THE CHERRY AND HAWTHORN SAWFLY LEAF-MINER.

P. J. PARROTT AND B. B. FULTON.

PUBLISHED BY THE DEPARTMENT OF AGRICULTURE.
BOARD OF CONTROL.

Governor Charles S. Whitman, Albany.
Commissioner Charles S. Wilson, Albany.
Burt E. Smalley, Interlaken.
Henry C. Harpending, Dundee.
C. Willard Rice, Geneva.
C. Green Brainard, Waterville.
Thomas Newbold, Poughkeepsie.
William H. Manning, Saratoga Springs.
Parker Corning, Albany.

OFFICERS OF THE BOARD.

Burt E. Smalley, 
President.

William O’Hanlon, 
Secretary and Treasurer.

STATION STAFF.


George A. Smith, 
Dairy Expert.

Frank H. Hall, B.S., 
Vice-Director; Editor and Librarian.

Percival J. Parrott, M.A., 
Entomologist.

Hugh Glasgow, Ph.D., 
†Fred Z. Hartzell, M.A., (Fredonia), 
Associate Entomologists.

Harold E. Hodgekiss, B.S., 
†Bentley B. Fulton, B.A., 
Frank H. Lathrop, M.S., 
Assistant Entomologists.

Ulysses P. Hedrick, Sc.D., 
Horticulturist.

Roy D. Anthony, M.S.A., 
†Fred E. Gladwin, B.S. (Fredonia), 
Associate Horticulturists.

George H. Howe, B.S.A., 
Charles B. Tubergen, B.S., 
Joseph W. Wellington, B.S., 
Assistant Horticulturists.

Orrin M. Taylor, 
Foreman in Horticulture.

F. Atwood Sirrine, M.S. (Riverhead), 
Special Agent.

Jessie A. Sperry, Director’s Secretary.

Frank E. Newton, 
William F. Patchin, 
Lena G. Curtis, 
Agnes E. Ryan, 
Mae M. Melvin, 
Clerks and Stenographers.

Computer and Mailing Clerk.

Address all correspondence, not to individual members of the staff, but to the New York Agricultural Experiment Station, Geneva, N.Y.

The Bulletins published by the Station will be sent free to any farmer applying for them.

*Absent on leave. †Connected with Grape Culture Investigations.
SUMMARY.

During recent years sour cherries, principally of the variety English Morello, have exhibited a disorder of foliage which is characterized by light-colored blister-like areas, revealing a loss of chlorophyll, that are due to the destruction of the pulpy tissues. Studies by this Station show that this injury is caused by a leaf-mining hymenopteron (*Protenusa collaris* Mac Gillivray). This is a new orchard pest in New York and one not heretofore recorded as injurious to fruit plantings in this country. It was first reported from a cherry orchard near Geneva, N. Y., during the summer of 1910, and has since been found in injurious numbers in cherry plantings about Germantown, in the Hudson River Valley. It doubtless occurs in other localities. As a hawthorn pest the sawfly is definitely known to occur in New York and Massachusetts.

The adult insect is a small sawfly which varies from one-eighth to one-sixth of an inch in length. The body of the female is metallic black, with the prothorax rufous in color. The flies make their appearance during early May, at which period the first leaf clusters are unfolding and the blossom buds are beginning to open. The eggs are laid singly through incisions in the upper epidermis, and the lower surface of the egg usually lies in contact with the lower epidermis, which has been cut free from other tissues of the leaf so as to form a small blister-like cavity or pocket. The majority of the eggs are deposited in the basal portion of cherry leaves. Hatching occurs during the middle or the latter portion of May. The young larva works its way to the parenchyma immediately beneath the epidermis of the upper surface of the leaf and mines towards the distal end of the leaf, generally keeping close to the margin. The injury is first indicated by a small, sinuous channel, which finally swells out into a large, blister-like area. The blisters are very conspicuous on the upper surface of the leaves during early June, at which time the larvae are making their maximum growth.
With the completion of their mining operations, about the middle of June, the larvæ abandon the foliage, bury themselves in the ground and construct an earthen cell. The insect passes the winter in the larval stage. Pupation occurs during the latter portion of April or during early May.

The injury to cherries by this species is due to the work of the larvæ which mine the leaves and destroy the mesophyl or pulpy tissues. Frequently the entire leaf is mined, but usually only from one-quarter to one-half of the leaf area is destroyed. The leaves that are most seriously affected shrivel and die, and finally drop to the ground. The damage is largely confined to the foliage that unfolds with the bursting of the buds. The extent of damage with cherries varies in importance according to the extent of infestation and influence of seasonal conditions on the rate of growth. Injuries to foliage of certain species of Cratægus are generally more severe than with cherries, and in certain localities have greatly reduced the attractiveness of these hawthorns for ornamental purposes.

The leaf-miner is subject to attack by two species of hymenopterous parasites which, during some seasons, have greatly lessened the numbers of their host. An ichneumon (*Pezoporus* (*Schenkia*) *tenthradinarum* Rohwer) has been collected in cherry plantings, while a chalcidid (*Trichogramma minutum* Riley) has been reared from eggs of the sawfly deposited in foliage of cherry and hawthorn.

In experiments to check the mining of cherry leaves the larvæ of the sawfly proved to be very resistant to lime-sulphur solution, naphthalene, kerosene emulsion, miscible oil, nicotine solution, kerosene, or gasoline. Picking of affected leaves at first appearance of injury and destruction of hawthorns in the vicinity of cherry orchards are advised tentatively as the most practical means of avoiding injuries to cherries by the leaf-miner. Ploughing and cultivation, especially during late April or early May, would doubtless destroy many of the insects in the ground, although the exact value of this practice has not been determined. Fumigation with hydrocyanic-acid gas proved to be the only direct treatment of the foliage which effectually checked the destructive work of the larvæ in cherry leaves. An application of nicotine solution and soap when the young larvæ are beginning to tunnel the foliage apparently affords efficient protection to hawthorns.
INTRODUCTION.

In comparison with other fruits, sour cherries are singularly free from attacks by injurious insects. They are practically immune to the San José scale and generally are not much troubled with the plum curculio or plant lice, all of which are very destructive pests to other stone fruits, such as sweet cherries, plums or peaches. Of the pests that attack them, those of the greatest commercial importance in the State of New York are the cherry fruit flies (*Rhagoletis cingulata* and *R. fausta*) which cause maggoty fruit; the fruit-tree bark-beetle (*Scolytus rugulosus*) which burrows into the bark and wood of the branches and trunks; and the pear slug (*Caliroa cerasi*) which skeletonizes the leaves.

The comparative immunity which sour cherries have enjoyed from defoliating insects is now threatened by a leaf-mining hymenopteron which, in certain plantings of English Morello, has become quite prominent in recent years. The studies herein recorded were undertaken for the purpose of ascertaining the life history, habits and economy of the creature which, at the inception of the investigation, proved to be an unknown species and of rather widespread distribution.

HISTORY, BIOLOGY AND WORK OF INSECT.

DISCOVERY AND IDENTIFICATION.

The existence in the State of New York of a leaf-miner attacking cherry foliage was brought to the attention of the Experiment Station by the receipt of affected foliage during the latter part of June, 1910. An examination of the orchard from which the material had been collected showed that more or less of the leaves on nearly all of the trees of a variety known as English Morello had shriveled and died, while here and there were others with well-defined light-colored areas or blisters, revealing a loss of chlorophyll. Siftings of earth from beneath the trees showed that the causal agent was the larva of a species of sawfly. A number of these were carried through successive stages of development to the following year, when adults were obtained. Some specimens were forwarded to Dr. A. D. [553]
MacGillivray, formerly of Cornell University, who reported that the insect represented a new species, the type of a new genus, and should be recorded as *Proenusa collaris*. The information was also given that a small collection of the creatures reared from hawthorns growing about Boston, Massachusetts, had previously been received by him but the material was in too unsatisfactory a condition to describe. For popular usage we have proposed the name "The Cherry and Hawthorn Sawfly Leaf-Miner."

HOST PLANTS.

According to present knowledge the host plants of the leaf-miner are the cherry and the hawthorn. Of the cherries it has so far largely confined its attacks to the variety known as English Morello. It is not commonly observed on the Montmorency or Early Richmond, which would indicate that its presence on these varieties is accidental and occurs when these sorts are grown in close proximity to the Morello. The susceptibility of one fruit and the apparent unattractiveness or resistance to the insect of the other fruits are curious facts, since all are cultivated varieties of the same cherry, *Prunus cerasus*; and plantings of each kind, growing side by side, may be frequently observed in this State. The two sorts Montmorency and English Morello represent groups of cherries which vary more or less in both tree and fruit, but have a constant difference only in a single character — the juice in the fruits of one is colorless, in the other it is red. This sharp discrimination on the part of the leaf-miner seems all the more anomalous when considered in the light of its extreme partiality to the foliage of certain hawthorns, which are only remotely related to the cherry.

In its attacks on hawthorns the leaf-miner tunnels the foliage in the same fashion as that of the cherry. During the course of our studies it has been very evident that the pest is more destructive to certain species of Crataegus than it is to the cherry. As has been rarely observed with the cherry, one may find as many as five larvae mining a single leaf. With hawthorns having a relatively small and narrow leaf, as *Geneseensis*, there may be an entire destruction of the pulpy tissues, in which event all that remains of the affected leaf is the epidermis, which dries up and ultimately falls to the ground. At the height of an attack, which occurs when the larvae are reaching

---

1 Letter, dated June 2, 1911.
maturity, hawthorns which are much infested take on a brownish cast and appear as if struck by a blight or swept by fire. The destructive work of the insect may seriously mar the attractiveness of certain species of hawthorns as ornamental shrubs.

About Geneva the leaf-miner is most common in the foliage of an unidentified hawthorn belonging to the Medixoimæ group, while such species as *C. pedicellata* and *C. punctata*, growing in the immediate vicinity of the former, have so far shown little or no injury and are generally exempt from attack. Dr. C. S. Sargent, Director of the Arnold Arboretum, writes that the insect has become established in the Crataegus plantings and that it is especially destructive to hawthorns of the Crus-Galli group and *C. nitida*, *C. rotundifolia*, *C. pruinosa* and other species. Similar conditions exist at the New York Botanical Garden and, as elsewhere, certain species of Crataegus are pretty badly infested, while a few species have so far been free from attack.

In the public parks at Rochester, notably Genesee Park, the insect has in recent years become a serious pest. Hawthorns representing a wide range of species and grown in extensive numbers feature prominently in certain landscape plantings. In these the leaf-miner has become established and its destructiveness may be readily observed during May and June. Some haws have been seriously affected, while others have been exempt from injury. Here again various hawthorns of the Crus-Galli group have proven very susceptible to the pest, and certain species of other groups have shown considerable injury. It is not yet clearly demonstrated in all cases whether freedom from the pest is a matter of chance or that some species are actually immune to the insect. Through the courtesy of Mr. John Dunbar, assistant superintendent of parks, a recognized authority in the systematic knowledge of the Crataegi, an examination was made during June, 1915, of the hawthorns in the arboretum and the condition of the plants with reference to the work of the leaf-miner were noted. The accompanying list indicates the relative importance of the insect during the past summer to various hawthorns of different groups:

<table>
<thead>
<tr>
<th>Name of Species</th>
<th>Species Much Infested.</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Crataegus sp.?</td>
<td></td>
<td>Coccineæ</td>
</tr>
<tr>
<td>2. Crataegus sp.?</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>3. Crataegus Brunetiana</td>
<td></td>
<td>Rotundifolius</td>
</tr>
<tr>
<td>Name of Species</td>
<td>Group</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>4. <strong>Crataegus Geneseensis</strong></td>
<td>Crus-Galli</td>
<td></td>
</tr>
<tr>
<td>5. <strong>Crataegus persimilis</strong></td>
<td>“</td>
<td></td>
</tr>
<tr>
<td>6. <strong>Crataegus Bartramiana</strong></td>
<td>“</td>
<td></td>
</tr>
<tr>
<td>7. <strong>Crataegus Engelmanni</strong></td>
<td>“</td>
<td></td>
</tr>
<tr>
<td>8. <strong>Crataegus erecta</strong></td>
<td>“</td>
<td></td>
</tr>
<tr>
<td>9. <strong>Crataegus fertilis</strong></td>
<td>Tomentosæ</td>
<td></td>
</tr>
<tr>
<td>10. <strong>Crataegus sp.?</strong></td>
<td>“</td>
<td></td>
</tr>
<tr>
<td>11. <strong>Crataegus sp.?</strong></td>
<td>Medioximæ</td>
<td></td>
</tr>
</tbody>
</table>

**Species Slightly Infested.**

<table>
<thead>
<tr>
<th>Name of Species</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>12. <strong>Crataegus sara</strong></td>
<td>Molles</td>
</tr>
<tr>
<td>13. <strong>Crataegus Lennoniana</strong></td>
<td>Pruinosæ</td>
</tr>
<tr>
<td>14. <strong>Crataegus inusitula</strong></td>
<td>“</td>
</tr>
<tr>
<td>15. <strong>Crataegus perjuncta</strong></td>
<td>“</td>
</tr>
<tr>
<td>16. <strong>Crataegus tardipes</strong></td>
<td>Coccinæ</td>
</tr>
<tr>
<td>17. <strong>Crataegus Thayeri</strong></td>
<td>“</td>
</tr>
<tr>
<td>18. <strong>Crataegus sp.?</strong></td>
<td>“</td>
</tr>
<tr>
<td>19. <strong>Crataegus Boothiana</strong></td>
<td>Tenuifoliiæ</td>
</tr>
<tr>
<td>20. <strong>Crataegus Streeteræ</strong></td>
<td>“</td>
</tr>
<tr>
<td>21. <strong>Crataegus rotundifoliiæ</strong></td>
<td>Rotundifoliiæ</td>
</tr>
<tr>
<td>22. <strong>Crataegus audita</strong></td>
<td>“</td>
</tr>
<tr>
<td>23. <strong>Crataegus Jackii</strong></td>
<td>“</td>
</tr>
<tr>
<td>24. <strong>Crataegus sp.? No. 594</strong></td>
<td>Tomentosæ</td>
</tr>
<tr>
<td>25. <strong>Crataegus sp.?</strong></td>
<td>“</td>
</tr>
<tr>
<td>26. <strong>Crataegus ferentaria</strong></td>
<td>“</td>
</tr>
<tr>
<td>27. <strong>Crataegus spinulosa</strong></td>
<td>“</td>
</tr>
<tr>
<td>28. <strong>Crataegus aprica</strong></td>
<td>Flave</td>
</tr>
<tr>
<td>29. <strong>Crataegus dissona</strong></td>
<td>Medioximæ</td>
</tr>
<tr>
<td>30. <strong>Crataegus Dunbari</strong></td>
<td>Anomale</td>
</tr>
<tr>
<td>31. <strong>Crataegus nigra</strong></td>
<td>Pentagynæ</td>
</tr>
</tbody>
</table>

**Species Not Infested.**

<table>
<thead>
<tr>
<th>Name of Species</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>32. <strong>Crataegus mollis</strong></td>
<td>Molles</td>
</tr>
<tr>
<td>33. <strong>Crataegus submollis</strong></td>
<td>“</td>
</tr>
<tr>
<td>34. <strong>Crataegus Arnoldiana</strong></td>
<td>“</td>
</tr>
<tr>
<td>35. <strong>Crataegus Holmesiana</strong></td>
<td>Coccinæ</td>
</tr>
<tr>
<td>36. <strong>Crataegus fucosa</strong></td>
<td>Medioximæ</td>
</tr>
<tr>
<td>37. <strong>Crataegus chlorosarea</strong></td>
<td>Sanguineæ</td>
</tr>
<tr>
<td>38. <strong>Crataegus spp.</strong></td>
<td>Intricatae</td>
</tr>
</tbody>
</table>

**DISTRIBUTION.**

As a cherry pest the leaf-miner is definitely known to occur in injurious numbers in orchards of English Morello about Geneva in western New York and about Germantown, which is located in the Hudson Valley. It has been reported² to the Station as occurring about Schenectady, but the statement of its presence in that locality has not been verified. In view of its occurrence in two communities which are widely separated, it would seem reasonable to suppose that the pest exists in other localities where sour cherries are extensively grown. However, a careful survey by the orchard and

nursery inspectors of the Department of Agriculture in all of the leading fruit-growing counties of the State has failed to find any evidences of the work of the insect except in the foregoing localities. A study of available literature indicates that the insect is not known to occur as a cherry pest outside the State of New York.

As a depredator of hawthorns the leaf-miner has a wider range of distribution. It is known, as already indicated, as a serious pest of hawthorns growing about Boston, Mass., and it is common on various species of Crataegus growing in the vicinity of New York City, Rochester, Ithaca, Geneva and Skaneateles, all of which are located in this State.

APPEARANCE OF THE INJURY.

As implied by its common name, the insect is a leaf-mining species and its work is very characteristic. The injury is first indicated by a small, thin, sinuous channel which finally swells out into a large blister-like area of a light brown shade resembling that of dead leaf tissues (Plate V). The attack by the larva of the sawfly begins on the edge of the leaf toward the stem, and continues along one side toward the leaf apex, the tunnel increasing in dimensions with the growth in size and the progress of the insect. Upon reaching the tip of the leaf the grub reverses its course and works backward toward the stem, consuming the remainder of the pulpy tissues between the main rib and the margin of the leaf. As a result, the parenchyma or soft cellular tissue is eaten, leaving the epidermis, which turns brown and forms a large blister. These blisters are very conspicuous in the upper surfaces of the leaves. Oftentimes the whole leaf is mined, but usually one-quarter to one-half of the whole area of a leaf is destroyed. Only the leaves that first unfold are subject to attack, but during some seasons hardly any of these escape the insect’s depredations. The principal damage occurs during the last week of May and the early part of June or about one month before the harvesting of the fruit. With the disappearance of the larvæ the leaves most seriously affected shrivel and die, and finally drop to the ground, causing defoliation which varies in importance according to the extent of infestation and the influence of seasonal conditions on the rate of growth. The actual effect of the work of the insect upon the crop is not easily measured and, during most years, is perhaps not of serious extent. However,
as previously indicated, the destructive power of the pest is mainly exercised on the leaves that unfold with the bursting of the buds. In years of slight precipitation and when new growth is of small extent and of slow development the plant is dependent on such foliage as it carries at the time, and any extended injury to it must result in a set-back, with corresponding ill effects on the maturing crop of fruit. In years when the production of new growth is more rapid the damage caused by the sawfly is of much less importance as the large leaf surface under the circumstances is sufficient for the needs of the plant and the loss of affected foliage does not result in an important reduction in leaf area.

The hawthorns are more subject to severe attacks than the Morello cherry, and during some seasons plants may be observed on which there is hardly a leaf that does not show injury. Notwithstanding the partiality of the sawfly for this plant, hawthorns seem able to withstand considerable destruction of foliage without marked external evidences of the weakening of the trees. As shown in Plate VI, the attractiveness of the plants as ornamental shrubs may be seriously marred.

**BIOLOGY OF THE INSECT.**

The Tenthredinoidea, to which this species belongs, constitute a large and important group of hymenopterous insects, including some very destructive forms, as the pear slug (*Caliroa cerasi* Linn.), the rose sawfly (*Endelomyia rosea* Harr.) and the currant worm (*Pteronus ribesii* Scopoli). It is estimated that there belong to this superfamily about two thousand species, and according to Dr. MacGillivray\(^3\) seven hundred or more species are recorded for this country. Of these occurring in the United States probably not more than five to eight per ct. are of sufficient economic importance to be classed as injurious insects. The adults are very much alike, and in spite of their numbers few species only attract the attention of the general observer; and these almost solely because of the destructive role of the larvæ. The vernacular name bestowed on these insects originated doubtless from the fact that the ovipositor of the female is a cutting organ, operating in much the fashion of a saw. This is composed of two small chitinous structures, finely serrated, which lie side by side and may be projected from a protective sheath and moved up

---

\(^3\) Letter of Sept. 20, 1914.
and down with a saw-like motion. These saws are employed to lacerate vegetable tissues and form apertures or pockets in the plant substance where the eggs are placed. The larvae reveal great similarities in their more important characters of structure and habit. Some forms, as the pear slug, are covered with a slimy secretion and pass more easily for slugs than insect larvae; others are coated with a waxy substance which may completely conceal their identity; while many, such as the rose and currant species, resemble caterpillars and feed in exposed positions and on a great variety of plants. A number of species reside in galls, while a few forms are leaf-miners. When mature the larvae of most species descend to the surface of the ground and spin cocoons about themselves.

DESCRIPTION OF LIFE STAGES.

Egg.—The egg (Fig. 1) is elliptical in shape, but is not entirely symmetrical in its outline, as one side shows a greater curvature than the other. It is, when removed from surrounding plant tissues, circular in cross section, but in its normal position in the leaf structures it is much flattened owing to pressure. The chorion is a thin, white, shining, flexible membrane. The measurements of eggs when not compressed are: Length, 0.5 to 0.7 millimeter; and diameter, 0.28 to 0.36 millimeter.

Larva.—To determine the number of instars the mines were carefully examined for all insect remains, when the head molts were collected and measured as to width. The body remnants from some of the molts in first larval instars were occasionally missing, having probably been eaten, but in very few cases were the head structures not in good condition for purposes of examination. The width of the head is fairly constant for the first larval instar but in the more advanced stages there is considerable variation. On the
basis of head measurements it appears that the larva normally molts five times in its mine. It finally enters the ground and molts again in transforming to a pupa.

The first five instars have the same general form and differ one from the other principally in size. The body is broadest at the first and second thoracic segments, and gradually tapers toward the rear. The thoracic legs are short and conical and are composed of five segments, which include the thick basal and the small hooked terminal structures. All the abdominal segments except the last bear short rounded prolegs on the ventral side. The head (Fig. 2) is horizontal in the early stages, but slopes downward slightly in later instars. It is broad and flat, rounded on the sides and obtuse in front. On the dorsal side it bears four longitudinal sutures. The outer pair run back from the ends of the clypeus and divide the head into three almost equal sections. The inner pair extend one-half way across the middle section, dividing it into three equal areas. Eyes are wanting. The antennæ are very short and are apparently composed of three segments. The maxillary palpi are large and protrude from beneath the head. The labial palpi are very small. The mandibles are short and thick, deeply hollowed on the inner side and do not protrude beyond the end of the broadly notched labrum.

The technical description of each of the larval stages follows:

First instar. (Plate II, fig. 1).—Body translucent, white, shining; only slightly wrinkled, and with a green streak, due to alimentary tract, showing plainly in the abdominal segments. Prolegs appear as only slight elevations.

Head is slightly brownish, being of darker color on the outer and posterior edges; mouth parts are reddish brown. The ventral side of the first thoracic segment has a pair of brownish gray marks, shaped roughly like a T with the cross bar running longitudinally and the perpendicular reaching outward to a point just in front of the leg. A semicircular line of the same color occurs in front of the anus and is interrupted on the median line.

Newly-hatched larvae are about 1.2 mm. in length, and after feeding the body grows, reaching a length of 2.3 mm. Width of head, 0.36 to 0.42 mm.; average, 0.39 mm.

Second instar. (Plate II, fig. 2).—All markings of body are more extensive than in preceding stage. Dorsal side with some specimens has a broad, faint, brownish-
gray, transverse band on the first thoracic and two spots on the second thoracic segments. The pair of marks on ventral side of first thoracic segment are shaped more like inverted V's, and between them there is a large longitudinal band. The second and third segments have medium oval spots. Each proleg is marked by a narrow crescent on the anterior side. A semicircular mark on the last segment extends over half a circle and is not interrupted on the median line.

Length, 2.6 to 3.00 mm. Width of head, 0.48 to 0.55 mm.; average, 0.52 mm.

Third instar. (Plate II, fig. 3).—All markings are the same as in preceding stage, but are much fainter. Prolegs are more prominent; those on the first and penultimate abdominal segments are small.

Length, 3.2 to 4.3 mm. Width of head, 0.63 to 0.73 mm.; average, 0.67 mm.

Fourth instar. (Plate II, fig. 4).—The characteristic markings in preceding stages practically disappear in this instar. A ring of several rows of minute papillae surrounds the anus. These probably exist in the earlier instars and escape detection because of their small size.

Length, 4.5 to 7.2 mm. Width of head, 0.8 to 0.9 mm.; average, 0.85 mm.

Fifth instar. (Plate II, fig. 5).—This is similar to fourth instar. There are no distinct color markings.

Length, 6.5 to 7.5 mm. Width of head, 0.92 to 1.07 mm.; average, 1.0 mm.

Sixth instar. (Plate II, fig. 6).—The body does not differ from that of preceding stage. The head assumes a vertical position. The four sutures on the dorsal side are very faint. The clypeus and labrum are shorter than in fifth instar. The mandibles protrude prominently and do not meet at the ends. The labium and maxillae project from beneath the head to beyond the tips of the mandibles.

Length is same as in fifth instar or may be a trifle shorter. Width of head, 0.90 to 1.05 mm.; average, 1.0 mm.

Pupa. (Plate II, fig. 7).—Until color of adult begins to show the pupa is white in all portions except the eyes, which are reddish. Length about 5 mm.

Adult.* (Plate I, figs. 1 and 2).—"Body of female black, with the clypeus, labrum, malar space, the mandibles, the first segment of the antenna, the tegula, the narrow margin to the pronotum, and the legs, for the most part, whitish. The prothorax, except the parts named, the cephalic part of the mesopleure, and the pectus, rufous; the posterior femora more or less shaded with fuscous; the head smooth with antennal furrows interrupted on the middle of the face; the furrows surrounding the postocular area deep and distinct; the vertical furrows not reaching the occiput; the median ocellus placed on a flat depression; a pit above the antennal socket; the median fovea minute but distinct; the clypeus truncate; the first and second antennal segments subequal, the third segment subequal to one and two together and longer than four; the saw-guides with the dorsal and ventral margins converging and the apex bluntly pointed.

The male differs in having the rufous part of the thorax inclined to whitish and extending over the entire pleura, the venter of the abdomen and a broad band on the lateral part of the dorsal aspect, broader behind, sometimes fused on the meson, whitish; the posterior femora not fuscous. Length, 3 to 4 mm."

ANATOMY OF REPRODUCTIVE ORGANS.

Ovipositor.—The ovipositor serves as a saw, and this organ is composed of two pairs of blades and a sheath, formed of a single pair of valves. It lies just posterior to the seventh abdominal sternum and is partly covered by the sides of the eighth and ninth terga. Each valve of the sheath is made up of three sclerites; a small triangular plate (Fig. 3, a, and Fig. 4, c) at the anterior end and hidden

---

* The original description copied from the Can. Ent. 46:364–366. 1914
by the eighth tergum and a large elongated structure (Fig. 3, b, and Fig. 4, d) reaching from the seventh sternum to near the end of the body where it is hinged to the third selerite (Fig. 3, c), which is a spoon-shaped plate that projects posteriorly and bears a number of hairs. The four blades of the saw are arranged in pairs, a lower and an upper pair, and as these structures are very thin and held in close contact with one another the bifid nature of each pair is not plainly apparent. The lower pair (Fig. 3, d, and Fig. 4, b) bears a number of teeth on the lower edge and really constitutes the saw proper. The upper pair (Fig. 3, e, and Fig. 4, a), which have a number of thickened crossbars and are joined together for a short distance on the upper edge opposite the proximal tooth of the saw, really serve as a support for the saw. The saw and this latter structure or support are connected along the edge by a tongue and groove joint, which permits one to slide on the other lengthwise (Fig. 4, e). At the base both pairs spread apart like the arms of a Y. The base of each blade consists of two thin chitinous rods, connected by a thin membrane. One of these basal rods of the support is continuous with the lower edge of its respective blade and fastens to the lower anterior angle of the large middle selerite of the sheath (Fig. 4, g), while the other rod fastens along the anterior end of the same selerite and con-
tinues part way along the blade as a thickened rib (Fig. 4, f). The larger basal rod of the saw is continuous with its upper edge and passes clear around the anterior end of the sheath and fastens to the small triangular sclerite (Fig. 4, h). The smaller rod is continuous with the lower edge of the saw and fastens to the hind edge of the seventh sternum beneath a thin projecting median flap (Fig. 4, i).

Male genitalia.—The testes are small and are composed of a large number of rounded lobes (Fig. 5, a). The vasa deferentia are rather large and much coiled (Fig. 5, b). Each connects with a very large, saccate seminal vesicle, near its efferent end. (Fig. 5, c.) The ducts (Fig. 5, d, and Fig. 6, l) leading from the vesicles unite, forming the ejaculatory duct. (Fig. 5, f, and Fig. 6, j.)

The external genital parts appear to be entirely derived from the tenth abdominal segment, which is drawn up in the tip of the abdomen and is completely protected from below by the large plate of the ninth abdominal sternum (Fig. 6, c). In general shape the genital armature is cylindrical and is flattened dorso-
ventrally. The base is oblique, the upper side extending farther anteriorly, and is bordered by a narrow chitinous ring (Fig. 5, e). The main body of the organ is made up of two large lateral valves (Fig. 5, h, and Fig. 6, f), whose bases are joined to the ring and are prolonged above and below so that they meet on the dorsal and ventral median line and form a complete circle. The end of each lateral valve bears a spoon-shaped movable flap on the lower side (Fig. 5, j, and Fig. 6, b). Just above the hinge of this flap, in the hollow of the valve and closely united to it there is another structure bearing two blunt lobes (Fig. 5, i, and Fig. 6, d) directed forward and inward. A narrow arm of the same piece extends inward from the upper edge of the lateral valve and forms the posterior margin of a thin membrane (Fig. 5, g) which roofs over the space between the upper edges of the valves. On the median line the membrane dips down between two small inner valves (Fig. 5, k, and Fig. 6, a) which constitute the penis, while the ejaculatory duct opens out at the bottom of this fold. The two inner valves are thin, concave on the inner side and reveal a flaring tip. These structures are in contact for a short space, but they spread apart at the outer and inner ends. During coition the outer ends are held close together forming a tube. The end of each valve is rodlike and has attached to it five muscles. Two of these originate on the dorsal part of the base of the outer valve and are attached to the middle and inner end of the rod (Fig. 6, i and k), serving to raise and lower the outer end respectively. Two
PLATE I.—THE CHERRY AND HAWTHORN SAWFLY.
1, Male; 2, female.
(Enlarged 12½ times.)
PLATE II.—LARVAL STAGES AND PUPA OF SAWFLY LEAF-MINER
(Enlarged 12½ times.)
PLATE III.—COCOONS OF THE CHERRY AND HAWTHORN SAWFLY LEAF-MINER.
(Enlarged.)
Plate IV.—Condition of Cherry Leaves and Blossoms at Period of Maximum Oviposition.
Plate V.—Cherry Leaves Injured by Sawfly Leaf-Miner.
others originate on the ventral part of the base of the outer valve; the innermost of these is attached near the middle of the rod and pulls the outer end downward and inward (Fig. 6, g); the other is attached to the inner end and serves to raise the outer end (Fig. 6, h). The remaining one which originates on the ventral and lateral part of the outer valve and is attached near the middle of the rod pulls the outer end downward and outward (Fig. 6, e).

**Fig. 6.—Male Genital Armature.**

I. Tip of abdomen showing position of armature; II, Median section showing left half of armature, 7, 8 and 9, corresponding abdominal segments; a, Inner valve; b, Movable flap; c, Subgenital plate or sternum of ninth abdominal segment; d, Bilobed piece; e, Outer valve; e, g, h, i, and k, Muscles attached to the base of the inner valve; j, Ejaculatory duct; l, Vas deferens.

**Life History and Habits.**

**Emergence of Adults.**

From puparia obtained on April 18, 1913, by sifting earth from beneath cherry trees, two males and seven females made their appearance during a period extending from April 28 to May 2. On May 6 six males and six females were obtained in a cherry orchard, and only one of the sawflies was obtained in cages intended
to trap the creatures as they emerged from the ground. On May 7 five males and seven females were caught in breeding cages, and at this date the insects were present in large numbers on the trees. The insects continued to appear in the cages, a few each day, until May 19, which was the latest date for the emergence of the sawflies for that year. During 1915 adults were observed on cherry trees during the first and second weeks in May and none of the insects were observed after the fifteenth day of this month. Observations for several seasons show that the flies make their appearance when the first leaf clusters are unfolding and the cluster buds are beginning to open (Plate IV).

EARLY HABITS OF THE SAWFLIES.

At the time of their emergence from the ground the sawflies are fully colored and are very active creatures. They are apparently very susceptible to temperature conditions. If disturbed on cold days they drop suddenly from the foliage, attempting to fly while in mid-air. Failing in this effort, they drop to the ground and crawl to some elevated object, on which they renew their attempts to seek flight.

They copulate within less than a day after their appearance from the soil. In this act, the male approaches the female backwards so that the tips of the abdomens come in contact while their heads face in opposite directions. Then the male reaches back with the hind legs and grasps the female over the back of her body, placing the tip of his abdomen under that of the female and inserting the penis under the flap at the base of the ovipositor. The outer flaps of the male genitalia are pressed closely against the underside of the female’s body. The whole process is a matter of one to three minutes. One pair contained in an observation jar copulated three times within a space of half an hour.

OVIPosition.

The females are apparently ready to oviposit soon after they make their escape from the ground. One specimen was dissected about seventeen hours after its appearance, and in the ovaries and oviducts there were counted fifteen fully developed eggs. Another that had been out for two days began to deposit eggs immediately when cherry leaves were introduced into its cage. In the orchard eggs
were first found during the year 1913 on May 7 in which season adults were first observed on May 6, although the insects may have been present on the trees for a day or two before and escaped detection. In 1915 all of the eggs were deposited by May 15. During the first days of the oviposition period one or sometimes two leaves in a cluster may show the presence of eggs. The females seem to manifest a preference for the leaves that first appear and which are still in an unfolded state. (Plate IV). The process of oviposition requires only about one minute, but details of this operation proved difficult to determine and were not ascertained because of the extreme shyness of the females, which fly quickly on the approach of any object.

The lower surface of the egg lies in contact with the lower epidermis, which has been cut free from the other tissues of the leaf so as to form a small blister-like cavity or pocket. The egg is usually within one or two millimeters from the edge of the leaf; rarely on the extreme edge or more than three millimeters from the margin. On the upper side at the edge of the cavity there is usually a stoma through which the ovipositor is probably thrust. An examination of ninety-one eggs at random shows that they are more often deposited near the base of the leaf than the tip. About seventy per cent. of the eggs were in the area of the leaf from one-eighth to one-third the distance from the base; twenty per cent. near the middle and about ten per cent. of the eggs occurred in the portion of the leaf toward the tip. From one to five eggs were observed on a single leaf and the average for all observations was two and three-tenths eggs per leaf.

PARTHENOGENESIS.

Parthenogenesis frequently occurs among sawflies. According to Cameron⁴ complete parthenogenesis may be observed “with such European species as Eriocampa ovata, Pæcilosoma pulveratum and Cræsus varus while the mixed parthenogenesis of Nematus ribesii and N. miliaris is beyond dispute.” He further says that “from the readiness with which so many species deposit ova without having any connection with the males, and from the general scarcity of the latter, it seems evident that further investigation will show that the phenomenon is of very common occurrence.” It is also to be noted that reproduction of this nature may also extend beyond

one generation. With the species \(^8\) *A. fasciata* a third generation was produced without any male connection.

Webster \(^6\) has recently suggested that parthenogenesis probably occurs with the pear slug (*Caliroa cerasi*), a destructive and widely distributed species in this country, although this has not been satisfactorily proven. In his studies he collected and examined large numbers of the adults, without finding a male, and in breeding experiments virgin females deposited eggs, some of which hatched, the larvæ unfortunately living only a few days. He makes the statement also that no specimens of the male exist in the collection of this species in the United States National Museum. Nevertheless Harris and several European writers have in their discussions of the species mentioned the occurrence of a male.

In view of the foregoing accounts *Profenusa collaris* was observed carefully with respect to the relations of the sexes to each other. Out of doors the females appeared in larger numbers at a somewhat earlier period than the males, but judging from collections taken at irregular intervals it does not appear that marked numerical differences existed between the sexes. To all appearances the adults copulated freely. In one breeding cage, containing no males, two females made their appearance, and these were isolated and supplied with cherry twigs to induce oviposition. This they did and five days later three eggs hatched. This experience suggests that fertilization is not absolutely necessary for the development of the eggs and also indicates that parthenogenesis may occur, although it is perhaps not an important factor in the life of the species.

**HATCHING AND LARVAL ACTIVITIES.**

During 1913 young larvæ were first observed on May 24 as trees were coming into full bloom, but, judging from the sizes of some of the mines it was evident that a few eggs had hatched one or two days earlier. By May 27 the hatching period was practically completed. During 1915, a few eggs were hatching on May 15. In the field it proved difficult to determine the period of incubation, but eggs deposited on cherry in the insectary hatched in five to eight days from date of oviposition. Under normal conditions incubation would probably extend over a larger number of days.

---

\(^8\) Cited by F. V. Theobald in *Insect Pests of Fruit*, p. 276, 1908.

Upon hatching the young larva works its way through the tissue of the leaf until it reaches the upper epidermis. It usually mines towards the distal end of the leaf, generally keeping close to the edge and feeding with the ventral side in contact with the upper epidermis. When the tip of the leaf has been reached the creature reverses its course, proceeding along the area adjoining the midrib, or if there is no interference by another larva it may cross over the mainrib and tunnel back along the edge of the opposite half of the leaf.

The mine, as viewed from above, during its first stages of development is rather dark brown in color, which is accounted for in part by frass along the edges of the roof of the tunnel. As the affected area increases in size, especially in its breadth, the mine becomes light brown, while the edges incline to a darker shade. Observed from beneath the only visible indication of the initial activities of the insect is a small oval spot which marks the original cavity constructed by the adult for the reception of the egg, and this contains in addition to the shriveled egg membrane accumulations of frass from the early feeding operations of the larva. Later the under side of the tunnel also becomes brown, with the exposed epidermis wrinkled, but in general the destructive work of the insect is not so apparent on the lower as on the upper surface of the leaf.

There is a fairly definite relationship between the size of the mine and the age of the larva with respect to the different instars. In general mines under 5 millimeters long and 2 millimeters at their greatest width contain larvæ in the first instar; mines that are 5 by 2 millimeters to 12 by 4 millimeters contain larvæ in the second instar; mines that are 8 by 5 millimeters to 18 by 6 millimeters contain larvæ of the third instar; mines that are 18 by 6 millimeters to 28 by 8 millimeters contain larvæ of the fourth instar, and mines of greater dimensions than the foregoing are occupied by larvæ of the fifth instar.

PUPATION.

Upon reaching maturity the larvæ make a hole in the tissues forming the mine, usually the upper epidermis, which forms the roof. From the opening they make their escape to the edge of the leaf, when they drop to the ground. During 1912 the larvæ began to leave the foliage on June 7, and by June 10 it was estimated that
fifty per ct. of the insects had abandoned their mines. On June 18 it was difficult to find a specimen on the tree, while June 22 was the latest date that any of the insects were seen on the leaves. During 1915 small numbers of larvæ began to drop from the leaves to the ground on June 5, and by June 16 the foliage of cherries was practically free of the insects. Upon reaching the ground the creatures bury themselves several inches deep in the soil and construct an earthen cell. The cocoon, which is oval in shape, consists of particles of earth glued together and lined with a cement which renders it impervious to water and strong enough to resist considerable pressure without crushing. (Plate III.) The insect passes the winter in the larval stage. However, the pupa begins to form in the fall. Specimens obtained during October showed the developing compound eyes and ocelli, while of examples secured the following April the adult characters of the head could be plainly seen through the skin, and their bodies were decidedly humped. One of these specimens which was kept in a cool room transformed to a pupa on or before April 23 of the following spring. Others obtained from an orchard on May 2, 1913, were all in the pupal stage, and one female pupa was partly colored.

NATURAL ENEMIES.\(^7\)

An efficient enemy of \(P.\) collaris is the chalcidid \textit{Trichogramma minutum} Riley (Fig. 7), which is an egg parasite. According to Girault\(^8\) this species leads as the most prominent and widespread parasite of the eggs of insects, having been recorded from thirty or more hosts in North America alone. It is stated that with one or two exceptions its hosts are all insects of the first economic importance, as the codling moth, brown-tail moth, etc., and that it confines its activities to the Lepidoptera and Hymenoptera. Besides the leaf-miner, the subject of this account, this parasite attacks other species of sawflies, as the peach and plum-leaf sawfly (\textit{Caliroa amygdalina})\(^9\) and the pear slug (\textit{Caliroa cerasi}). Webster\(^10\) in his account of the latter states "that the pest is rarely destructive for many

---

\(^{7}\) Through the courtesy of Dr. L. O. Howard the identifications of the parasites were made by Messrs. A. A. Girault and S. A. Rohwer of the U. S. Bureau of Entomology.

\(^{8}\) Girault, A. A. \textit{Psyche} 18:146. 1911.


\(^{10}\) Webster, R. L., Iowa Bul. 130:187. 1912.
years at a time. It may be abundant for a year or so, then drop out of sight for several years.” This alternating abundance and scarcity of the insect he attributes largely to the activities of its natural enemies, and in Iowa for several years during the course of his studies there were two species of egg parasites, of which *T. minutum* was the more common. One instance is noted when there was apparently a total parasitism of the eggs of its host.

During the past five years that *P. collaris* has been under observation by this Station, *T. minutum* has twice made its appearance in conspicuous numbers in cherry orchards infested with the sawfly, in 1912 and in 1915. During the former year the larger percentage of the eggs of the sawfly were parasitized and on some trees it was difficult to find an egg-bearing leaf which had not been visited by the parasite. In 1915, parasitism ranged from about forty to ninety per cent., on different trees. Taking all trees into consideration of the eggs deposited by the sawfly more than half failed to hatch, and for this mortality *T. minutum* appeared to be largely responsible.

The parasite was reared from both cherry and hawthorn foliage. The majority of the eggs of the sawfly that were dissected contained a single parasite, and in only a few instances were twin larvae or pupae observed. On June 2, 1915, the parasites were all in the larval state, but on June 5 when the larvae of *collaris* were beginning to abandon their mines in the foliage about fifty per cent. of the

---

**Fig. 7.—Egg Parasite (*T. minutum*) of the Sawfly.**

a, Pupa; b, Adult (enlarged).
parasites were in the pupal state. By June 7 they had nearly all transformed to pupae, and on June 9 the first adult appeared. During succeeding days the chalcidids appeared in large numbers, and the last specimen to make its appearance emerged on June 14. While the parasite was abundant about Geneva during this year it was relatively quite scarce in plantings of _Crataegus_ at Rochester.

Besides the foregoing parasite there has been reared from _P. collaris_ an ichneumon which proved to be a new species and has been listed as _Pezoporus tenthredinarum_ Rohwer. During 1913 quite a few pupae were observed to be parasitized, presumably by this species, and in one collection of eleven cocoons of the sawfly, six specimens were parasitized. During this year adults of this parasite made their appearance in breeding cages from May 2 to 21, and some individuals were collected from cherry trees on May 29.

The larva (Fig. 8, a) is a whitish, spindle-shaped grub and is 4 to 5 millimeters long. The body is composed of thirteen segments and the head is small and inconspicuous. The entire skin is thickly covered with minute teeth.

The pupa (Fig. 8, b) is whitish with dark eyes and shows all the characters of the adult. The wing pads are narrow and lie between the folded femora and tibiae of the last two pairs of legs. The antennae are extended along the ventral side, reaching about the fourth abdominal segment. The ovipositor curve dorsally around the last abdominal segment. The original description\(^{11}\) of the adult is as follows:

almost impunctate; postcellar line subequal with the ocellocular line; posterior orbits as broad as the cephalocaudal diameter of the eye; flagellum stout, larger apically, the first joint slightly shorter than the second and a little more than twice as long as its apical width; second joint $2\frac{1}{2}$ times as long as its apical width, the third, fourth and fifth joints subequal and $1\frac{1}{4}$ times as long as their apical width; malar furrow well defined and limiting the granular, opaque sculpture of the face, separating it from the shining sculpture of the posterior orbits; mandibles with the teeth of equal length; mesoscutum shining, practically impunctate; suture between the scutum and scutellum broad, shallow, bottom finely foveolate; scutellum shining, practically impunctate; propodeum opaque; the longitudinal carinae defining the basal area and the areola well defined; basal area and areola confluent; basal median lateral areas separated by a poorly defined carina which becomes subobsolete laterally; first tergite smooth, without strong sculpture, the lateral carinae extending from base to apex; second and following tergites smooth, practically impunctate; areolet hexagonal with the basal and apical ends subequal, black; mandibles except the piceous apices, clypeus, antennae (becoming infuscated and darker apically), and tegulae white or whitish; legs rufo-ferruginous; first three tergites rufo-ferruginous, but the sides of the first and small lateral spots on the second and third, infuscate.

Male.—Length 4.5 mm. Sculpture agrees well with the female; the antennae are slightly longer and not so robust apically; the third joint is distinctly longer than the fourth; fourth and fifth are subequal, the sixth is slightly shorter than the fifth. Agrees with the female in color except the bases of the posterior coxae are black and the tergites are black except the small ferruginous spot on the apex of the first, transverse apical bands on the second and third.

Apparently there is associated with the foregoing ichneumon an undescribed Tryphonine, but owing to the small numbers collected it is impossible to make any statement at this time as to its status as a parasite of the sawfly.
STATION EXPERIMENTS TO CONTROL THE SAWFLY ON CHERRY.

TESTS AGAINST NEWLY-HATCHED LARVAE.

By reason of the habits of the larvæ in burrowing into the interior of the leaves, insects such as the cherry sawfly are regarded as very difficult species to combat. The chief difficulty is that most spraying mixtures, when applied to foliage, fail to exert their toxic properties against the creatures, which is accounted for by the resistance of the leaf structures to penetration by the insecticides. An exception among this class of pests is the elm sawfly\(^{12}\) (*Kaliosyphinga ulmi* Sund.), an insect with habits quite similar to the cherry species and which in recent years has been shown to be quite sensitive during the early stages of attack to nicotine solutions. The successful results in this case pointed to the desirability of tests on the spraying of cherry orchards with the same preparation in an effort to destroy the mining larvæ at the first appearance of initial injuries. To this end an orchard of English Morello belonging to Mr. Chas. K. Scoon of Geneva was placed at the disposal of the Station for two years, and each season the trees were sprayed with nicotine solution (40 per ct.) in the proportions of either one or two pints to one hundred gallons of water to which were added five pounds of soap. In spite of very thorough treatments and liberal applications of spraying mixtures there was no evidence at the conclusion of the operations of penetration of the mined areas of the leaves by the liquid or of any influence of the nicotine spray upon the larvæ. Later observations of the trees confirmed earlier impressions, for none of the treated trees showed any appreciable benefit from the different applications. Because of these results further attempts to combat the pest by this means were abandoned.

TESTS AGAINST MATURE LARVAE.

As previously described, the larva in its older instars consumes the mesophyll or pulpy substance of the leaf, leaving only a thin papery epidermis to protect the creature within its mine. The undermined epidermis forming the tunneled area or blister shows a shriveled or wrinkled appearance during dry weather, which would suggest that it might absorb spraying mixtures and prove penetrable to them to

the disadvantage of the enclosed insect. The following tests were
designed to determine the effectiveness of various insecticides upon
the insect under such conditions.

On May 28 several lots of branches each showing several larvæ
were noted. Applications of various insecticides were then made
and three days later the different lots of branches were examined to
determine the effects of the treatments upon the larvæ. The results
are summarized in Table I.

<table>
<thead>
<tr>
<th>No. of twig</th>
<th>Treatment</th>
<th>Effects on Larvæ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No. dead</td>
</tr>
<tr>
<td>1</td>
<td>Concentrated solution of naphthalene in alcohol</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Concentrated solution of naphthalene in alcohol</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Kerosene emulsion, 1 to 15</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Kerosene emulsion (1-15), 45 parts; naphthalene in alcohol, 5 parts</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Kerosene emulsion, 1-10</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Kerosene emulsion (1-10), 45 parts; naphthalene in alcohol, 5 parts</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>Commercial miscible oil, 1-50</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Miscible oil (1-50), 45 parts; naphthalene in alcohol, 5 parts</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>Miscible oil (1-50), 40 parts; naphthalene in alcohol, 10 parts</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Nicotine solution, 40 per ct., 1-800</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Nicotine solution, 40 per ct., 1-800</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>Nicotine solution, 40 per ct., 1-800</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>Nicotine solution, 40 per ct. (1-800), 15 parts; oil emulsion, 1 part</td>
<td>2</td>
</tr>
<tr>
<td>14</td>
<td>Nicotine solution, 40 per ct. (1-800), 15 parts; oil emulsion, 1 part</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>Nicotine solution, 40 per ct. (1-800), 10 parts; oil emulsion, 1 part</td>
<td>4</td>
</tr>
</tbody>
</table>

The great resistance displayed by the larvæ to the foregoing
insecticides prompted some tests with undiluted kerosene and gasoline,
applied to trees by spraying machine or to the mines of the insect
directly by means of a paint brush. The results were somewhat
marred by the fact that some of the larvæ were beginning to leave
the foliage; but the difficulty of killing any appreciable number of
the insects by even these substances is indicated by the accompanying
counts, which were made twenty-four hours after the applications.
TABLE II.—EFFECTS OF OILS ON LARVAE OF CHERRY SAWFLY LEAF-MINER.

<table>
<thead>
<tr>
<th>No. of twig</th>
<th>Treatment</th>
<th>Conditions of Mines with Respect to Larvae.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No. dead.</td>
</tr>
<tr>
<td>1</td>
<td>Kerosene as a spray</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Kerosene as a spray</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Kerosene applied with a brush</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Gasoline as a spray</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Gasoline applied with a brush</td>
<td>1</td>
</tr>
</tbody>
</table>

The results of the foregoing tests require no extended comments. The experiments point consistently in one direction, showing that the larvæ of *Profensusa collaris* when under normal conditions in the foliage are not susceptible to ordinary spraying practices, as the more common insecticides do not penetrate the epidermal tissues of the cherry leaf.

TEST WITH HYDROCYANIC ACID GAS AGAINST LARVAE.

For comparison with various spraying mixtures one tree was fumigated with hydrocyanic acid as the eggs were hatching and the mines of the young larvæ were first beginning to show. Potassium cyanide was used at the rate of 0.20 gram per cubic foot and twenty minutes was allowed for the period of fumigation. Of the various treatments given cherry trees to combat the larvæ this was the only one that proved efficient. There was a total destruction of the insects and, in marked contrast to adjacent trees, the foliage of the fumigated tree was absolutely free from mines or blisters so characteristic of the work of the pest.

REMOVAL OF AFFECTED LEAVES.

It is to be noted that of the foregoing tests fumigation with hydrocyanic acid gas was the only treatment that efficiently checked the destructive activities of the mining larvæ. Effective as is fumigation, it appears from our experience with the pest that this is an impracticable means of protecting cherry orchards, as the losses due to the work of the insect would hardly warrant the expenditure for necessary equipment. There remains only for consideration the removal
of affected leaves as the most economical and really satisfactory method of combating the sawfly. The chief merit of this operation is that an almost complete destruction of the larvae may be effected, but this involves the removal of all the tunneled leaves. The loss of foliage may seem large, but it is more apparent than real since many of the leaves are liable to be so severely injured as to be of little service to the tree; and moreover with careful work, accompanied by destruction of uncultivated host plants, smaller numbers of the leaves should need to be removed with each succeeding year. In a test to determine the labor involved there was required approximately one and one-half hours per tree for a man to remove all affected leaves, ranging from a thousand to twelve hundred in number, from trees that averaged about thirteen feet high and of about the same breadth. Compared with the cost of spraying for certain fruit pests the expense, on the basis of these figures, is not large and could doubtless be greatly reduced by the employment of children or other cheap help.

TEST WITH SWEETENED BAIT TO POISON ADULTS.

At the time of appearance of sawflies in maximum numbers on the trees, applications of a sweetened arsenical spray, composed of arsenate of soda and sugar, were made on May 20, 1913, to the foliage for the purpose of poisoning the insects. The ground beneath a number of trees was covered with cheesecloth screening for the purpose of catching such flies as should happen to drop from the leaves as a result of feeding on the poisoned bait. A few sawflies did actually feed on the sprayed leaves and one of the specimens died in about one hour, but the majority of the insects were not attracted to the mixture. Observations of the sprayed plat for several days failed to detect any of the creatures on the screens spread beneath the trees.

The foregoing experiment was repeated on May 18, 1914, on four rows of Morello cherries, averaging about fifteen trees to a row. The following formula was used:—arsenate of lead 4 ounces, corn syrup 2 pounds, and water 4 gallons. The spray was applied in quantities sufficient to wet the foliage of individual branches, and applications were made to different portions of a tree. The cherries were in full bloom, at which time the flies were numerous and very active. There was no evidence of feeding on the poisoned bait by
any appreciable numbers of the insects. Oviposition on succeeding
days was quite extensive, and as was the experience during the previous
year the application of the arsenical afforded no apparent pro-
tection to the trees.

TESTS WITH NICOTINE SOLUTION TO DESTROY ADULTS.

As the sawflies are sluggish during cold mornings and if disturbed
attempt to drop rather than fly, two experiments were made in
successive years to destroy them when temperatures were low by
applying nicotine solution, 40 per ct., three-fourths pint to one
hundred gallons of water and five pounds of soap. In each case
the treatments were ineffectual as only a few of the flies were
apparently affected by the application.

TEST OF SPRAYING TO PREVENT OVIPOSITION.

In an effort to prevent oviposition or reduce the extent of egg-
laying, ten rows of Morellos with fifteen trees to a row were sprayed
as leaves were unfolding as follows:

Two rows with bordeaux mixture (6-6-50) and lead arsenate
3 pounds.
Three rows with nicotine solution, 40 per ct., three-fourths pint
to 50 gallons of water and 3 pounds of soap.
Two rows with lime-sulphur, 1-50.
One row with whitewash, 25 pounds lime to 50 gallons of water.

In spite of thorough spraying of the unfolding leaves the trees
receiving applications of the above mixtures showed no appreciable
benefits as a result of the different treatments.

CONTROL OF THE LEAF-MINER ON HAWTHORNS.

Contrary to the results of our spraying experiments in cherry
orchards (see page 574), the leaf-miner when on hawthorns appears
to be susceptible to spraying with nicotine solution and soap. Dr. C.
S. Sargent of the Arnold Arboretum states that in order to protect
the hawthorn plantings, it has become necessary to spray them each
year, and that the most effective treatment is the foregoing mixture,
which should be applied as soon as the larvæ begin to tunnel the
leaves.

\textsuperscript{13} Letter of June 11, 1915.
This spring, under the direction of Mr. John Dunbar, Assistant Superintendent of Parks, Rochester, a test was made of this same mixture on a goodly number of hawthorns of the variety *C. Geneseensis*. In one plat an application was made on May 8, at which time the eggs of the species were being deposited, while in a second plat treatment was given on May 24 when the larvæ were hatching. The earlier spraying was quite ineffective, but the later application resulted in a noticeable reduction in the number of affected leaves. While the plants were not entirely free from affected foliage, they presented much better conditions than the checks and the plat that received the early treatment.

METHODS OF CONTROL.

REMOVAL OF AFFECTED LEAVES.

Of the operations, systematically practised, one that will probably prove most effective and economical in controlling the leaf-miner is the picking of affected leaves. This species is peculiarly susceptible to this kind of repressive method since there is only one brood of larvæ to attack the foliage and oviposition extends over only a short period. The effect is that hatching of eggs and maturing of larvæ are, practically speaking, almost simultaneous for all of the creatures, and their activities during their injurious stages are restricted to a relatively short period. By careful timing it is possible at a single picking to collect practically all of the larvæ by removing the affected leaves, which should then be burned to destroy the insects. The removal and destruction of all mined leaves, coupled with another practice — the destruction of wild hawthorns in the immediate vicinity of the cherry orchard — should leave few opportunities for the pest to develop to injurious numbers.

FUMIGATION WITH HYDROCYANIC ACID GAS.

Of the various measures employing insecticides tested by this Station to protect cherry foliage from the work of the leaf-miner, only fumigation with hydrocyanic acid gas was effective. Most cherry growers in New York are not equipped with suitable apparatus to undertake this means of affording protection to their trees, and fumigation should only be undertaken as an extreme measure and in an experimental way under expert direction.
CULTIVATION.

Cultivation, if done with care and at the proper time, is destructive to many insects with subterranean habits. Species especially that undergo pupal development in the ground are not only peculiarly sensitive to disturbances of the soil, but ploughing and cultivation, besides breaking up the cells of hibernating larvae, exerts another detrimental influence, exposing the helpless insects to insectivorous birds and other foes. Since it is the normal habit of the larvae of this sawfly to live in earthen cells for the greater portion of the life cycle of the species, such practices as fall or early spring ploughing or cultivation are to be recommended from an entomological standpoint. These measures, fortunately, are standard operations which are invariably practiced by the more successful cherry growers.

DESTRUCTION OF UNCULTIVATED HOST-PLANTS.

The fact that the sawfly is very partial to hawthorns, especially of the *Crus-Galli* group, and breeds most abundantly on them, suggests the desirability of destroying these plants when they exist in the immediate vicinity of an orchard of the English Morello cherry. The value of this operation is not known; but until there is more knowledge of the breeding habits of the pest the removal of wild plants along roadsides and hedge rows that are attractive to the insect for purposes of propagation would appear advisable as a precautionary measure.

SPRAYING OF HAWTHORNS.

For the protection of hawthorns in decorative plantings, spraying seems to be preferred to any of the preceding measures. The insecticide which has given the most satisfactory results is composed of one pint of nicotine solution (40 per ct.) to one hundred gallons of water to which are added four pounds of soap. In making the treatment the liquid should be used in liberal amounts and applied with rather high pressures at the time when the insects first begin to mine the foliage.