Peach Insects of Illinois and Their Control

STEWART C. CHANDLER

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Peach Insects
of Illinois and Their Control

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This paper is a contribution from the Section of Economic Entomology.
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The frontispiece shows a nonstop sprayer in action. Because the operator rides at a considerable distance from the point of discharge, this type of sprayer is especially useful for the application of the new insecticides that are either dangerous or objectionable to the operator.
Peach Insects
of Illinois and Their Control

STEWART C. CHANDLER

INSECT pests of peaches are found in Illinois wherever peaches are grown. They do the greatest amount of damage in the fruit-growing counties of the southern third of the state.

The relatively heavy damage in southern Illinois is due partly to the extensive plantings there of peaches and apples, partly to geographical location, and partly to the rugged topography characteristic of much of the region.

In the southern fruit-growing counties, most peach orchards are close enough to apple orchards or other peach orchards to allow insects to travel readily from one to another. Close proximity of peach and apple orchards permits the interchange of such insects common to both as scale, plum curculio, oriental fruit moth, and red-banded leaf roller.

Because the northern and the southern limits of Illinois are nearly 400 miles apart, climate in the southern counties differs markedly from that in the northern part of the state. The longer growing season in the southern counties allows some kinds of insects to produce more broods each year, and the milder climate there results in lower winter mortality.

Part of the peach-growing region of southern Illinois (most of the area south of Carbondale and Harrisburg) is unglaciated. Because of the hilly character of the unglaciated area, many orchards there are irregular in shape and they have extensive borders bounded by woods or brushy fencerows in which some insects hibernate and others develop. Such orchards are harder to cultivate and spray than the rectangular-shaped orchards common on level land, and insects usually are more numerous in them than in the prairie orchards.

The principal peach-growing areas of Illinois are indicated in fig. 1.

* The author is Consulting Entomologist of Southern Illinois University as well as Associate Entomologist of the Illinois Natural History Survey.
Fig. 1.—Map of Illinois, showing the principal peach-growing counties of the state. Data from Illinois Co-operative Crop Reporting Service for crop year of 1915. The locations of Centralia, in Marion County, and Carbondale, in Jackson County, are indicated by dots. Both Centralia and Carbondale are important centers of the peach industry.
For a number of years, detailed surveys have been made annually in peach-growing counties to determine the degree of infestation of some of the important pests of peach. Some of the infestation records of these surveys have been summarized and are presented in tables 1 and 2; other information gathered through the surveys is discussed later in relation to individual insect species.

In a number of surveys made at harvest time, information has been obtained relative to spray and dust schedules and to materials used to control peach pests. Some of the information is summarized in tables 3, 4, 5, and 6.

During each growing season, a Spray Service Report containing information on abundance and control of fruit insects and diseases is issued weekly to press and radio of Illinois and some neighboring states by the Illinois Natural History Survey in co-operation with the University of Illinois and other agencies. Peach growers find these reports useful in determining the

Table 1.—Average percentages of peaches damaged by plum curculio, oriental fruit moth, and red-banded leaf roller, as determined by harvest surveys of approximately 30 representative peach orchards in southern Illinois, 1934-1949. Also included is the percentage of oriental fruit moth larvae parasitized, as determined by rearings made in a federal laboratory.

<table>
<thead>
<tr>
<th>Year</th>
<th>Per Cent of Fruit Infested with Plum Curculio Larvae</th>
<th>Per Cent of Fruit Infested with Oriental Fruit Moth Larvae</th>
<th>Per Cent of Oriental Fruit Moth Larvae Parasitized</th>
<th>Per Cent of Fruit Catfaced</th>
<th>Per Cent of Fruit Injured by Red-Banded Leaf Roller</th>
</tr>
</thead>
<tbody>
<tr>
<td>1934</td>
<td>—</td>
<td>—</td>
<td>20.0</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1935</td>
<td>—</td>
<td>22.1</td>
<td>17.7</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1936</td>
<td>—</td>
<td>3.3</td>
<td>17.3</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1937</td>
<td>2.0</td>
<td>12.2</td>
<td>28.0</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1938</td>
<td>4.3</td>
<td>3.7</td>
<td>56.8</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1939</td>
<td>3.8</td>
<td>1.2</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1940</td>
<td>No crop</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1941</td>
<td>0.7</td>
<td>0.3</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1942</td>
<td>7.2</td>
<td>1.6</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1943</td>
<td>7.8</td>
<td>5.8</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1944</td>
<td>1.7</td>
<td>0.9</td>
<td>—</td>
<td>19.9</td>
<td>—</td>
</tr>
<tr>
<td>1945</td>
<td>3.6</td>
<td>1.6</td>
<td>51.0</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1946</td>
<td>6.0</td>
<td>5.2</td>
<td>48.3</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1947</td>
<td>3.4</td>
<td>2.2</td>
<td>—</td>
<td>4.8</td>
<td>—</td>
</tr>
<tr>
<td>1948</td>
<td>4.6</td>
<td>5.2</td>
<td>53.9</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1949</td>
<td>4.5</td>
<td>2.0</td>
<td>—</td>
<td>9.6</td>
<td>3.3</td>
</tr>
<tr>
<td>1950</td>
<td>1.7</td>
<td>3.2</td>
<td>—</td>
<td>8.6</td>
<td>0.2</td>
</tr>
</tbody>
</table>
general insect situation in their areas. They should, of course, supplement these reports with careful examination of their own orchards.

Table 2.—Abundance of European red mite* eggs on peach twigs in orchards in two Illinois areas, 1948 and 1949.

<table>
<thead>
<tr>
<th>Year</th>
<th>Area</th>
<th>Number of Orchards Examined</th>
<th>Orchards with Moderate to Large Number of Eggs</th>
<th>Orchards with Small Number of Eggs</th>
<th>Orchards with Eggs Present</th>
<th>Total Number</th>
<th>Total Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1948</td>
<td>Carbondale</td>
<td>55</td>
<td>14</td>
<td>25.5</td>
<td>6</td>
<td>10.9</td>
<td>20</td>
</tr>
<tr>
<td>1948</td>
<td>Centralia</td>
<td>45</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1949</td>
<td>Carbondale</td>
<td>46</td>
<td>30</td>
<td>65.2</td>
<td>9</td>
<td>19.6</td>
<td>39</td>
</tr>
<tr>
<td>1949</td>
<td>Centralia</td>
<td>45</td>
<td>3</td>
<td>6.7</td>
<td>3</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

* Although mites are not classed as insects, they are considered in this publication because of their close relationship to insects and their economic importance as pests.

Table 3.—Numbers and kinds of early-season applications of sprays and dusts used in southern Illinois peach orchards, as determined by annual harvest surveys. (Applications included in this table were those made from blossoming time to late June, or through the first brood of plum curculio, except the DDT applications for control of oriental fruit moth, which were made both early and late in the season.)

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Orchards</th>
<th>DDT for Catface</th>
<th>LeadArsenate</th>
<th>BHC</th>
<th>Chlorovane</th>
<th>Cryolite</th>
<th>DDT for Fruit Moth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1st</td>
<td>2nd</td>
<td>Spray</td>
<td>Dust</td>
<td>Spray</td>
<td>Dust</td>
</tr>
<tr>
<td>1938</td>
<td>30</td>
<td>—</td>
<td>—</td>
<td>33</td>
<td>24</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1939</td>
<td>35</td>
<td>—</td>
<td>—</td>
<td>56</td>
<td>44</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1940</td>
<td>No crop</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1941</td>
<td>27</td>
<td>—</td>
<td>—</td>
<td>39</td>
<td>28</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1942</td>
<td>26</td>
<td>—</td>
<td>—</td>
<td>25</td>
<td>54</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1943</td>
<td>14</td>
<td>—</td>
<td>—</td>
<td>19</td>
<td>44</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1944</td>
<td>27</td>
<td>—</td>
<td>—</td>
<td>29</td>
<td>89</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1945</td>
<td>36</td>
<td>—</td>
<td>—</td>
<td>37</td>
<td>125</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1946</td>
<td>36</td>
<td>—</td>
<td>—</td>
<td>34</td>
<td>232</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1947</td>
<td>30</td>
<td>6</td>
<td>12</td>
<td>37</td>
<td>131</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1948</td>
<td>27</td>
<td>15</td>
<td>6</td>
<td>23</td>
<td>79</td>
<td>16</td>
<td>48</td>
</tr>
<tr>
<td>1949</td>
<td>38</td>
<td>25</td>
<td>15</td>
<td>28</td>
<td>24</td>
<td>21</td>
<td>159</td>
</tr>
<tr>
<td>1950</td>
<td>36</td>
<td>32</td>
<td>21</td>
<td>20</td>
<td>8</td>
<td>15</td>
<td>87</td>
</tr>
</tbody>
</table>

1 First in bloom period; second in shuck-crack period.
2 Includes early and late applications.
Table 4.—Numbers and kinds of late-season applications of sprays and dusts used in southern Illinois peach orchards, as determined by annual harvest surveys; also, season’s totals and percentages of certain applications. (Late-season applications were those made from late June through harvest and the end of the oriental fruit moth season.)

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Orchards</th>
<th>Lead Arsenate</th>
<th>BHC Chlor dane Spray</th>
<th>Parathion Spray and Dust*</th>
<th>Sulfur without Poison</th>
<th>Season’s Applications for Curculio</th>
<th>Per Cent of Curculio Applications Applied as Dusts</th>
<th>Curculio Poisons per Orchard</th>
</tr>
</thead>
</table>
Table 5.—Percentage of total number of applications, both spray and dust, in which each of several insecticides was used for control of the plum curculio in Illinois peach orchards, 1911–1947, 1948, 1949, and 1950, as determined by annual harvest surveys (data from tables 3 and 4).

<table>
<thead>
<tr>
<th>Year</th>
<th>Lead Arsenate</th>
<th>BHC</th>
<th>Chlordane</th>
<th>Parathion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1941–47</td>
<td>100.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>1948</td>
<td>67.86</td>
<td>27.78</td>
<td>4.36</td>
<td>0.00</td>
</tr>
<tr>
<td>1949</td>
<td>32.43</td>
<td>56.49</td>
<td>10.54</td>
<td>0.54</td>
</tr>
<tr>
<td>1950</td>
<td>21.83</td>
<td>45.23</td>
<td>15.00</td>
<td>17.00</td>
</tr>
</tbody>
</table>

Table 6.—Number of DDT insecticide applications per orchard in approximately 30 representative southern Illinois peach orchards, 1947–1950, for control of catfacing insects and oriental fruit moth. Data were gathered at time of peach harvest surveys.

<table>
<thead>
<tr>
<th>Year</th>
<th>For Catfacing Insects</th>
<th>For Oriental Fruit Moth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1947</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>1948</td>
<td>0.8</td>
<td>1.3</td>
</tr>
<tr>
<td>1949</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>1950</td>
<td>1.5</td>
<td>0.9</td>
</tr>
</tbody>
</table>

**Insects Attacking Bark and Trunk**

**SAN JOSE SCALE**

*Aspidiotus perniciosus* Comst.

Appearance and type of injury.—A heavy infestation of San Jose scale is characterized by a grayish layer of overlapping and very small scales covering the entire bark. Rubbing the scales between the fingers crushes the yellow, saclike bodies of the insects beneath the scale covering and produces a greasy sensation and appearance. A light infestation shows as dark gray, or nearly black, round specks on the bark; when viewed with the aid of a hand lens, each of these specks exhibits a raised, nipple-shaped center. On San Jose and on Forbes scale, a reddish border nearly an eighth inch wide surrounds each scale or group of scales. This border is easily seen on light-colored bark or on yellow-skinned apples.

San Jose scale is found in all parts of the state but is most abundant and persistent in the southern third. South of a line running through Alton and Robinson it may increase seriously in a single season, especially if weather conditions are favorable for
it. Several seasons showing marked increases of infestation have occurred in the past 20 years, as shown by annual scale surveys. The accompanying graph, fig. 2, shows that the percentage of orchards containing infestations classed as moderate to severe reached a high point usually every third year. In those years, approximately 60 to 70 per cent of the orchards contained one or more moderately to severely infested areas. Usually, a high point was followed the next year by a big reduction in infestation and 3 years later by another high.

The reasons for this 3-year cycle are not entirely clear, but observations show that, following each year of high infestation, growers, rightly alarmed, make especially thorough dormant applications. Possibly these thorough applications reduce the infestation to the point where natural enemies of the scale become scarce, with the result that through its prodigious possibilities for reproduction the scale rapidly increases until it is again at a dangerous level.

A second high year in succession is shown in 1948 and very little reduction in 1949; this situation may be a reflection of the use of organic insecticides. The discovery of Forbes scale on
Illinois peach trees in November of 1949 probably means that some of the infestation listed as San Jose scale in the previous 2 or more years, fig. 2, was in reality Forbes scale. The effect of a heavy infestation of San Jose scale is shown in fig. 3.

Control.—Before the use of oil sprays was begun in 1922, San Jose scale was much more difficult to control on peach than it is today. The best recommendation previous to that time involved the application of a dormant spray of standard, commercial, liquid lime sulfur, 1 gallon to 7 gallons of water. This spray was found to leave 7 to 11 per cent of the scales alive, whereas oil emulsion or miscible oil sprays, 2 per cent actual oil, did not leave more than 2 per cent alive. A spray of 3 per cent actual oil in our tests rarely left over one-half per cent of the scales alive. These percentages were arrived at through tests involving the examination of hundreds of thousands of scales in Illinois. On severe infestations it is advisable to use oil emulsion or miscible oil sprays of 3 per cent actual oil. Liquid lime sulfur, 1 gallon to 7 gallons of water, may have a place in central and northern

![Peach trees showing the effect of a single season's heavy infestation of San Jose scale and the consequent winter injury. The failure of trees to leaf out and the almost total lack of bud-bearing wood mean loss of crop for one year and poor prospect for the next.](image-url)
Illinois peach orchards where scale is much less a problem than farther south and where peach leaf curl infection is frequently severe. It has the advantage of being a fungicide as well as an insecticide and eliminates mixing of other materials, such as those necessary with oil sprays, if leaf curl control is desired. However, it is usually more expensive than the dormant oils and more caustic to the skin of the operator.

**Combined scale and leaf curl control.**—To control leaf curl, as well as scale, plant pathologists in this and other states sometimes find it necessary to add a fungicide, such as Bordeaux mixture, to the dormant oil sprays if liquid lime sulfur is not used as suggested above. A cold-mixed Bordeaux and oil emulsion can be made by emulsifying the oil in the spray tank. The easiest method is as follows:

To make 100 gallons of cold-mixed emulsion of Bordeaux and oil, run about 25 gallons of water into the spray tank. With the agitator running, sift in 6 pounds of powdered copper sulfate. Make a paste of 4 pounds of hydrated lime and add it to the contents of the spray tank, or, if agitation is sufficient, slowly sift the dry lime directly into the tank. The result is the Bordeaux mixture. Now pour in 2 gallons of oil and run the engine so that for a few minutes the mixture is pumped through the spray gun and back into the tank. Add additional water to make 100 gallons. The result is the cold-mixed oil emulsion. For larger amounts of the oil emulsion, proportionally greater amounts of the materials will be needed, but during the mixing only enough water should be added at first to allow for good agitation. A somewhat better suspension of the Bordeaux is obtained if about half of the copper sulfate and lime is placed in the tank before the oil is added and the remainder later while the tank is being filled.

Observations over a period of years indicate that there is little danger of leaf curl infection if the standard treatments, including sulfur, are applied each year. Because Bordeaux mixture slightly weakens the insecticidal value of the oil and increases the labor and expense of spraying, there is an advantage in omitting it. However, if the standard sprays or dusts containing sulfur are omitted in any year because of crop failure or other reason, a dormant spray containing Bordeaux mixture or liquid lime sulfur should be used the following year.

Spring spraying is recommended for scale control because it is a little more effective than fall spraying and because severe
injury occasionally results from the effect of cold weather following the application of dormant fall sprays, especially oil sprays. Some growers prefer to take the risk of injury from fall spraying rather than wait till spring, when unfavorable soil conditions and lack of proper drainage in their orchards might prevent their completing the spraying in the dormant stage of the peach. However, very little damage results from spring spraying of peaches almost into the blooming period, if no cold weather follows. There is some evidence to indicate that oil-winter injury is somewhat more likely to occur if the oil used is in the form of a miscible oil rather than an emulsion.

A certain degree of control of San Jose scale may be expected from the use of parathion during the summer for control of other pests. Tests in 1949 and 1950 showed parathion to be very efficient for control of the important insects attacking the fruit of peach, and, if this insecticide should come into general use for this purpose, control of scale might be greatly aided. General acceptance of parathion has been retarded pending further data on hazards to spray operators.

**Life history.**—Only the partly grown nymph of the San Jose scale lives through the winter. Temperatures of the winter months are often a deciding factor in the following year’s infestation. Usually, winter mortality ranges from about 25 per cent to 98 per cent, and varies with the severity of the weather; 20 degrees below zero Fahrenheit will kill 90 to 95 per cent of the scales. Spraying for San Jose is advisable even when winter mortalities are as high as 90 per cent.

When sap begins to flow in spring, the overwintering scales resume development and become fully grown by the time the shucks are being pushed off the peaches. At this time the male scale emerges as a tiny, yellow, two-winged insect. The female, which never moves from under her protective waxy covering, is fertilized by the male soon after his emergence and shortly thereafter gives birth to young.

The young have six legs and are active crawlers; in appearance they resemble yellow mites. It is during this active stage, lasting not more than a day or two for each individual, that scales are spread from tree to tree. Birds and large insects accidentally transport the scales, but most of the spread results from the action of the wind. On finding a place to their liking, the crawlers pierce the bark with their threadlike mouthparts and begin sucking the sap. Shortly afterward they shed their skins, lose their
antennae and legs, and become to all appearances mere yellow sacs. They exude a waxy, white substance which turns gray and then black, and which hardens and forms the scales that cover their bodies.

The number of broods in a year depends upon temperature and length of growing season. Ordinarily, two broods in a year occur in northern Illinois and as many as six in the extreme southern end of the state. From Centralia south, during mild fall weather, crawling young have frequently been observed as late as the middle of November, and, in exceptionally mild autumns, young of the same age have been found in the latitude of Carbondale as late as the middle of December.

FORBES SCALE

Aspidiotus forbesi Johns.

Appearance and type of injury.—Like San Jose, this is one of the “ring and nipple” scales. It is similar in general appearance to San Jose, but the nipple-shaped center has a reddish or yellowish appearance, instead of dark gray, and the ring is less distinct. These characteristics, which can be observed with the aid of a hand lens, are not very reliable in distinguishing the two scales, but they are the only ones available to the average peach grower. Often, both scales occur on the same branch.

Importance to peach.—When first recognized, Forbes scale was considered mostly a pest of cherry. It was mentioned by Forbes (1903) as “commonest perhaps on the cherry.” Subsequently it became moderately to very severe on apple, principally in northern Illinois. So rarely has it been found on peach that this fruit was not listed as a host plant by entomologists Metcalf & Flint (1939). Following the advent of DDT into the apple-spray schedules of the state in 1946, Forbes scale began to increase on apple until by the following year some very serious infestations on this host were found in all parts of the state. The increase has been ascribed to destruction by DDT of parasites and predators of scale insects and to the lack of use of summer oil, a material generally not recommended for use with DDT.

Because of a suspicion that some of the scales on peach were not San Jose, samples from heavily infested trees in representative peach orchards of southern Illinois were submitted for identification to the Natural History Survey’s Section of Faunistic Surveys and Insect Identification. The samples were found by
Lewis J. Stannard, Jr., Assistant Taxonomist, to contain in some cases Forbes scale only and in others a mixture of Forbes and San Jose scales. DDT was not used commercially in Illinois on peaches before 1947, table 3; its use increased in the following 3 years. Summer oil is rarely, if ever, used on peaches. It is quite probable that the close proximity of peach to apple orchards in Illinois has been the most important cause of the infestations of Forbes scale now found on peach.

**Life history.**—Observations on pure colonies of Forbes scale on apple in 1948 and 1949 indicate that the life history is approximately the same for Forbes and San Jose scales. Crawling young of Forbes have been found late into November, indicating that this scale is potentially as severe on peach as is San Jose.

**Control.**—Same as for San Jose scale.

**WALNUT SCALE**

*Aspidiotus juglanse-regiae* Comst.

**Appearance and type of injury.**—The walnut scale has been found recently in numbers on peach trees in southern Illinois. This scale has been known throughout the state on other trees and is potentially a serious pest not only of fruit trees but of shade trees. It is remarkably similar in appearance to San Jose and Forbes scales, except that it is larger than either. In appearance, under a hand lens, it is closer to San Jose than to Forbes. Positive identification of any of these scales can be made only under high magnification in the laboratory. However, provi-
sional field determinations of the walnut scale can be made if the loose scale is removed in order to make visible the shape of the body lying underneath. The body of the walnut scale is deeply indented near the broad head end, whereas San Jose and Forbes scales are characterized by the broad, egg-shaped mass of the head end, which is only slightly indented.

Life history.—According to Herrick (1935), the walnut scale overwinters as a partly grown, fertilized female, and not in the nymphal stage, as is the case in San Jose scale. The female grows to maturity and lays eggs the following spring.

Control.—As far as is known, control is the same as for San Jose scale.

PEACH TREE BORER
*Sanminoida exitiosa* (Say)

Appearance and type of injury.—Masses of exuded gum and frass at the base of a tree usually betray the presence of the peach tree borer, figs. 4 and 5. Examination of the trunk, for several inches above and below the ground line, of a tree so marked usually reveals the white, wormlike borers working in brown areas of the bark or outer wood.

The cheapest and most effective methods of controlling the peach tree borer involve the use of one of three chemicals: para-dichlorobenzene, commonly called PDB, ethylene dichloride emulsion, or dichlorodiphenyltrichloroethane, commonly called DDT.

Control by PDB.—From one-half to 2 ounces of PDB crystals should be used to a tree, according to its age and size. A quarter ounce is sufficient for a tree 1 full year old and three-quarters

![Fig. 6.—Application of PDB for control of the peach tree borer. Left, the ring of PDB, around the trunk on leveled ground. The PDB should not be allowed to touch the bark, or injury to the tree may result. Right, the mound around the base of the treated tree.](image-url)
of an ounce for a tree 3 to 5 years old. The amount for a tree more than 5 years old depends upon the circumference of the tree. Tests conducted at Centralia with 15-year-old trees demonstrated that 2 ounces per tree are required to kill borers on trees having circumferences of about 40 inches.

In applying PDB, spread a ring of the crystals around the base of the tree trunk not closer than 1 inch nor more than 3 inches away from it, fig. 6. Cover the PDB with four or five spadefuls of earth and tamp the earth a little with the back of the spade. Several years of tests show that it is not necessary to remove growths of grass and weeds that do not interfere with correct placing of the PDB around the tree.

In sandy soils it is sometimes advisable to pull the mounds from the trees 2 or 3 weeks after treatment, but in all our southern Illinois tests this practice has not been found necessary. However, the mounds should be leveled off by the first week of the following July, when the moths begin to lay their eggs. If the mounds are left, the moths will lay higher on the tree trunk, making control more difficult.

The PDB treatment may be applied either in spring or fall. Tests conducted in southern Illinois for 8 years under proper conditions of soil temperature gave an average kill of 83.4 per cent in the spring and 94.2 per cent in the fall. In spring it is necessary to wait until the ground temperature is about 60 degrees Fahrenheit, usually about May 1 in southern Illinois, before applying the PDB.

Fall treatment should be applied within a month after the moths cease emerging. The peak of emergence for southern Illinois occurs between August 29 and September 15, according to a 6-year record tabulated by the Natural History Survey, fig. 7. In the southern end of the state, PDB should be applied from September 25 to October 15; in the Centralia-Olney-Flora district, between September 20 and October 5; and in central Illinois, from September 15 to October 1. A 3-week period after these dates usually occurs during which the soil temperature is high enough to afford maximum results from the treatment.

Control by ethylene dichloride emulsion.—Ethylene dichloride may be applied at the rate of one-fourth pint of 15 per cent emulsion to a 2-year-old tree, one-half pint of 15 per cent emulsion to a 4-year-old tree, and one-half pint of 20 per cent emulsion to a 10-year-old tree. Trees should be mounded following application, as when PDB is used. Ethylene dichloride has given effec-
tive control of peach borers at temperatures not high enough for
good control by PDB, and therefore it can be used earlier in
spring and later in fall than PDB. It has the disadvantage of
all liquid treatments; it requires that several times as much
weight (as compared with PDB crystals) must be brought into
the orchard by horse- or tractor-drawn equipment.

Control by DDT.—Although the use of PDB has been a cheap
and very efficient method of controlling the peach tree borer,
some method that will eliminate the necessity for building and
later removing mounds is desirable. With increased labor costs
in recent years and the general tendency to mechanize farm
operations, the demand for a labor-saving method of control has
been widespread. DDT was used successfully for control of the
borer in Illinois tests for the first time in 1948. In these experi-
ments, three applications of 3 pounds of actual DDT per 100 gal-
rons of water were made to the trunks and bases of trees at 3-
week intervals, beginning July 8, at the rate of about 1 gallon
of diluted material per tree 8 to 10 inches in diameter. These ap-
plications kept the trunks covered during the moth emergence
period shown in fig. 7. Re-
ports have come from Illinois
and other peach-growing
states that this practice of
spraying with heavy DDT
concentrations two or three
times during the emergence
period of the moths, as a
substitute for the regular
PDB treatment, has been
followed by a number of
growers with results as good
as with the PDB method.
Observations in grower-
treated orchards in 1948 and
1949 appear to substantiate
these reports.

The optimum dosages of
DDT required for control of
the peach tree borer under
Illinois conditions have not
yet been determined. The
heavy concentrations used
in early experiments were

Fig. 7.—Composite records of peach
tree borer emergence in orchards near
Carbondale, 1924–1929.
considered necessary to give protection during the long emergence period of the moths. Even these heavy concentrations did not give better results in small plot tests than the commonly used PDB. Tests in New Jersey by Driggers & Smith (1944) indicate that two applications of DDT (1 pound actual DDT per 100 gallons of water) made to the entire tree for oriental fruit moth in July and August may control light to medium infestations of the peach tree borer.

Other materials, including parathion and benzene hexachloride, show promise experimentally.

There is objection on the part of some growers to driving through an orchard when the branches are full of fruit in order to spray the tree trunks, and the need for doing so two or three times in a season is considered by some growers to outweigh the advantages gained through use of DDT. Whether DDT or possibly some other material used in this manner will supersede PDB will depend not only upon the efficiency of the new insecticide but also upon the economy of the operations.

Life history.—The peach tree borer hibernates in the inner bark of the tree near the ground line as a partly grown larva, resuming its feeding and growth in the spring. This larva or borer is white except for its head, which is brown. When full grown it attains a length of about 1 inch, fig. 4. Upon reaching maturity it spins a cocoon of silk, covered with dirt, frass, and gum, in its burrow in the tree or in the soil close by. In this cocoon it spends the pupal stage until it emerges as a moth. Larvae of all sizes are found in the trees in spring and, as indicated by the emergence chart, fig. 7, feeding goes on over a long period.

In flight, the moth of the peach tree borer, especially the female, looks like a wasp. The female lays large numbers of eggs on the tree trunk and in cracks in the soil within a few inches of the tree. The peach tree borer produces one brood a year.

LESSER PEACH TREE BORER

*Synanthedon pictipes* (G. & R.)

Appearance and type of injury.—The lesser peach tree borer is prevalent in Illinois orchards but causes less damage than the peach tree borer. The larvae of these two insects are similar, and the work of the lesser peach tree borer greatly resembles that of the peach tree borer except that the minor pest usually attacks the upper part of the trunk or a large branch, fig. 8.
stead of the base of the trunk. Usually the lesser peach tree borer enters a weakened tree or an injured area in a tree.

Control.—The best control for lesser peach tree borers is to keep the trees in healthy growing condition and to prevent mechanical injuries.

Five seasons of tests in Illinois with PDB dissolved in miscible oil at the rate of 2 pounds of PDB to 1 gallon of oil and the solution diluted with water to make 2 gallons (2 ounces of PDB in 1 pint of mixture) averaged 86.7 per cent kill of lesser peach tree borers when the mixture was painted on the affected areas.

A control measure has been developed in Georgia by the United States Department of Agriculture Bureau of Entomology and Plant Quarantine. This measure consists of painting only the affected areas with a PDB solution. 1 pound of PDB dissolved in 2 quarts of cottonseed oil (Snapp 1941).

Life history.—The appearance, except for its smaller size, and the life history of this insect are almost identical with those of the peach tree borer. Moth emergence begins in mid-June.

Fig. 8.—Injury caused by lesser peach tree borer.
BARK BEETLES


Peach Bark Beetle, *Phloeotribus liminaris* (Harr.)

Appearance and type of injury.—These two bark beetles attack the trunk and branches of peach trees. A characteristically inj-

![Branch of peach tree infested with bark beetles: the bark has been pulled off to show the white grubs in position.](image)

jured branch looks as if it had been hit with a charge of shot: it has many small, round holes with dots of gum exuding.

Control.—As the beetles attack chiefly weak or injured trees and appear to have little effect upon healthy trees in which the sap is flowing freely in the branches, a primary method of control is to keep the trees in good condition. Measures that stimulate tree growth, such as conservation of moisture through cultivation, application of fertilizer, and thorough pruning, are benef-

So is control of scale. All peach prunings and diseased trees should be removed and burned during the dormant season.

If infestation persists despite the measures suggested, the affected areas on the trunk and branches may be painted with the PDB and miscible oil combination indicated for the lesser peach tree borer. Three seasons of experiments showed a 98
per cent kill of beetles of the shot-hole borer, but only a 17 per cent kill of grubs, indicating that this treatment should be used when adults are first observed and before they have laid eggs.

Life history.—These bark beetles are brownish-black insects about one-tenth inch long. The larvae are tiny, pink-white, footless grubs, which make a series of tunnels just beneath the bark, fig. 9. At least two generations occur each year in southern Illinois. Adults have been observed as early as June and as late as October in this area.

TERRAPIN SCALE

Lecanlum nigrofasciatum Perg.

Appearance and type of injury.—This brown, hemispherical scale, about one-eighth inch across, is occasionally found covering twigs and small branches of peach trees in southern Illinois, fig. 10. In summer the insect exudes honeydew, and peach leaves and fruit may be covered with this sticky substance, on which grows a sooty black fungus that frequently renders the fruit unsalable.

Terrapin scale does not spread from orchard to orchard as rapidly as does San Jose, and consequently is not as generally present, but there have been numerous instances in which it was very serious and persistent in certain blocks for 2 or 3 years.

Fig. 10.—Terrapin scale adults on peach twigs. About six times life size. Illustration courtesy United States Department of Agriculture Bureau of Entomology and Plant Quarantine.
Control.—Oil sprays having a strength of at least 4 per cent actual oil applied in the dormant stage are necessary for control. There is some evidence to indicate that infestation is greatest on the undersurfaces of twigs. Such locations are difficult to reach with spray material on low-hanging branches, but they must be reached to eliminate the persistent heavy infestations that frequently are found in southern Illinois orchards. Tests in Illinois in 1949 with parathion indicate that against the terrapin scale this material is of little value in the dormant period at dosages of 2 or 4 pounds of 15 per cent material per 100 gallons of water.

Observations in 1949 in Michigan showed excellent control of a closely related species, Lecanium fletcheri, with a summer application of 1½ pounds of 15 per cent parathion per 100 gallons of water when about 25 per cent of the eggs had hatched and young crawlers had appeared. Control of Lecanium nigrofasciatum by this means might be expected.

Life history.—The partly grown, fertilized female on the bark of a small branch or twig carries the terrapin scale over the winter. The female resumes feeding early in the spring. In late May or June it produces young that, 1 or 2 days after hatching, crawl from under the female to the leaves. Here the young feed for a month, when the males mature as two-winged insects and mate with the females, dying soon after. The females continue feeding until cold weather.

Insects Attacking Twigs, Foliage, and Fruit

ORIENTAL FRUIT MOTH

Grapholitha molesta (Busck)

Appearance and type of injury.—The first indication of injury by oriental fruit moth is usually the wilting of young twigs, caused by the boring of the small worms in terminal shoots, fig. 11. This twig injury has about the same effect as tip pruning, as it causes new growths to be put out below the point of injury; in extreme cases it dwarfs the tree. Injury to the fruit may or may not be seen. When visible, it appears as brown, sawdust-like frass mixed with gum and sometimes a few threads of silk exuding from the peach. This frass usually distinguishes oriental fruit moth injury from that of plum curculio, in which only gum exudes. The feeding of fruit-moth larvae inside the peach
is a little cleaner than that of curculio and is nearly dry, with some webbing usually present, fig. 12.

**Extent of infestation.**—The oriental fruit moth is a major pest of peach in Illinois. It was first found in the state in Pulaski

![Fig. 11. - Injury to twigs of the peach tree by burrowing larvae of oriental fruit moth.](image-url)
County in 1927. By 1929 it had increased in prevalence until infestations as high as 29 per cent were found in fruit. Since then the infestation on Elbertas, which constitute over 70 per cent of

all the peaches grown commercially in Illinois, has fluctuated widely because of extremes in heat and cold, because of drought, and also because of parasites of the insect.

As may be seen in table 1, the highest average infestation found in surveys at harvest was 22.1 per cent, in 1935. The season of 1936 was one of drought and excessive heat, and many larvae were found dead in the twigs, apparently from the effect of this kind of weather. At harvest the infestation average was found to be 3.3 per cent, or only about one-seventh that of the preceding year. With conditions more favorable to the insect, the infestation increased to 12.2 per cent in 1937. By that time the effect of introduced parasites began to be felt, and other control measures were developed; no such high average annual percentages of infestation have been found since. The extremely low infestation average seen in 1941 probably was a result in part of the absence of crop the previous year, even though the oriental fruit moth can live from year to year on peach twigs and on apples. It was a result in part also of the very low temperatures in the winter of 1939-40, which killed the peach buds. The oriental fruit moth cannot stand the extremes of heat or cold that its near relative the codling moth can.

Fig. 12.—Cross section of peach showing injury by oriental fruit moth larvae. Illustration courtesy Purdue University Agricultural Experiment Station.
No recent data have been gathered on infestations among late varieties of peaches, but, in the early years of the surveys, infestations of 50 to 80 per cent on Heath Cling and Krummel's October peaches were very common. The result was that entire blocks of these varieties were pulled up, and today there are no late varieties grown commercially in Illinois.

Control by parasites.—Since introduction into the United States in 1912 of parasitic control of oriental fruit moth, notable reductions in infestation have been achieved in several eastern states. Of the 40 or more parasites attacking the oriental fruit moth, probably the one of greatest importance is Macrocentrus ancyllivorus Roh., a parasite of the larva. This parasite is not native to Illinois. Liberations have been made in almost every peach-growing county of the state, with the co-operation of Dr. H. W. Allen of the United States Department of Agriculture Bureau of Entomology and Plant Quarantine. In Illinois a somewhat longer period was required than in the eastern states for parasitism to become a factor in control. Table 1 records average infestations, as found in surveys made at harvest, and average degrees of parasitism, as reported by Dr. Allen from twig collections sent to him for rearing.

Wide fluctuations in infestation occurred in the period 1935 to 1937, inclusive, table 1. The degree of parasitism had changed little for 3 years until an upturn started in 1937. In 1938, a season of very favorable weather for oriental fruit moth increase, the infestation dropped to 3.7 per cent, probably largely the result of parasitism, which reached an average of 56.8 per cent for southern Illinois, twice that of the previous year and more than three times that of the years 1935 and 1936.

In the period 1939–1944, no rearings of parasites were made; the average infestations were low compared with those of previous seasons, table 1. Rearings in 1945, 1946, and 1948, all showing a comparatively high degree of parasitism, make it seem reasonable to assume that parasitism remained at a high level during the 1939–1944 period. Although averages of infestation in most years are low, table 1, high infestations are found in a few orchards almost every year. This situation may be due partly to lack of parasites in these particular orchards. Under similar situations in certain eastern peach areas, mass liberations of parasites have been successful. Details of this method of control are given in a publication of the Bureau of Entomology and Plant Quarantine (Allen 1942).
Control by sprays and dusts.—Because the larva of the oriental fruit moth has a habit of ejection all the material it bites out in boring into the twigs or fruit, the common stomach poison, lead arsenate, has proved ineffectual against this insect. For this reason and because a large proportion of Illinois peach growers are equipped for dusting, rather than spraying, as indicated in table 4, a control for oriental fruit moth was worked out over a period of years, beginning in 1929, that makes use of oil dusts that kill the larva by contact. The formula found most satisfactory is as follows:

60 pounds dusting sulfur
35 pounds dusting talc
5 pounds lubricating oil of 80–100 viscosity

When 10 pounds of lead arsenate are added to this mixture for the control of plum curculio, the amount of sulfur is reduced to 50 pounds, and 15 pounds of the talc are replaced by a like amount of lime to reduce the arsenical injury. The ingredients must be thoroughly blended in a dust mixer. Simply stirring the materials together will not make a satisfactory dust. Over a period of 10 years, figures based on checks in Illinois indicate 75 to 80 per cent control of the oriental fruit moth on Elberta peaches. Because little reduction in infestation was apparent as a result of applications made against the first or second brood of larvae in the twigs, the attack was directed against only the late third and early fourth broods after twigs had hardened and fruit was nearing maturity, when it was more easily entered by the larvae. However, because this plan did not interfere with reproduction by the first two broods, the infestation greatly increased. Dusts at 5-day intervals beginning 3 to 4 weeks before harvest are recommended at the rate of at least one-half pound of dust per tree per application. In orchards equipped for spraying, a commercial fixed nicotine, Black Leaf 155, at the rate of 4 pounds per 100 gallons of water during the same period gave as good results as the oil dust.

In 1946, tests were begun in Illinois for the control of this insect with DDT sprays and dusts. These tests indicate that sprays containing 1 pound actual DDT per 100 gallons of water or dusts containing 5 per cent DDT give better control than the fixed nicotine sprays or the common oil dusts. Tests in 1948 in Illinois and in some other peach-growing states show that these applications are effective when used against the second and third broods of oriental fruit moth in June and July. Their use is now
recommended during these months, when control measures are more effective than late in the season, and when there is less danger of food contamination from poisonous residue than is likely when DDT is applied in the last 3 weeks before harvest.

That the use of DDT during the time parasites are attacking the larvae in the twigs may result in a reduction of parasites was shown in tests conducted by Dr. H. W. Allen, Bureau of Entomology and Plant Quarantine, at Moorestown, New Jersey, and reported in correspondence with the author in November, 1948. Whether the better control obtained by the use of DDT will overbalance the loss of some of the natural control remains to be seen over a period of years.

Parathion has been shown to be valuable in controlling oriental fruit moth in twigs and fruit. The value and hazards of this material will continue to be studied.

Experimental work in 1948 and 1949 in Illinois and other states showed an increase in oriental fruit moth infestation in plots in which BHC and chlordane were used as sprays. Illinois tests showed no increase where these materials were used as dusts, indicating the value, as previously stated, of control by contact with dusts, with or without poisons. Three possible explanations for the greater oriental fruit moth infestation found in plots or orchards receiving certain organic insecticides than in those sprayed with lead arsenate are as follows: (1) reduction of parasites by the organic insecticides; (2) ranker growth and greater number of terminals susceptible to attack by oriental fruit moth larvae in trees sprayed with organic insecticides than in those sprayed with lead arsenate; and (3) a slight degree of control of the oriental fruit moth by lead arsenate—more control than has been ascribed to lead arsenate in view of the larva's habit of ejecting materials that enter its mouth as it works its way into the twig and fruit.

Supplementary control measures.—During the early years of heavy oriental fruit moth infestations in Illinois and surrounding states when, despite the use of the best spray and dust materials then available, infestations still continued high, much attention was given to other measures that might help reduce the population of this insect. Several of these were listed in an earlier publication (Chandler & Flint 1939), but only those that now seem to be most practical are suggested here.

1. Removing late-maturing peach trees.—Some growers like to have a few late-maturing peaches for home use, even though
Infestation with oriental fruit moth is greater in late varieties than in early ones. Trees of the late varieties are centers of infestation for this insect because of the large number of larvae that overwinter on them, as shown by Table 7. Information for this table was secured at a time when the oriental fruit moth was more of a problem than it is now.

2. Removing Hale "buttons."—For the same reason that late-maturing varieties of peach become heavily infested with oriental fruit moth, the late crop of small fruit on the Hale variety, called "buttons," is usually infested to a greater extent than is the main crop. Often these late, misshapen fruits are left on the trees, and on two occasions infestation was seen to be greater the following year in that part of an orchard where these fruits were left than it was where they had been picked. These "buttons" should be removed as soon as possible after the regular crop is harvested.

3. Avoiding the interplanting of peach and apple.—In orchards in which apples and peaches are interplanted, the infestation of peaches by oriental fruit moth is, in general, heavier than in orchards containing only peaches. Interplanting may result also in considerable damage to the apples. This condition is explained by the fact that the apples provide food for late-brood larvae, and the peaches furnish food for the first three broods.

4. Using insecticides against overwintering larvae.—As may be seen in Table 8, 21 per cent of the overwintering oriental fruit moth larvae can be reached by the regular PDB treatments without extra work. Tests made at the time these data were obtained showed that from 70 to 90 per cent of the larvae reached by PDB...
were killed. It is possible that certain of the spray materials now used for control of plum curculio and oriental fruit moth will kill some of the overwintering larvae of the oriental fruit moth. Parathion, used experimentally, was shown to be effective in killing overwintering codling moth larvae on apple and, presumably, would be effective against overwintering oriental fruit moth larvae.

**Life history.**—The oriental fruit moth passes the winter as a full-grown larva in a cocoon on some part of the tree or on the ground under the branches. In the winters of 1928–29 and 1929–30, studies were made to determine the percentage of worms hibernating in different situations. Approximately 1,000 larvae were found and their locations recorded, tables 7 and 8.

The larva of the oriental fruit moth is pinkish yellow and about one-half inch long. It is very active and will drop suspended from a silk thread if disturbed when crawling about. It should not be confused with the larva of the peach twig borer: the latter is reddish brown and has well-defined body segments that give a ringed appearance.

In spring, the larva of the oriental fruit moth changes to the pupal stage at or before the time peach trees are in full bloom. A small brown or grayish moth emerges in a week or two, the time of emergence depending upon temperatures. Cool spells that are fairly common at this time of year may delay the emergence. The eggs of the female moth are about half the size of a pinhead, white, and flattened. They are laid chiefly on the undersides of leaves near the tips.

Usually the first moths of the season emerge about the time shucks are beginning to crack, normally the first part of May in
the peach area of southern Illinois, and progressively later in central and northern Illinois. A second brood of larvae appears about 30 to 40 days later, usually about the middle of June in southern Illinois. First-brood larvae begin entering the twigs when the tender terminal twigs are about 2 inches long. First- and second-brood larvae feed mostly as borers in these twigs, but a small percentage, varying somewhat from season to season, attacks the small, green fruit. It is during the second-brood period that larval parasites are most active and effective, while the terminals are tender and attractive to the larvae. Some of the third-brood larvae, appearing normally in July in southern Illinois, also attack twigs, but, from that period on, increasingly larger percentages enter the fruit. The amount of damage by the fourth brood, which begins to hatch in August, usually about the time of Elberta peach harvest, depends partly upon the degree to which the hatch coincides with harvest. By this time peach twigs have hardened, and larvae feed primarily on fruit. Parasites are of least value at this time. In southern Illinois, the fifth brood of larvae appears after the commercial peach harvest and feeds on apple, quince, pear, and late varieties of peach.

In central and northern Illinois, the life history of the oriental fruit moth is less prolonged than in the southern counties, and it includes at least one less brood.

PEACH TWIG BORER
Anarsia lineatella Zell.

Appearance and type of injury.—The peach twig borer is chiefly a pest of unsprayed orchards. Only once in the past 29 years (1930) has it become abundant in commercial plantings, and then it did very little damage. This borer causes an injury similar to that of the twig-boring oriental fruit moth, but the two pests may be distinguished on at least two counts. The peach twig borer is active before the oriental fruit moth, as indicated by the 1930 infestation, boring into the tough wood of the tree as soon as the first leaves appear, fig. 13; the oriental fruit moth is not active until the trees have new growths 2 to 4 inches long, when it attacks only the more tender twigs. Unlike the oriental fruit moth, the peach twig borer rarely attacks the fruit.

Control.—Because this insect seldom appears in Illinois in damaging numbers, regular control measures are not necessary.
CHANDLER: PEACH INSECTS AND THEIR CONTROL

Fig. 13.—The peach twig borer. Eight times life size. Inset, wilting condition of twigs injured by larvae, which attack the tender shoots and cause injury resembling that produced by oriental fruit moth.

Should control become advisable, it is probable that the measures used in California (Bailey 1948), where the insect is a very important pest, will be satisfactory in Illinois. Lead arsenate is recommended at 2 to 4 pounds, or DDT at 1 pound (actual), per 100 gallons of water; or a DDT dust (5 per cent). The application should be made when wilted twigs begin to appear, or later in the season if the insect attacks the fruit.

Life history.—The peach twig borer passes the winter as a partly grown, reddish-brown larva, one-eighth inch long, in a silken case on the trunk of a peach tree. The larva leaves this shelter to attack the tree about the time first leaves appear and by its feeding causes the new twigs to wilt and die back to the old growth. It attains a length of one-half inch. Segments of its body are well marked. Two generations of the insect occur each year in Illinois.

PLUM CURCULIO

*Conotrachelus nenuphar* (Hbst.)

Appearance and type of injury.—The plum curculio, fig. 14, which attacks apple, apricot, cherry, and plum, as well as peach, is one of the most destructive pests of the peach fruit. Infestation of peach by curculio larvae is usually evidenced by gum or wax on the outside of the fruit. Presence of larvae in the fruit may be detected by early drop of small peaches, premature ripening, and drop shortly before harvest.
Fig. 14.—The plum curculio. Upper left, adult; below, larva; right, pupa. Nine times life size.

Two other types of injury by the plum curculio are important. Punctures on the fruit made by the curculio in feeding and egg laying encourage the development of brown rot, which is always

Fig. 15.—Peach from which larva of plum curculio has emerged. The exit hole of the larva is surrounded by large brown-rotted area with groups of spores showing as tiny white dots. Plum curculio infestation leads to brown rot infection.
severe when this insect is abundant, fig. 15. Catfacing, the major proportion of which is usually attributed to the tarnished plant bug, is caused in some amount by the plum curculio. This injury appears as scarred places on the fruit where the curculio beetles have fed early in the season, fig. 16.

**Control by lead arsenate.**—The peach grower must rely chiefly on spraying or dusting for control of plum curculio. As he does much of this work for control of curculio and the brown rot that it helps to spread, this insect adds greatly to his expenses.

Before modern organic insecticides were widely used in Illinois orchards, our standard recommendation for control of plum curculio by poisoning was to spray with acid lead arsenate at the rate of 3 pounds per 100 gallons of water containing a safener (2 pounds of zinc sulfate and 3 pounds of lime), or to apply oil dusts containing 10 per cent acid lead arsenate and 5 per cent oil with lime, talc, and sulfur as a safener, carrier, and fungicide. If basic lead arsenate is to be used, 50 per cent more is needed in the spray or dust formula than the amount of acid lead arsenate recommended. Where conditions warrant it, the spray dosage may be reduced to 2 pounds of acid lead arsenate per 100 gallons of water, but the 3-pound dosage is considered better as a general recommendation. Other insecticides than lead arsenate that have been used against curculio are discussed in later pages.
The comparative values of spray and dust programs in which lead arsenate is used for control of plum curculio on peach have

Table 9.—Percentage of peaches infested with plum curculio larvae at harvest time in untreated check plots, in blocks treated with lead arsenate dust (10 per cent), and in blocks treated with lead arsenate spray (3 pounds lead arsenate to 100 gallons water in most cases), southern Illinois, in 10 years beginning in 1929 and ending in 1950.

<table>
<thead>
<tr>
<th>Year</th>
<th>Dust</th>
<th>Spray</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>1929</td>
<td>5.0</td>
<td>2.3</td>
<td>28.3</td>
</tr>
<tr>
<td>1931</td>
<td>0.2</td>
<td>0.1</td>
<td>8.8</td>
</tr>
<tr>
<td>1932 (Test 1)</td>
<td>2.7</td>
<td>2.5</td>
<td>24.8</td>
</tr>
<tr>
<td>1932 (Test 2)</td>
<td>4.8</td>
<td>7.0</td>
<td>15.8</td>
</tr>
<tr>
<td>1935</td>
<td>1.2</td>
<td>0.3</td>
<td>6.4</td>
</tr>
<tr>
<td>1937</td>
<td>2.6</td>
<td>0.8</td>
<td>8.8</td>
</tr>
<tr>
<td>1938</td>
<td>4.6</td>
<td>3.7</td>
<td>14.1</td>
</tr>
<tr>
<td><strong>Average 1929–1938</strong></td>
<td>3.0</td>
<td>2.4</td>
<td><strong>15.3</strong></td>
</tr>
<tr>
<td>1947</td>
<td>4.7</td>
<td>5.3</td>
<td>—</td>
</tr>
<tr>
<td>1948</td>
<td>9.0</td>
<td>2.5</td>
<td>—</td>
</tr>
<tr>
<td>1949 (Test 1)</td>
<td>10.4</td>
<td>9.2</td>
<td>—</td>
</tr>
<tr>
<td>1949 (Test 2)</td>
<td>10.0</td>
<td>22.8</td>
<td>—</td>
</tr>
<tr>
<td>1950</td>
<td>13.2</td>
<td>10.4</td>
<td>—</td>
</tr>
<tr>
<td><strong>Average 1947–1950</strong></td>
<td>9.5</td>
<td>10.0</td>
<td>—</td>
</tr>
</tbody>
</table>

Fig. 17.—Typical records of occurrence of plum curculio in plots of peach trees, each plot treated with one of four insecticides (parathion, lead arsenate, chlordane, benzene hexachloride) on April 19 and 29, May 9, 19, and 30, June 10, and July 1. Records are based on results of jarring of five trees in each plot, 1949.
Fig. 18.—An Illinois peach grower jarring for plum curculio to determine location and abundance of the insect.
been tested over a period of years in Illinois. Table 9 summarizes the harvest infestation data of tests from 1929 to 1950, inclusive. These data from the late tests, 1947 to 1950, inclusive, were substantiated by data from other methods of evaluation, including drop-peach examination and jarring. All of the data indicate that there is little difference between the spray and dust programs in results obtained.

In Illinois, the time of application of sprays and dusts has been studied over the years. There are two periods in which a poison for the curculio beetles is necessary: in the first-brood period when the adults that have overwintered feed and produce a first generation of grubs in the fruit, and in the second-brood period when the next generation of beetles, which emerge from the ground in the orchard, are feeding and producing a partial second brood of grubs. The graph based on results of jarring, fig. 17, shows these periods. The now common practice of jarring, figs. 18 and 19, which consists of knocking the beetles off onto sheets spread beneath the branches, gives information as to the population of beetles in an orchard or in various situations or blocks of orchards, and may be used in determining when a poison should be applied.

Frequently beetles just coming into an orchard from hibernation do not lay eggs for a week or 10 days, but they feed, and if

Fig 19.—Grower making count of plum curculio to determine abundance on tree that he has jarred.
any fruit is open to attack, it should be protected. Stung fruit, even though not wormy, is not readily salable. The poison-spray schedule, revised from year to year, calls at present for applications at the following times:

1. When shucks begin to split and expose the fruit to attack.
2. When three-fourths of the shucks are off.
3. Two to 3 weeks after the second application.
4. About 1 month before harvest.

Arsenical corrective applications, to prevent arsenical injury, should be used 10 days after the second and third sprays. They consist of 2 pounds of zinc sulfate and 3 pounds of hydrated lime, or 6 pounds of hydrated lime without zinc sulfate, per 100 gallons of water.

Dust schedules include applications for the following times:
1. When shucks begin to split and expose the fruit to attack.
2. When two-thirds of the shucks are off.
3. Ten days after the second application.
4. Ten days after the third application.
5. 6, and 7. At 10-day intervals after the fourth application.
8. One month before harvest.
9. One week after the eighth application.

More than twice as many dust as spray applications are listed, mainly because dust is applied at lower dosages than spray and from only one side of the tree at a time. Very frequently more spray applications than listed above are needed, especially in the first-brood period between applications 2 and 4. The average numbers of applications actually made by representative Illinois growers are shown in table 4.

To determine the general plum curculio situation as it applies to their areas, peach growers are urged to make use of the *Spray Service Report* issued weekly during each growing season in Illinois and neighboring states. They are advised to supplement the general reports by jarring to determine the extent of infestation in their own orchards.

The number of applications of any insecticide may be varied from year to year or from orchard to orchard in accordance with the population of insects. The heaviest infestation of plum curculio that growers can remember occurred in 1929. In 1931, the year after a total loss of the crop from a winter freeze, the cleanest crop on record was produced with very few applications of poison. Table 1 indicates a drop in plum curculio infestation in 1941 following a crop failure in 1940.
Table 10.—Numbers of plum curculios jarred from equal numbers of peach trees in the first rows and the fifth rows from the edges of Illinois peach orchards, 10 years, 1938-1948.

<table>
<thead>
<tr>
<th>Year</th>
<th>First Row</th>
<th>Fifth Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>1938</td>
<td>28</td>
<td>5</td>
</tr>
<tr>
<td>1939</td>
<td>215</td>
<td>68</td>
</tr>
<tr>
<td>1941</td>
<td>44</td>
<td>18</td>
</tr>
<tr>
<td>1942</td>
<td>74</td>
<td>20</td>
</tr>
<tr>
<td>1943</td>
<td>271</td>
<td>184</td>
</tr>
<tr>
<td>1944</td>
<td>150</td>
<td>40</td>
</tr>
<tr>
<td>1945</td>
<td>217</td>
<td>28</td>
</tr>
<tr>
<td>1946</td>
<td>633</td>
<td>385</td>
</tr>
<tr>
<td>1947</td>
<td>250</td>
<td>125</td>
</tr>
<tr>
<td>1948</td>
<td>92</td>
<td>45</td>
</tr>
<tr>
<td>Total*</td>
<td>1,975</td>
<td>921</td>
</tr>
</tbody>
</table>

* Ratio of first row total to fifth row total, 2.1 to 1.0. The ratios in early spring are greater than these totals show, because the population gradually spreads out over the orchard as the season advances.

Likewise, orchards located near woods, brushy fencerows, and other places where curculios hibernate are apt to be more heavily infested than orchards having intensively cultivated surroundings.

Control by new insecticides.—Although lead arsenate in many peach orchards and especially during some years has given fairly good control of curculio, tables 1 and 5, there has been from its first use a need to find a substitute because of the injury caused by this chemical to foliage and twigs. Injury to the wood shows as roughening of the bark and is usually accompanied on the younger twigs by exudation of gum around the axil of the leaf or fruit. Injury to wood is greatest on the previous season's growth. Injury to the leaves shows as marginal burning and a shot-hole appearance; it results in partial defoliation of the trees. In 1937, studies were made with cryolite as a substitute, and, as table 3 indicates, its use in Illinois had increased considerably by 1939. Foliage sprayed with cryolite suffered less injury than that receiving lead arsenate, but in Illinois tests cryolite did not give as good control of the plum curculio. An injury to the suture of the peach, a premature softening that developed following use of cryolite, caused this chemical to be discarded as an insecticide for plum curculio control.

In 1947, studies were begun on a number of organic insecticides for control of peach insects in Illinois and other peach-
growing states. Some of these materials, notably benzene hexachloride and chlordane, proved to be from 2 to 10 times as efficient as lead arsenate against the plum curculio.

Benzene hexachloride, commonly called BHC, has been studied the longest of the new organic insecticides. It has the advantage over lead arsenate, shared to a somewhat lesser degree by other organics, of killing many of the eggs and larvae in the fruit, thereby reducing the number of beetles in the second-brood period, fig. 17. Illinois tests showed, however, that BHC did not kill as rapidly as some other organics and that its use was followed by more stung fruit. In spray form, BHC cannot be used beyond the end of the first-brood period of plum curculio because of the danger of imparting a musty flavor to the fruit. As a dust, it can be used as late as the early part of the second-brood period with little danger of tainting fruit. It was widely used by Illinois growers in 1948, 1949, and 1950, tables 3 and 5, but did not stand up as well in 1949 and 1950 as in 1948.

Measures suggested in 1949 for control of the plum curculio in Illinois included applications of BHC, as either dust or spray, at 7-day intervals (Powell, Chandler, & Kelley 1949). The recommended spray consisted of 4 pounds of wettable powder containing 6 per cent gamma isomer of BHC per 100 gallons of water, equivalent to 0.24 gamma isomer of BHC per 100 gallons of water. The recommended dust consisted of 1 per cent gamma isomer of BHC. The 7-day intervals between applications were advised because BHC has a short period of efficiency.

BHC was shown by 1949 tests to be inferior to chlordane as a spray, and Illinois recommendations for 1950 omitted it from the suggested spray schedule (Powell, Chandler, & Kelley 1950). The recommendation for use of BHC as a dust was retained because parathion, hazardous to use, was the only other material in dust form giving at least equivalent control. Tests with aldrin and dieldrin dusts in 1950 showed these materials to be very promising.

Although chlordane as a spray has proved more efficient than BHC against plum curculio, as a 5 per cent dust it has given little better results than lead arsenate. Unlike BHC, chlordane as a spray will produce little if any off-flavor in the fruit and it can be used in the first application of the second-brood period. The suggested spray schedule in which chlordane is used calls for 10-day rather than 7-day intervals between sprays because chlordane has greater residual properties than BHC. It provides for
four sprays in the first-brood period and one in the second-brood period (Powell, Chandler, & Kelley 1950). Tables 3 and 5 show an increase in the use of chlordane and parathion by Illinois growers from 1948 to 1950. Table 4 shows the percentages of applications made in dust form. The reduction from 85 per cent of the applications in 1949 to 61 per cent in 1950 is due partly to increased use of chlordane sprays. It is also an indication that some growers regard organic sprays in general as being more effective than the dusts.

Two of the new materials, parathion and aldrin (trade name Octalene), ranked first and second, respectively, when used as sprays for control of plum curculio in the 1949 tests. Aldrin was used at two different concentrations, one-fourth and one-half pound (actual aldrin) per 100 gallons of water. Parathion when used as a dust, 1 per cent strength, also ranked high, but it was not quite so efficient as when used as a spray (the 15 per cent wettable powder at the rate of 2 pounds per 100 gallons of water).
Parathion is of value in controlling the oriental fruit moth, mites, red-banded leaf roller, and San Jose and Forbes scales, as well as plum curculio. Although the extent of such control is not at present known, it is so high that were it not for the hazard to the operator parathion would probably replace the other insecticides. Aldrin is known to be more cumulative in the human body than parathion and for that reason may be more dangerous to

Fig. 21.—Typical tree in lead arsenate sprayed block showing partial defoliation.

Fig. 22.—Typical tree in chlordane sprayed block showing relatively uninjured foliage.
the consumer. If either material is used the operator should be extremely careful to avoid injury to himself.

Dieldrin (trade name Octalox), when used in 1949 and 1950 tests against plum curculio, showed great residual qualities. In 1950, at a strength of only one-fourth pound (actual) per 100 gallons of water, and with only a few more than half the number of applications used for parathion, dieldrin gave control of plum curculio equal to, or slightly better than, that given by parathion. Two other new materials, EPN (ethyl p-nitrophenyl thionobenzene phosphonate) and Dilan, used as sprays, appeared very promising in 1950 tests. Parathion is the only one of the materials tested that gave some control of mites, oriental fruit moth, red-banded leaf roller, and Forbes and San Jose scales.

The value of an organic insecticide in the production of good foliage is shown in figs. 20, 21, and 22. Because of the heavier foliage produced, the general use of organic insecticides in place of lead arsenate may result in delaying the date of first picking as much as 3 or 4 days. Some injury to foliage is caused by the organics, probably due to the chlorine in the compounds, but it is minor compared with arsenical injury in the trees sprayed with lead arsenate.

For the application of any of the organic compounds that are either dangerous or objectionable to the operator, the use of a duster of the type shown on the cover of this circular or of a non-stop sprayer, such as is shown in the frontispiece, is desirable because it is operated by only one man, who rides at a considerable distance from the place of discharge of the material. These machines have the additional advantage of taking the individuality out of spraying and dusting, and of giving all trees a uniform coverage.

**Supplementary control measures.**—A number of supplementary control measures are of value in reducing the damage by plum curculios.

1. **Winter clean-up.**—The following orchard sanitation measures will eliminate a large number of possible hibernating places for plum curculios and will reduce the spring population of the adult insects: burning piles of prunings; removing piles of trash and old lumber in or near the orchard; cleaning out nearby brushy fencerows; eliminating thickets and brier patches that encroach upon the orchard from wooded areas; reducing the growth along small streams or drainage ditches that flow through or along the edge of the orchard.
2. Pickup of drops.—Research shows that regularly 50 to 90 per cent of the early drops are wormy; when infestation is severe and labor costs are low, picking up these early drops may be a profitable procedure. The first pickup should be made about a month after bloom, and two or three additional collections at intervals of 5 or 6 days. The drop peaches should be burned, buried at least 2 feet deep, or dumped into a pond of water.

3. Cultivation.—Late spring and early summer cultivation destroys larvae and pupae in their cells in the ground. In southern Illinois, best results are obtained if cultivation is done within a period of 2 or 3 weeks after all larvae have entered the ground and before emergence begins in July.

Life history.—The adult plum curculio is a dark brown beetle, about one-fourth inch long, with four small humps on its wing covers, fig. 14. Its mouthparts are at the end of a trunklike snout, which is nearly a third as long as the body. The adult passes the winter in orchards in which clean-up measures have been neglected and in brush piles, fencerows, edges of woods, and similar situations. It comes out of hibernation in spring. At about shuck-fall time in peaches the female cuts a crescent-shaped slit in a young peach, apple, plum, or apricot. In the flap thus produced she deposits one of the several eggs she lays. A white, footless grub hatches from this egg and feeds on the pulp of the fruit. The infested fruit usually drops in the course of 2 or 3 weeks; the larva, when full grown, leaves the fruit to burrow 2 or 3 inches into the ground. Here it makes a cell in which to pass the pupal stage. From the pupae the next brood of beetles emerges: emergence begins the first part of July and continues into August. The emerging beetles feed on the peaches and are accountable for some of the stung fruit at harvest. Some of them go into hibernation, but a large number deposit eggs, which result in many small larvae in the fruit at harvest. Insectary rearing in 1927 and again in 1935 showed that some second-generation beetles developed in late August and early September, and jarring has shown some curculio beetles present in southern Illinois as late as the middle of October.

Moisture largely determines the extent of emergence of plum curculio from the pupal stage. Table 11 records results of emergence experiments in which 1,550 to 8,000 wormy drop peaches, or apples, were placed each year in screened cages sunk in the ground under the branches of orchard trees. The dates and numbers of beetles emerging were recorded. As the table shows,
Table 11.—Emergence of plum curculio in cages from drop peaches, 8 years, and apples, 1 year, in southern Illinois.

<table>
<thead>
<tr>
<th>Year</th>
<th>Wormy Drops in Cages</th>
<th>Number of Plum Curculios Emerged</th>
<th>Percentage of Plum Curculios Emerged</th>
</tr>
</thead>
<tbody>
<tr>
<td>1925</td>
<td>1,700</td>
<td>15</td>
<td>0.9</td>
</tr>
<tr>
<td>1926</td>
<td>2,100</td>
<td>13</td>
<td>0.6</td>
</tr>
<tr>
<td>1927</td>
<td>2,000</td>
<td>69</td>
<td>3.5</td>
</tr>
<tr>
<td>1928</td>
<td>3,000</td>
<td>33</td>
<td>1.1</td>
</tr>
<tr>
<td>1929</td>
<td>8,000</td>
<td>564</td>
<td>7.1</td>
</tr>
<tr>
<td>1930*</td>
<td>4,000</td>
<td>16</td>
<td>0.4</td>
</tr>
<tr>
<td>1931</td>
<td>1,550</td>
<td>35</td>
<td>2.3</td>
</tr>
<tr>
<td>1932</td>
<td>2,000</td>
<td>420</td>
<td>21.0</td>
</tr>
<tr>
<td>1933</td>
<td>1,600</td>
<td>165</td>
<td>10.3</td>
</tr>
</tbody>
</table>

* Apples; all other years, peaches.

there was a heavy emergence in the wet year 1929 and a very slight one in the drought year 1930, with a return to an approximately normal emergence in 1931. The rainfall in 1932, while not excessive, was very evenly distributed during the period most important to the insect. In 1933, excessive rainfall occurred from early spring until the middle of May; the rest of the year was exceedingly dry. There appeared to be sufficient hold-over effect of the early moisture to allow a considerable percentage of emergence.

TARNISHED PLANT BUG

*Lygus oblineatus* (Say)

**Appearance and type of injury.**—The tarnished plant bug, fig. 23, although considered in the past a minor pest of peach, has recently been found to be responsible for much of the injury called catfacing. Stink bugs and, to a lesser extent, the plum curculio produce some of it. Table 1 shows that 3.8 to 19.9 per cent of the fruit was catfaced in the years 1942 to 1950, inclusive. Catfacing is the most common injury inflicted by the bug. This sometimes appears as closed lesions varying from slight dimples to extensive puckered areas, fig. 24. Little or no pubescence develops on the injured places. The damage is done early in the development of the fruit and it may be localized on a given tree, some branches having a large part of their peaches disfigured, while others nearby have little or no affected fruit.

Less important than catfacing, except in seasons of very light set of fruit, is a second type of damage caused by the tarnished
Injury to peach fruit (cat-facing) caused by adult tarnished plant bug.

Stopback or dieback is a third injury, important chiefly to nurserymen. The tarnished plant bug causes a wilting or dying back of new growth when it sucks the sap from the tender terminals. Injury is caused either by the injection into the tree by the bug of some toxic substance or by a complicated reaction of the tree to the plant bug feeding.

Control.—Previous to 1945 no satisfactory control by means of insecticides for insects causing cat-facing had been developed.
although several insecticides had been used experimentally (Porter, Chandler, & Sazama 1928; Chandler 1943). From 1946 to 1948, inclusive, experimental work was carried on in Illinois for control with DDT, BHC, and chlordane. Some of these tests have been reported in detail elsewhere (Chandler 1946, 1948). They showed that two applications of DDT are advisable: one when about 50 per cent of the blossoms are open, fig. 25, and when tarnished plant bugs are most abundant, and the other when shucks are just cracking, at which stage stink bugs begin to appear, fig. 26. DDT should be used at 1 pound (actual) per 100 gallons of water or as a 5 per cent dust. Tests in 1946 gave an average of 80.9 per cent control with DDT applied at these
stages of development, but in 1947 and 1948 the averages were 57.0 and 62.3 per cent, respectively. The use of DDT in the blooming period is open to some objections because of the possible poisoning of honey bees. Recent studies showed that this poisoning is not nearly so extensive as was at first feared (Smith, MacSwain, Linsley, & Platt 1948). However, because objections were anticipated, tests were conducted in 1947 in which DDT applications were delayed until petal fall. The resulting control was 37 per cent, which compared unfavorably with the 57 per cent control obtained when DDT was applied in the blooming period. Jarring over a period of years has shown that most of the tarnished plant bugs come and go with the bloom. A typical graph of occurrence of the insects causing catfacing is shown in fig. 26.

In a further attempt to eliminate the use of DDT on the peach blossoms, tests were conducted in orchards with legume cover crops in which it was found, by sweeping and jarring, that tarnished plant bugs went from the peach blossoms to the legume and vice versa. In such situations, spraying or dusting the cover crop with DDT was as effective as applying the material to the tree. It resulted in a smaller amount of DDT on the peach blossoms and a consequent lower mortality of bees. Later applications of insecticides to orchards with legume cover crops might result in heavy mortality among bees if the legume is in blossom at the time the poison is applied.

In 1948, tests showed that chlordane or BHC could be substituted for DDT with about equal control of catfacing insects. Thus, a grower intending to use a BHC or chlordane schedule could use DDT for the bloom application and begin with one of the other two insecticides at shuck split. The increasing use of DDT for prevention of catfacing is shown in table 3.

**Supplementary control measures.**—Limited control of tarnished plant bug may be obtained by keeping down grass and weeds in and around the orchard and by planting suitable cover crops. Since legumes are a favored host of the tarnished plant bug and of stink bugs, it frequently happens that catfacing is increased when they are grown in peach orchards. We have observed a few cases where very severe catfacing has been correlated with growth of legumes in or near an orchard. However, as suggested above, spraying or dusting the cover crop may help to control the insect.
Thinning, although it cannot be classed as a method for control of catfacing insects, is a means of reducing the losses from catfacing. It is not at all unusual in the thinning operation to pull off more than half the fruit on the tree in order to produce fruit of marketable size. To be a control measure, thinning must be done selectively. The rubber-hose method of tapping the branches apparently knocks off the same proportion of perfect and imperfect fruit. The injured fruits may easily be detected and removed by hand as the peaches increase in size. Experiments by Dorsey & McMunn (1926) indicate that effective thinning may be done as late as 4 weeks before harvest. These experiments, conducted in southern Illinois peach orchards a number of years ago, have not to the knowledge of the author been repeated experimentally in any peach-growing area. However, field observations since 1926 indicate that the findings apply as well today as at the time the experiments were reported. Many growers have taken advantage of these findings to eliminate defective fruit by thinning.

**Life history.**—The adult of the tarnished plant bug is a coppery brown insect flecked with darker brown and yellow; it is oval-shaped and about a quarter inch long, fig. 23. In Illinois it passes the winter hidden in many kinds of shelter, but it prefers alfalfa, clover, wild parsnip, and, most of all, mullein. So greatly is the last-named plant preferred that we have used the number of bugs found hibernating in it as an index to abundance of the insect.

In early spring the adult becomes active and flies to peach trees. It leaves them for other crops rather early in the development of the fruit and feeds largely on legumes.

**STINK BUGS**

*Euschistus euschistoides* (Voll.)
*Euschistus variolarius* (Beauv.)
*Podisus maculiventris* (Say)
*Stiretrus anchorago* (Fab.)
*Banasia dimidiata* (Say)
*Dendrocoris humeralis* (Uhl.)

*Euschistus tristigmus* (Say)
*Euschistus servus* (Say)
*Acrósternum hilare* (Say)
*Thyanta custator* (Fab.)
*Solubea pugnax* (Fab.)
*Mormideca lugens* (Fab.)

*Hymenacryus nervosa* (Say)

Of the above list of stink bugs jarred from peach in the course of catface studies in 1943 and 1944, *Euschistus servus* constituted approximately 50 per cent, *E. tristigmus* 30 per cent, and *E.
variolarius 6 per cent of the total. Excluded from these figures was a predaceous species, Brochymena sp., not considered in the jarrings.

**Appearance and types of injury.**—Two types of injury, cat-facing and dimpling, are commonly caused by stink bugs, fig. 27. The green stink bug, as Acrosternum hilare is commonly called, specializes in dimpling the fruit. The other species listed are known to cause catfacing in Illinois; they start about petal fall and continue to produce injury for 5 or 6 weeks. They are responsible for much of the late catfacing injury that occurs on peaches in southern Illinois.

Another type of stink bug injury, observed especially in 1949, was the result of the puncturing of peaches in July. Tiny droplets of gum appeared, often many on a single peach. Under the skin could usually be found small, shallow areas of injured flesh. Stink bugs were observed feeding on these injured peaches. As a check on the suspected cause of injury, stink bugs were caged with uninjured peaches on the trees; they produced the typical injury.

**Control.**—The control measures discussed under the tarnished plant bug are applicable to the stink bugs, but with some difference in timing of applications. Because of the importance of timing, a graph, fig. 26, has been prepared to show the normal
occurrence of the insects responsible for catfacing: plum curculio, tarnished plant bug, and stink bugs. The graph shows the relation to the development of the blossom and fruit. The peak of occurrence of stink bugs is somewhat later than that of the tarnished plant bug. For these two insects is recommended either of two treatments: (1) two applications of DDT or (2) one application of DDT and a second of chlordane or BHC (Powell, Chandler, & Kelley 1950). The first of the applications, put on when about 50 per cent of the blossoms are open, fig. 25, is timed primarily for the tarnished plant bug, because this insect is present principally during the blooming period, and supposedly does most of its damage then. Some DDT from the first application may persist until petal fall, when stink bugs have begun to increase. The second application is put on when shucks are cracking, because at this time the young peach is just beginning to be exposed to insect attack. Although this time is somewhat past the peak of stink bug occurrence, the insecticide is put on then because stink bugs persist for a longer period, though in diminishing numbers, and, according to our cage tests, continue to do injury. The second application for stink bugs coincides with the first curculio application. If BHC or chlordane is used for this application it will serve as a poison for both the plum curculio and the stink bugs.

Our experience with parathion indicates that if this new organic insecticide were used for plum curculio control it would be helpful in controlling other catfacing insects, also, beginning with the shuck-split stage, but we have not conducted parathion tests designed for control of plant bugs and stink bugs only. Jarring records and other records relating to curculio and catfacing, in test orchards and also in other orchards not included in tests, lead to the belief that stink bugs are more difficult to control than tarnished plant bugs.

Fig. 28.—Adult of the stink bug, *Euschistus servus* (Say), one of the insects causing catfacing. Inset shows the bug approximately life size.
Life history.—Stink bugs have a modified triangular form about a half inch long and a quarter inch wide, fig. 28, and are usually brownish green. They hibernate as adults and appear on the peach in large numbers at about petal fall. A few species lay small groups of eggs on the peach foliage, fig. 29. After the young hatch they cluster about the egg masses for a few days until they molt. Then they leave the peach trees and may be found in large numbers in fields of cowpeas and soybeans, where they feed upon the plants. They also feed extensively on weeds, particularly on one of the fleabanes, *Erigeron canadensis*, commonly called butterweed or horseweed. Some species produce a second brood. Our jarring shows some increase in numbers of stink bugs in late June or July. This increase corresponds approximately to the time when the injury by late puncturing took place in 1949, as discussed on page 47.

**JAPANESE BEETLE**

*Popillia japonica* Newm.

Appearance and type of injury.—The injury to peach by the Japanese beetle occurs entirely from the feeding of the insect on the ripe or nearly ripe fruit. The beetles do not feed on the fruit while it is green, but just as it is beginning to ripen they descend upon it. In areas where they are abundant they eat
most of the fruit on the trees or break the skin and gouge the
fruit in such a way as to render it unmarketable. Clusters of
the beetles may be found on the fruit, sometimes 50 or more on
a single peach.

Control.—Before the advent of DDT, the Japanese beetle was
very difficult to control when heavy infestations occurred. In
New Jersey, where the beetle has been a serious pest of peach,
DDT at the rate of 1 pound of actual DDT to 100 gallons of water
applied about July 15 was found to control the insect for a
month. Time of this application coincides with the time of a
DDT application for third-brood oriental fruit moth. With the
increasing use of DDT in Illinois for oriental fruit moth, the
Japanese beetle should not be a serious pest of fruit if and when
it reaches the peach area of the state.

Life history.—The Japanese beetle is a robust, bronze and
green beetle about a quarter inch wide and one-third inch long,
fig. 30. The wing covers are bronze. The insect has a metallic
green, triangular, shieldlike area just behind the head and four
white dots on the tip of the abdomen, which protrudes from un-
der the wing covers. It has been found in most of the states to
the east of Illinois, in St. Louis, Mis-
souri, and in two Illinois cities.
East St. Louis and Chicago. More than 2,500 Japanese beetles
were caught in traps in the Chi-
cago region during the 5 years from 1935 to 1939, inclusive. Up
to the present time the Japanese beetle has not reached the com-
mmercial peach orchards of the state.

The Japanese beetle in most of its range has one complete
brood each year, fig. 31. In certain parts of the eastern United
States where the soil is wet and cold the beetle may produce only
one brood in 2 years. It passes the winter in the grub stage in a
cell several inches deep in the soil. In the spring the grubs feed
until late May and then go into the pupal stage, in which they re-
main for several weeks. In June they start emerging as beetles
and continue to emerge through August and in small numbers
into September.

The eggs are laid singly in the soil and hatch in about 2 weeks
into small grubs, which feed at first principally on decaying
vegetable matter and to some extent on living plant roots. At the start of cool weather the grubs go down in the soil to a depth of 2 to 6 inches and form the protective cells in the soil in which they winter.

GREEN JUNE BEETLE

*Cotinis nitida* (L.)

Appearance and type of injury.—The green June beetle, as found in southern Illinois, feeds on a wide variety of plants and occasionally attacks peaches just before ripening. The insect eats off the surface of the fruit, usually causing a decaying area to develop. Occasionally it cleans off all flesh clear to the pit.

Control.—As no poison spray can be used at the time of attack by this insect, no control other than jarring or hand-picking avails. Manure piles in the vicinity of orchards, which may act as breeding places for the insect, should be removed.

Life history.—The beetle is a conspicuous green in color, about three-fourths of an inch long and somewhat flattened, fig. 32.
The larva is a dirty-white grub, reaching a length of about 2 inches, which feeds on decaying vegetation and is recognized by the habit of crawling on its back, fig. 33.

**COTTON LEAFWORM**

*Alabama argillacea* (Hbn.)

**Appearance and type of injury.**—The adult of this insect is the only moth found in Illinois that is capable of puncturing the skin of such fruits as peach, grape, and apple. The moth attacks the ripe peaches, chiefly of the late varieties, such as Krummel's October and Heath Cling, on which it may be seen in very large numbers. Although the moth may puncture the skin, it feeds extensively through cracks in it, fig. 34. Brown rot usually results from this feeding.

**Control.**—Application of sulfur dust or spray helps to control the brown rot that follows the moth injury, and may have some repelling effect on the moth. The use of poison is not recommended because the moth attacks at about the time of harvest.

**Life history.**—The moth of the cotton leafworm is about 1 1/4 inches from tip to tip of wing, and is olive tan, with three wavy, transverse bars on each front wing. The larva feeds only on the leaves of cotton. It is a subtropical insect and does not winter in Illinois. The moth is a strong flier; it has been found as far north as Michigan in the United States and frequently in southern Canada.
APHIDS

Black Peach Aphid, *Anuraphis persicae-niger* (Smith)
Green Peach Aphid, *Myzus persicae* (Sulz.)

Appearance and type of injury.—A greenish aphid or plant louse occasionally found sucking the sap from peach twigs and new fruit is the green peach aphid. Occasionally working in the tree but chiefly on the roots is a brownish colored plant louse, the black peach aphid. This insect occasionally causes serious damage to the roots of young trees planted in old peach orchards, sucking the sap and frequently causing death of the trees.

Control.— Aphids rarely become of sufficient importance in Illinois peach orchards to justify control measures. Those aphids found in the upper part of the tree may be killed by a 40 per cent nicotine sulfate solution, 1 pint to 100 gallons, with 2 pounds of potash fish oil soap, if the spray is applied thoroughly enough to strike their bodies. This spray is compatible with most of the materials commonly used on peach except lime and may be combined with them. No definite control is known for the black peach aphid, as it works on the roots, but if infestation occurs it is advisable to apply one-fourth ounce of PDB per tree, keeping the material away from the trunk, and to increase fertility of the soil to stimulate plant growth. Work by the Ohio Agricultural Experiment Station indicates that lack of good growth in young trees may be due not so much to the aphids as to infertility of old peach soil. The Ohio experimenters found it possible to get good growth of young trees planted in old orchards when new earth was brought in from outside and used next to the roots.

GRASSHOPPERS

*Melanoplus* spp.

Appearance and type of injury.—Occasionally grasshoppers become sufficiently numerous in a peach orchard to cause serious damage by eating the foliage and gnawing the bark from the twigs.

Control.—Of the organic insecticides found to be of value in controlling grasshoppers probably the best are chlordane used at one-half to 1 pound per acre and toxaphene at 1½ to 2 pounds, the heavier dosages being needed for adult hoppers. Other materials such as BHC, aldrin, and parathion, which the grower may have on hand because of their use for other insects, may be substituted, although they do not have as long a residual effect.
BLACK-HORNED TREE CRICKET

*Oecanthus nigricornis nigricornis* Wlk.

**Appearance and type of injury.**—The black-horned tree cricket occasionally causes slight injury to peach by laying rows of eggs in the twigs, 50 to 75 eggs in a row and about 25 to the

![Image of adult female tree cricket](image)

Fig. 35.—Adult female tree cricket. Four times life size.

inch. That part of the twig above the series of punctures may die. Eggs of the tree cricket are pale yellow in color and each egg is about one-eighth inch long.

**Control.**—Control of tree crickets has never been necessary on peach in Illinois. It is probable that ordinary spraying and dusting hold down infestation.

**Life history.**—The adult tree cricket is a very slender, green insect with antennae or feelers longer than the body, fig. 35. One generation occurs each year. The insect winters in the egg stage. Eggs, deposited in the fall, hatch in spring. The adult male produces chirping notes by rubbing together specially modified parts of the forewings.

PERIODICAL CICADA

*Magicicada septendecim* (L.)

**Appearance and type of injury.**—The extent of the damage done to twigs of peach by the 13- and 17-year races of the periodical cicada class this insect with those usually unimportant but occasionally severe. The injury is produced by deep egg-laying cuts, 1 to 4 inches long, in the twigs. The cuts sometimes cause the twigs to break off. The injury is more severe in young trees than in those of bearing age. In the latter the weight of the peaches may break the twigs, causing the loss of fruit. Infestation is greatest near wooded areas, or where the land was wooded
13 or 17 years before, and for this reason is especially heavy in the hill section of southern Illinois.

Control.—Grower experience during the heavy attack of this insect in 1950 showed good control with TEP (tetraethylpyrophosphate) at the rate of one-fourth to one-third pint of 40 per cent material to 100 gallons of water applied when the cicadas were quiet, in early morning or at night. Sprays should be applied just as egg-laying starts and 7 to 10 days later. Parathion, BHC, lead arsenate, aldrin, dieldrin, and chlordane, as used in Illinois curculio tests, were of no value against the periodical cicada. DDT had proved to be of some value but not altogether satisfactory in previous seasons' tests. The old suggestion of covering small trees with cheesecloth is good but not always practical.

MITES

European Red Mite, _Paratetranychus pilosus_ (C. & F.)
Two-Spotted Spider Mite, _Tetranychus bimaculatus_ Harvey

Appearance and type of injury.—With increasing use of DDT on peach, table 3, mites have become a problem in Illinois peach orchards. Under a severe infestation, foliage of injured trees from a distance appears pallid or sickly, and considerable defoliation may take place. Individual green leaves are mottled with many tiny white dots, the result of removal of the chlorophyll by the feeding mites. The bronzing common on mite-injured apple leaves is usually only slight on peach leaves. Injury is greatest on the undersurface of the leaf if done by the two-spotted species but is about the same on both surfaces if done by the European red mite.

Control.—The need for special measures to control mites on peach is not definitely established but is being studied. It is possible that the normal number of spray or dust applications given to peach, most of which contain sulfur, may reduce the mite population to the point where no special treatments will be necessary. There is some evidence to show that the two-spotted spider mite may be more easily controlled by sulfur than is the European red mite. The red mite, because it winters as an egg on the tree, may be greatly reduced by a dormant spray of oil emulsion or miscible oil at the rate of 3 per cent actual oil in 100 gallons of water. Scales as well as the red mite may be controlled by this application. Several mite sprays for summer application are on the market. One of these commonly suggested for control
of mites on apples (Powell, Chandler, & Kelley 1950) was used successfully in a test on peach in 1949. This is a dinitro compound called DN 111. Good control was obtained with this material used at the rate of three-fourths pound per 100 gallons of water for the two-spotted spider mite and 11/4 pounds for the European red mite. Although DN 111 when applied at these dosages in hot weather has frequently produced some foliage burn on apple, our observations show that this material is much less likely to produce foliage burn on peach. With the increase in importance of mites, several other new materials have been developed for their control. Aramite has given excellent control on apple.

**Life history.**—The European red mite hibernates as a tiny red egg on the underside of a twig, usually on the rough, scarred bark that marks the end of a year’s twig growth. The egg of this mite hatches into a very tiny, reddish crawler, which later becomes a red or brownish adult. The mite passes through about 10 generations each year in southern Illinois. The average period required for the life cycle is about 18 days, but a wide variation in length of life cycle (some generations require a much longer period) adds to control difficulties.

The two-spotted spider mite winters as a reddish adult, usually under weeds and growth in or near the orchard and sometimes, more often on apple than on peach, under the rough bark of the tree. There is no easy way of reaching this species in the dormant period. The two-spotted spider mite goes through its life cycle in a shorter period and produces more broods than does the European red mite.

The two-spotted spider mite does not usually start feeding on the peach early in the season but feeds for considerable time on other vegetation in the orchard. Only the hibernating generation of this mite is red; the color of the other generations is yellowish or greenish. Eggs are whitish or greenish. The two-spotted spider mite is more likely to be found under a webbing than the other species.

At present, certain areas seem to be better suited to one species than to the other. In the Centralia area, the two-spotted spider mite is the more abundant species; however, 1949 figures indicate that the European red mite is invading this territory, table 2. In counties surrounding the Centralia area, notably in the Carbondale area, the European red mite is the more abundant. Both species of mites may exist in the same orchard, but not usually on the same tree.
CHANDLER: PEACH INSECTS AND THEIR CONTROL

RED-BANDED LEAF ROLLER
Argyrotaenia velutinana (Wlk.)

Appearance and type of injury.—The red-banded leaf roller, figs. 36–39, observed in southern Illinois only occasionally in 1948, appeared in 1949 to be an important pest on peach. The harvest survey of 1949 revealed an infestation responsible for damage that ranged in individual orchards from 0 to 16.6 per cent of the fruit. The average infestation was comparable to that of two of the other important insects attacking the fruit, the plum curculio and the oriental fruit moth. Injury by this leaf roller seems to be associated with the use of organic insecticides except parathion, and with an absence of lead arsenate, which, in combination with natural enemies, apparently controlled the insect until 1948.

Fig. 36.—Adult moth of the red-banded leaf roller. This insect gets its common name from the conspicuous, reddish-brown band extending across the forewings of the moth, which is about one-half inch long. Moths of the first brood emerge from pupae in early spring. This and the following three illustrations reproduced through courtesy of the New York State Agricultural Experiment Station, Geneva, N. Y.

Fig. 37.—Eggs of the red-banded leaf roller are laid in patches like this with about 40 eggs to a patch on the trunks and limbs of trees. The eggs, which are yellowish, hatch into green, threadlike larvae or caterpillars. Hatching of eggs of the first brood starts at the end of the blossom period. Probably three full broods of this insect and at least a partial fourth occur annually in southern Illinois.
This new peach pest, after causing considerable damage in 1949, was responsible for very little damage in 1950, table 1. The reason for the decrease is not clear. In 1950, parathion was used in several of the orchards surveyed and TDE (dichlorodiphenyldichloroethane) in two. Use of these insecticides might be assumed to account for the decrease of damage in the orchards treated, except that damage was low even in orchards where little or none of these materials was used. It is thought that some unknown natural factors were responsible for the decrease of damage in 1950.
The peach-harvest survey of 1949 indicated that leaf-roller infestations associated with BHC were not as high as those associated with chlordane, possibly because lead arsenate was used in conjunction with the BHC spray program. Most peach growers using the BHC program gave one or more lead arsenate applications to their orchards because fear of a musty flavor from BHC caused them to stop use of this insecticide early. Many growers using the chlordane program used no lead arsenate, but applied chlordane as late in the season as they thought needful.

As the name of this insect indicates, the larva rolls the leaf on which it feeds. While feeding, it protects itself by part of this leaf or by another, which it sometimes ties to the first leaf with a web. The injury the larva does to the leaf is minor compared with the damage it sometimes does to the fruit. The larva, fig. 38, ties a leaf to the fruit and, thus protected, feeds on the surface of the fruit. greatly disfiguring it. Toward harvest, the larva, protected by a small amount of webbing, feeds around the stem end of the peach. Late-brood larvae, after the fruit is harvested, feed on the leaves, especially along the midribs.

**Control.**—Growers using a lead arsenate schedule need no special control measures for the red-banded leaf roller. A still more effective insecticide than lead arsenate for the leaf roller is TDE, which should be used at the rate of 2 pounds of 50 percent wettable powder in 100 gallons of water. TDE seems to be quite specific for this insect: it is inferior to most other commonly used insecticides on peach and apple for the other pests that must be controlled. Part of its control of the red-banded leaf roller lies in its quality of irritating the larvae to the extent that many crawl out from their protective coverings, drop to the ground, and are unable to return to the trees, though still alive. Para-thion, hazardous to use, also will reduce the infestation of leaf rollers on peach.

**Life history.**—The red-banded leaf roller hibernates as a brownish pupa, about one-fourth inch long, in bits of dead leaf on the ground. In the spring (in southern Illinois in 1949 and 1950 about the time peaches were beginning to bloom), it emerges as a moth, about one-half inch long and rusty brown in color except for a V-shaped red band extending across the forewings. The female moth lays yellowish eggs in small oval masses, usually on one of the main inside branches of the tree. The eggs hatch into green, threadlike larvae or caterpillars, which grow to a
length of nearly three-fourths inch. They begin to hatch about the time the shucks are cracking. The larva spins up either on a leaf on the tree (the leaf may drop later), or it drops to the ground and there spins up on a leaf. Observations in 1949 and 1950 indicate that there are three full broods and at least a partial fourth in southern Illinois. The last brood of larvae, observed feeding on peach foliage well into October in southern Illinois, is responsible for the carry-over from one season to the next. The second and third broods do most of their feeding on the fruit of peach; the first and fourth broods feed principally on foliage.

Eggs of the red-banded leaf roller were very difficult to find on peach in the spring of 1950 in southern Illinois and southern Indiana, even in orchards heavily infested in 1949. Possibly the insect does not survive the winter on peach as well as on apple.

**Parathion**

In this publication parathion has been mentioned several times as an insecticide that might be used for the control of a number of insects. Because there is a possibility that this one material might replace several others in the peach spray and dust schedules, it is quite probable that its use in Illinois will increase unless fatalities among operators result. Table 5 shows a marked increase in the use of parathion in 1950. Because of the hazards involved in its use, the following statement was agreed upon after careful deliberation by the chief economic entomologists of 12 north-central states, including Illinois, at a meeting in Chicago in November, 1949, with the recommendation to the colleges of agriculture of the 12 states that it be included with every published recommendation or suggestion for the use of parathion.

"Parathion is a deadly poison and in view of the known hazards to those handling or applying it this material is not recommended. Although parathion is a highly effective insecticide for many purposes it should not be used where a safer material would give reasonably satisfactory control. Where situations demand it and when the operator is in a position to enforce precautions its use may be justified. The following information is provided for the guidance of those who will assume full responsibility for its use."
In the peach-spray schedule, parathion may be substituted for chlordane and applied at the rate of 2 pounds of 15 per cent wettable powder in 100 gallons of water, one application about a month after the shuck-split stage and another about a month before harvest. These applications would help materially in the control of plum curculio, oriental fruit moth, red-banded leaf roller, and San Jose and Forbes scales. As a dust at 1 per cent strength it could be used at the times indicated for spray applications. However, it is probable that weekly applications of dust, from shuck-split time to a month before harvest, would be necessary to equal the results obtainable from the wettable powder in spray form at 2 pounds of 15 per cent parathion to 100 gallons of water.

**Important Precautions in Using Parathion**

1. Use only 15 per cent wettable powder or 1 per cent dust.
2. Do not use with oil.
3. Do not spray from the inside of the tree.
4. Use mask to protect lips, nose, and mouth from accumulating residue. This precaution is especially important when emptying parathion sacks into the spray tank.
5. Stand out of the drift when putting the powder into the tank or emptying the sacks of dust into the hopper for dusting.
6. Do not wash the material through the screen into the tank. Sift it in quickly with the screen removed.
7. Do not breathe dust or powder.
8. Dust or spray with the wind and be careful when making turns at the ends of rows to avoid inhaling dust or spray. A type of duster or sprayer operated by one man with controls at the tractor is safer than the more common, manually operated, two-man outfit.
9. Wash hands thoroughly after each contact with the material, before touching the lips, eyes, etc., and before eating any food.
10. Do not smoke while spraying or dusting.
11. Change clothes and bathe at least daily after using parathion. Remove accidentally soaked clothes at once.

Atropine is the emergency antidote for parathion poisoning. It is obtainable only on a doctor's prescription. The doctors in your neighborhood should be informed regarding the symptoms of parathion poisoning and the treatment therefore, as shown below. Consult your doctor and arrange with him for a prescrip-
tion of atropine grains 1/120 (0.5 mg.) to be kept on hand for emergency use.

Never take atropine or any similar drug until after warning symptoms appear. The symptoms of parathion poisoning include headache, blurred vision, weakness, nausea, cramps, diarrhea, and discomfort in the chest. If you feel any of these symptoms while spraying with parathion, quit spraying, take two atropine tablets at once, and go to a doctor.

Persons not in a position to enforce the rigid observance of all precautionary measures should not use parathion.

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