THE POPLAR AND WILLOW BORER.
(Cryptorrhynchus lapathi L.)

W. J. Schoene.
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W. J. Schoene.

SUMMARY.

This bulletin deals with the poplar and willow borer, an imported beetle, which is causing extensive injuries to nursery stock and basket willows, and threatens ornamental poplars and willows.

This species has one brood a year. Egg-laying occurs during August and September, and from eighteen to twenty days are required for the eggs to hatch. The larval stage lasts till the following July when pupation occurs. The pupal period occupies about two weeks and the beetles commence to appear about July 15. From this date they may be found until the middle of October.

To avoid injuries by the beetle, new plantations of poplar and willow should not be planted near old blocks. In plantings subject to slight attacks, the borer may be controlled by cutting out and destroying in June the parts affected with the grubs. The numbers of the insect will be reduced by burning all branches and trees broken by the wind or otherwise injured and rendered unsalable.

Observations have been made of the feeding habits of the beetles which show that they do not discriminate between sprayed and unsprayed plants, and that beetles feeding upon sprayed plants succumb in three or four days. It is believed that nurserymen could avoid important injuries by this insect by spraying during July with bordeaux mixture containing an arsenical poison. Experiments are now being conducted to determine the value of this treatment.
INTRODUCTION.

Attention has been called to the work of the poplar borer by complaints, from a number of nurserymen in Western New York, of the extensive and continued injuries sustained in the growing of poplars and willows. In the year 1902 some blocks of poplars and willows near Rochester were so badly injured by this insect that some of the growers contemplated abandoning their culture. Since that time the annual loss in many nurseries has not been less than 10 per ct. of the trees and occasionally the entire planting has been ruined. In many localities the native willows along swamps, streams and canals are badly attacked, the trees often being so severely affected that many of them will ultimately die as a result of the injury. The same is true of certain species of willows planted for ornamental purposes. On account of the growing importance of this insect, an investigation was undertaken to determine its habits with special reference to discovering means for its control in nursery plantations.
HISTORICAL.

GENERAL.

The beetle was described by Linnaeus in 1763 in his "Systema Naturae," and mention is also made of this species in Turton's Linnaeus. 1 Kaltenbach 2 states that the adult feeds upon the dock, Rumex hydrolapathum. Later Prof. Schwägerichen 3 states that in the year 1844, the larvae appeared in the young alders in the Saxon Oberlausitz. In 1863, Westwood reported a serious outbreak of the larvae of this curculio among the cultivated willows in the County of Essex, England. Ratzburg in his "Waldverderbniss," 4 under the heading "Erlanrüsselkafer" or alder snout beetle, gives a somewhat detailed account of the life history and habits of the insect, including reports from others who have observed its work. He states there is no record to show that the beetle has been seen sucking or chewing on the "dock Lapathum." Forstmeister v. Kamptz observed the work of the insect in 1863 on the black alder, which is very susceptible to the attacks of the beetle. In Brehm's "Thierleben" 5 Dr. E. L. Taschenberg mentions Cryptorhynchus lapathi as being the only European representative of a South American genus. Prof. F. M. Webster, in an article entitled "The Imported Willow and Poplar Curculio," 6 states that there are now sixteen species of this genus inhabiting North America, north of Mexico, the majority of them being found in the south or southwestern states. Taschenberg makes the statement that the adult only becomes injurious through its feeding on the leaves. Dr. Bernard Altum 7 states that near Eberswalde upon the Leuenberger Weisen, an outbreak of C. lapathi was controlled by the

2Die Pflanzenfeinde aus der Klasse der Insekten.
3Wiegmann's Archiv, 11: 337.
5Bd. IX, p. 152. 1877.
7Forstzologie: Insekten, Abth. I.
cutting out of the affected stems. Dr. Altum also reports that in the district of Schonlanke (Bromberg) a plantation which had given eighty cords of wood per acre was ruined. A similar instance is reported from Weisbaden to the effect that about five acres of white alders were threatened with destruction. The Danish writer Dr. I. E. V. Boas, in 1888, in an article entitled "An attack of the snout-billed Cryptorrhynchus lapathi upon willows" gives a short account of its habits and life history in Denmark, and also mentions the devastation of a plantation of willows, Salix viminalis, grown for the purpose of making hoops. In 1897 Dr. Freiherr von Tubenf,⁴ states, in effect that, between Brenner-Post and Fenna, and also between eastern Arte and Brenner Bad, districts in Tyrol, Austria, the mountain alders presented a sickly appearance. Examination proved this was largely due to the work of C. lapathi, and that many of the trees were also attacked by a fungus Valsa oxystoma Rehm. The injuries by these two agencies are similar in external appearance.

HISTORY OF THE SPECIES IN THE UNITED STATES.

Attention was called to the appearance of Cryptorrhynchus lapathi in this country by William Juelich in 1882, who found the insect in the northern part of New York City.⁵ Five years later the willows near West Bergen, N. J., were discovered to be infested, and in 1891 Dr. J. B. Smith reported that in New Jersey willows were being killed by this insect. The beetle was found in injurious numbers at Melrose, Mass., in 1895 by Dr. C. H. Fernald. The presence of this insect in the willows about Boston and other towns in Eastern Massachusetts had been known for many years. During the following year the beetle was found at Buffalo, N. Y., by Ottomar Reinecke; and in 1901 Mr. A. F. Burgess collected one specimen near the city of

²Entomologica Americana, 3: 123.
Ashtabula, Ohio. In 1903 the insect was found in two nurseries in the State of Wisconsin by Mr. Christian Bues, the State nursery inspector\(^1\) and in 1904 Prof. F. L. Washburn reported that he had received specimens of *C. lapathi* from North Dakota where it had been found upon poplars that had been imported into that state from a New York nursery.\(^2\)

**ECONOMIC IMPORTANCE.**

**THE BEETLE A NURSERY AND A SHADE TREE PEST.**

The poplars, willows and alders, while not counted among our most valuable or most beautiful trees, serve useful purposes and are well worthy of preservation. They claim our attention not only for their quick growing qualities and economic value, but also for the native beauty possessed by many of the species. Indeed certain schemes of landscape decoration would be incomplete without some of the more attractive kinds. The native willows perform an important function as holders of the soil along the margins of lakes and streams; the poplars on account of their hardiness and rapid growth are invaluable as shade trees in newly settled suburbs; and in Western New York the growing of the basket willow is an important industry.

In Europe this insect has been long recognized as an injurious pest upon alders and willows, and its work and life history have been a fruitful source of much discussion by German zoologists. The beetle is reported to be destructive in England, Germany, Austria and Denmark. There are many instances on record of injury to the basket willow and to the alders along the streams and in the forest, and more especially to the plantations of willows and alders cultivated for commercial purposes, which have often been destroyed.

From New Jersey, Dr. J. B. Smith reported that "*C. lapathi* was spreading and was doing serious injury to willows. Nearly


\(^2\)Ninth Annual Report of the State Entomologist of Minnesota, p. 115.
all the clumps of willows near Newark and Arlington had been destroyed, and some fancy and garden trees had been killed."\(^1\)

Another interesting and somewhat similar account of injury by the insect was reported in 1899 by Mr. A. H. Kirkland from his observations of the behavior of this species in Massachusetts. In Winthrop, Revere, and other shore towns in the eastern part of the State, the land is somewhat marshy, and the Balm of Gilead poplar, being the indigenous tree that thrives best, is largely planted in the streets and yards for shade purposes. The branches are weakened by the boring of the larva and are broken down by the ice storms and winds. At present there is hardly a sound Balm of Gilead poplar in the localities mentioned. Mr. Kirkland also states that the work of this beetle caused similar injuries to the poplars in the larger nurseries of eastern Massachusetts, and that nurserymen were thinking of abandoning the growth of poplars and willows. Another observer states,\(^2\) "So abundant is the pest and so extensive its ravages, that it is rarely possible to find a good healthy plant among the shrubby willows about Boston." Drs. C. H. and H. T. Fernald, entomologists of the Massachusetts Experiment Station, reported in 1893\(^3\) that for several years *C. lapathi* has been present in great abundance. The injuries which it causes to willows, poplars and similar soft-wooded trees are frequently serious; and it is now almost impossible to raise these trees in some localities, thus greatly reducing their value for planting as holders of the soil in such places as sandy beaches.

The dissemination of this insect in the State of New York has been easy and rapid, because of the great number of lakes, canals, and small streams that are everywhere bordered with willows. The abundance of these trees aids in the propagation of the species and undoubtedly serves as a means of distribution. The insect spreads not only to the native willows along the

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\(^1\) *Can. Ent.,* 23: 221.
waterways but also to the ornamental willows in the cities and to the cultivated poplars and willows in the nurseries. The insect has now become well established in many localities and the industry of growing poplars and willows is seriously threatened, as well as the usefulness and beauty of trees already mature.

**FOOD PLANTS.**

The beetle attacks practically all of the poplars, willows and alders, for there are very few species that escape injury. Mr. J. G. Jack reports that the beetle has proved destructive to almost all species of willow and all the cultivated poplars grown in the Arnold Arboretum. It has been found boring in the stems of all native willows with the exception of a few mountain or very slender stemmed species which are too small to afford the borers sufficient sustenance. Of the foreign willows which make large trees, such species as the white willow, crack willow and laurel-leaved willow, are more or less attacked, though not so liable to injury as the Babylonian weeping willow. The beetle has been rarely found in small plants of two species of birch, the dwarf birch, *Betula pumila*, and the red or river birch, *B. nigra*.


have been observed to sustain injuries in this immediate locality are *P. monilifera* Ait., *S. lucida* Muhl., *S. caprea* L., *S. cordata* Muhl., *S. sericea* Marsh., *S. alba* L., and *S. amygdaloides* Anders.

These latter were kindly determined by Prof. W. W. Rowlee of Cornell University.

**LIFE STAGES AND HABITS OF THE INSECT.**

**THE EGG STAGE.**

*Description of egg.*—The egg is of a white color turning to a pale yellow when several days old. The shell is thin and fragile, the surface being smooth and slightly viscous. The shape is elongated oval, obtusely rounded at the ends, oftentimes determined by the shape of the cavity. The longer axis is 1.1 mm. and the shorter axis .8 mm. in length.

*Parts of the plant selected for oviposition.*—Oviposition occurs in the corky portions of the wood, near a bud or branch, or in the overgrowths caused by pruning. A cut or break in the bark is a favorite place. When the infestation is marked, eggs can be readily found in the callosities caused by injuries of this beetle in previous years.

*The egg period.*—The egg stage lasts eighteen to twenty days. This was determined as follows: A number of beetles were permitted to feed upon and to oviposit for one day in an uninfested cutting from the stem of a nursery poplar. This operation was repeated on succeeding days, fresh wood being used each time. The beetles were then excluded, the cuttings being kept in moist sand under cover to prevent reinfection. After remaining for fifteen or more days, the entire bark was carefully examined, to ascertain the number and condition of the eggs deposited in the respective cuttings. The following is the result:
Table I.—Time of Incubation of Egg of C. lapathi.

<table>
<thead>
<tr>
<th>Cutting No.</th>
<th>Date of oviposition</th>
<th>Date of examination</th>
<th>Interval between oviposition and examination</th>
<th>Number of eggs</th>
<th>Condition in which the eggs were found on examination of the bark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sept. 13</td>
<td>Oct. 4</td>
<td>Days. 21</td>
<td>6</td>
<td>Eggs hatched and larvae beginning to feed.</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>3</td>
<td>19</td>
<td>2</td>
<td>Eggs about ready to hatch.</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>4</td>
<td>19</td>
<td>1</td>
<td>Egg just hatched.</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>4</td>
<td>18</td>
<td>2</td>
<td>Eggs hatching.</td>
</tr>
<tr>
<td>5</td>
<td>18</td>
<td>9</td>
<td>21</td>
<td>2</td>
<td>Eggs hatched and larvae beginning to feed.</td>
</tr>
<tr>
<td>6</td>
<td>19</td>
<td>4</td>
<td>15</td>
<td>4</td>
<td>Eggs nearly ready to hatch.</td>
</tr>
</tbody>
</table>

Description of the Larva and its Growth.

Larva, Sept. 22, 1905.—When newly hatched, the larva is a soft fleshy grub destitute of feet and bearing a number of very fine hairs. It is 1.6 mm. long and .6 mm. thick at the broadest points, and .4 mm. at the caudal extremity. It is somewhat shining and of a pale yellow color, being whitish toward the caudal extremity. The head is light brown and the mouthparts are dark brown, the tips of the mandibles and maxillae being black. The body is nearly cylindrical in form, tapering a little behind and swollen at the anterior extremity.

Larva, April 19, 1906.—At this time the larva has much the same appearance as the newly hatched form, except that it is larger, being 4.5 mm. in length. It is more cylindrical, the abdominal segments being slightly swollen. The latter have a pale brown color with a pinkish tint.

Larva, May 19.—The appearance of the larva is the same as the younger stages. Some of the individuals begin to show a slight variation in size. The length ranges from 5 mm. to 6 mm.

Larva, June 12.—The larvae show greater variation in size than was noted upon previous observations. Some members of
the brood have apparently ceased to grow, while others have made a rapid growth. The larvae vary in length from 5 mm. to 11 mm., the average length being about 8.5 mm. The larger specimens have begun to bore in the heart wood and in most cases have made a channel about one-half inch long.

*Larva, June 21.*—At this time the larvae show still greater range in size, the length varying from 12.5 mm. in the larger specimens to 5 mm. in the smaller specimens. The largest larvae were ready to pupate.

**HABITS OF THE LARVA.**

Most of the eggs hatch between August 15 and October 1, and the larva upon hatching begins to bore into and feed upon the cambium tissue. During the winter the larva remains dormant, making very little growth until spring. There is no uniformity in the shape of the larval borings or channels during the first months of activity. The larva may remain in one place, making a flat irregular shaped chamber, or sometimes a zigzag channel, though more often the cambium layer is girdled, either partly or entirely, depending on the size of the tree. At first the channel of the young larva is small and has but one opening in the bark, but as the larva increases in size, the channel is gradually enlarged and frequently another opening is made.

The larva works in the cambium layer until within 3 or 4 weeks of the time to pupate. It then bores at an angle into the woody tissue until the heart of the branch is reached, when the direction is changed upward. It can usually be determined whether the larva is working in the cambium layer or the woody tissue by the character of the larval chewings and particles of excrement together with sap from the tree that appear as an exudation at the opening to the larval chamber. While the larva is in the cambium layer, the exudations are brown or black in color, being made up of very fine splinters. The exudations
thrown out from the heart wood are clean, usually white, and larger both in length and thickness. In opening the channels, a few splinters or chips can always be found; but when the larva is ready to pupate, the channel is packed for the full length, with the exception of the pupal chamber at the upper end. After filling the channel with chips and making the pupal chamber, the larva turns itself head downward, in which position the pupa will be found.

DESCRIPTION OF THE PUPA.

The pupa is about one-fourth of an inch long, being somewhat stout and of a pale yellow color. The head, rostrum, and other parts of the body, have a number of small tubercles, most of which bear curved brown hairs. The antennal case is nearly parallel with and slightly overlaps the femur of the foreleg. The wing cases are partly covered by the first two pairs of legs and in turn almost cover the third pair. The tip of the abdomen is provided with a pair of short strong inward-curving hooks.

THE LENGTH OF THE PUPAL STAGE.

In the vicinity of Geneva, most of the larvae pupate some time during July, as is shown by the following observations. In an examination of some twenty larval channels, made July 8, one adult, two pupae and fifteen larvae were found. In another examination of some larval channels on July 12, four adults, four pupae and ten larvae were found. While there were many adults in the larval channels up to the latter date, none had emerged. The appearance of the trees on July 30 seemed to indicate that practically all of the beetles had emerged. The pupal stage lasts from ten to sixteen days. In one instance, a larva ready to pupate was kept under observation. Pupation occurred during July 13 and the adult emerged July 27, the period being fourteen days.
A DESCRIPTION OF THE BEETLE.

The body of the beetle varies from one-third to three-eighths of an inch in length. The general color is a dull black, though the rear third of the wing covers, the basal half of the front thighs, and the ventral part of the prothorax, are covered with white scales. The other portions of the body are covered with black scales interspersed with a few white scales. A few jet black tufts of erect bristles or scales are found upon the wing covers and thorax. When the wing covers are magnified, each is plainly pitted in ten longitudinal rows, the thorax also being minutely, though irregularly, punctured. The under side of the abdomen and the legs are black, being marked here and there by white scales which are especially numerous on the femora, giving the latter a slightly banded appearance. The head and proboscis are black in color. There is a very marked groove in the sterna which lies between the first and extends to the middle of the second coxal cavities. If the beetle is not active, the proboscis is contracted into this groove. When handled the beetle frequently emits a squeaking noise, which is evidently made by rubbing the parts of the thorax together.

HABITS OF THE ADULT.

The adult belongs to the same family as the well known plum curculio and has somewhat similar habits. When moving about the beetle does not run, but walks with a slow, steady lumbering motion. The beetle does not fly when disturbed but will drop to the ground with limbs and snout contracted, or if on the top side of a branch, will roll over on its side and to the ground. No beetles have been observed to puncture the leaves.

HABITS OF THE FEMALE DURING OVIPSPOSITION.

The female usually eats thirty to forty minutes in making a cavity to conceal the egg. She then reverses herself and stands still with ovipositor thrust deep in the opening for thirty seconds.
or a minute. The abdomen is then worked up and down as if the egg were being packed in. The whole operation requires two or three minutes. The position is again reversed and the female works the packing with snout and antenna for several minutes until apparently satisfied, when she moves off in search of another place in which to deposit an egg.

THE NUMBER OF EGGS OVIPOSITED BY ONE FEMALE.

Some observations were made in 1905 and 1906 to determine the number of eggs deposited by adult females. When the investigation of the life history of this insect was taken up, in the latter part of August, 1905, practically all the beetles of that year's brood had emerged from the larval channels. It was therefore too late to obtain beetles that summer to determine the capacity for egg laying, and know with certainty that no eggs had been deposited. However, some observations were made upon beetles that had been captured in a poplar plantation, and it is thought that since the beetles continue to emerge for several weeks after the first appearance of the adults, at least some of the beetles had not begun to oviposit.

The details of the observations are as follows: A pair of beetles while copulating were confined in a separate breeding cage, in which had been planted cuttings about an inch in diameter that had been made from the stem of a two or three year old nursery poplar to serve as food and for purposes of oviposition. After the beetles had fed upon and oviposited in the cuttings for several days, the punctures were dissected with the aid of a lens, the eggs not being counted until they were seen.

Observations were made on ten pairs of beetles lasting from Sept. 6 to Oct. 11. The examinations for the eggs in the bark were made at irregular intervals. The egg laying record of the insects is as follows:
### Table II.—Number of Eggs Deposited by Female, C. lapathi.

<table>
<thead>
<tr>
<th>Insects</th>
<th>Sept. 6</th>
<th>Sept. 7</th>
<th>Sept. 8</th>
<th>Sept. 9</th>
<th>Sept. 10</th>
<th>Sept. 13</th>
<th>Sept. 15</th>
<th>Sept. 18</th>
<th>Sept. 21</th>
<th>Sept. 25</th>
<th>Oct. 11</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
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<tr>
<td>D</td>
<td></td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>4</td>
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<td>E</td>
<td></td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>27</td>
</tr>
<tr>
<td>F</td>
<td></td>
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<td>2</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>7</td>
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<td></td>
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<td></td>
<td>23</td>
</tr>
<tr>
<td>G</td>
<td></td>
<td>1</td>
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<td></td>
<td></td>
<td>3</td>
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<td></td>
<td>10</td>
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<tr>
<td>H</td>
<td></td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>3</td>
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<td>14</td>
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<tr>
<td>I</td>
<td></td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
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<td></td>
<td></td>
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<td>15</td>
</tr>
<tr>
<td>J</td>
<td></td>
<td>1</td>
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<td>4</td>
<td>1</td>
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<td></td>
<td></td>
<td></td>
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<td>4</td>
</tr>
</tbody>
</table>

The average number of eggs deposited by the ten females is 16.3, and the greatest number deposited by one individual is 27.

An effort was made in 1906 to repeat these observations, upon beetles that had emerged in breeding cages. Many beetles were secured from the wood of some badly infested poplars and willows. A week or ten days after emerging some of the beetles began to copulate and a number of pairs were isolated. But for some unaccountable reason the beetles were short-lived and very few eggs were deposited.

### Feeding Habits of the Adult.

The adult is a voracious eater and obtains subsistence by puncturing the bark and feeding on the cambium layer. For the first week or ten days after emerging the beetle feeds extensively upon the tender bark of one year old branches, then copulation takes place, after which the beetles are more often found on the older parts of the tree. One observation seems to indicate that young bark is a prime necessity. A number of beetles developed in a breeding cage in which there was only the old wood from which they had emerged. The beetles did not eat the old bark and many, appeared dead after three or four days, but revived when put on a diet of young twigs. This was probably the ripening period for oviposition, as during the first
PLATE II.—Figs. 1 and 2, Bark Punctured by Adults; Fig. 3, Exudations of Splinters and Excrement from Larval Channels; Fig. 4, Bark Removed Showing Girdling by Larva.
week or ten days after emerging no eggs are deposited. When
the beetles are ovipositing they are more often found puncturing
the bark of two to four year old wood, and if at this time they
are given twigs and small branches of one year old wood ex-
clusively for food, they will riddle the bark with punctures but
will not oviposit in the bark. In several instances similar to
this the eggs have been deposited on the floor or walls of the
breeding cage. No eggs have been detected in the bark of one
year old wood. This apparent distinction shown by the beetle
between one year and two year bark is brought out strongly in
one of the methods of growing poplars in the nursery, which is
as follows: A cutting of one year wood is put in the ground.
This is allowed to root and one bud to grow. After one year’s
growth the shoot and tap root are pruned and the stock replanted.
At the end of another year it is called a one year old tree, though
it may have six or eight inches of two year wood above ground.
These one year trees are often infested but the point where the
eggs are inserted will invariably be in the two year old wood.
According to nurserymen, this pruning and replanting is done to
give the tree a better root system.

DISTANCE THE BEETLES TRAVEL TO FIND NEW PASTURES.

In infested localities the beetles seem to be present everywhere
upon willows and poplars, and it is evident that they occasionally
migrate or are scattered by some means. However, none have
ever been observed in the act of migration. The beetles have
perfect wings but in the observations of two summers none have
been seen flying. In a grove composed mostly of poplars and
willows, some of which were badly infested with this beetle,
a lantern trap was placed on the nights of October 4th and 5th,
1905, and again for eleven nights during August, 1906. The
catch of insects in each instance was large, both in variety and
numbers, but included no C. lapathi. Some observations that are
of interest in this connection were made in one of the nurseries
belonging to Mr. H. E. Merrill of Geneva. There are four blocks of poplars in a line east and west, each about one hundred yards apart. The west and east blocks are the youngest, one being one year old, and the other, cuttings; and though frequently inspected no beetles were found on either. But the central blocks, one two years old and the other three years old, were each badly infested.

During the summer of 1906, in order to learn more of the migratory habits of the beetle, thirty-five specimens were caught in a nursery poplar block and marked so that they could be recognized. These marked beetles were then liberated at a distance of fifty yards from the block in which they were captured. At intervals of several days all the neighboring poplars were carefully examined, and more than four times the original number of beetles were captured, but none of the marked beetles were collected.

While these observations are not conclusive, yet it is believed from the behavior of the beetles that they do not naturally travel far and that they rarely migrate from an abundant food supply.

EXPERIMENTS WITH POISON SPRAYS FOR THE CONTROL OF THE PEST.

The adult is an external feeder and obtains subsistence by puncturing the bark.—The great number of punctures made in the bark by the adult while feeding at once suggested the possibility of using arsenical sprays as a means for the control of the pest in the nursery. In order to learn the effect of these sprays upon the beetles, a number of experiments were made, as follows:

SPRAYING TESTS OF 1905.

Experiment No. 1.—On August 26, 1905, the branch of a poplar tree was sprayed with paris green at the rate of one pound to fifty gallons of water. Three pairs of beetles were then put on the branch, which was covered by means of strong mosquito
netting. Four days later some of the beetles were apparently dead and the others were ailing. On September 1, six days later, all the beetles were dead. The bark showed no evidences of injury by the beetles.

Experiment No. 2.—On August 29, 1905, the tops of two poplars in a nursery row were headed in and then sprayed with arsenate of lead, using two pounds to fifty gallons of water. Eight pairs of beetles were then placed on each tree, being enclosed by means of large cheesecloth bags. On September 4, six days later, twenty of the thirty-two beetles were dead. The wood had been only slightly punctured.

Experiment No. 3.—On September 29, 1905, forty beetles were enclosed in a similar manner as in experiment 2 on two trees that had been sprayed twenty days previously with arsenate of lead, using two pounds to fifty gallons of water. The greater part of the spray had apparently washed off during the twenty days. On September 29, ten days later, some beetles were dead and all appeared ailing. On October 10, all but one of the forty beetles were dead.

As a check on the preceding experiments, twenty-six beetles, divided into five lots, were confined in bags on unsprayed trees to determine if the confinement itself affected the insects unfavorably. The results are as follows:

<table>
<thead>
<tr>
<th>Date beetles were confined in bags.</th>
<th>Number of beetles to each lot.</th>
<th>Number alive September 23.</th>
<th>Number alive October 13.</th>
<th>The bark in each instance was badly punctured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug. 26..........................</td>
<td>14</td>
<td>11</td>
<td>2</td>
<td>The bark in each instance was badly punctured</td>
</tr>
<tr>
<td>Aug. 26..........................</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Aug. 25..........................</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Aug. 25..........................</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Aug. 25..........................</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
From the above table it will be seen that on September 23, twenty-nine days after the beetles were confined in bags, twenty-two of the twenty-six beetles were still living. On October 15, fifty days after the beetles were confined, six adults were still living. From these results it is believed that the use of bags to enclose beetles had no appreciable effect upon the health of the insect.

SPRAYING TESTS OF 1906.

On August 23, 1906, the following experiments were undertaken to corroborate the results of 1905 with the use of poisons for the control of the beetle.

A tree was selected that had been sprayed thirty-nine days previously (July 14) with bordeaux mixture, containing five pounds of arsenate of lead to fifty gallons of the spray. Most of the application had apparently washed off during the interval. The larger limbs of the tree were cut back and the tree was enclosed in a strong bag of mosquito netting in which twenty beetles were placed.

On the same day another tree was selected from a block of poplars which had been sprayed August 6 with arsenate of lead, using three pounds of the poison to fifty gallons of water. During the intervening seventeen days all but a trace of the poison had apparently washed off. This tree was bagged as the preceding one and twenty beetles were also confined.

A third tree was chosen from a block of poplars that had not been sprayed and was covered with mosquito netting to contain twenty beetles, to be used as a check. In three days the effect of the poison began to show upon the activities of the beetles, for the individuals on the sprayed trees appeared dormant. On September 5, thirteen days after being put on the trees, the contents of the bags were examined. All the beetles, forty in number, on the sprayed trees, were dead. Of the twenty specimens
on the check tree, only four were dead. The remaining sixteen were apparently not affected by being enclosed in the bag of mosquito netting.

CONCLUSIONS OF THE EXPERIMENTS WITH POISON.

While the experiments with poison sprays were conducted according to laboratory methods and the number of beetles involved in the experiments was limited to about three hundred, the results are encouraging and indicate that thorough spraying with an arsenical poison of the poplar and willow plantations about July 15, will materially reduce the number of beetles and thereby lessen the number of eggs deposited in the trees.

THE EFFECT OF CONTACT SPRAYS UPON THE HIBERNATING LARVAE.

A number of experiments have been made to determine the effect of various washes, composed largely of lime, kerosene and arsenical poison in combination. These washes were applied during the winter to learn the effect upon the young larvae. In each case the application had no appreciable effect upon the larvae.

DOES POISON REPEL OR DESTROY THE BEETLES?

After the spraying and bagging experiments of 1905 were completed, it was evident that enclosing beetles in bags upon trees that had been sprayed with poison resulted in the death of the beetles. It was now desirable to ascertain whether the beetles died as a result of poison or of starvation. To determine this, on August 4th, 1906, forty-five beetles, divided into lots of fifteen individuals, were fed in three glass containers with an abundance of food. The first container held only sprayed twigs and branches, the second held both sprayed and unsprayed twigs, while the third held only unsprayed twigs. The beetles in container two fed upon both sprayed and unsprayed food
with apparent relish, showing no discrimination between sprayed and unsprayed bark. On August 11, seven days afterward, of the beetles in containers one and two, only one beetle in each lot was alive, while in container three, holding only unsprayed food, thirteen beetles were alive.

NURSERY PRACTICES THAT FAVOR THE BEETLE.

In a study of the various methods of growing poplars and willows, a practice has now and then been observed that is favorable to the multiplication of the poplar beetle. It has been learned that in most cases the degree of infestation increases with the age of the poplar and willow blocks. Oftentimes a block of one year or two year trees that is practically free from infestation one year, will in the following season be so badly infested that from twenty-five to fifty per cent. of the trees will be unfit for sale. For this reason nurserymen should, as far as is practicable, dispose of the stock when it is not more than two or three years of age. When a tree becomes so badly injured by the beetles that it is unsalable, it should be taken out and burned, as the chances for its recovery are small, and such trees serve as a breeding place for the beetle. The same practice should be pursued with infested native willows that are frequently allowed to grow in swampy places or along canals or streams adjacent to nurseries. Any brush or injured trees taken from the nursery blocks should be burned. On several occasions brush in nurseries has been found to contain adult beetles ready to emerge. A special instance was noted as follows: Several one year old trees were found in a nursery brush pile with the appearance of having been there a week or more. A number of these that had been broken off by the wind as a result of the girdling habit of the beetle, were put in a dry place and examined two weeks later. Of the larval channels that were
examined, a number of the beetles had emerged, some were still in the channel ready to escape, and of thirty larvae present in the channels, all but three reached the adult stage.

DIRECTIONS FOR PREVENTION OF INJURY AND CONTROL OF BEETLES.

From observations that have been made, it is believed that planting young blocks of trees adjacent to old plantations facilitates the spread of the beetles, and their injurious work. Whenever practicable, young trees should not be grown near old infested blocks. When a few trees or a plantation is slightly infested, the insect can be effectually controlled by cutting out and burning the infested parts in June, before the beetles emerge. The presence of the larvae in the wood is indicated by the appearance of sawdust and excremental particles, and the exudation of sap at the external opening of the larval channel. Also much benefit will be derived by destroying by fire all branches and trees broken by the wind or otherwise injured, as they are likely to be infested. Plate II, fig. 3.

Poplar and willow blocks grown in localities where the beetle is abundant should be sprayed during the last two weeks in July with bordeaux mixture, containing three pounds of lead arsenate to fifty gallons of the mixture. This is advised experimentally, as the tests in the nurseries to determine the value of this treatment are not as yet completed. The trees should be thoroughly sprayed so that all parts of the bark, including that of the small branches, are well coated with the poison.

The total cost of this treatment when applied to two year old nursery trees in our experiments, was approximately one-fourth of a cent per tree. The experiments indicate that if the treatment is properly applied it will control the poplar weevil. This spray also protects the tree from many other insect and fungus enemies.
If willows or poplars planted for windbreaks, or screens, or holders of the soil, should become so badly injured as to impair their beauty, it is advisable to dig out and burn the infested trees during the winter or spring, and to replant with some other kind of a tree. For this purpose, Mr. A. H. Kirkland of Massachusetts, recommends the silver maple, *Acer dasycarpum*, or its variety *weirii*, either of which are said to make a good growth in damp localities.