the male are destitute of scales except for a cross vein in the fore wing and the margin of both wings. The abdomen of the female is marked by an orange colored band. The female larvae are considerably larger than the larvae that develop into males. The cocoon therefore accomidating the female pupa would necessarily be larger.

Dissemination

Insects differ greatly in their powers of dispersal; and this is an important element in determining the cause of their destribution. In the peach tree borer we find the powers of dispersal approaching a maximum; though the adult is not of a tenacious character it is at the

same time quite capable of evading natural agencies that tend toward its extinction.

N. Banks, in the "Principal Insects Liable to be Distributed on Nursery Stock", gives an account of S. exitiosa, and no doubt shipment of nursery stock infested with peach borer larvae is directly responsible for the present widely infested area. The small larvae can easily secure hold in the crown of young nursery trees, and with the shipment of same consigned to a distant locality is certain to cary the pest to the locality wherever the infested trees are planted.

Local and general spread results from flight of the adults. The distance which the adult will fly is probably short, but by this means the pest will, once established, continue to spread from orchard to orchard.

Methods of Control

Parasitic Control

Owing to the importance attached to parasites in the control of many insect pests, considerable time was devoted to breeding any parasitic enemies of the peach borer that could be found. As many as eight species of insects are known to be parasitic upon this pest; viz., Phoegenes ater, Ephialter irritator, Bracon mellitor, Microgaster sp., Bracon sp., Bracon nigropictus, all of which are hymenopterous insects; and to this list should be added two species of Chalcid flies.

Only one species of natural enemy could be found in sufficient numbers as to warrant any breeding work. The one enemy found to be abundant near Stillwater was first collected on the 15th of July, and Dr. Howard writes us that Mr. Cushman of the Bureau reports the parasite as Microbracon sp. No specific name was given. This insect seems to have never been recorded as a parasite of the peach tree borer in any previous publication.

Life History of Parasite

The eggs are deposited by the female upon the surface of the borer, or at least on the interior of its cocoon. The number

of eggs deposited ranges from 10 to 50. In most cases they are placed singly, but in several instances two to four eggs were found lying side by side. The incubation period of the eggs is 5 days. They hatch into small footless larvae, that are armed with suckers by which they are able to extract nourishment from their host. The larvae remain clinging to the body of their host for four days, then they begin to spin a silken cocoon about their own body, and within two days transform into pupae. The entire life of the parasite until the adult stage is reached is passed inside the cocoon of the borer. The duration of the pupal stage was found to be 8 to 10 days.

About the first of September the last generation of parasites ordinarily has reached maturity. The larvae construct a roomy cocoon as described above but do not make further transformation until spring but pass the winter in the larval stage.

Eggs. The egg is milky white, semitransparent, slender, slightly larger cephalad and gradually tapering to a very fine point; straight, 0.5 mm. long and 0.16 mm. wide. So small is the egg as to be almost invisible to the naked eye, and in many cases would likely escape observation without the assistance of a magnifying glass.

Larva. The mature larva is about 2 mm. long and one-half as wide; creamy white; dorsal aspect deeply furrowed, slightly convex; body broadened near the caudal end, cephalic end constricted and bent

ventrad; sucker slightly protruding, brownish line leading from outer portion of sucker terminating at distal margin of second cephalic segment. Ventral side clothed with many minute short hairs. Thirteen segments in body; dorsal half overhanging the ventral half. The larva is devoid of legs and is but very slightly motile.

Pupa. Color same as body of adult, dull brown, slightly convex, head normal; antannae, legs and ovipositor folded under ventral side, all distinct. The head, abdomen and thorax are distinctly differentiated from each other.

Oviposition

The process of oviposition of this parasite is analagous in many respects to oviposition of the parasitic Ichneumon flies. The adult parasite, when given access to peach borer cocoon containing a larva would crawl slowly over it, from end to end, and from side to side. The antennae were alternately lowered and raised laterally and kept in constant vibration, except when broken by intervals of stillness. Using the antannae as means of apparently locating the borer within the cocoon and after selecting the desired spot, the parasite would elevate the abdomen and bend it dorsally, and bring the ovipositor more vertically under the body. It appears that the insect gives all the time necessary to making preparations, by carefully procuring ample

footing and a hold that would not give way, and then by pressure the ovipositor was inserted.

Number of Generations

There are as many as two generations per year in Oklahoma and possibly three. Adults issued on the 16th of July and two generations were reared in the laboratory following this date. The second brood of larvae reached maturity about August 21, but no adults issued until the following spring. If the adults issuing on July 16th were the first generation to emerge then only two generations occur annually.

Behavior of Parasite

When first the adults issued in the laboratory a few females were transferred to a small breeding cage in which larvae of the peach tree borer had been placed; also in the base of the cage was placed gum exudate, frass and bark from the peach tree, in which the borers were working. Some of the borers were preparing to pupate and had begun to form a cocoon while others were not so far advanced in their development. The parasite proved itself very compitent in making choice between the different stages of her host. She had disappeared from sight and remained beneath the fragments, undisturbed for two hours,

but when interrupted the parasite did not fly off but crawled out and rested upon the piece of bark that had hid her body. Directly beneath this piece of bark and gum was a mature borer larva spinning its cocoon and upon examination eggs were found to be adhering to the body of the latter.

In a second cage was placed one borer larva that showed no signs of preparing a cocoon and one that was making ready for pupation. Female parasites were given access to these same as in the previous cage, and after a few hours examination was made and all the parasites were found to be ovipositing on the mature borer.

In another breeding cage where parasites and a borer that was preparing a cocoon, though not complete, and another borer that had just finished the task, was placed the latter again gained the attention of the parasites. The adult parasites gave no attention to completly transformed pupa.

Then in all cases the parasite showed a decided preference toward mature borer larvae, rejecting those that were not far enough to spin a cocoon, and ignored the pupa altogether.

Parthenogenesis

The breeding experiments prove conclusively that this parasite is parthenogenetic. During the time the parasites were under observation,

no males were present. Of the two generations reared in the laboratory and other specimens collected in the orchards, only females appeared. Parasite as soon as they emerged were transfered to a small breeding cage and they immediately began ovipositing and the eggs were fertil.

Effect of Parasite on Borer

A number of specimens inside the cocoon, on which the parasite had oviposited, were examined before the eggs had hatched and in no case could any injury to the borer, by the adult parasite be detected. And in all cases the borer was found to be active. But in one instance the eggs were removed from the body of the borer, that died a few days later. Yet it appears to be the larval stage of the parasite that is so instrumental in arresting the growth of the borer. Immediately upon hatching the small larvae begin feeding upon the borer, and they do not abraise the epidermis of the borer but with their sucker attached in a short time a few of them are capable of extracting enough of the vital fluids from the body of their host so that development of the latter ceases. Where the borer is infested with a considerable number of parasites, each one obtaining food in the manner described above, at the time the parasitic larvae have reached maturity about all that will remain of the borer will be its dried skin and head. Though the infested borer soon dies it does not

putrify. Shrinkage in the borer facilitates the growth and development of the parasite, in that in many cases the cocoon of the borer is completely filled by its parasitic population.

Number of Parasites per Host

The number of parasites found living on a single larval host varies greatly, ranging from a few up to 50, the greatest number found. Where as many as 50 parasitic larvae were found infesting a single borer only one-fifth of them matured and emerged, and one-half of these remaining perished as immature larvae, and on the same borer occured as parasites in stages from very small larvae to pupa ready to emerge. In such cases the food supply became completely exhausted and nothing remained of the borer except dried skin and head, and the parasites were unable to secure sufficient food necessary for continued development. However, there is food enough in one borer larva to furnish the required amount of nourishment for more than on-fifth of 50 parasites but when apportioned to such a large number, a majority must necessarily suffer. As many as 36 parasitic larvae is known to have developed on a single host, matured and transformed to the pupal stage.

Distribution in Oklahoma and Importance

The importance of this parasite about Stillwater is by no means insignificant. In some of the peach orchards near here this single parasite is very active and in 1915 and 1916 was effective in controling the peach tree borer to a marked extent. In collections made during the latter part of August as high as 72% of the specimens were parasitized. Near Guthrie one large orchard in particular, where the borers were present in great numbers, few parasites were found. No parasites were found at Chicasha or Durant. The eastern part of the state is badly infested with peach borers, but very few parasitized forms were discovered there.

All the other localities visited in Oklahoma exhibited the parasites liking or present in much smaller numbers than about Stillwater.

Artificial Control

The orchard in which the experimental work was done consisted of 100 peach trees which at the beginning of the work were 4 years of age. The trees were thrifty and had received good cultivation prior to the experiments. The trees were not seriously infested by borers but there was not a single tree in the orchard that did not exhibit some indications of injury by the borer, while some of the trees were maintaining as many as 6 to 10 borers each.

Eight different remedial measures were applied to eight rows of trees, each row containing 10 trees. One row was reserved as a check. The result and application of the entire plot is given here.

Row 1. Treatment. Borowax was applied to only that portion of the tree above the ground. The dirt was not removed from the base of the tree.

Results. Examination proved that 3 borers were inflicting damage to the trees of this row.

Row 2. Treatment. Borowax was applied according to directions of the manufactures, which are as follows:

First, level off the earth around the tree and tramp it down firmly and smoothly with the foot. Second, with the finger, form a furrow in the earth about 1½ inches deep, entirely encircling the tree trunk. Third, fill the furrow with Borowax.

Results. Examination of the trees showed that one tree was

maintaining 3 borers, the other 9 being free of larvae.

Row 3. Treatment. The soil was removed from around the base of the tree, to a depth of 1½ to 2 inches and Borowax was applied to the exposed parts including the trunks of the tree up to its head. The applications were made with a coarse paint brush in such a manner as to give the trunk a thorough veneering.

Results. Examination reveiled the presence of four borers, but no more than one larva was found in a single tree.

Row 4, control. No treatment was given.

Results. Examination of these trees proved that a total of 13 borers had gained entrance thereto, and only one tree was void of larvae.

Row 5. Treatment. The soil was removed from around the base of the tree to a depth of 1½ to 2 inches and a 50% solution of sulfocide was applied to exposed parts up to the forks of the trees. The soil was then returned.

Results. Examination did not reveil the presence of borers in any of the trees.

Row 6. Treatment. The treatment was a duplication of row 5, with the exception that the sulfocide was applied in concentrated form.

Results. And the results were the same as those optained in row 5, i. e., no borers were found.

Row 7. Treatment. The soil was removed from the base of the tree to a depth of 2 inches and afterwards replaced. A coating of Borowax was made to encircle the trunk of the trees, covering a space 2 to 3 inches wide just below the forks. Newspaper was then placed about the base and extending upward so as to come in contact with the Borowax, in fact was made to cover it. The paper was then tied with ordinary twine, both below and at the top.

Results. No borers were found to be injuring any of these trees.

Row 8. Treatment. The soil was removed from the base of the tree to a depth of 2 inches and after the application was replaced. The exposed parts were given a thorough coating of whitewash, to which was added 1 pint of sour buttermilk to 1 gallon of whitewash.

Results. Examination revealed the presence of 3 borers working in this row of trees.

Row 9. Treatment. The soil was removed from the base of the trees and afterwards replaced. Self-boiled lime-sulphur, in a rather concentrated form was applied to the tree trunks.

Results. Three borers were found to be infesting this row of trees.

The Scott Tree Borer Protector was also given a place in the control measures. The results secured by this mechanical device were very satisfactory, but as they were placed upon the trees after the adult moths had begun to emerge the results cannot be taken as conclusive.

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Plate I.

Fig. 1. Eggs of Sanninoidea exitiosa on bark of peach tree twig, slightly enlarged.

Fig. 2. Same, much enlarged.

Fig. 3. Larva of S. exitiosa in tunnel after bark has been removed, enlarged.

Fig. 4. Pupa, male, S. exitiosa.

Fig. 5. Pupa, female, S. exitiosa.

Plate I

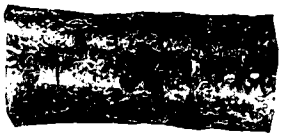

Fig. I

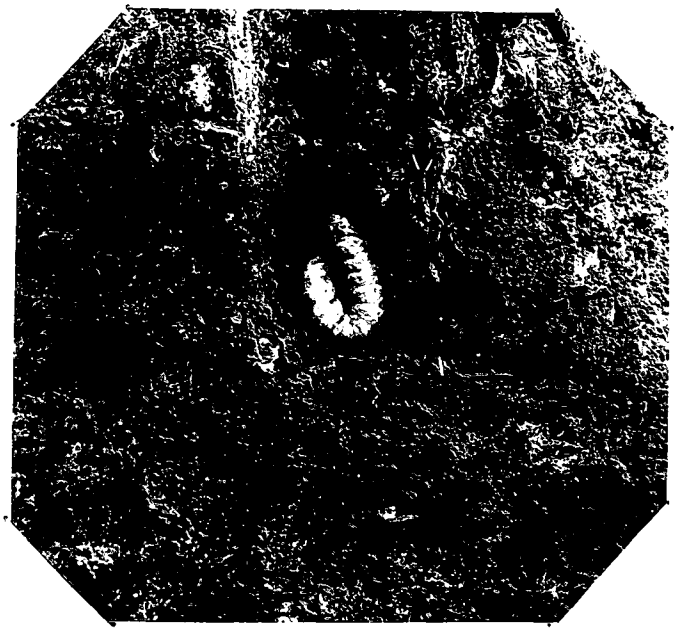

Fig. 3

Fig. 2

Fig. 4

Fig. 5

Plate II.

Fig. 1. Female adult, S. exitiosa, enlarged.

Fig. 2. Male adult, S. exitiosa, enlarged.

Plate II

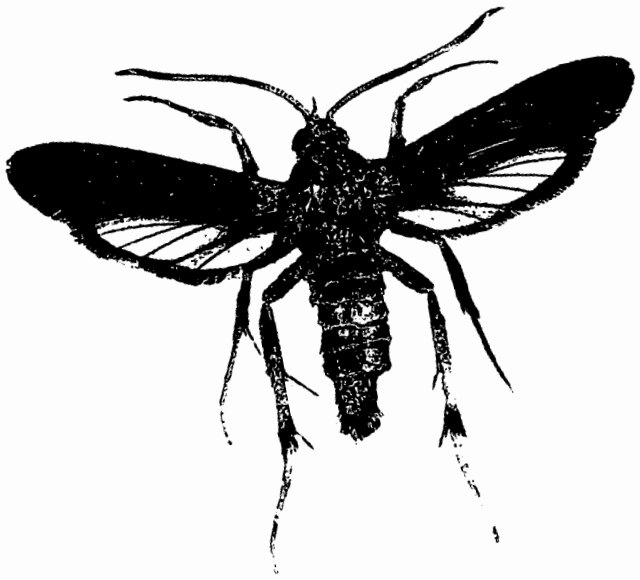

Fig. 1

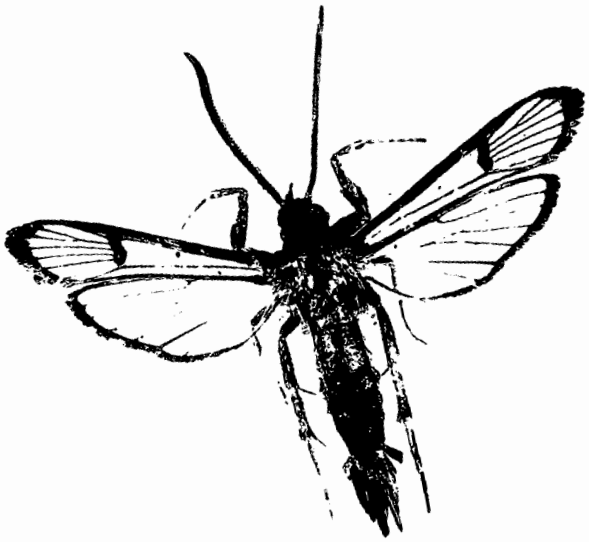

Fig. 2

Plate III.

Fig. 1. Cocoon of S. exitiosa.

Fig. 2. Pupa projecting from cocoon, prior to emergence of adult moth.

Fig. 3. Same after the adult has emerged, showing the pupa skin that remains attached to empty cocoon.

Plate III

Fig. I

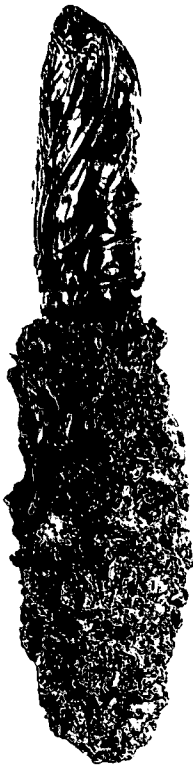

Fig. 2

Fig. 3

Plate IV.

Fig. 1. Showing the natural location of Fig. 3, Plate III, at base of the food plant.

Fig. 2. Parasitized form of S. exitiosa. One half of the cocoon of the borer removed to expose the many cocoons of the parasite.

Plate IV

Fig. I

Fig. 2

Plate V.

Small peach tree, showing the initial stage of borer infestation. The tree taken from orchard and washed free from soil to expose the gummy exudate, slightly reduce.

Plate V

Plate VI.

Same as Plate V, somewhat enlarged.

Plate VI

Plate VII

Fig. I. Soil mound about peach tree, ready to receive Scott Tree Protector.

Fig. 2 Scott Tree Protector applied to trunk of peach tree, resting on mound of soil. Also showing the effect of the sumer sun on borene

Plate VII

Fig. I

Fig. 2