SOME INSECTS INJURIOUS TO FORESTS.

THE LOCUST BORER.

BY

A. D. HOPKINS,
In Charge of Forest Insect Investigations.

ISSUED JUNE 13, 1906.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1906.
LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, D. C., March 27, 1906.

SIR: I have the honor to transmit herewith the manuscript of a paper entitled "The Locust Borer," prepared by Dr. A. D. Hopkins, in charge of forest insect investigations, and comprising a summary of information from published accounts supplemented by data secured by recent investigations. It deals more particularly with practical methods of controlling this, our most important enemy of the black locust, and is designed to be of service to owners of plantations and forests, as well as to investigators, in the prevention of injuries to this useful tree. It is the first contribution to a series of papers to be published as a bulletin under the title "Some Insects Injurious to Forests." I recommend its publication as Bulletin No. 58, Part I, of this Bureau.

Respectfully,

C. L. MARLATT,
Hon. James Wilson,
Acting Chief of Bureau.

Secretary of Agriculture.
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SOME INSECTS INJURIOUS TO FORESTS.

THE LOCUST BORER.

(Cyllene robiniae Forst.)

By A. D. Hopkins,
In Charge of Forest Insect Investigations.

OBJECT OF PAPER.

The object of this paper is to give a summary of the more important published information, supplemented by recently determined new facts relating to the locust borer and methods of controlling it, which will be of service to the investigator in the determination of additional facts, and to the owners of plantations and forests in suggesting methods of preventing losses.

ECONOMIC IMPORTANCE OF THE INSECT.

The economic importance of the well-known locust borer as affecting the growth of the black locust or yellow locust (Robinia pseudacacia) is fully realized by everyone who is interested in this valuable forest and shade tree, and the urgent need of additional information on the subject is indicated by the frequent inquiries of correspondents and by the recent articles in newspapers, journals, and special publications which have been called forth by the proposed extensive commercial planting of the locust by railroad and other companies and by individuals.

INVESTIGATIONS.

In connection with the general study of insects injurious to forest trees, the locust borer has received considerable attention by the writer since 1890. In March, 1905, a plan of cooperation between the

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a Order Coleoptera, Family Cerambycidae.

b From 1890 to 1892 for the West Virginia Experiment Station, and since 1902 for the U. S. Department of Agriculture.
Bureau of Entomology and the Forest Service in the investigation of insect enemies of the black locust was proposed and adopted, by which the subject is receiving special attention from the viewpoint of both the forester and the entomologist, with the primary object of practical results.

**CHARACTER OF THE INSECT AND ITS WORK.**

The locust borer is a whitish, elongate, so-called "round-headed" grub or larva (fig. 1), which hatches from an egg (fig. 2) deposited by a black or brown and yellow striped long-horned winged beetle (fig. 3) found on the trees and on the flowers of golden-rod from August to October. The eggs are deposited in the crevices of the bark of living, growing trees from August to October, and the young borers (fig. 2, b, c) hatching therefrom mine into the outer portion of the living inner bark (fig. 5), where they pass the winter, and in the spring bore through the bark into the sapwood and heartwood. Here they transform in July and August to pupae (fig. 4) and in August and September to adult beetles, which soon emerge from the trees and deposit eggs for the next annual generation of borers and beetles.

The injury to the trees (Pl. I) consists of wounds in the bark and sapwood which, if sufficiently severe or repeated year after year, result in either a stunted worthless growth or the death of young and old trees, while the numerous worm holes in the wood reduce its commercial value or render it worthless.

The presence of the insect in injurious numbers is indicated (1) by the frequency of the adults on the golden-rod flowers and on the trees, from August to October; (2) by the slight flow of sap and by the brownish borings where the young larvae are at work in the bark, during April and May; (3) by the whitish sawdust borings lodged in
WORK OF THE LOCUST BORER.

a, Section of young tree 3 inches in diameter; b, section of young tree 2 inches in diameter, which was broken off near surface of ground; c, d, section of branch from badly damaged tree, showing healing wounds in surface of wood; e, transverse section of same; f, g, sections of branches one-half inch in diameter or less, showing in each the total length of burrow in which a larva developed and transformed to the adult beetle. (Original.)
the rough bark, in the forks of the tree, and on the ground around the base of the trunk, during May, June, and July; (4) by the breaking down of the branches and young trees, and by the sickly appearance of the young twigs and leaves in July and August.

This insect appears to be present and more or less injurious in all of that part of the United States which is east of the Great Plains and north of the Gulf States. Published information and reports of forest officials and others indicate that in Oklahoma and Indian Territory and west of the Great Plains the locust is now quite free from injury by the borer; but that these regions will remain exempt is by no means certain.

**EXTENT OF DAMAGE OR LOSS.**

So extensive is the damage to natural growth, artificial plantations, and shade trees that in some sections within the natural range of the tree in the Eastern States, but particularly in the Middle West, where both the tree and the insect have been introduced, it is considered unprofitable to grow the tree for shade or timber, and in such sections the natural sprout growth is often considered a pest rather than otherwise.

The loss resulting from defective timber, stunted growth, and the death of trees is represented by the difference in value between the damaged growth or product and the same if uninjured and healthy. This, if expressed in dollars, would represent a large sum.

**POSSIBILITIES OF PREVENTING LOSSES.**

There are sections, especially in the natural home of the tree, where, as has been frequently observed by the writer and others, the damage is not sufficiently severe to seriously affect the vitality of the trees or the commercial value of the product; and our present knowledge of the insect and of methods of preventing losses from its ravages indicates that in properly selected localities, and under proper forestry methods of management, the tree, so far as this insect is concerned, can be grown successfully on an extensive scale, and can be made to yield most satisfactory returns.

**HISTORICAL REFERENCES.**

The first reference to this insect, according to Fitch, is a figure and description by Pitiver in his Gozophylacium, published in London in 1702. Drury figured it in 1770, and the following year, 1771, Forster gave it the specific name of *robinia*, under which it is at present rec-
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It has been referred to many different genera, but is now recognized as belonging to the genus Cyllene. Both Drury and Forster received it from the "Province of New York," and referred to it as inhabiting the locust tree (*Robinia pseudacacia*). It is therefore evidently an American species.

Some of the principal writers who have contributed important facts on the life history, habits, distribution, and remedies are: Dearborn, 1821; Harris, 1826-1841; Fitch, 1858-1863; Walsh, 1865-1867; Riley, 1867; Lintner, 1890; Schwarz, 1890; the writer, 1891-1898; Felt, 1901-1905; Cotton, 1905; White, 1906, and others. (See list of publications, p. 15.)

**Fig. 3.—The locust borer (*Cyllene robinia*): a, male beetle; b, female beetle. Much enlarged (original).**

REVIEW OF PUBLISHED DATA.

Gen. H. A. S. Dearborn was the first to record the more important facts in the life history and habits of the insect. Indeed, so complete and accurate were his observations that comparatively little has been added by subsequent writers, who have extensively quoted and repeated them. He found the beetles on the trunks of trees from the 1st to the 25th of September, the females depositing their "snow white" eggs in the crevices of the bark, four to nine in each place. These eggs hatched before cold weather, and "the young larvae just buried themselves in the tender inner bark," where they remained until about the 1st of April, when they commenced boring, and soon passed into the solid wood. He stated that it could always be ascertained when and where the borers were at work by the oozing of sap from the wounds.
made by them. By the 20th of July the larvae attained their full size, by the 28th some of them changed to pupæ, and the perfect insects were on the trees September 3. These observations were made on his grounds near Roxbury, Mass., during several years previous to 1821, when they were reported in a letter to John Lowell, and published, together with an account of his unsuccessful experiments with whitewash, mortar, and plaster, in the Massachusetts Agricultural Journal, Volume VI, 1821, pages 270–275.

Col. T. Pickering, in a letter to Mr. Lowell the same year and published in the same volume, stated that there were trees in New Hampshire uninjured by the borer, as well as in some of the Southern States; that he had observed the stems of young trees in Washington, D.C., infested, while in Georgetown (D.C.) he saw large thrifty trees uninjured; and he concluded that natural growth in groves was much less liable to injury than transplanted growth.

Fitch, writing in 1858, stated that numbers of specimens were sent to him year after year from Indian Territory. Schwarz (1890) observed that in and around the District of Columbia the insect lives in large colonies, affecting all trees of small groves, while long hillsides full of locust are not infested.

R. S. Kellogg, in his discussion of forest planting in western Kansas, says:*

By locating plantation on good ground and giving it first-class care, the trees will reach fence-post size before the borers do much damage. They should then be cut and utilized. The rapid sprout growth will soon make a new crop. A stump sprout sometimes attains a height of 10 feet the first season. Handled in this manner, black locust can be profitably raised in many places where it is altogether unsuited for a permanent tree.

At present borers are a menace to black locust trees throughout western Kansas and Nebraska, though there are occasional local areas that are not affected. They


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have so far done little damage in southwestern Kansas, but they are moving both southward and westward. They are abundant at Pratt, Kinsey, Dodge, and Scott, and are appearing at Medicine Lodge, Coldwater, Meade, and Garden City. Yet of the numberless trees that have been killed or seriously injured nearly all reached a size that could well be used for posts or stakes before succumbing. This shows that black locust may be successfully grown in commercial plantations if cut as soon as large enough for posts.

Just south of the Kansas line, in Woods County, Okla., black locust grows remarkably well, and has not yet been molested by borers.

Cotton (1905) observed that in Ohio injury was greater in single trees and plantations of considerable size than in natural forests.

Dearborn found that whitewashing the trees in April and filling the holes with mortar in July was not entirely successful as a remedial measure, but he suggested cutting out and burning infested trees in April and protecting the young, thrifty trees. Harris suggested the collection of the beetles by children, and Fitch, the planting of goldenrod to attract the beetles, so that these could be collected and destroyed. Lintner suggested the application of soap solution and carbolic acid to prevent the beetles from depositing eggs, and the cutting out of young larvae when their presence is indicated by sap and borings. Riley suggested destroying the young borers as soon as hatched. The writer recommended severe pruning in March, and clean culture was recommended by Felt.

The insect has been recorded from Canada southward to Pontchartrain, La., Texas, and Indian Territory, and westward into Nebraska.

Some of the records of destructive ravages are the following: Peck (1818), Harris (1826), in New England; Fitch (1858), in New York; Rogers, Reed, and Bethune (1855 to 1867), in Canada; Walsh (1866), in Illinois and Kansas; Laurent (1893), around Philadelphia; the writer (1891 to 1898), in West Virginia; Smith (1898), in New Jersey; Cotton (1905), in Ohio; White (1906), in the Mississippi Valley, about twenty years after extensive planting was begun by settlers.

REVISION OF PUBLISHED DATA.

Some of the published records relating to the insect which have been frequently quoted or repeated require, according to the writer's observations, some amendments and corrections.

It would appear that normally but a single egg is deposited in a place, rather than clusters of four to nine. The female does not pierce the bark or place her eggs in the cambium layer. The larva do not enter the sapwood before winter, but, as observed by Dearborn and verified by the writer, remain in the outer portion of the inner bark. Records of the insect infesting honey locust are probably due to the fact that the black locust is sometimes referred to under this name, which is the correct one for an entirely different tree. It
appears now that its attack is confined entirely to Robinia. It is not necessary that a tree or branch should be some inches in diameter before it is damaged, for the writer has found full-grown larvae in sprouts and branches less than one-half inch in diameter.

In the writer's opinion, all attempts to cultivate locust in the eastern United States should not be abandoned on account of the borer, although this has been recommended by some recent writers. It has been stated that the locust would probably not be injured by the borer in the southern limit of its range and in the country west of the Great Plains. While this may be true, precaution should be taken to prevent its introduction into such localities, since it is not improbable that if the insect be introduced and become established it may prove even more destructive there than in its natural home, as was demonstrated in the Mississippi Valley.

Nearly all methods heretofore recommended are subject to practical application to shade trees and small plantations only; therefore there is special need for suggestions of practical methods of combating the insect and preventing losses in large commercial plantations and in natural forest growth, and it is hoped that this paper will contribute something of value along this line.

**OBSERVATIONS BY THE WRITER, 1890-1905.**

Adults were collected on golden-rod flowers at Piedmont, Md., and Mineral County, W. Va., on August 25, 1890, and on golden-rod and locust leaves at Morgantown, W. Va., September 16 and 17, 1891. Young larvae were found mining in living bark of trees at Kanawha Station, W. Va., May 1, 1891, and on May 20 the same larvae had entered the wood, but a great many had died.

It was frequently noted that the locust in the forests of Chestnut Ridge in Monongalia and Pendleton counties, Laurel Hill in Preston County, and especially on Rich Mountain in Randolph County, W. Va., showed but slight damage by the borers. Similar observations were made in many other sections of the State, while in near-by and widely separated sections the damage was found to have been severe and continuous during the life of some of the older trees. In 1898 it was observed that badly damaged shade trees near Morgantown, W. Va., which had been severely pruned in March and April, had recovered, and the crowns were renewed by dense, vigorous, healthy growth, which suggested this method of treating badly damaged shade trees.

On October 9, 1904, it was found that the locust in the vicinity of Chevy Chase, Md., was but slightly damaged by the borer, although beetles were found in numbers on golden-rod and feeding on sap from wounds in bark of living sumac. This habit of feeding on sap is of special interest from the fact that it suggests the possibility of killing
the beetles by means of a bait of some poisoned substance which would
be attractive to them.

On May 23, 1905, it was found that the locust trees of all sizes in
the open and in dense thickets along the old canal on Arlington Farm,
Virginia, were thickly infested with the borers, which were all in the
wood and ranged in size from quite small to nearly full grown. The
ground around some of the trees in the open and on the borders of the
groves was found to be covered with the sawdust borings to the depth,
in some cases, of an inch or more, and the larvae could be distinctly
heard at work in the wood. Some of the young trees had been literally
honeycombed and were broken off at the ground, others had many
branches broken and hanging by the bark or fallen from the tree,
and some other trees had the leaves turning yellow and dying, while
one isolated tree in a field had failed to put forth leaves on some of
the branches. Some infested branches cut on this date and placed
in a box in the laboratory were found on July 12 to contain fully
matured adults, and on July 20 they began to emerge, thus showing
that the larvae will complete their development in the wood after it
is cut from the tree and becomes perfectly dry. Indeed, this record
shows that the dry condition contributes to the rapid development
of the insect, for on the same day (July 20) on which the beetles were
found in the box, the trees from which the branches had been cut
were examined and found to contain nothing but larve. Some more
branches were cut on this date and placed in a tin can, where they
were kept moist. The first beetles emerged from these on August
24, or more than thirty days after adults had emerged from the dry
branch. On August 30 many adults had emerged. September 20
ten living adults and many dead ones were taken from the can, and on
October 2 several more dead ones were removed.

When the trees were examined on July 20, a larva was found min-
ing in a two-year-old branch less than one-half inch in diameter, and
the cocoon of a parasite of the borer was found in one of the mines,
but the adult parasite was not reared. Many dead borers were found
in their mines in the trunks and branches surrounded by a white
powdery fungus.

The trees were again examined on September 14, when adults were
found abundant on the foliage, branches, and stems, and also on
flowers of golden-rod. Adults and pupae were also found in con-
siderable numbers in the dead wood of broken branches, as well as in
the living wood, and dead larvae were frequent. Larve of an elaterid
(click beetle) were quite frequent in the wood, where they had evidently
been feeding on the locust borer.

Examination during August, 1905, of the locust on a hill near
Kanawha Station, W. Va., where this tree forms the principal growth
over old abandoned fields and in the adjacent forests, showed that the
damage by the borer was very slight in trees of all sizes. On August 26 many adults and a very few pupae, but no larvae, were found in small trees in the valley, while the large trees in the same locality were but slightly damaged.

OBSERVATIONS BY MEMBERS OF THE FOREST SERVICE.

The following notes by Mr. S. N. Spring, forest assistant in the Forest Service, were submitted October, 1905, as a contribution to the results of cooperative studies. Early in July the work of the borer was noticed in the central portion of Westmoreland County, Pa. The first adult insect was seen on August 29. Evidence of the work of this insect was found in the localities investigated, but, for the most part, it was not serious enough to prevent the planting of locust for fence posts. To the north and west of Greensburg, in Westmoreland County, and in Allegheny County many roadside trees were badly bored. The work of the borer is slight on Chestnut Ridge and Laurel Hill, where locust thrives. Posts and pit props cut in these mountains show slight injury only. In the few places where injury was found to be great, within the area studied, the trees were dying, and many branches were broken off where the trees had been extensively bored by this insect. Owing to the fact that places of serious injury were so few, it was impossible to carry out any observations that would be of value in a study of immunity. In general the locust on the two high ridges thrived better than those on the lower elevation of Westmoreland and Fayette counties, and less injury due to this insect was found among the trees on the ridges.

Mr. J. W. Fetherolf, of the Forest Service, informed the writer, on January 26, 1905, that a grove of black locust planted in Salt Lake City, Utah, prior to 1850, is still in a thrifty condition and apparently free from all insect injury. The same can be said about this species seen elsewhere in the Salt Lake Valley.

Mr. Wesley Bradfield, of the Forest Service, informed the writer that he found the adult beetles common on badly damaged trees, 5 to 8 years old, near Marshall, Mich., in August, 1905; also, that according to his observation the locust in the southern quarter of Michigan was seriously damaged, while in the northern three-quarters, especially toward Lake Michigan, it was not.

RECENT OBSERVATIONS BY THE WRITER.

On March 11, 1906, it was found at Arlington Farm, Virginia, that the young larvae had passed the winter in minute cells which they had excavated in the outer layers of the living bark and just beneath the outer corky bark (fig. 5), as recorded by Dearborn. So common were these hibernating larvae in the trees that in the bark of some of them there were fifteen or twenty within an area of a few square inches;
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but of the several hundred examined there was only one larva in a place, which would indicate that the eggs are not deposited in clusters, but that they are scattered about in the crevices, so that each larva occupies a separate hibernating cell. The slight wound thus produced in the outer layer of the living bark results in a small dead area surrounding the cell. This dead and brown condition was found, on the date mentioned, to have penetrated the thick inner bark to the wood. This condition evidently facilitates the operation of the young larva in boring through the inner bark to the wood, which a healthy condition of the immediately surrounding bark might prevent. It is not improbable that this small area of dead bark may be caused by a plant disease, which finds its way to the living plant tissue through the slight wound made by the larva and which, if this be so, may contribute greatly to the death of badly infested trees.

The young larvae were found in nearly every case in the part of the bark which had not been injured previously, thus indicating that the female deposits her eggs where the bark is perfectly healthy and not in or around the old scars. Indeed, the habit of the larva appears to render this quite necessary for their more or less isolated work. It was particularly noted that the remaining unaffected bark of the trees which had suffered most from previous generations of the insect was thickly infested with hibernating larvae, while that of near-by large trees which had escaped previous injury contained very few, thus indicating that from some cause there are individual trees which are more or less immune. This fact, which has been so often observed, suggests the importance of experiments in the propagation of immune stock by means of seed or root cuttings from immune trees growing among badly infested ones.

The hibernating habits of the larvae also suggest a simple method of destroying them, namely, the cutting and barking of the trees during the period between the first of November and the first of May. The simple removal of the bark, without burning, is sufficient to kill the larvae.
It should be remembered that all the holes found in a tree and all other damage by the borer are not the work of one generation, but usually that of repeated annual attack during the life of the tree; also, that a burrow in the sapwood of a young tree remains the same burrow in the heartwood of the old tree, without change, except in the healing of the original entrance; therefore the number of borers and the amount of damage each year is not so great as it might appear, and, while each female is doubtless capable of depositing more than a hundred eggs, it would appear from the writer's observations that only a small percentage of the larvae hatching from them survive the bark-infesting stage or complete their development to the adult stage. This suggests that any method of management which will insure the destruction of a large number of larvae and beetles each year will reduce the damage to a point where there will be practically no loss.

**SUGGESTIONS FOR CONTROLLING THE INSECT AND PREVENTING LOSSES.**

With our present knowledge of the life history and habits of the locust borer, it would appear that the following suggestions might be of practical value in the control of insects in large plantations and forests.

The fact that the young larvae from eggs deposited during the summer remain in the outer bark during the winter and do not enter the wood until the following May suggests that if locust for all purposes were cut between November and May, the bark removed from that portion which is of value, and the remainder burned, it would destroy vast numbers of the insects and contribute greatly toward the protection of the remaining growth.

The fact that badly infested trees may be detected during May, June, and July by the ejected sap and borings, suggests this simple method of locating such trees, which should be cut close to the ground and burned, before the first of August, to destroy the borers before

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*a An examination of the ovaries (fig. 6) of beetles collected in August shows that they may contain as many as fifty mature eggs at one time, in addition to a large number of immature ones.*
they transform to the adult beetles and emerge. If preferable, the same end may be accomplished by burning the tops and worthless parts and by submerging the valuable parts in ponds or streams until the borers are killed.

**DAMAGE TO CUT WOOD AND DANGER OF INTRODUCTION INTO NEW LOCALITIES.**

As we have shown that after the borers have once entered the wood they may complete their development in the cut and dry branches, they will evidently do so in posts or other material manufactured from trees cut between the first of May and the middle of September; therefore, it is plain that locust should not be cut during this period for any purpose except to destroy the borers, or, if it should be necessary to cut it, the tops should be burned and the logs submerged in ponds or streams for a few days before they are shipped or manufactured. This is very important both to prevent damage to the manufactured material and the introduction of the insect into the far West and other sections of the country which are at present free from it.

**PROPER LOCATIONS FOR EXTENSIVE PLANTATIONS.**

The fact that there are many sections and localities of greater or less extent within the natural home of the locust and its insect enemies where, from some unknown cause, the tree grows to large size and old age without perceptible injury from borers and other insects, suggests the importance of selecting such localities for any proposed extensive operations in the line of artificial plantation, or utilization of natural growth. It will be found, however, that no area of considerable extent, even in such localities, is entirely free from this and other destructive insect enemies, and that certain precautions and well-planned methods of management with reference to their control will be necessary.

**PRELIMINARY REQUISITES.**

In the first place it is necessary, in order to provide against future losses from the borer, that a thorough survey be made in May and June, not only of the area to be utilized but of the entire neighborhood for a radius of a mile or more from its borders, for the purpose of locating and destroying scattering trees and groves which are more or less seriously infested or damaged by the borer. It would seem that the control of such large areas, by purchase or under a plan of cooperation between the owners of the land or trees, is one of the most important requisites for success in preventing future losses from the ravages of this and other insects in small as well as large plantations.
In fact, it is the writer's opinion that, with this precaution properly and continuously carried out, locust may be successfully protected from the borer in any locality.

**SUBSEQUENT MANAGEMENT.**

In the subsequent management of plantations and of natural forest and sprout growth it is important each year to locate and destroy the worst infested trees for the purpose of killing the borers in the wood, and to conduct the thinning and commercial cutting operations during the period between November of one year and May of the next in order to destroy the eggs and young before they enter the wood.

Worthless, scrubby, borer-infested trees should be killed outright by stripping the bark from 4 or 5 feet of the lower stem during August to prevent sprouts and seed production from them and at the same time to destroy the eggs and young borers. Trees deadened in this manner, as was demonstrated near Morgantown, W. Va., some years ago, may be so completely killed that not a single root sprout will appear. Therefore this method is of special value in preventing sprout reproduction from inferior individual trees.

**COLLECTING THE BEETLES FROM GOLDEN-ROD FLOWERS.**

Collecting the beetles from golden-rod flowers, by means of insect sweep nets, before they deposit their eggs, would be advisable, even for the protection of large plantations, and, as has been suggested, the planting of patches of the plant, or the cutting of all but certain strips and patches of natural growth for this purpose, would serve to concentrate the beetles where they could be caught in the nets and destroyed by emptying them into a pail containing water covered with a film of kerosene.

**POISONED BAIT.**

Experiments should also be made with poisoned baits, as suggested on pages 7-8.

**SUGGESTIONS FOR PROPAGATING BORER-RESISTANT TREES.**

**FROM SEED (SEXUAL METHOD).**

The fact that some trees are, to a greater or less extent, immune from attack or injury by the borer, while adjacent ones in the same grove are attacked year after year and seriously damaged, suggested the idea of breeding races and varieties of the species which would be permanently immune. This suggestion was included in the plan for cooperative investigation mentioned on pages 1-2. It was then thought that if the seed for general planting were collected from immune trees
found growing among badly damaged ones, a much larger percentage of the product would resist attack and, by continuing this method of selection and breeding, immune varieties could in time be established. There are, however, some serious difficulties to be overcome by this sexual method, especially that of cross-fertilization and variation and the very long time required to get definite verified results.

FROM ROOT CUTTINGS (ASEXUAL METHOD).

It has since occurred to the writer that insect-resistant varieties might be secured by a much shorter method, namely, that of propagating from root cuttings and possibly from twig cuttings. By this simple method of asexual propagation a large number of offspring, in every respect like the parent stock, may be secured at once for the starting of experiments to determine whether or not the asexual product of trees which have not been injured by the borer will produce plantations equally as immune. The writer's experience in the establishment of improved varieties of timothy by this method leads him to believe that insect-resistant varieties of locust can be established. If so, the principal difficulties in the problem of preventing losses from the ravages of the borer will be solved.

It should be mentioned in this connection, however, that it is possible that the borer, if deprived of the trees which are most attractive to it, may gradually adapt itself to the more resistant ones and become more or less injurious to these, and that other insect enemies may be troublesome. There will be so many advantages, however, in propagating from healthy vigorous stock that, in the writer's opinion, the matter should receive immediate attention, and selection and propagated experiments should be started at once. The success of the effort will depend largely on the proper selection of immune trees from the worst infested groves or sections rather than from those growing in partially immune localities.

Domestic animals and cultivated plants have been improved by selection and breeding to meet almost every need and requirement of man, and it is well known that some races and varieties are much less susceptible to injury by disease and enemies than are others. It is reasonably certain, therefore, that the locust will not be an exception, but that it will yield to the breeders' manipulations and may be made to produce insect-resistant varieties and forms specially fitted to supply the different needs of commercial planting, shade, and ornament.

In the meantime, much of immediate practical value and importance may be accomplished by following the suggestions herein contained for the direct control of the insect in extensive plantations and in natural forest growth.
THE LOCUST BORER.

PUBLICATIONS RELATING TO THE LOCUST BORER.

This list is not a complete bibliography, but it includes most of the titles referred to in this paper.


1841. Harris, T. W.—Insects injurious to vegetation, p. 85.


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1905. Felt, E. P.—Insects affecting park and woodland trees. Mem. 8, N. Y. State
    White, C. A.—The black locust tree and its despoliation. Popular Science