THE PEAR BORER

Major Thesis In Economic Entomology

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By

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Approved.

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THE PEAR BORER

(*Aegeria pyri* Harris)

This insect, while not generally considered as of economic importance in Virginia, has in some instances caused considerable damage. This is especially the case in the orchard of the Salem Orchard Corporation at Salem, Va., where the pest has been studied, an account of which is given in the following paragraphs.

History and Distribution.

The pear borer is an American insect and is widely distributed in the eastern part of this country. It has been recorded from the following states: Maine, New York, New Jersey, Pennsylvania, Michigan, Maryland, West Virginia, Virginia, North Carolina, South Carolina, Georgia, Mississippi, Alabama, Missouri and Texas.

Food Plants.

The principal food plants of the pear borer are the pear and apple. Other plants have, however, been recorded. Mr. Fred E. Brooks [1] reports as having found the larvae attacking juneberry (*Amelanchier canadensis*) and thorn (*Crataegus* sp.). The larvae have also been frequently found in the black knots caused by *Plowrightia morbosa*, a disease that occurs on wild and cultivated cherry (Prunus spp.).

1. Fred E. Brooks, Pear Borer, U.S.D.A.,Bul. 887,Sept.29,1920.

Injury.

The injury is done by the larvae (Plate I.Fig.C) feeding in the

bark, and may be classified into three types, the first being that done by the larvae burrowing in the bark around pruning scars (Plate III Fig. B, and Plate V Fig. B). This, perhaps, is the worst type of injury; it keeps the wound from healing properly or from healing at all. The larvae seem to prefer the exposed bark around these wounds. Decay often follows, and as the bark decays, cracks and gradually falls off, the larvae burrow deeper, thus enlarging the wound. In some cases where water sprouts have been cut off and the bark failed to heal the larvae have started feeding and have caused rough unhealed places as large as one's hand. Some small limbs have been seen almost girdled by injury of this nature. This burrowing around the pruning scars not only makes rough, bad looking trees but also greatly weakens them, especially where a branch at a crotch has been cut off in shaping or thinning the tree.

The larvae also burrow in the thick spongy bark around the crotches of the trees, (Plate IV Fig. B, and Plate V Fig. A). This may be called the second type of injury. The rough bark affords an excellent and attractive place for the moth to deposit her eggs, and the soft, spongy bark affords an equally attractive place for the larvae to feed. A dozen or more may be found feeding around one crotch.

The third type of injury is that done by the larvae burrowing under scales of old bark, (Plate II Fig. D, Plate III Fig. C, and Plate IV Fig. A). This type is not so dangerous since it is generally scattered about over the tree. These "worms" are easily located by the frass exuding from their burrows and may be cut out with a knife. The

damage done in cutting these out is generally not bad since the "worms" do not usually burrow more than two inches. One orchardist, however, reports that his men, when cutting out the borers, found some burrows extending more than six inches from where the "worm" entered the bark. In most cases observed the "worm" burrows only a short distance.

Life History.

The pear borer passes through four stages in its life cycle, viz., the egg, the "borer" or larva, the pupa and the adult moth. A knowledge of time of occurrence and the length of these stages is necessary to combat this insect successfully.

In Virginia the moths begin to appear during the first of May and continue to emerge until the latter part of June. Not long after emerging the female moths lay their very small, oval, light brown eggs (Plate I Figs. A-B.) in cracks and under bark scales on the trunk and larger limbs of the trees. These eggs hatch in from four to eight days and the minute larvae - the young borers - at once work their way into a crevice in the bark, or an old wound, and begin feeding on the inner layers of bark. Here they continue to feed until winter sets in, when they stop feeding until early the next spring when activity begins again. In the spring of 1921 a few larvae were feeding as early as March 5, the season this year being exceptionally early. Their work is marked by the exuding of frass, and often by a few drops of reddish brown liquid oozing from the wounds. The winter is spent in a silk lined hibernaculum constructed by the larva in that part of the burrow where it happens to

be when overtaken by the cool weather. It is possible that some of the larvae attain full growth in the fall and after wintering construct cocoons in the spring without further feeding.

The length of the larval period in Virginia has not been definitely worked out, but apparently some have a one-year and others a two-year period. Mr. Fred E. Brooks [1], who made a study of this

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1. Fred E. Brooks, Pear Borer, U.S.D.A., Bul. 887, Sept. 29, 1920.

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insect in Pennsylvania, West Virginia and Mississippi, states that of over one hundred larvae under observation approximately 25 per cent had a one-year larval period, and 75 per cent had a two-year larval period. He also states that this may apply more to the North where the feeding season is short than to the South where the season is longer. After the larvae attain their full growth, which is in the latter part of April and first of May, they cease feeding, and spin about themselves a cocoon made of pieces of frass and bark fragments held together by a silken fiber. A few days after the cocoon is made the borer changes to a pupa in which stage it remains about three weeks. From the pupa the moth emerges, thus completing the life cycle. Of those having the one-year life cycle, about ten months are spent in the larval stage. Of those having the two-year life cycle, about twenty-two months are spent in the larval stage. The larva, however, spends about fifteen days in the cocoon before pupation takes place. During the time in the cocoon the larva does not feed.

It can be seen that since so much of the life cycle is spent

in the larval stage, only a short time - a little more than a month - is required for the egg, pupa and adult stages. A study of these three stages in the laboratory gives us some idea as to the duration of each stage. No larvae were available to study from the time of hatching to time of pupation.

The Incubation Period.

But very few eggs were available for study. These were collected in the field and brought to the laboratory where they were watched daily and their hatching records kept. The eggs under observation hatched in from four to eight days, but the number studied was too small to draw definite conclusions as to the length of the incubation period.

The Pupation Period.

The pupation period, or the time from the date of pupation until the emergence of the moth, as shown by records of those studied in the laboratory, averaged 18 days for the individuals under observation with a maximum of 20 days, and a minimum of 14 days.

The Life Activity of the Adult.

The moths evidently mate very soon after emergence and begin laying at once. The period of their life is only a few days at most. Moths kept in cages, but not mating or laying, lived six or seven days. Moths which mated and laid eggs lived only three or four days. A week, perhaps, will cover the length of the life of most of the adults. The egg laying takes place during the warm sunny hours of the day, from about 10 a. m., until 4 p. m.

Oviposition.

Oviposition was first observed on June 2, (1921) in Mr. Gittens' orchard at Salem, Va. A single female was noticed ovipositing on a badly infested tree about 11 a. m. Some of the eggs were collected and the moth was caught. Later, on the afternoon of June 21, a number of ovipositing females were observed. The day was very warm and clear and the moths were very active from two o'clock, when the observation was begun, until about four-thirty when there occurred a change in the weather accompanied by wind and clouds.

A group of badly infested trees were located and a number of female moths were found flying about the trunks and larger limbs. Their flight was rapid and they could easily dart out of sight, but the yellow markings on the abdomen and the antennae made the moths fairly conspicuous against the bark of the tree. Some of the moths were very timid and would dart away as soon as one approached the tree upon which they were resting, while others could be observed from a distance of only a few inches. When they were frightened, however, it was useless to try to follow them with the eye for they disappeared from sight almost instantly. When ovipositing the moths flew about the trunk and larger limbs of the tree with the antennae brushing the bark. They seemed not to light at any particular place on the tree, but after lighting they moved the tip of the abdomen back and forth as they crawled over the bark seeking a crack or rough place in which to deposit the egg. When a suitable place was found the tip of the abdomen was inserted and held motionless while the egg was being laid. As far as could be seen from close observation a female lays but one egg

in a place at a time, but the visits of different females to the same suitable location result in the eggs being grouped together by the end of the laying period. In several instances three, and in one instance five, eggs were found together in one crevice. The eggs are very small and are very hard to find in the bark even with an ordinary hand lens. Pieces of bark were taken on which there was thought to be only one egg, but when examined under the microscope several eggs were discovered.

The Egg.

The egg (Plate I Figs. A-B.) when first deposited is almost yellow, but turns to a light, glossy brown. It is oval and flattened, with one end slightly truncate and one side having an elongate depression which covers half the central surface of the side, the length being 0.62 mm., width 0.35 mm.

The Larva.

The larva (Plate I Fig. C.) when first hatched is about 1 mm. long, is white with a brown head. The body tapers slightly from the head to the anal segment and is covered with fine hairs. As the larva becomes full grown it has more of a creamy white color, the body being more sparsely covered with hairs. The first two segments may be slightly wider, but the first ten segments are about a uniform width. The last three taper to a blunt tip. The full grown larva is from 12 to 15 mm.

long and about 2.5 mm. wide.

The Pupa.

Pupation takes place within a cocoon constructed of fine bits of bark and frass, held together by a tough fiber of silk. The cocoon is always constructed in the burrow under a scale of bark or wood fragments about the burrow (Plate II Fig. C.). The pupa (Plate I Fig. D.) is from 8 to 10 mm. in length, has a yellowish white color at first but soon changes to light brown which darkens as the time for emergence is approached. Some pupae turn almost black, and the yellow bands which appear on the abdomen of the adults may be seen on the pupa case after the moth has emerged. The abdominal segments have slightly darker brown rings on the posterior margins. Each segment beyond the sixth has two rings of saw-tooth-like points which slant backwards, those of the front ring of each segment being the largest. The points are larger on the anal segments, those of the last segment being considerably larger than the others.

When the adult is ready to emerge, the pupa, by a wriggling movement, works out of the cocoon until only the tip of the abdomen remains. There is generally a small hole in the bark at the head end of the cocoon, or near the cocoon which the larva made before cocooning. The pupa projects out through this hole. The pupa case then splits across the head and the moth emerges rather suddenly and crawls away a short distance to harden and expand the

wings. The empty pupa case is left in the bark. The length of the pupal stage varies, but in five cases observed it covered a period of twenty days. The time of the season and weather conditions no doubt have some control over the length of the pupal period.

The Adult.

The adult of the pear borer (Plate I Figs. E-F. and Plate II Fig. A.) is a small wasp-like moth, much smaller, but resembling the beach borer (Sanninoidea exitiosa Say). It has an expanse of from 12 to 18 mm. and a length of from 8 to 11 mm. The wings are transparent, the veins, borders and tips being metallic purplish or brownish black. The dark areas have yellow scales beneath. From above, the head, thorax, and abdomen, are purplish black, there being some white and yellow markings about the head and three, more or less, distinct yellow bands around the abdomen, the third from the thorax being the most distinct. The under parts of the body, the legs, anal brush, and antennae are marked with bright yellow, Both the black and yellow colors have a metallic luster, especially in fresh specimens.

Natural Enemies.

Natural enemies play an important part in the control of this pest. Some of the burrows have been found to be opened and the larvae removed by woodpeckers. Several Hymenopterous parasites

have been reared in the laboratory from larvae and pupae collected in the field. These have been observed to be quite numerous flying about the trees in the orchard. The larva of some beetles has been found, in many instances, in a burrow with a half devoured larva or pupa of the pear borer, on which it was feeding.

Measures for Controling the Pear Borer.

Cutting out the Borers.

Since the borers work in the bark near the surface many can be removed with a sharp knife, but where this was done in Mr. Gittens' orchard more or less injury was done, especially where the borers were numerous. The cutting around wounds and pruning scars adds to the effect of the work of the borer and helps keep them from healing over properly. These, however, should be covered with some protective covering such as coal-tar creosote tree paint, or some viscous material such as tree tanglefoot. This viscous material applied to the crotches and rough places should catch many of the moths when they visit these places to lay their eggs.

Washes (Sprays).

Besides cutting out, the use of washes seems to be the only method of control. The use of penetrating oily or poisonous liquids such as kerosene emulsion and the standard emulsified oil sprays,

Table No. II.— Showing the Results of the Different Materials Used in the Experiment Outlined in Table No. I.

Material Used In Treatment Of Tree	No. Of Tree	Number Of Larvae Taken From Tree	Notes
Kerosene Emulsion 1 - 5.	1	8	Rough barked tree.
	2	6	Smooth barked tree.
	3	21	Rough barked tree.
	4	15	Rough barked tree several wound scars.
Tree Tanglefoot.	1	28	Rough barked tree- six of the larvae were taken from under tanglefoot.
	2	8	Smooth barked tree.
	3	16	Rather a smooth barked tree.
	4	11	Fairly rough tree- not heavily infested.
	5	29	Rough tree- most of infestationaround tanglefoot. Ten larvae taken from under tanglefoot.
Kerosene Emulsion 1 - 5	1	1	Smooth barked tree- signs of where several larvae had been feeding but none found.
	2	4	Rough tree -no appreciable signs of feeding except by worms collected.
Sodium Arsenate 1 - 50.	3	0	Fairly smooth barked tree- lot of pruning scar some rough places- no appreciable feeding.
	4	2	Rather smooth bark on limbs but trunk and crotch rough.
Scalecide 1 - 12	1	1	Smooth barked tree except lower trunk and crotch- some pruning scars no signs of feeding
	2	0	Tree about as rough barked as most trees- no appreciable signs of feeding.
Sodium arsenate 1 - 50.	3	0	Comparatively smooth barked tree- lower trunk and crotch rough-several pruning scars.
	4	0	Small tree with plenty of loose bark.
Scalecide 1 - 12.	1	4	Large, rough, but tight barked tree with scarred trunk-apparently heavily infested at one time.
	2	4	Tree very much same as number 1.
	3	5	Same type tree as 1 and 2, smoother bark.

Table No. 2 Continued.

	1	7	Fairly smooth barked tree with large loose scales of bark- little signs of feeding.
Sodium Arsenate	2	2	Fairly rough barked tree- few signs of feeding but larvae not found.
1 - 50	3	2	Fairly rough but close barked tree.
	1	32	Not particularly rough barked but having soft pulpy crevices under the bark.
Black-leaf 40	2	12	Tree very similar to number 1.
1 - 500	3	16	Trunk and crotch much like 1 and 2.
	1	18	A rough, but close fitting, barked tree having pulpy crevices.
	2	19	Smooth barked tree with large loose scales scattered over trunk and limbs- larvae were under these scales.
Checks	3	10	Rather a smooth close fitting bark.
	4	15	Rather smooth bark with large loose scales scattered about over tree.
	5	7	Tree with rough, but tight, dry, hard bark - apparently had been very heavily infested at one time.

with a small amount of sodium arsenate, has been recommended. An experiment, the outline of which is given in the accompanying table, was carried on to test the usefulness of some of these materials.

Table I. Showing Materials Used, Number of Trees Treated and Date of Application.

Number	Material Used	Number of Trees Treated	Dates Treatments were Applied		
1	"Black Leaf 40 1-500 and Soap	3	June 4, 1921	June 28, 1921	July 15
2	Sodium Arsenate 1-50	3	June 4, 1921	"	"
3	Scalecide 1-12	3	June 4, 1921	"	"
4	Kerosene Emulsion 1-5	4	June 2, 1921	"	"
5	Sodium Arsenate 1-50 Scalecide 1-12	4	June 4, 1921	"	"
6	Sodium Arsenate 1-50 Kerosene Emulsion 1-5	4	June 2, 1921	"	"
7	Tree Tanglefoot	5	June 2, 1921	"	"

In the above table the first six treatments are washes (spray treatments). These were applied to the trunks and the larger limbs of the trees. A three gallon compressed air sprayer was used to apply them. The tree tanglefoot was applied with a small paddle about the crotches and rough places on the trees.

At the time of the first application, all stages of the borer were present on the trees, those in the pupal stage being most abundant. The washes were applied with the intention of killing the larvae and pupae, more especially the very young larvae which hatched this spring. The tree tanglefoot was used with the hope of catching the moths as they flew about the trunks looking for places to oviposit. Of this only one application was necessary.

About a week before the second application was put on, the trees were gone over carefully to get results of the first application. On the trees treated with tanglefoot, only a few moths were caught. Dead larvae and pupae were found in all the trees to which the washes were applied. At this time many moths were ovipositing and close observation was made. On trees sprayed with "Black Leaf 40" and with sodium arsenate, moths were ovipositing freely, but only several were observed visiting the trees sprayed with kerosene emulsion or scalecide.

When the second application was put on a number of trees were examined, but no pupae were found. A few very small larvae and a scattering of almost full grown larvae were present; moths were very few, only several being seen. None were seen to be ovipositing. The trees were gone over again just before the third application to get results of the second. Only several dead larvae and several very small larvae were found on all the trees treated. No moths were seen.

Two weeks after the third and last application, all trees treated and a number of untreated trees close by were gone over carefully with the following results:

Only one young larva was found on the trees treated with kerosene emulsion alone; two on the trees treated with kerosene emulsion and sodium arsenate, both on the same tree; two on trees treated with scalecide; one on trees treated with scalecide and sodium arsenate; three on the trees treated with "Black Leaf 40"; and three on trees treated with sodium arsenate. No young larvae were found on trees treated with tree tanglefoot.

On the untreated trees, one or two young larvae were found on each tree except on the smooth barked trees, and trees which had not previously been badly infested. All trees treated were badly infested, rough barked trees.

Result of the Use of "Washes" in Controlling the Pear Borer.

It was deemed advisable to wait until fall, after the borers had ceased feeding and had gone into their winter hibernaculum, to make the final examination and determine the results of the experiment. This would give them time to grow and do enough damage so that they could be easily located. On November 22nd this final examination was made. Each tree in the experiment was gone over carefully and all the borers that could be found were cut out and counted and notes taken as to the condition of the tree.

It was found that the Scalecide sodium arsenate wash apparently gave perfect control, there being only one borer found on four trees as an average of the fourth of a "worm" to a tree. The kerosene emulsion sodium arsenate wash proved next best with an average of only one and three-fourths worm to a tree. Both scalecide and sodium arsenate along, while not proving as effective as the kerosene emulsion or the scalecide sodium arsenate washes, gave fairly good results; they having an average

of four and one-third and three and two-thirds worms to the tree respectively. Kerosene emulsion, "Black Leaf 40", and tree tanglefoot were apparently ineffective. The trees treated with Black Leaf 40 averaged twenty worms to the tree and those treated with tanglefoot averaged eighteen and two-fifths worms to the tree, averaging six and one-fifth and three and three-fifths more borers respectively to the tree than did checks, which averaged thirteen and four-fifths worms to the tree. The trees treated with kerosene emulsion averaged slightly less than the checks, their average being twelve and one-half borers per tree.

The results in tabular form are given in table number II.

Conclusions.

From the results obtained it seems that the sodium arsenate was the controlling factor, since three of the four blocks showing control were sprayed with washes containing this material, they being kerosene emulsion and sodium arsenate, scalecide and sodium arsenate, and sodium arsenate alone. Scalecide used alone, however, proved about as effective as these materials.

Three applications of the materials used should be made, and at such intervals during the oviposition period as to catch the newly hatched larvae before they have time to burrow into the bark where they would be more or less protected. By making the first application about ten days after the emergence of moths begins, following with the others at intervals of from fifteen to twenty days, the oviposition period should be well covered and most of the young larvae killed.

At the time the first application should be made most of the preceding year's larvae (overwintering larvae) have either pupated or have

ceased feeding and are ready for pupation. If a heavy and thorough application be made, many of these will be killed in their burrows by the kerosene emulsion or scalecide; especially those under loose pieces of bark, in the crotches, and in pruning scars where the materials can soak in.

Tree tanglefoot apparently did not repel the moths when depositing eggs nor the larvae when feeding. Many larvae were taken from under bark covered with tanglefoot. It did, however, catch some of the moths, as they flew about the crotches and pruning scars, where it was applied, looking for places to deposit eggs.

Cutting the worms out of the trees is very effective, but in badly infested trees the wounds made damage them considerably.

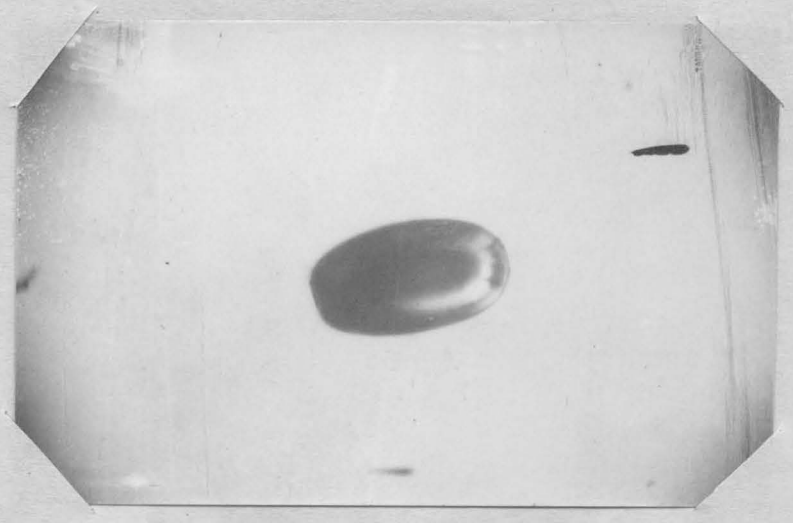
Trees having crevices containing soft pulpy bark are generally heavily infested in those places. Heavy and thorough applications of the washes should be made on these trees.

Smooth barked, thrifty trees are not so badly infested as rough barked,unthrifty trees. Keep the trees growing and in good condition.

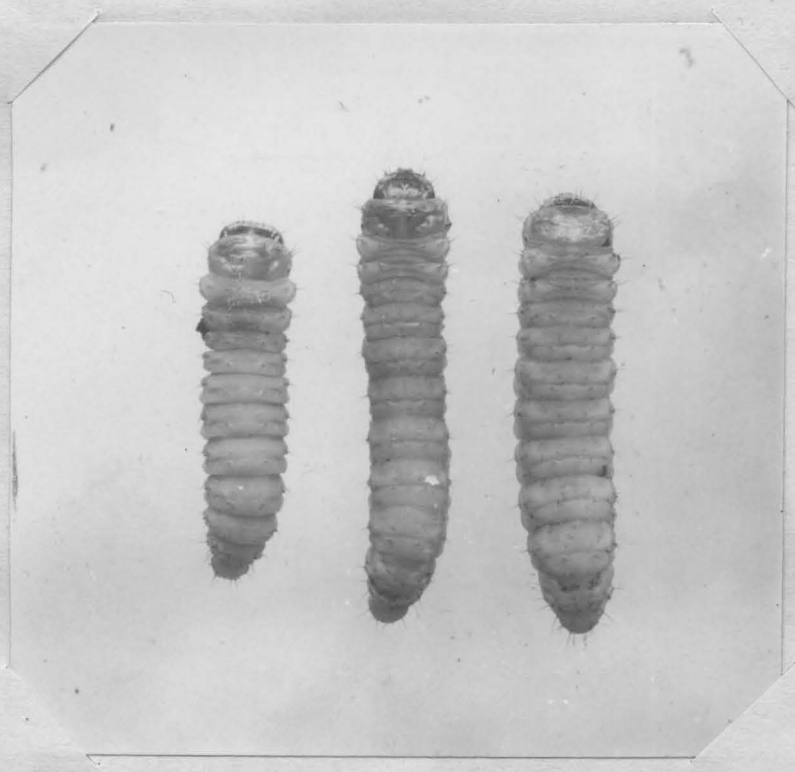
Pruning should be done carefully, and a clean, close cut that will heal over quickly should be made. Cover large wounds or scars with some protective material such as coal tar creosote tree paint.

PLATE I.

A



B



C

D

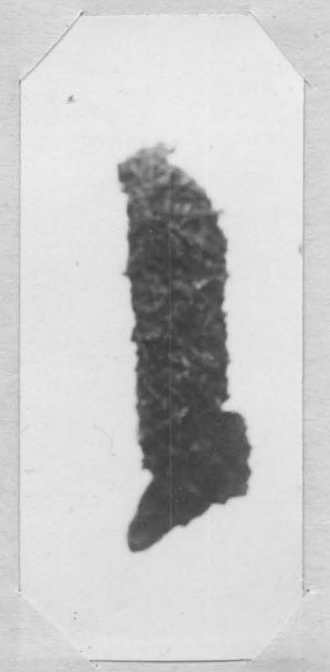
E

F

Stages of the Pear Borer.

A, Eggs in natural position on piece of bark;much enlarged. B,Egg highly highly magnified. C,Larvae,enlarged. D, Pupae,enlarged. E,F, Adults enlarged.

A



B

C

D

E

A, Adult, about natural size. B, Cocoon, enlarged. C, Cocoon on scale of bark opened to show the pupa within; enlarged. D, Showing injury done by larvae burrowing under scales of bark; old scale on the right and burrow on left. E, Showing larva in burrow; slightly reduced.

PLATE III.

A

B

C

A and B, Showing the work of the pear borer around pruning scars.
C, Showing the work of a borer under a scale of old bark.

A

B

A, Bark showing burrows made by the pear borer. B, A closer view of the crotch of tree shown in plate VI, showing the injury more in detail.

A

Crotch of a badly infested apple tree. Five pupa cases were projecting from the bark and three larvae were feeding in the side of the crotch shown in the photograph when it was taken.

B

Showing the work of the pear borer around a pruning scar. In removing the limb the cut should have been made closer and the scar painted with some protective covering.

A

Trunk of apple tree badly injured by the pear borer.

B

Opposite side of tree shown in A.

A bad place in a limb caused by the borers working in a wound made by machinery used in the orchard.

Trunk of apple tree badly infested with the pear borer. From the knife in the tree to the ground twenty six pupa cases were projecting from the bark of the side of the trunk shown in the photograph when it was taken.