A CHERRY PEST IN COLORADO

By GEORGE M. LIST
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FORT COLLINS, COLORADO

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Insect pests of a cultivated crop may come from two sources: (1) Another locality or country where this crop has been grown and pests are definitely established, or (2) the same section where native insect species occur that may find the introduced crop plant to their liking. We hear a great deal now, and rightly so, about the introduction of new pests. The prevention of this very thing has become one of the most important fields in economic entomology. This emphasis, however, causes us to overlook the possibility of danger in the immediate vicinity.

It may be expected that such polyphagous insects as grasshoppers, cutworms and wireworms will attack most plants of a similar nature to their native hosts, but there is always the possibility of a species with a restricted food habit taking to a cultivated host that is similar to its native host. Most any textbook on entomology will cite numerous examples of this, such as the transfer of the apple maggot, *Rhagoletis pomonella* Walsh, from the native haws, or *Crataegus*, to the apple, and the development of the plum curculio, *Conotrachelus nenuphar* Herbst, a native insect on the wild plums of America, to probably the most serious pest of the peach, an imported fruit. Probably an outstanding example of a pest of this nature for Colorado people is the Colorado potato beetle.

With the introduction of the potato into Colorado, the potato beetle immediately found the plant more to its liking than the sand bur, *Solanum rostratum*, its native host. Before this the insect was confined to the localities where the sand bur grew as a weed, but the potato suddenly provided almost unlimited possibilities for spread, and, as a result, the Colorado potato beetle is a pest in practically all potato-growing areas in North America, and has recently become established in some foreign countries. The insect still goes unnoticed on the sand bur, but the example serves to remind us that there are undoubtedly thousands of other unnoticed species that are potential enemies of man.

*The data upon which this study is based were collected on funds furnished jointly by the Colorado Experiment Station and the Office of State Entomologist.*
The rather recent introduction of the sour cherry as a commercial crop into Northern Colorado, where wild cherries grow abundantly in the foothill regions of the mountains, is paralleling the introduction of the cultivated *Solanum*, the potato, into the habitat of the wild *Solanum*, the sand bur.

Within the short period of the experience of the writer, at least two native insects have become major pests on the cultivated cherry. This paper is a treatise on one of these. The work is by no means complete, but the same can be said in regard to the work on many of our pests of much longer standing. Since the form involved seems to be new to science, it seems advisable to discuss the entire genus to clear up the relationship to closely related species.

**ACKNOWLEDGMENTS**

The writer is indebted to a number of workers for assistance during the time of these studies. Thanks are hereby extended to Dr. C. P. Gillette for his interest and suggestions; to Mr. Elwood H. Sheppard, Mr. Sam C. McCampbell and Mr. Carl A. Bjurman, who have at different times helped with the details of life history and control studies; to Dr. E. C. Van Dyke for his suggestions and help in connection with the systematic studies; to the many who have loaned or presented specimens for study; to Dr. A. B. Gahan for his determination of the parasites; to Mr. Henri McClelland and Mr. George Brittell in whose orchards most of the control work was done and especially to Miss M. A. Palmer for her painstaking care in making most of the drawings herein used.

**THE GENUS TACHYPTERELLUS**

This genus was described in 1891 by William G. Dietz (7) 2 under the name of *Tachypterus*. In 1907, Fall and Cockerell (8), upon finding that the generic name *Tachypterus* was preoccupied, proposed the name *Tachypterellus*.

**GENERIC CHARACTERS AND DESCRIPTION**

In following thru Dietz's synopsis and key of the genera of *Rhynchophora* (7), we find that the following characters take us to the genus:

- Claws toothed.
- Middle coxae subcontiguous.
- Posterior tibiae unguiculate.
- Pygidium covered; claws armed with a long tooth.
- Beak long and slender; eyes placed latero-superiorly, not approximate beneath.

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1 Order Coleoptera. Suborder Rhynchophora. Family Curculionidae.
2 Reference is made by number to literature cited.
April, 1932

A CHERRY PEST IN COLORADO

Following is the original description of the genus made by Dietz (7):

"Head moderately convex. Eyes rather small, round and moderately convex. Beak long and slender; scrobes deep, linear, directed toward, but not quite attaining the eyes; antennae inserted at a distance from the apex, slender; scape not attaining the eye; funicle 7 jointed, first joint long, 2-7 short. Clave elongate, acuminate at apex, rather loosely articulate. Prothorax wider than long, constricted at apex, sides rounded; base bisinuate. Elytra wider than the prothorax at base; each elytron protuberant at the base, fitting into the emargination at the base of the prothorax; strongly convex and declivous posteriorly, concealing the pygidium. Surf·ace tuberculate or uneven, striae punctured. Prosternum moderate in front of the coxae. Mesosternum rather narrow between the coxae. Metasternum short, about as long as the first ventral segment at middle. Abdomen broadly ovate, first and second segments moderately long, subequal, third and fourth shorter, fifth longer. Legs moderately stout. Thighs feebly clavate, anterior bidentate, middle and posterior unidentate. Tibiae somewhat compressed, anterior subangulate about the middle, bisinuate; articulating surface oblique, all unguiculate at the apex. Tarsi rather stout; first joint a little longer than the second; third joint deeply bilobed; fourth moderate; spongiopilose beneath. Claws cleft, teeth convergent."

Dietz made *Anthonomus quadrigibbus* Say the type species and added a new one to which he gave the name *T. consors*. These two species make up the genus.

The original descriptions of these two species are as follows:

"*Tachypterellus (Anthonomus) quadrigibbus* (Say)

"*A quadrigibbus* (27). Ferruginous; elytra with about four tubercles.

"Inhabits United States.


"Body full ferruginous; rostrum more than half the length of the body; thorax with three obsolete whitish lines; pleura bilineate, of which one is more distinct; elytra with double series of punctures, the interstitial lines alternately elevated, the two inner ones on each with two or three compressed elevations, of which the posterior one on the inner line is more prominent; posterior declivity paler; anterior thighs two-toothed, the posterior tooth prominent.

"Length (exclusive of the rostrum) less than three-twentieths of an inch."

"*Tachypterellus consors* Dietz (7)

"*T. consors*, n.sp. Ovate, rufotestaceous, thinly pubescent. Head convex, punctured with a fine frontal carina; frontal puncture deep. Eyes moderately convex, small. Beak long and slender, feebly curved, median elevated line not pronounced, substriate each side and densely punctured. Antennae slender, second joint scarcely longer than the third. Prothorax broadly rounded on the sides and feebly constricted at apex, base not strongly bisinuate. Surface very coarsely punctured with a
dorsal line of condensed, white pubescence. Elytra subquadrate, slightly wider behind and scarcely one-half longer than wide at the base; humeri rounded, a transverse impression behind the scutellum; striae feebly impressed, punctures moderate and rather closely placed; a small tubercle on the third interspace on the summit of the declivity; interstices equal, slightly convex, roughened; underside of thorax more densely pubescent. Long, 2.75 mm.; .11 inch.

"Hab.—Oregon. An unique female in Dr. Horn's collection represents this species."

The species *T. consors* was based upon one specimen in the collection of Dr. G. H. Horn, taken in Oregon. The species does not seem to have been recognized generally by other workers, as the writer has been unable to find a single reference to it since its description. All references to forms of the genus have been under the species *T. quadrigibbus* (Say).

**Material Studied**

Even tho *quadrigibbus* is supposed to be distributed over the entire United States and part of Canada, it is surprising how few specimens are in collections. Where any exist they are usually in such small numbers that few representative series are available. This is probably accounted for by the fact that they are rather common and are superficially recognizable in the field, hence few have been preserved. This lack of material has made it difficult to study the genus as critically as one would like, but enough material has been available to point out quite clearly that a much greater variation occurs than has been supposed, and these variations are constant in certain regions.

Material from the National Museum, Washington, D. C., and specimens from state and personal collections have given representatives from 22 states and 4 points in Canada. After a careful study of these, the writer is led to the conclusion that *T. consors* is a valid species that is represented from the Rocky Mountains to the Pacific coast, and that there is a related form that is worthy of the rank of subspecies; therefore this form is designated as *T. consors cerasi*, new subspecies. Thruout parts of the Great Plains area, centered about Iowa and Kansas, there exists a form that has been taken as *quadrigibbus* which is much larger than the eastern form, differing in several other external characters as well as certain genital ones, and which the writer designates as *T. quadrigibbus magna*, new subspecies. These are accordingly described herewith.

*Tachypterebus consors cerasi. New Subspecies*

This subspecies (Fig. 1, B and D) resembles *T. consors*, but differs from it by being brick red in color while *consors* is brown, and the hairs over the entire body are coarser, shorter and yellow to amber in color; on *consors* they are much finer.
longer and almost white. The elytra are more coarsely punctured, alternate interspaces more convex. In the specimens of consors that were kindly compared with the type by E. T. Cresson, Jr., the protuberance on interspace five is wanting and the one on interspace three at summit of declivity is only suggested, while in T. consors cerasi they are both readily distinguishable. Eyes much less convex than in T. consors. They are somewhat smaller than most specimens of T. quadrigibbus, more brick red in color, elytra interspaces less convex, and more regular, protuberances less prominent, the transverse depression of elytra and the declivity less prominent. Rostrum shorter and slightly more curved. Only one, the median, light line on prothorax.

![Figure 1](image_url)

Figure 1.—Tachypterellus consors cerasi, n.subsp.: A. eggs; B. dorsal view of adult; C. side view of head and rostrum of male; D. side view of female; E. mature larva; F. pupa of male; G. dorsal spine of abdominal segment.

Color brick red to rufus, form ovate. Head, thorax, abdomen and legs covered with medium-fine, gray-to-amber-colored hairs, the clothure being more dense on
the ventral surface of thorax and abdomen. Head small, convex, median elevated line of rostrum extending past the anterior edge of eyes, but not pronounced; thinly pubescent, the hairs being almost amber colored and slightly more dense and longer between the eyes. Eyes moderately convex, small, but less convex than in *T. consors*. Rostrum long and slender, length in the males about half that of the body, in females more than one-half (Fig. 1, C and D), moderately curved, the curvature being greater in anterior half, substrate, densely punctured, the median elevated line not prominent. Antennae slender, second joint slightly longer than third. Antennae inserted at about the middle of rostrum in the females, and at about one-third distance from apex in males, scrobes deep, linear, reaching almost to the eye.

Prothorax broadly rounded on the sides, base slightly bisinuate; surface coarsely punctured and clothed with medium-fine amber-colored hairs which are more dense and lighter in color on apex, forming a yellowish dorsal line. The two laterodorsal, whitish lines shown in the *quadrigibbus* forms are wanting. The pleuron has one distinct, yellowish, lateral line, the clothure in general being from yellowish to amber in color, more sparse and shorter than with *quadrigibbus*.

Elytra subquadrate only very slightly wider behind; greatest width less than one-half length; humeri rounded, a slight transverse impression behind the scutellum, the impression being much less pronounced than in *quadrigibbus*, and the declivity not so prominent; striae almost equal distance apart, uniformly punctured; alternate interspaces slightly more convex; third interspace with small protuberance of height, including the upright amber-colored hairs, than one-half the width of eye, and a basal length of about the width of an eye; fifth interspace with smaller protuberance posterior to the one on the third; sparsely clothed with short, medium fine, gray to brick-red or amber-colored hairs.

**Measurements of Holotype.**—Length, exclusive of rostrum, 3.85 mm.; rostrum, length, 2.17 mm., width, .22 mm.; antenna, length of scape 1 mm., funicle, .91 mm.; eye, width, .25 mm.; prothorax, length .97 mm., width at base, 1.2 mm., at apex, .71 mm.; elytra, length, 2.65 mm., greatest width, 1.48 mm.; front femur, length, 1.57 mm.

**Measurements of Paratypes.**—Length, exclusive of rostrum, females, maximum 3.91 mm., minimum 2.94 mm.; males, maximum 3.57 mm., minimum 2.29 mm. Length of rostrum, females, maximum 2.37 mm., minimum 1.62 mm.; males, maximum 1.77 mm., minimum 1.09 mm.

**Holotype.**—Female, collected in cherry orchard, July, 1927, Fort Collins, Colorado.

**Paratypes.**—Twenty males and 20 females, from same material as holotype. In addition there has been available a large series of material of other collections made in cherry orchards of Northeastern Colorado, and made on the wild cherry in the foothills of the same region. There are in the United States National Museum collection, besides several representatives from the Fort Collins section, the following: One specimen with label stating it was collected by H. F. Wickham, Colorado Springs, Colorado, June 15-30, 1896, altitude, 6000 to 7000 feet; and two taken by Wickham, same locality, July 20-26, 1896; three specimens labeled Colorado Springs, Colorado, Hubbard and Schwarz; six specimens taken, Chama, New Mexico, May 11, 1918, and two taken at Lake Binford, New Mexico, June 10, 1918, all by A. Wetmore.

*Tachypteretes quadrigibbus magna* (New Subspecies)

This form (Fig. 2, B) need not be confused with *T. consors cerasi*; and can be distinguished from *T. quadrigibbus* by the large size, longer and less-curved rostrum, the more convex intervals, larger protuberance, the more pronounced transverse im-
pression of elytra, and the larger number of setae on the eighth abdominal sternite.

Color, walnut brown to chocolate, posterior declivity and ventral surface somewhat lighter; form, ovate, convex. Head, thorax, abdomen and legs heavily clothed with coarse gray-to-amber and chocolate-colored hairs. This covering is more dense on ventral surface of thorax and on anterior declivity of elytra.

Figure 2. - _Tachypeterellus quadrigibbus magna_ n. subsp.; A. head and rostrum of male; B. female beetle; C. showing the arrangement of spines and hairs on the dorsal portion of the second abdominal segment of pupa; D. pupa of female; E. egg; F. pupa of male.

Head small, convex, moderately clothed, the frontal somewhat heavier, with coarse, short, gray to amber-colored hairs. Eyes moderately convex, width equaling that of rostrum.

Rostrum long and slender, feebly curved, the curvature being almost uniform throughout length, substrate, densely punctured, the median elevated line fairly prominent. Length in females almost equal to that of the body; in males, more than one-half that of body. (Fig. 2, A and B.) Antennae, slender, second joint noticeably
longer than third, scrobes deep, linear, almost reaching the eye. Antennae inserted at about equal distance from apex and eye in females and about one-third distance from apex in males.

Prothorax, conical, approximately one-half wider at base than long and base nearly twice as wide as apex. Base bisinuate. Surface coarsely punctured and clothed with yellowish-gray to amber-colored, rather coarse hairs, so arranged that three distinct yellowish lines are formed. The pleuron has two distinct lateral yellowish lines, the upper one being broader and more prominent and is continued upon the sides of the meso and metathorax.

Elytra subquadrate, greatest width equal to or greater than one-half the length, humeri rounded but prominent, a pronounced transverse impression behind the scutellum, declivity prominent, striae unevenly placed, more deeply impressed and more coarsely punctured than in other forms of the genus; protuberant at base with a very large one on third interval. Alternate intervals wider and much more convex than in other forms; the third being somewhat irregular and with a very prominent protuberance, of a greater height, including the dense, coarse, dark-brown hairs, than the width of an eye; fifth interval with a protuberance about one-half the height of the one on the third interval, situated on the posterior declivity about midway between the summit and the apex, anterior to which the convexity is irregular, sometimes giving the interval the appearance of having two or more smaller protuberances. Seventh and ninth intervals regularly convex. The clothure on the anterior declivity gives it a gray appearance, while the summit is brown or chocolate and the posterior declivity is lighter, with a yellowish tinge.

**Measurements of Holotype.**—Length, exclusive of rostrum, 5.34 mm.; greatest width, 2.85 mm.; rostrum, length, 4.28 mm., width, .34 mm.; antenna, length of scape, 1.52 mm., funicle, 1.28 mm.; eye, width, .37 mm.; prothorax, length, 1.48 mm., width at base, 1.91 mm., at apex, 1.08 mm.; elytra, length, 3.85 mm., greatest width, 2.05 mm.; front femur, length, 2.57 mm.

**Measurements of Paratypes.**—Length, exclusive of rostrum; females maximum, 5.71 mm., minimum, 2.65 mm.; males, maximum, 5 mm., minimum, 2 mm. Length of rostrum; females, maximum, 4.71 mm., minimum, 2.65 mm.; males, maximum, 2.57 mm., minimum, 2 mm.

The male genitalia (Fig. 4, H) show no characters peculiar to the type for this genus, but the eighth sternite of the female is clothed with from 30 to 90 long setae, while in consors and consors cerasi from 28 to 36 occur and in *T. quadrigibbus* (Massachusetts specimens) 44 were found. (Fig. 4, D and E.)

**Holotype.**—Female, mounted by the writer at Ames, Iowa, May 31, 1925, from breeding-cage material collected in the apple orchard of B. M. Clark, Mitchellville, Iowa, by B. B. Fulton.

**Allootype.**—Collected in same orchard by B. B. Fulton, date not given.

**Paratypes.**—One female, 3 males from same collection as holotype; 10 females, 9 males, from same collection as allootypes; 2 females, 1 male, United States National Museum collection, collected by Wickham, Iowa City, Iowa; 4 females and 2 males, Troy, Kansas, collected by Howard Baker.

The holotype and allootype and four paratypes, 2 males and 2 females, of same collection as allotype, are in the United States National Museum; other paratypes in the Colorado Agricultural College collection.
A NEW DESCRIPTION OF Tachypterellus quadrigibbus (Say)

Since the original description of *T. quadrigibbus*, published by Thomas Say in 1831, is not very complete and the types are lost, it seems advisable to describe this form more in detail and establish a neotype. It has not been possible to get specimens from New Harmony, Indiana, where Mr. Say lived when the form was described, and none was available from the state, but since it is likely that he was familiar with the insect in his home state of Pennsylvania, where he was very active in the Philadelphia Academy of Natural Sciences between the years of 1812 to 1825, and may possibly have been describing material taken there, it seems appropriate to select a Pennsylvania specimen as the neotype. This description is therefore made largely from a female in the United States National Museum collection taken in Pennsylvania by Wickham, date and place not given. Material from New York and also an excellent and very uniform series from Massachusetts are being used.

**Tachypterellus quadrigibbus** (Say)

The size in many specimens of *quadrigibbus* (Fig. 3, B) does not differ greatly from that of *consors* and *consors cercasi*, but *quadrigibbus* can be distinguished from them by the more prominent lateral depression, the more convex intervals and the more prominent protuberances of the elytra, and the less convex eye than in *T. consors*. It is distinguished from *quadrigibbus magna* by being smaller, slightly different colored, by having a less pronounced declivity on elytra and smaller protuberances. The eighth abdominal sternite has fewer setae.

Color, dark brown or chocolate, more like that of *consors* than any other form; ventral surface, legs and rostrum somewhat lighter. Form, ovate, convex. Head, thorax, elytra and abdomen more sparsely clothed and with finer hairs than in *quadrigibbus magna*. Head, small, conical, moderately pubescent with yellowish to amber-colored hairs. Eyes, convex, width equalling that of rostrum.

![Figure 3.](image)

Figure 3.—A, head and rostrum of male *Tachypterellus quadrigibbus* (Say); B, neotype (female) *Tachypterellus quadrigibbus* (Say); C, female *Tachypterellus consors* Dietz.

Rostrum, long and slender, feebly curved, the curvature being almost uniform throughout length in female; in males somewhat thicker, with greatest curvature in apical half; substriate, densely punctured, the median elevated line, moderately prominent; length, in females, about two-thirds that of body; males, one-half. Antennae, long and slender, inserted at about the middle of rostrum of females and at one-third the distance from apex in males, scape and funicle about equal length, scrobes deep, linear, almost reaching the eye. Prothorax, conical, base slightly
bisinuate, almost twice as wide at base as apex, width at base approximately one-third greater than length. Surface coarsely punctured and sparsely clothed with light-amber to gray hairs, so arranged as to show a distinct median, dorsal, light line and two much fainter lines laterad of this. These lines are all much narrower than in *quadrigibbus magna*. The pleuron is marked with two yellowish lines as in *quadrigibbus magna*, but they are less prominent.

Elytra subquadrate, the greatest width equal to or greater than one-half the length, transversely impressed behind the scutellum, declivity less prominent than in *quadrigibbus magna*, protuberant at the base, with a more prominent one here on the third interval. Striae not as deeply impressed nor as coarsely punctured as in *quadrigibbus magna* and interspaces more uniform through length, and less convex. The alternate intervals are more convex than in *T. consors* and *T. consors cerasi*, the third interspace being somewhat irregular, with a protuberance just posterior to the summit of the declivity, of a height less than the width of an eye; fifth interval somewhat irregularly convex, with a protuberance of about one-half the size of the one on the third interval, situated on the posterior declivity midway between the summit and apex. Seventh and ninth intervals regularly convex through length. Pubescence more dense and gray in color on anterior declivity, especially over the transverse impression, a dark amber over the summit of declivity and protuberances, and a brick red on the posterior declivity.

**Measurements of Holoneotype.**—Length, exclusive of rostrum, 3.28 mm. (length given by Say in his original description was "less than three-twentieths of an inch" or 3.8 mm.); greatest width, 1.68 mm.; rostrum, length, 2.14 mm., width, .22 mm.; antennae, length of scape, .85 mm., funicle, .85 mm.; eye, width, .25 mm.; prothorax, length, .85 mm., greatest width, 1.42 mm.

**Measurements of Paraneotypes.**—Length, exclusive of rostrum; females, maximum, 3.71 mm., minimum, 3.42 mm.; males, maximum, 3.57 mm., minimum, 2.92 mm. Length of rostrum; females, maximum, 2.42 mm., minimum, 2 mm.; males, maximum, 1.85 mm., minimum, 1.28 mm.

The genitalia show no very noticeable differences from those of the other forms of the genus, only that the eighth sternite in the female (Massachusetts specimens from same collection as paraneotypes) had 44 setae in contrast to 80 or 90 in *quadrigibbus magna* and 28 to 36 in *consors* and *consors cerasi*.

**Holoneotype.**—Female from National Museum collection, taken by Wickham in Pennsylvania; date of collection, host, and exact location not given.

**Paraneotypes.**—One male, same data as holoneotype; 1 female, Buffalo, New York, C. V. Riley collection; 1 female, New York; 1 female, Buffalo, New York, collected by Hubbard and Schwarz; 1 male, R. A. Cushman, Geneva, New York, on *Craetagus*, May 18, 1915; 29 males, 4 females, Watertown, Massachusetts, C. C. Sperry, May 18, 1920; 1 male, 1 female, Retreat, North Carolina, Hubbard and Schwarz, all from the National Museum collection.

The holoneotype and all the paraneotypes are in the National Museum, Washington, D. C., except 2 females and 4 males, taken at Watertown, Massachusetts, by C. C. Sperry, which are in the Colorado Agricultural College collection.

**Key to Species**

The following table will assist in separating the species:

| 1. | Elytra with marked lateral impression posterior to scutellum; alternate intervals convex. third and fifth of irregular convexity anterior to prominent protuberances | 2 |
Elytra without marked lateral impression posterior to scutellum; intervals regular and only slightly convex, protuberances on third and fifth intervals small or wanting

2.—Alternate intervals very convex and irregular; third interval with protuberance on summit of declivity of a height equal to or greater than width of eye; a protuberance of about one-half the size posterior to this one on fifth interspace. \( T. \text{quadrigibbus magna, new subsp.} \)

Alternate intervals moderately convex, protuberance on third interval with height less than width of eye. \( T. \text{quadrigibbus Say.} \)

3.—Intervals uniform, striae not deep; protuberances on third and fifth intervals only suggested or very small; color, chocolate; hairs, gray or white; eyes, quite convex. \( T. \text{consors Dietz} \)

Alternate intervals, especially third and fifth, slightly convex. Third and fifth each with small protuberance; color, brick red. \( T. \text{consors cerasi, n. subsp.} \)

**STUDY OF GENITALIA**

Since genitalia show many characters that are valuable in classification and in showing the relationship of groups, a study was undertaken of both the male and female genitalia of the genus *Tachypoterellus*. The work was handicapped somewhat by a lack of material from some sections, but an abundance of Colorado material and good series from Kansas and Iowa were available. A limited number of both male and female genitalia from Massachusetts, Illinois and Texas specimens were examined.

In this work the usual method of softening the insect with a solution of caustic potash and dissection with needle points was used. The organs were then cleared in caustic potash and studied in alcohol after being mounted in gum arabic or balsam. The terminology used for the parts of the male genitalia is that of Sharp and Muir (28).

The male genitalia of all the forms are quite similar. The parts forming the genitalia of \( T. \text{quadrigibbus magna} \) are larger than those of the smaller forms and less chitinized. The median struts of \( T. \text{quadrigibbus magna} \) are not as long in proportion to the median lobe as in \( T. \text{consors cerasi} \), but these points probably have little significance. Side and ventral view camera—lucida drawing of the male genitalia from \( T. \text{consors cerasi} \) are shown in Figure 4, H and I. The following is a brief description of the male genitalia:

The median lobe forms a semi-chitinous, flattened and curved tube, supported along each side by a chitin strip; width almost uniform thru proximal two-thirds, then narrowing to a \( V \)-shaped point at apex, the median orifice being at the apex on the ventral surface; from the basal ends of the two lateral chitin strips extend two median struts which in \( T. \text{consors cerasi} \) are longer than one-half the length of the median lobe, and in \( T. \text{quadrigibbus} \), about one-half this length. The tegmen is formed of a strong chitinized ring-piece with a strong tegminal strut on the ventral surface. A long connecting membrane (C m 1) connects the tegmen to the median lobe, and a somewhat
Figure 4.—Genitalia of *Tachypereites* species. Explanation of figures. Female genitalia: P, proctiger; au, anus; 8th-t, eighth tergite; 8th-s, eighth sternite; c, coxite; s, stylus; v, vulva; 9th-sg, ninth segment. Male genitalia: ml, median lobe; mo, median orifice; ms, median strut; mf, median foramen; tg, tegmen; cm 1, first connecting membrane; cm 2, second connecting membrane; ej, ejaculatory duct; ts, tegminal strut; sp, spiculum; bw, body wall. A, ventral view of female *T. consors cerasi*, n.subsp.; B, side view of same; C, ventral view, female *T. quadrigibbus magna*, n.subsp.; D, eighth sternite female *T. consors cerasi*; E, eighth sternite female *T. quadrigibbus magna*; F, side view female *T. consors Dietz*; G, ventral view female *T. consors Dietz*; H, ventral view, male *T. consors cerasi*; I, side view of same. All drawings by camera lucida, H and I by Miss M. A. Palmer, the others by the author.
shorter connecting membrane (C m 2) connects the tegmen to the body wall (bw). The basal part of the second connecting membrane (C m 2) forms a ring about the aedeagus; the ventral portion of this ring having a U-shaped, slightly chitinized area from the base of which is a long, stout strut, the spicule (sp). The strut and the chitinized U-shaped area are considered by some as the last sternite. The ejaculatory duct is enlarged within the median lobe to form the internal sac.

The terminology used for the parts of the female genitalia is that of V. M. Tanner (30) who has made the most comprehensive study of the genitalia of female Coleoptera. A survey of the literature shows a wide disagreement as to the origin and structure of the parts, so here again Tanner is followed.

Camera-lucida drawings of the female genitalia of *T. consors*, *T. consors cerasi* and *T. quadrigibbus magna* are shown. *T. quadrigibbus* genitalia are not shown in drawings but several were examined. (Figure 4, A, B, C, D, E, F and G.)

These drawings were made with the parts distended and more completely protruding from the body than they would be during oviposition.

In this genus the seventh is the last visible segment, the eighth, ninth and tenth in much modified forms, go to make up the genitalia. The eighth segment consists of a distinct tergite and sternite. This eighth tergite has the typical semicircular shape but is much smaller than the seventh. The eighth sternite consists of a more or less semicircular sclerite with the connecting membranes attached to all edges, and from the base a long, strong apodeme protrudes. The caudal portion of the sternite is setiferous.

The ninth segment consists of a long, unchitinized tube, bearing two pairs of structures on the distal end. In regard to these structures, Tanner (30) says:

"My studies of these structures in species of sixty-six families lead me to the conclusion that these genital appendages are the coxites and styli of the ninth segment, and that the valvifers are a chitinized portion of the adjacent end of the ninth sternite which bears the coxites and styli."

In this genus the valvifers are wanting, leaving only the coxites and styli. The coxites consist of a more or less chitinized area on each side of the distal end of the segment. These have something of the shape of a handleless, pointed spoon with the point directed caudad. On the point of each is a round-pointed stylus bearing from 6 to 10 setae. The vulva is located in the corea between the coxites.
All that remains of the tenth segment is the membranous organ known as the proctiger. This is considered to come from the tenth tergite and bears the anus.

The eleventh segment in this genus is lost.

It will be noticed from the drawings that the female genitalia from the different forms are quite similar. The only character that might have specific value is the eighth sternite. This sclerite in more than 30 specimens of *T. consors cerasi*, taken at Fort Collins, Colorado, carried from 28 to 36 prominent setae, with 28 being the predominating number. One specimen of *T. consors* taken at Hotchkiss, Colorado, in the same collection as a specimen declared con-specific with Dietz's type by E. T. Cresson, Jr., showed 26 setae.

In a good series of *T. quadrigibbus magna* from Troy, Kansas and Mitchellville, Iowa, the number ranged from 80 to 88. The smallest specimen in these two series with a body length of 2.65 mm., which is well within the size of the other forms, showed 82 setae. Eighty setae were present on this sclerite in one specimen examined from a series taken at Victoria, Texas. In other respects this series agrees with *T. quadrigibbus magna* taken in Iowa and Kansas. Only a very limited number of specimens from the Eastern States were available for examination. Two specimens from Massachusetts showed 32 and 34, respectively; one from Quebec, 44; a small one from Hayworth, Illinois, 44; and a large one from Barry, Illinois, 64.

These data indicate that the number of setae upon the eighth sternite of *T. quadrigibbus magna* is quite uniform and higher than found in the other forms, and that the number in *T. consors cerasi* is also quite uniform. The specimens examined of *T. quadrigibbus* do not represent enough individuals to be of great value. The finding of a varying number in the Illinois material, however, lends support to the impression obtained from examining the material for other characters, namely, that there are areas where *T. quadrigibbus* and *T. quadrigibbus magna* come together and hybridize. This condition is often brought to our attention with closely related forms and seems worthy of further consideration here.

**SUBSPECIES AND HYBRIDIZATION**

The genitalia studies emphasize the fact that all forms of *Tachypeterellus* are closely related. While each is distinct in certain localities, the differences do not seem clear enough from a taxonomic viewpoint to justify giving the new forms the rank of species. This condition occurs in many groups of both plants and animals. There seems to be little doubt but that it will be found to occur even more generally than is suspected as we become more familiar with the mor-
phology and biology of animal and plant forms. This has brought about the use of the natural subdivision known as subspecies, or variety and race. Two good examples among the Rhynchophora are: 1. The cotton-boll weevil, *Anthonomus grandis* Boh., Schon., and its well-recognized subspecies or variety, *A. grandis thurberiace* Pierce. (26) The cotton-boll weevil has been a national problem for years and the subspecies has recently become the subject of intensive study and federal quarantine regulations. 2. The rose snout beetle, *Rhynchites bicolor* Fabricius, and its six subspecies (25), *cockerelli* Pierce, *ventralis* Pierce, *bicolor* Fabricius, *wickhami* Cockerell, *piceus* Pierce and *viridilustrans* Pierce. These are quite distinct in their several habitats, and, if their close relationship was not known, any one of them might have been described as a full species. Dr. Joseph Grinnell (12) writes:

"I am intensely interested in the barely discernible subspecies, because it is in the critical, formative stage, and there is a good chance that I may learn something of the causes and essential conditions of its differentiation.

"To my mind, then, in the study of subspecies as contrasted with the so-called full species we are dealing with the earliest stages in the phylogenetic process. In other words; subspecies are the fundamental elements which, in any really significant systematic and faunistic investigation, must receive primary recognition. The more accurately and acutely we can train our senses and instruments upon the detection of subspecies, the better understanding will we gain of their nature and the processes producing them."

It can be expected that such closely related forms as subspecies will hybridize when their ranges meet. This brings about a variation that presents a puzzling problem unless good series of the constant forms as well as the variants are available. By some workers the ability to hybridize has been taken as an indication of subspecies rank.

Dr. T. D. A. Cockerell (4), in discussing the Rocky Mountain bees, says:

"The problem of subspecies or races among bees is becoming very interesting. Its proper elucidation requires good series from many diverse localities. By the term subspecies I understand a group of individuals inhabiting a particular region, having in common, or at least normally, certain structural characters . . . . . . . . It is commonly said that subspecies are recognized by the fact of intergrading with the species. My conception is that they arise under conditions of isolation, for various reasons, and when it happens that they spread so that the ranges of two races meet, hybrids are formed."

Dr. A. C. Kinsey (14) has made a very comprehensive study of the intergrading of species and subspecies in his study of the gall wasp
genus *Cynips*. In this work he was not only able to study more than 17,000 specimens collected in many localities, but also had available 54,000 galls produced by the wasps, which served as a direct measure of one of the physiologic capacities of the insects. Of the 93 species and subspecies, each was constantly distinct in certain localities, but in many instances there were transition areas between species wherein hybrid individuals were of common occurrence. These hybrid populations were so common and extensive in the sections with the more uniform conditions, such as the Eastern United States, that the impression prevailed that there was one very complex and variable form occurring over the entire section. But this intensive study of large numbers showed that there is not a continuous gradation from one extreme to the other, but rather that there are definite areas of pure populations with hybrid individuals occurring in between.

The writer is of the opinion that the failure to study carefully large series of material from many localities has led to the general and erroneous assumption that the genus *Tachypterellus* is comprised of only one species which is very variable. There is not a gradual gradation from one extreme to the other. But rather there is in the Eastern States a uniform and constant population represented by material from Pennsylvania, New York, Massachusetts and Maryland, especially, which is widely different from an equally uniform and constant population represented by large series from Iowa and Kansas. On the theory that intergradation would occur if these two populations came together, a variable population could be expected thru a part of the intervening region. The limited amount of material available leads one to believe that this is the case. This material is not sufficient to outline this area of intergradation, but the population of Illinois and Missouri seems to be of this nature, with *T. quadrigibbus magna* predominating. Such an area may extend further east and north. It is also likely that it extends southward. The population from Louisiana seems to be typical *T. quadrigibbus*, while that from Victoria, Texas, is *T. quadrigibbus magna*. It would not be surprising to find intergradation at points between these regions.

The few specimens handled from Canada indicate that the population in the eastern part at least is composed of *T. quadrigibbus*.

The lack of host plants on the semi-arid region between the foothills of the Rocky Mountains and Kansas and Iowa probably has prevented the coming together of *T. consors cerasi* and *T. quadrigibbus magna*. Western material available is not representative enough to warrant any conclusions as to hybridization of the two western forms. In a group of insects as variable as is the genus *Tachypterel-
lus and ranging over the entire United States and Canada, and probably extending into Mexico, it would not be surprising to find other populations that can be considered distinct.

REVIEW OF THE MORE IMPORTANT RELATED ECONOMIC LITERATURE

As stated before, all references in literature are to *T. quadrigibbus* Say. There is no doubt but some of the workers, who presented the most valuable data, were dealing with *T. quadrigibbus magna*, n.subsp. It is possible that some of the conflicting statements may be accounted for by this fact, altho it is not likely that there is a great deal of difference in the habits and life cycles. Riley (18) gives the first report of consequence. He describes and figures the adult, larva and pupa, and goes into some detail to tell how they could be distinguished from the same stages of the plum curculio, which was also common. In Missouri he found it abundant on haws and wild crabs, but it was becoming more common in apple orchards. Others had reported it to him as attacking pears and quinces. Riley stated that the insect winters as an adult and appears later than plum curculio.

"They have generally got fully to work, and larvae may be found already hatched by the first of June, and they may be found in the fruit, in one stage or another, all along through the months of June and July and the greater part of August."

Riley stresses considerably his observation that:

"The fruit of the wild crab containing the larva never falls, and the fruit of our cultivated apples seldom."

He suggests:

"... that although we cannot jar down the beetles, we can jar down much of the infested fruit, which would, without jarring, remain on the tree."

It is interesting to note how this statement, which has been proved to be from faulty observations, has been repeated in most of our accounts of the insect and can be found in some of our latest textbooks. Slingerland and Crosby (29) seem to be the first ones to leave the impression that the infested fruits fall.

In 1926 Petch (21) says:

"The apples usually drop early if the larvae live, but apples have been found on the trees containing adults ready to emerge."

Fulton (10), writing from New York in 1920, says:

"The development of the young grub within the fruit does not always cause it to fall but it becomes stunted and shriveled and after the insect leaves it dries up."
Fulton (9), after considerable work in Iowa, says, 8 years later: "Normally the apple must drop if the life history of the insect is to be completed. The entire larval and pupal stages are spent within the dropped apple, which may become dried and mummified before the beetle emerges. Young living larvae were found in some apples picked off the trees in 1926, but none were found in apples picked in 1925. No large larvae have ever been found in growing apples. Evidently the insect is not completely adapted to the cultivated apple and is dependent on the June drop for survival."

This is an important point from the standpoint of control as demonstrated by Fulton. Hogs in the orchard during the early part of the season, to pick up the wormy fruits, gave almost perfect control. It might be said that Fulton was working with *T. quadrigibbibus* in New York and *T. quadrigibbibus magna* in Iowa, but there is no evidence available to show that they act differently in this respect.

Gillette (11) first described the egg laying and illustrated the egg and the egg punctures made in fruits. In his breeding cages, beetles began to appear July 22, and on August 16, 14 infested apples contained 13 larvae and 2 pupae. The conclusion is drawn that the beetles are probably not all out of the fruit until late in August. Crandall (5) gave the first detailed life history. The following are some of the important results:

The hibernating beetles in the orchard could not be found in the spring. In 1903 the first beetle was taken on the trees, April 27; they were abundant by May 10. On May 13 egg laying had begun. In 1904 the first beetle was taken on May 2. The average time taken by 10 females in the process of making an egg puncture and depositing an egg was 1 hour and 28 minutes. The egg punctures were all sealed with excrement. Twenty females under observation deposited the first egg May 25 and the last one July 22. The last over-wintering beetle died August 14. The average number of eggs was 65.8 and maximum, 122. The maximum for one female in a day was 6. The development period of the larvae varied from 19 to 21 days. Those hatching in small apples ate in and about the core while those in larger fruits remained in the pulp. The time from egg to adult varied from 27 to 48 days. Beetles fed freely for 10 days after emergence.

Fulton (9) added considerably to the knowledge on life history and habits. Most of the eggs are deposited in apples before the June drop is complete but some laying continues until the apples are nearly half grown. The larvae seldom, if ever, mature in growing fruits. The rapid filling in of the egg puncture by new tissue destroys the egg or larva. The first beetle to reach maturity appeared July 3. In apples taken from the ground August 9, 54 percent of the in-
sects found were in the larva stage, 31 in the pupa, and 15 in the adult. The last eggs were found in the laboratory July 7. Hibernating adults were found under matted grass in outdoor breeding cages.

Brooks (2) apparently has based many of his statements in regard to life history and habits largely on the statements in literature. More than half of 25 specimens reared by him from crab apples did not leave the fruit until after August 10. The hosts are haws, wild crabs, and occasionally the cultivated apple.

Petch (21) states that:

"The insect has been found in all apple growing sections of the Province of Quebec and annually destroys a considerable portion of the crop. From recent observations, this insect has increased enormously and it is now one of our most destructive apple insects . . . . . . it has been recorded in Quebec as attacking pear, plums, wild crab, cherry, and hawthorn."

Watson (32) took one specimen on cotton in Florida.

The first controls mentioned were only suggestions. Riley (18) suggested the shaking and collection of the wormy fruits. Gillette (11) stated that arsenical sprays, as used for the codling moth, would probably control the curculio. This could be supplemented with jarring off and collecting the beetles and the destruction of the fallen fruit by collecting, or by allowing hogs and sheep to run in the orchard. Brooks (2) advocated the destruction of the native hosts. Fulton (10) advocated the raking of the dropped fruit into the sun where the heat would kill the developing insect. Crandall (5) failed to get good control with arsenicals. Petch (21) reports good results with spraying or dusting with arsenicals. The addition of sulphur or lime-sulphur increases the effectiveness as the sulphur seems to act as a deterrent. Fulton (9) has demonstrated the effectiveness of hogs in the orchard in controlling the pest.

Brooks (2) reared one specimen of the parasite Pristomeridia agilis (Cress.) from crab apples infested with curculio. Fulton (9) found 7.2 percent of 235 curculio in various stages, parasitized by a chalcid fly of the genus Eurytoma, probably undescribed. Crandall (5) observed one female eating her own egg. Pierce (24) reared Catolaccus hunteri Crawford and Crambycobius cyaniceps Ashmead from this curculio at Victoria, Texas.

DISCUSSION OF THE SPECIES

_Tachypterellus quadrigibbus_ (Say)

The description of this species and the review of literature gives us the essential facts. The distribution seems to be over the eastern part of Canada and throughout the Eastern States and as far south as Florida. The western limit of its range cannot now be established,
but in the South it seems to extend as far west as Louisiana and further north it probably extends westward into Indiana, Illinois and Missouri, where it intergrades with *T. q. magna*. A report in the Insect Pest Survey, United States Bureau of Entomology (31), of injury to pears in British Columbia, led the writer to ask the entomologists there for more details. Under date of September 28, 1929, Mr. E. R. Buckell, Entomological Laboratory, Vernon, British Columbia, wrote as follows:

"In regard to the apple curculio, *Tachypterillus quadrigibbus* at Salmon Arm, British Columbia, I am afraid I have very little information to give you.

"The insect had never been recorded to my knowledge, as attacking cultivated fruit in British Columbia until this spring. I find that it has been beaten from hawthorn by Coleopterists. On the 23rd of June my father asked me to come and look at our pear trees as something was feeding in the young pears and causing them to drop. I found about 80 percent of the pears, which were about the size of the top of my thumb, at that time, to be attacked. By this date most of the small pears had dropped to the ground, and showed evidences of internal feeding by some larva.

"I soon found some on the trees containing weevil larvae. I also found the adults upon the pears still ovipositing. I was able to find only four adults at this time and saw none later, so I suppose there was only the one brood. The pears that did not drop off were very misshapen when ripe. I afterwards found that several people at Salmon Arm had lost their pears for the past three years in this way. At present I have no evidence to show that any apples were attacked, although the pear trees were in the apple orchards in every case."

Mr. Buckell wrote on November 12, 1930, that there had been no injury during 1930. He was good enough to send two specimens taken in 1929 which seem to be *T. quadrigibbus* (Say). The writer had expected them to be similar to the West Coast form from farther south. It is very likely that the two forms will be found to be overlapping or intergrading. There seems to be no other reports of *T. quadrigibbus* west of the Rocky Mountain range.

The species is reported from the hawthorn, wild crabs, cultivated apple, pear, plum, cherry, shadbush and cotton, the latter probably not being a host.

*Tachypterillus quadrigibbus magna*, N. subsp.

This form has been more definitely dealt with in the economic literature reviewed than *T. quadrigibbus*. Its range includes Iowa, Kansas, Eastern Nebraska, Illinois, Missouri and Texas. In part of this area, and undoubtedly in some more, it intergrades with *T. quadrigibbus*. There is one specimen in the National Museum col-
lection from "Chiric" Mountains, Arizona, that seems to be identical with the Texas series.

It is over this range that the greatest damage to cultivated apples has occurred. Heavy damage has at different times been reported from Iowa, Kansas, Eastern Nebraska, Illinois and Missouri. The only injury reported from the East that might parallel it is that in Quebec. It is reported from wild crabs, the hawthorn, cultivated apple, pear and there is one specimen in the United States National Museum collection labeled from the plum.

**LIFE HISTORY NOTES ON T. q. magna, N. SUBSP.**

The life history of *T. q. magna* has been quite well worked out by Crandall, Fulton and Gillette, and their work has been summarized in this paper, but a few notes taken by the writer during 1929, under Colorado conditions, might be of interest here in comparison with data given for *T. c. cerasi*, n. subsp.

Mr. William Clark sent 5 specimens from Mitchellville, Iowa. These were received June 24, 1929. Four of them died the following day. As they had been enclosed in a box with a small apple and some apple leaves that showed considerable arsenate of lead spray, it was presumed that they died from poisoning. The fifth specimen, a female, was carried in a cage and given apples daily until July 25, when she died. During this time 32 eggs were deposited, and from these 8 adults were reared. These emerged between the dates of August 13 and 31. The average development period from egg to adult was 39.2 days. These new generation adults fed freely upon apples and were active and feeding until September 26, when they were killed and mounted. Fresh food punctures had been made on this date.

In contrast with this, the last cherry curculio eggs were deposited in the laboratory June 23 or 2 days before this beetle deposited her first egg; altho undoubtedly she had deposited some before being caged. She laid her last egg July 21. This same season 66 percent of the cherry curculio had emerged from the fruit July 19, 73 percent July 24, and 100 percent August 7, while the progeny of the *T. q. magna* female all emerged between August 13 and 31, or almost 1 month later. All of the cherry curculio were in hibernation by August 1, while these fed heavily during the fore part of September, with some feeding taking place up until September 26.

**Tachypterellus consors DIETZ**

The locality for Dietz's type specimen is Oregon, host not given. The writer has examined only three other specimens that he feels certain represent the species. Two of these which were compared with
the type by E. T. Cresson, Jr., and pronounced conspecific with it were taken at Hotchkiss, Colorado, which is in the western part of the state, by G. P. Harris, July 12, 1927. Mr. Harris was at that time a student in entomology, doing some summer work in Delta County. Unfortunately we have no data as to the host. Hawthorn, wild cherry, cultivated apple, pears, cultivated cherries, plums and other stone fruits grow in the section. Several attempts have been made to collect more specimens, but without success.

The third specimen was sent by Mr. Claude Wakeland, University of Idaho, Moscow, Idaho, with these statements, under date of November 20, 1920:

"Following are the data which we noted on the accession card: 'June 30, 1922. Small dark-colored punctures noticed on apples, 3/4 inch in diameter on Sunnydell Orchard Company ranch. (Rexburg, Idaho; altitude, 4864 feet). Waxy exudate coming out of some of the punctures; examination showed small punctures near surface nearly or quite closed by corky growth. Within apple puncturing enlarges to cavity, in some cases 1/16 inch in diameter, in the bottom of which is fastened a small creamy-white glistening, oval egg, or in which is a small yellow-white shapeless larva; measurement of two eggs under microscope showed one to be .407 mm. and the other .601 mm. long. July 17, 1922—Collected one adult weevil by Whelan (Don B.) resting on apple.' In the Sunnydell Orchard we frequently found punctured apples but during several trips to the orchard succeeded in finding only one adult weevil. We were suspicious the infestation was coming over from some of the native shrubs such as haw, but never succeeded in collecting curculionids from any of them. We have not been back to the community since but the curculio problem apparently has not been a serious one, since we have had no reports from there."

**Tachypterellus consors cerasi, n.subsp.**

The definitely known range of this form is the foothill region in Colorado, east of the Rocky Mountain Range, and New Mexico. Dr. E. C. Van Dyke has sent one specimen from Modoc County, California, that he is calling *T. consors*, and there are two similar specimens in the United States National Museum collection from Siskiyou County, California, all of which are much more like *T. consors cerasi* than *T. consors*. Until a larger series of this far-western material is available it would seem best to give the range as that mentioned above.

The remainder of this paper gives the results of studies of this form as a cherry pest in Colorado.

**TACHYPTERELLUS CONSORS CERASI, N.SUBSP.**

**A CHERRY PEST IN COLORADO**

**HISTORICAL**

Injury to cherries by this insect first came to the attention of the writer in 1914. On July 30, while going thru the orchard of C. G.
McWhorter, Masonville, Colorado, which is in the foothills, about 12 miles southwest of Fort Collins, the writer's attention was attracted to fruits on the trees showing insect exit holes. These reminded one of the exit holes made in plums by the plum gouger, *Coccutorus scutellaris* Le Conte, only they were smaller. Many fruits that did not show the exit holes looked as tho they had been stung earlier in the season. No insects were found that were thought to be responsible and none were reared from fruit taken to the laboratory. In 1915 a somewhat earlier trip was made to the orchard and injured fruit collected. From this two adult curculionids were reared. One of these was sent to Dr. A. L. Quaintance of the United States Bureau of Entomology, who determined it as *Tachypterellus quadrigibbus* (Say). Following this an examination of the haws and wild cherries of the vicinity was made, with the result that the same type of injury was found in the wild cherry or chokecherry, *Prunus melanocarpa* (A. Nels) Rhdb., and one adult insect was taken from the pit of a chokecherry on July 13.

In 1916 the insect was more common in Mr. McWhorter's orchard and a limited number was found in two orchards near by. No notes were made during 1917 and 1918, but the following was written June 26, 1919:

"Visited the McWhorter orchard and found as high as 20 percent of the cherries on some trees infested with what has been determined as *T. quadrigibbus* (Say). Some are in adult stage in fruit but none leaving the fruit. A few still in the larval stage. They are less numerous in chokecherries near by. Many cultivated cherries are blemished by food punctures, but no food or egg punctures can be found on apples near by, altho this insect is supposed to prefer apples and not go on stone fruits."

Annual examinations of the orchards in the Masonville section were made, but there was little increase in the extent of the infested area. In 1922 the injury was probably as heavy as in 1919. That year specimens were sent for determination to Dr. E. A. Schwarz of the United States National Museum. He called them *T. quadrigibbus* but questioned the accuracy of his determination.

On June 10, 1926, Mr. George Brittell asked for some one to investigate an injury to his cherries in three orchards about 4 miles south of Fort Collins. Dr. C. P. Gillette visited them and found all the orchards infested with this insect, the crop in one being an entire loss. The writer, who was away at the time, visited the orchards June 30 and made a study of the pest during the next few weeks. Since 1926 other orchards in that section have become infested. In 1930, some infested cherries were received from Jefferson County, and upon investigation a much larger infested area was found than had been observed in Larimer County about Fort Collins and Masonville. The
Jefferson County growers had noted some injury in 1929, but failed to report it. This year, when the factories began turning down their fruit, they became alarmed. The loss in these orchards varied from 10 percent to as high as 85 percent. This condition in two rapidly expanding cherry-growing areas presents an alarming situation.

**Common Name**

In order to discuss an insect problem intelligently with fruit growers, and to avoid confusion thru the use of many local names, it is advisable to establish a common name. With this in mind we have been using the name "cherry curculio," which seems quite appropriate, and it has come into general use among the growers and canning-factory men. It has helped to overcome the impression that the insect is the same as the plum curculio, fruit maggots, or other insects that some of the growers may have been more or less familiar with in other sections. The insect will be referred to in the pages following as the cherry curculio.

**Description**

**Egg**

Length 0.71 to 0.88 mm.; average of 20 measurements 0.791 mm.; width, 0.342 to 0.457 mm., average of 20 measurements 0.413 mm.; elliptical, with a very short and sharp tubercle on one end, semi-opaque, shining water-white when deposited, becoming slightly tinged with yellow as incubation advances; chorion, soft and easily punctured. (Fig. 1, A, and Fig. 5.)

**Larva**

When full grown the larva (Fig. 1, E) usually has a dorsal length of from about 6 to 7 mm. and a width of about 1.5 mm. It is a white, fleshy, completely legless grub rather thick bodied, cylindrical, tapering slightly anteriorly and posteriorly. The dorsal portion of thoracic segments and the first six abdominal segments are lengthened, giving the larva an arched shape. Head, free, yellowish-brown with mandibles and mouth-frame darker, each epicranial half with two prominent setae; ocelli, small.

The three thoracic segments are similar in shape, the prothorax not as thick as the meso- and metathorax; a small, circular spirical opening on each side of prothorax; the prothorax with five prominent setae on each side dorsal of spirical and two ventrad; the meso- and metathorax each with three setae dorsad and three ventrad of spirical region.

Figure 5.—The two eggs shown on the right are of the cherry curculio *T. consors cerasi*. The one on the left is from *T. quadrigibbus magna*. Note the difference in size. Enlarged.
There are nine visible abdominal segments. The first six are similar in form, shape and size, and when viewed from the side, each is seen to bear a circular spirical opening, dorsad of which are four setae and ventrad one; the seventh segment is shortened ventrally and bears three setae; eighth irregular in shape with three setae; ninth forming the rounded anal end and bears two setae.

PUPA

Length, 3.14 to 3.57 mm., average of 20 measurements 3.39 mm.; width, 1.71 to 2.14 mm., average of 20 measurements 1.88 mm.; color, at first white, with a slight cream cast, the eyes and appendages becoming darker as the adult stage is approached. The appendages such as beak, antennae, and legs are visible, the elytra-cases being between the second and third pairs of legs. (Fig. 1, E.) Elytrae show the striae and protuberances found on the adult, the tips of elytra-sacs ending in point; rostrum in females reaching to the tip of elytra-case, in males about one-fourth shorter; bears usually four rather prominent setae; pronotum prominent with eight prominent hairs arranged in almost a complete circle on each side of the median line, each hair arising from the anterior side of a sharp spine-like protuberance; scutellum, prominent; the abdominal segments distinctly separated, each having a transverse row of sharp, spine-like protuberances, usually from 8 to 10 in number and similar to those on pronotum, on the posterior sub-margin, these spines being longer on the last segments. A prominent hair arises from the caudal side of each spine. (Fig. 1, G.) The terminal segment ends in a stout curved spine. The last segment of the abdomen that is retracted in the adult can be seen thru the pupal case as an exposed and distinct segment of the pupa.

ADULT

The adult has been described in the first section of this paper. (Fig. 1, B and D.)

HOST FRUITS

ORIGINAl HOST

All evidence leads to the conclusion that the chokecherry, *Prunus melanocarpa* (A. Nels) Rhdb., is the native host. This is a very common wild fruit in the foothill region from 4000 to 7000 feet altitude, wherever sufficient moisture is available, and is sometimes found growing for a considerable distance into the plains area along streams and irrigation ditches.

In the foothill region from Littleton north to the Wyoming line, infested fruits can be found quite generally. The infestation decreases above an altitude of 6000 feet. Two other wild cherries, the Wild Red Cherry, *Prunus pensylvanica* L., and the Sand Cherry, *Prunus besseyi* Bailey, are found in the region. A rather limited search has not shown them to be hosts.

CRATAEGUS

At least three species of *Crataegus*, *C. occidentalis* Britton, *C. coloradensis* A. Nels, and *C. coloradoides* Ramaley, grow in this same foothill region. When the insect was first determined as the apple curculio we expected to find it feeding on the fruits of these. But during several years of observations the writer has failed to find infested fruits or to take the adults by beating. It is quite probable
that the insect could survive on them, but they certainly are not pre­ferred hosts. In a number of instances the hawthorns and choke­cherries have been found growing side by side and the insect could be readily found on the cherries and not on the hawthorns.

**PLUM**

Wild plums are fairly common in the foothills but the writer has never taken an infested fruit. In 1929, feeding on wild plums growing along a drain ditch in the Henri McClelland orchard, south of Fort Collins, was more or less common. Several beetles were seen in the act of feeding and two fruits were taken with eggs in them. Some of the fruit was placed in cages and that on the trees was watched, but there was no evidence that insects matured. However, a large portion of this fruit was destroyed by plum pocket, *Exoascus pruni* Fuckel.

**PEAR**

Very few pears are grown in the general area under discussion. However, a few trees exist in at least three infested commercial orch­ards. Two of these orchards have been watched for a number of years and the third one was examined this last season without finding any evidence of food or egg punctures.

**APPLE**

The insect will feed upon the apple but the experience has been that it does not take to it readily. In the C. G. McWhorter orchard, where the insect was first noted attacking cherries, it has never been found injuring apples and several varieties grow in the same orchard. At the place of Henri McClelland, where heavy commercial loss has occurred in the cherries, only an occasional food puncture has been found on apples, and the orchard, which is one of the oldest in that part of the state, has some 30 or 40 varieties, which would afford cons­iderable selection. An example of the preference shown for cherries over apples is indicated by an experience of May 27, 1929, when 12 small cherry limbs in the McClelland orchard were shaken over an umbrella and 45 beetles collected while the same amount of shaking on apple trees in the next row gave only one beetle.

The greatest amount of injury to apples seen by the writer oc­curred in the George Brittell orchard in 1926. Two trees of the vari­ety Wagner standing near the farm buildings and in the edge of a cherry orchard showed considerable injury. Eggs and recently hatched larvae were found in fruit on the trees. Some of these were picked and placed in cages but no beetles developed, and from observ­ations made, none developed from the fruit on the trees. The wind­falls were destroyed by livestock.
Efforts to rear the insect in small apples in the laboratory failed except in 1929, when one was carried thru to the adult stage.

MAHALEB CHERRY

The beetles feed readily upon the fruits on the sprouts from the mahaleb stock, to which many cultivated varieties are budded. Fruits have been taken with exit holes made by the adults.

CULTIVATED CHERRY

The cherry has been by far the most preferred cultivated host and evidence indicates that there may be a preference for the cultivated varieties over the chokecherry. For instance, in one orchard where there is a hedge of chokecherries growing in a fence row, the infestation has been heavier in the first row of orchard trees than in the wild hedge. The rapid spread of the pest in an important cherry region makes the problem alarming. The nature and extent of this injury is discussed elsewhere.

ECONOMIC IMPORTANCE

The economic effect of an insect upon an important canning crop like cherries can by no means be measured by the loss of fruits actually injured. A very small percentage of wormy fruits, especially if they cannot be cheaply and successfully sorted out, may make a crop useless for canning. There is always the indirect effect that comes from a condition of this kind upon the trade, and the advantage of it that it is possible for the trade to take. Northern Colorado cherries have often sold at a premium because of their freedom from worms. Cherry growing is a comparatively new industry in the state, probably almost one-half of the acreage is not yet in bearing, so the occurrence of an insect of importance is having a direct effect upon the continued expansion of this industry and will discourage some in the care of their present orchards. At least three of the seven factories have already felt the effect of the inspection, grading and sorting work.

VARIETIES OF CHERRIES ATTACHED

The varieties grown in the Northern Colorado section all belong to the sour cherry group. Those that are in commercial quantities in the orchards studied, named in order of their importance, are Montmorency, English Morello and Early Richmond. The insects do not seem to show any feeding preference among these; however, there are some factors, such as the seasons of blooming and of ripening, the time of harvest, and the time of hardening of the pit, that have a direct bearing upon the problem. These factors will be discussed elsewhere.
Seasonal History and Habits

Brief Outline

Before taking up a detailed discussion of the insect’s habits and development, it may be well to give a brief general statement of its life cycle.

Winter is passed in the adult stage, the beetles hibernating under grass or rubbish on the soil. They appear in the orchard about as the cherry trees are blossoming and feed upon the blossoms and small cherries. The eggs are deposited in the fruit in cavities eaten out by the female. Egg-laying begins when the fruit is about the size of a small pea and continues for 2 or 3 weeks. The larva goes into the pit and feeds upon the kernel. Pupation takes place within the pit and the adults begin to emerge about as the mid-season varieties begin to ripen, and go into hibernation after only a few days of feeding. There is but the one generation per year. They are, therefore, in the beetle stage almost 11 months of the year and inactive almost 10. These habits make the insect well adapted to a short-season crop like the cherry.

Difficulties in Life-History Studies

The reports of those who have worked with the apple curculio indicate that it acts quite normally in captivity and little difficulty has been experienced in getting data on the different stages of development. This has not been true with the cherry curculio, as a number of difficulties have been met and the results of much work have been discouraging. The beetles do not take readily to captivity and comparatively few eggs have been secured under these conditions. About the same experience has been had when the adults were caged on the tree. Probably the most serious handicap has been the rapidity with which the immature cherries, especially the kernels within the pits, break down after being taken to the laboratory. In three seasons of work we have on this account failed to carry a single larva to maturity under laboratory conditions.

For these reasons the information is limited on such points as the oviposition period, larval feeding period, and many such points that can best be studied in the laboratory.

Life-History Studies Made

 Quite extensive life history studies were carried on during the seasons of 1927 and 1929, and less extensive ones in 1930. During 1928 the cherry crop in the most seriously infested orchards was so reduced by winter and spring weather that the project was not followed closely. The data of these years have been supplemented by numerous notes taken in the orchards over a period of years.
The beetles used in the studies were collected as early as possible after appearance from hibernation. Nine cages containing 10 beetles each and 9 containing 1 pair each were carried thru the season in a natural temperature insectary in 1927. Complete daily records were made upon the number of food punctures made, eggs laid, the death of both sexes, and any other points of interest. Battery jars, 5 by 9 inches, were used and a freshly cut twig of cherries, the stem of which was placed in a vial of water, was placed in each cage each morning and the old one removed. All fruit was then examined for eggs and the eggs kept for incubation studies and for a supply of larvae for larval studies. A number of methods of handling the cherries to get data on the larva development were tried, but all failed on account of the quick breaking down or drying of the small cherries.

Ten cages with 10 beetles each and 10 with 1 pair each were again carried in the natural temperature insectary in 1929. In order to make certain of having a good supply of eggs for certain studies and to determine the effects of a controlled temperature on egg laying, 2 cages of 10 beetles each and 5 with 1 pair each were carried in a laboratory where the temperature was maintained between 80 and 85 degrees Fahrenheit. In addition, a number of beetles were caged on trees in cheesecloth bags, in order to see if the beetles would act more nearly normal, and to have the fruit in a condition that it would continue to develop during the development period of the larvae. Two such cages contained 25 beetles each, 5 contained 5 each, and 5, 1 pair each. These were each moved to a new twig each day and the exposed twig tagged for further observation. (Fig. 6.) This method had the objection that the fruit could not be cut into to determine the number of eggs deposited, but it did serve to give some data on the development from egg to adult. The results were discouraging, however, in that the beetles again failed to oviposit freely.

The same season a number of heavily fruited limbs were selected after pollination had taken place and the cherries were forming to the point where they could be counted, then encased in cheesecloth bags and a definite number of beetles introduced. One such cage contained 10 beetles, one 5, one 2 pair, and 8, 1 pair each. For checks, limbs were similarly enclosed but no beetles added. The cages were allowed to remain until the fruit was ripening, then removed and the fruit examined to determine the number maturing and the number infested.

In 1930 the studies consisted largely of orchard observations and the handling of some beetles in bags on trees.

The data collected are not given in detail but the more important facts are made use of in the following discussion of the life history.
Figure 6.—An English Morello cherry tree on which much of the cage work with the cherry curculio was done in 1929. Each of 12 cages was changed daily to a new twig and in this way a definite number of beetles was carried thru the season and an accurate record obtained of their daily injury, egg deposition and other activities of interest. This was the only method found of getting accurate data on the development period of the insect.

TIME OF APPEARANCE OF THE BEETLES

Observations made in the orchards indicate that the overwintering adults appear in numbers rather suddenly in the spring. In general this is about as the cherries are blooming. For example, in 1927, no beetles could be found in the George Brittell orchard on May 10, when an occasional blossom could be found. On May 13, when the Montmorency variety was beginning to blossom freely, 8 beetles were taken by beating limbs over an inverted umbrella. May 14, 26 beetles were shaken from one small tree that would produce about 3 gallons of fruit and 14 from another tree of about the same size. May 16, the Montmorency trees were almost in full bloom and the insect had apparently reached its peak in numbers; 111 beetles were collected from a tree that it was estimated would produce 10 gallons of fruit, and it was thought this represented about one-half the population on the tree.

In 1929 no beetles could be found in the Henri McClelland orchard on May 13; the buds on the Montmorency variety were swelling rapidly, occasionally a cluster bud was breaking and some green tips
of leaves were showing. May 17 a few blossoms were opening on the Montmorency but none were out on the English Morello, yet the first beetles of the season, 8 in number were taken. May 20 beetles were becoming numerous and the Montmorencies were blooming freely. Collections made on May 24 and 27 indicated that the beetles were as numerous as they were at any time later.

In 1930 the first beetles were taken in the McClelland orchard May 12, when the trees were beginning to bloom freely. May 12 and 13 were warm for the season and in the afternoon of May 13 beetles were almost as numerous as they were later.

HABITS OF THE BEETLES

Upon being disturbed the beetles frequently feign death and drop to the ground, where they lie motionless for a short period. If they are not in an exposed position when disturbed they are more likely to cling tightly to the blossom, fruit, or whatever they may be on and remain motionless for a minute or two. They have been observed to move slowly to the opposite side of an object upon the approach of a person. While they appear quite sluggish, the near resemblance of their color to that of bud scales, twigs and fruit-stem scars and their slyness in hiding themselves, make them rather difficult to see upon the tree. Their habit of feigning death under some conditions makes it possible to collect them quite readily by jarring a limb over a collecting net or inverted umbrella. In doing this, tho, one is always surprised to see how many can be taken by shaking the same limbs only 5 or 10 minutes later.

When the temperature is 55 degrees Fahrenheit or lower, the beetles are, many of them, in blossoms, curled bud scales, or other places for protection and are not easily dislodged. The best time to collect them is when the temperature is around 65 or 70 degrees. Under these conditions they are feeding but are not active enough to take to their wings before hitting the ground or net, as they will do if the temperature is much higher.

The beetles prefer to feed in the more open parts of the tree. On the cooler days, especially, they will be found on the top and outer limbs, often in the most direct sun. The injury is always greater in these portions of the tree.

DISPERSAL.—While they are quite strong fliers when they are made to take to their wings, they do not seem to fly much. One never sees them flying from one tree to another and their rate of dispersal does not indicate that they move about a great deal. In one 10-acre orchard the infestation has been watched to advance only a few tree rows for each of 3 years. Since the conditions in and around this
orchard are quite uniform, this would indicate also that they hibernate, when conditions are at all suitable, quite close to where they have fed.

The lack of fruit in an infested orchard may cause flights of considerable distance. Some severe weather during the winter of 1927-28 caused a complete crop failure in the George Brittell orchard the following spring, with the result that the beetle population in an uninjured orchard, 1 mile away, materially increased and on the side next the Brittell orchard.

FEEDING ON THE BLOSSOMS.—When the beetles appear in the spring they have just broken a quiescent period of between 9 and 10 months, so, as one would expect, begin to feed ravenously. The flower buds, blossoms and small fruits suffer accordingly. Severe injury that is easily overlooked may occur at this time. Holes may be eaten into the opening buds that result only in holes thru the petals, but the insects much prefer to eat in at the base of the flower and eat the fleshy base of the flower parts, and thus they may often destroy the ovaries. Flower stems are very commonly fed upon and the flowers

![Figure 7.—Cherry blossoms showing injury from the feeding of the cherry curculio. All the specimens show food punctures made into the base of the flowers. The three on the left have had a part of the husks or calyx tubes removed, to show that the injuries extend into the small fruits. Most of the small fruits injured, at this stage of their development, fail to develop further. The three blossoms on the right show typical injury to the stems, the second one having the stem entirely cut. In some cases this early injury has reduced the set of fruit from 25 to 40 percent.](image)

fall. (Fig. 7.) On May 20, 1927, when the blossoms were falling freely, 95 small fruits picked at random in the Brittell orchard showed 37 of them, or 39 percent, injured by this type of feeding. Most of these were injured to such an extent that a fruit could not be produced. Another such count made May 21 showed a 33 percent injury. It was estimated that from 25 to 40 percent of the possible set of fruit was destroyed in this way.
FEEDING ON THE FRUITS.—With the mouth-parts situated on the apex of the long, extended beak or rostrum, the insect is enabled to "drill" deep holes into the fruit for feeding. A circular cut only large enough to admit this beak is made in the skin and feeding continues to as great a depth as the length of the beak will permit.

![Figure 8—Cherries about one-half grown, showing typical food punctures recently made by the adult cherry curculio.](image)

(Fig. 8.) In the blossoms and small fruits, apparently the skin that is cut away in making the opening is eaten, but later, as the skin becomes tougher, some of it, at least, is discarded. These feeding punctures are enlarged slightly beneath the skin, but from that point they are of almost equal diameter. (Fig. 9.) When the cherries are small, the punctures may extend into the pits and holes be made in the forming kernel. The insects seem to show no preference for any of the different layers but feed the full length of the rostrum. As the fruits become larger and the layer of flesh becomes thicker, the punctures may extend only to the pit.

When the fruits are small, especially before the "husks" fall, a favorite place for the food punctures is at the juncture of the small fruit and stem (Fig. 7); later, feeding may take place at any point on the fruit. More than one puncture may be made upon a single fruit. In fact there is something of a tendency to stay on one fruit until sometimes several punctures are made. This is probably brought about by a natural sluggishness of the beetle when undisturbed.

The cherry shows considerable ability to heal the wounds; this decreases as the fruit nears maturity. The kernel and the hardening shell of the pit lose this ability earliest. The healing of an injury to a pit results in a hard, sharpened protuberance. While the proliferat-
ing cells of the fruit flesh may fill in the flesh puncture, there is always a streak of blackened, tough tissue remaining and a black, hard scar on the surface. As the cherry grows, there is often a marked depression about the puncture. (Fig. 10.) In many cases this is so marked that the skin is "tied" to the pit. This is a very objection-
able type of injury as it results in a serious tearing and mashing of the fruit when pitted. Fruits with several punctures on a single side, which is a condition not uncommon, may be entirely one-sided and useless.

Feeding of this nature continues as long as the beetles are active; some of it may occur up until the fruit of some of the earlier varieties is ripening. On cherry trees, 110 caged beetles produced a total of 10,911 food punctures, or an average of 99.2 per beetle, during 1929. This does not represent their entire injury from feeding punctures as they were not caged until June 1 and 4. That season the first beetles appeared in the orchards May 17 and were numerous on May 20, so, no doubt, the same beetles made a large number of feedings before they were collected and caged. The average for the entire season must have been well over 150. The peak of daily feedings came before the middle of June and the last feeding took place July 27. The last of these beetles died August 3. A discussion of the injury caused by the feeding of the newly emerged beetles is given later.

**Figure 10.—A cherry showing the external appearance of food punctures made before the fruit lost the power of healing the wound. The injuries have largely healed, but black streaks of tissue extend the depth of the punctures.**

**EGG LAYING**

The eggs are placed in punctures or cavities made in the fruit by the female. In external appearance these punctures resemble the food punctures, but have a considerably different shape below the surface and, on the average, are deeper. The food punctures are of about equal diameter their entire length, while those made to receive the eggs are much wider at the bottom and the sides converge at the opening, making the cavity subtriangular in cross section. They, like the food punctures, may extend into the pit when the fruits are small, but in larger fruits they may not even reach the pit. (Fig. 11.)
The insects are so shy that it is not often one sees them making the egg cavities. In this respect they differ from the apple curculio. Crandall (5) reports removing twigs bearing fruit from the trees and taking them to the laboratory for observation without the females being disturbed. The writer handled a few specimens of *T. q. magna* in the laboratory in 1929 and found that the female had to be almost knocked off the fruit to get her away from a cavity that she was making; but with the cherry curculio, in handling numbers of them during the different seasons, he failed to find an individual that could be watched during the process of making the cavity and oviposition. On May 29, 1927, a female was noticed with her beak in a hole, but, when watched more closely, she stopped feeding, left the hole a short distance, then came hurriedly back and placed the tip of the abdomen to the hole. After a few seconds the tip of the abdomen was raised and lowered two or three times and an egg was seen to appear from the partly distended ovipositor and drop loosely into the cavity. The female moved away without turning to the egg or hole. She did not seal the hole with excrement as does the apple curculio. In probably three-fourths of the cases the holes are sealed with a light-brown speck of excrement that later hardens. In the laboratory few of the cavities were sealed. The egg cavities are seldom made on the basal half of the fruit.

The number of eggs laid.—The number of eggs laid per female in the breeding cages has been quite low. The total for 64 females in the natural temperature insectary during 1929 was 149, or only 2.3 per female. One deposited 12 eggs. Fourteen females, carried in a laboratory where the temperature was maintained at from 80 to 85 degrees, deposited 104 eggs or 7.4 per female. Two of these in one cage deposited 32. Seven pairs that were placed in cages on growing limbs in 1929 produced 53 progeny or 7.57 per female. One produced no progeny, one 13, and the maximum was 19. It is possi-
ble that eggs that did not produce progeny were laid but this could not be determined. Crandall (5) gives the average number of eggs laid in cages by the apple curculio as 65.8.

THE PERIOD OF EGG LAYING.—The egg-laying period of the cherry curculio is comparatively short for an insect of this type. The egg deposition of the beetles carried in the laboratory in 1927 and 1929 is shown graphically in Figures 13 and 14. The first egg was deposited in 1927 on May 25 and the last ones July 2. This was the longest period of oviposition of any year the insect has been observed.

It will be noted from the graph that there was some very cool weather from June 11 to 17, which practically stopped deposition. During this time the beetles were very inactive and it was thought most of them were going to die, but they survived and several eggs were deposited during the latter part of the month. Apparently many of the beetles in the orchard did not revive after those cold, rainy days. It was difficult to take adults and no new egg punctures could be found. Two hours of examining fruit on June 23 failed to reveal a single egg. The first egg was found in the orchard that season on May 21.

In 1929 the first eggs of the season were found in the orchard June 4 and none could be found June 28. The first eggs in the lab-
oratory were also deposited June 4 and the last ones June 23. Beetles could be taken in the orchard later than these dates, but apparently egg laying had ceased.

The egg laying begins when the cherries are shedding their "husks" and reaches the peak when the fruit is about one-half grown. Some eggs may be deposited as late as when the earlier varieties are almost full grown.

Figure 13.—The unbroken line shows the daily egg deposition of the cherry currulo in cages during 1927. The broken line shows the daily mean temperature during the egg laying period.

Figure 14.—The unbroken line shows the daily egg deposition of the cherry currulo in cages during 1929. The broken line shows the daily mean temperature during the egg laying period.

LONGEVITY OF THE BEETLES

From the laboratory data one draws the conclusion that beetles are present in the orchard in numbers during the entire year; that is, the new generation is appearing before all of the overwintering ones have died, but, as a matter of fact, the overwintering ones are very
difficult to collect for several days before the new ones emerge. In 1927 the last overwintering beetle died in the cages August 8. The last ones were inactive and fed very little after July 7. In 1929 the last beetle died in the laboratory cages July 23. That same season, of 35 beetles bagged on the tree in one experiment, 12 were alive July 28, when the bags were removed for examination.

In another experiment, where 59 beetles were in 12 cages on trees, all deaths, except 4, occurred during July. These 4, represent-

Table 1.—Egg incubation, 1927, in specified days. Days of incubation.

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Average incubation period, 6.37 days.
Failed to hatch, 27 or 30.8 percent.
Table 2.—Egg incubation, 1929, in specified days.

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1 1 74 46 1 123 669 12

Average incubation period, 5.36 days.
Failed to hatch, 12 or 8.8 percent.

ing 2 males and 2 females, occurred during the first 3 days of August.
Twenty-five percent of the males and 27 percent of the females died
before July 20.

**INCUBATION PERIOD OF THE EGG**

The average incubation period of 61 eggs observed during 1927
was 6.37 days, the minimum 4, and the maximum 11 days. The average
for 123 in 1929 was 5.36 days, minimum 3 days, and maximum
7 days. It will be noted that the average in 1927 was 1 day longer
than in 1929. This was due to the cool weather that occurred July
11 to 17. During this period it took from 9 to 11 days for the eggs to hatch and several failed to hatch. In 1927, 30.6 percent of the eggs failed to hatch, and in 1928, 8.8 percent. Some of this failure to hatch was probably due to handling. Eggs removed from the fruit would dry and fail to hatch. The incubation period of the eggs handled in 1927 and 1929 is given in specified days in Tables 1 and 2.

LARVAL HABITS

The larvae are primarily seed eaters. During the several years when fruits were examined from experimental control blocks by opening the fruits and cracking the pits, 2361 larvae, pupae and adults were recorded and only 78 or 3.3 percent were found in the flesh. As stated elsewhere, some of the eggs deposited when the fruits are small may be placed directly into the seed by the adult, but most of them are not. The larvae from the latter must eat their way into the seed, which they appear to do immediately without feeding to a noticeable extent upon the flesh. The egg punctures then heal over as completely as do the food punctures and a wormy cherry cannot be detected. The feeding upon the seed does not cause the fruit to drop, nor does it affect materially the development of the fleshy portion.

In those cases where the larvae developed in the flesh, it appears that they hatched after the pits had hardened and were unable to make entrance. Either their instinct to get to the seed or their preference for the pit over the flesh as food makes them endeavor to feed upon this hard shell. In all cases of this kind there has been a marked depression gnawed out of the pit. The mortality among these is high and those that do mature are very clearly under-nourished.

The larvae that make entrance into the seed feed entirely upon the kernel. In a few cases where the kernel of the seed failed to develop and there was not sufficient food for maturity, evidence indicates that they came out and fed to a limited extent upon the flesh, but these cases have been extremely rare. The entrance hole into the pit is only large enough for the needs of the then small larva, but before pupation, which takes place in this emptied food chamber, the larva enlarges this opening or makes a new one for the exit of the adult. (Fig. 15.) In practically all cases the entrance hole is enlarged, but a few cases have been found where this has been disregarded and a new opening made. In all cases the exit holes are made only thru the pit, the openings thru the flesh being left for the adult to make.
Fulton (9) has established the fact that eggs of the apple curculio deposited in a growing apple are usually mashed or the newly hatched larvae mashed by the rapid healing and resultant closing in of the egg cavity. The writer has never found this condition occurring with cherry curculio, although the fleshy portion of the fruit fills in the cavities quite rapidly. It is possible that it may occur in some cases. It seems that it is only in the very early stages of development that the cells of the pit shell can heal an injury, so a larva that reaches the pit, even though it might not be able to make entrance, does not have the new tissue crowding in from all sides. The larvae that do not enter the pit make only a surprisingly small cavity next to the pit, which cannot be detected until the fruit is opened. Since a large portion of these larvae die, such cavities are of varying sizes.

LENGTH OF LARVAL FEEDING PERIOD

All efforts to get accurate data upon the exact larval period of the cherry curculio have failed. Since the egg, larval and pupal stages are all spent in the same fruit and cannot be successfully transferred to another, the only way we can get data on the length of the larval period is by deducting the time of the egg and pupal periods of other individuals from the total time from egg to adult. By doing this with a rather limited number of individuals, we get a larval period of from 18 to 24 days. It appears that 20 days is about the average.

PUPATION

Pupation takes place within the pit of the cherry while it is normally still upon the tree. Only a few individuals have been watched thru the entire period. In examining large numbers of fruits, it has
been possible to get some larvae that were mature or had just started into the pupal period. These, when kept in a moist container, apparently have behaved normally. The following notes taken in 1929 give an idea of the pupal changes as they can be observed:

"July 1—5 p. m. A rather sluggish larva taken from cherry somewhat more yellow than normal—pupation probably starting. July 2. Prepupal moult took place during night, moulted skin clinging to tip of abdomen. The outline of most of the appendages can be made out—all water-white and opaque, abdomen a light cream-yellow; eyes can be detected only by outline. July 3. No material change in color—appendages somewhat more distinct—mouth-parts darker. July 4. Eyes, light amber-brown, more prominent, elytrae showing striae and protuberances. All appendages darker in color. July 7. Emerged sometime during afternoon."

The pupal period of this individual was a few hours less than 6 days. The average for all individuals observed was 6.9 days.

After the adult emerges from the pupal skin there is a rest period of from 1 to several days. During this time there is a darkening of the color and a hardening of the body walls and appendages. The beetles do not emerge from the fruit until after this rest period. Too much disturbance or handling during this time usually proves fatal, so, as a result, many of those removed from the pits do not make normal individuals.

THE EMERGENCE OF THE BEETLES

The first new beetle in 1926 was taken July 2. On July 3, 200 cherries were examined with the following findings: One adult left fruit, 38 adults in the fruit, 48 pupae, 13 larvae. On July 12 the beetles were numerous in the orchard and were probably at their peak on July 15. On July 20 only an occasional beetle could be found in the cherries and these were mostly individuals that were having difficulty in getting out thru the exit holes. This was an early season for both the insect and the fruit.

Table 3 gives the stages that the insect was found in when fruit was examined on definite dates during the seasons of 1927, 1929 and 1930. Most of these records were made in connection with the examination of fruits for control data, in which cases all the fruits were cut open and the pits cracked. The records for 1927 are interesting in showing the period of transformation and the appearance of the beetles. A count, July 1, showed 83 larvae, 9 pupae, 1 adult in fruit, and 1 having left the fruit. On July 9, 80 percent were found to be pupae and adults still in the fruit. July 12 almost 31 percent had left the fruit and 63 percent were in the adult stage but had not left
the fruit. Only 5 out of 284 were in the larval stage. July 15, 70 percent had left the fruit as adults, 27 percent were adults within the pits, or a total of 97 percent in the adult stage.

In 1929 the period of transformation came a little later. Sixty-six percent had left the fruit July 19, 73 percent July 24, and 100 percent August 7. The season of 1930 was very similar to 1929.

**HABITS OF THE NEW ADULTS**

The new generation of adults, as has been stated before, remains in the pit of the cherry from 1 to several days after emergence from the pupal skin. After this resting or hardening period, they eat their way thru the flesh of the cherry, the opening thru the pit having been prepared for them by the larvae. Their object in life during the next few days seems to be to eat. Undoubtedly they are preparing for the long, quiescent or hibernating period of about 10 months that is ahead, as they go into winter quarters and are inactive until the blossoming time of the cherry the following spring. Even

<table>
<thead>
<tr>
<th>Date examined</th>
<th>Larvae</th>
<th>Pupae</th>
<th>Adults found in fruit</th>
<th>Adults escaped</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 1, 1927</td>
<td>83</td>
<td>9</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>July 8, 1927</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>July 9, 1927</td>
<td>3</td>
<td>19</td>
<td>31</td>
<td>9</td>
</tr>
<tr>
<td>July 11, 1927</td>
<td>11</td>
<td>21</td>
<td>79</td>
<td>14</td>
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<tr>
<td>July 12, 1927</td>
<td>5</td>
<td>14</td>
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<td>87</td>
</tr>
<tr>
<td>July 13, 1927</td>
<td>1</td>
<td>-</td>
<td>31</td>
<td>21</td>
</tr>
<tr>
<td>July 14, 1927</td>
<td>2</td>
<td>6</td>
<td>95</td>
<td>182</td>
</tr>
<tr>
<td>July 15, 1927</td>
<td>1</td>
<td>4</td>
<td>47</td>
<td>121</td>
</tr>
<tr>
<td>July 13, 1929</td>
<td>2</td>
<td>16</td>
<td>21</td>
<td>2</td>
</tr>
<tr>
<td>July 19, 1929</td>
<td>20</td>
<td>13</td>
<td>48</td>
<td>164</td>
</tr>
<tr>
<td>July 21, 1929</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>July 22, 1929</td>
<td>3</td>
<td>5</td>
<td>39</td>
<td>100</td>
</tr>
<tr>
<td>July 23, 1929</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>July 24, 1929</td>
<td>4</td>
<td>5</td>
<td>14</td>
<td>63</td>
</tr>
<tr>
<td>Aug. 7, 1929</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>70</td>
</tr>
<tr>
<td>July 22, 1930</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>132</td>
</tr>
<tr>
<td>July 23, 1930</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>40</td>
</tr>
<tr>
<td>Aug. 7, 1930</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>135</td>
</tr>
</tbody>
</table>
when they are kept in cages they cease feeding and become inactive after a week or 10 days.

It will be recalled that in 1926 the beetles were thought to be at their height in the George Brittell orchard on July 12. On July 22 a decrease in numbers could be detected and fresh food punctures were less evident. On July 26 fresh food punctures were difficult to find and the beating of several limbs produced only 2 beetles, where probably 100 would have been taken 10 days before. No beetles could be found in the orchard August 5 or 13. This is typical of their disappearance during the several years.

**HIBERNATION**

Little is known of the hibernation habits of the cherry curculio. In cages they will go into or under rubbish of most any nature. When soil is in the cage they do not attempt to go into it. They prefer to hide next to the soil, but under some protective material such as grass. Careful searches in the orchards have failed to reveal any. It is thought that they hibernate close to where they have fed, at least their rate of spread in certain orchards would indicate this.

**INJURY DONE BY THE NEW BEETLES**

The feeding of the new generation of beetles is confined to a comparatively short period just before hibernation; nevertheless it can be responsible for considerable loss. It occurs at a time when most of the varieties of cherries are beginning to ripen or are almost fully grown. At this time they have lost the power to heal the wounds. With the varieties that are ripening, the injuries make it possible for other insects such as *Diptera*, bees, and other *Hymenoptera* to feed. In a heavily infested orchard the trees may be humming with these other forms. The injured cherries will soon begin to dry and shrivel and may become mummified upon the tree. In a few cases almost the entire crop has been seen to remain on the tree in this condition until fall or until they were all taken by the birds. With the later varieties, such as the English Morello, the late food punctures will callous enough to prevent the drying of the fruit, but they remain as open, blackened cavities.

**VARIETAL SUSCEPTIBILITY**

The cherry curculio seems to show no marked preference for any of the varieties growing in the orchards under observation, but there are some characteristics of certain of these varieties that may prove to have an influence. The Early Richmond is a quick-maturing variety; the pit hardens early and some of the larvae fail to make entrance. They are harvested about as the new beetles are appear-
ing in numbers, so the late injury is largely avoided. This variety, however, is not an important canning cherry.

The Montmorency is the most important canning cherry grown in the two counties now having losses. Its blooming period coincides with that of the early activity of the insect. The pits harden early enough to keep quite a few larvae from making entrance, but this point is offset by the fact that the fruit ripens when the new beetles are abundant. It is therefore subject to their feeding and the subsequent attack of other insects that feed upon the broken tissue. Ninety-seven percent of the individuals found developing outside of the pit were in fruits of this variety and almost as many English Morello were examined.

The English Morello variety, which is the second in importance for canning, blossoms slightly later than the Montmorency and the blooming is more irregular and extended. The pits are more heavy-shelled than either of the other varieties mentioned but do not harden quite so quickly. It is the latest variety and is not harvested until after all the feeding of the new beetles is past. The fruits, however, do not shrivel after being fed upon, and still have the ability to callous but not to heal the wounds. There is a likelihood of taking many insects from the orchard in fruits of the earlier varieties and thus reduce to that extent the overwintering population. This, no doubt, increases the possibility of spread thru transportation of the fruit. Considering everything, it is believed that the Montmorency has been better adapted to the insect’s habits and has shown greater injury than the others.

Selection of Small Fruits

Ordinarily but few fruits of the cherry are dwarfed and fall. However, in 1929, there was a very heavy fall of small fruits when they were about one-third grown. This was especially true on the variety, English Morello. The fruits stayed on the trees for about 10 days after they began to turn yellow. It was interesting to note that the beetles preferred to feed upon these. On June 20, in the Henri McClelland orchard, 64.4 percent of these yellow cherries had been fed on and 18.5 percent of the growing fruits. One thousand of the yellow fruits showed 1050 punctures and 1000 of the other, 231 punctures.

Probably about the same preference was shown for the egg laying, but this was rather difficult to determine accurately. On July 9, 355 of these fruits were taken from the ground and examined. A total of 7 percent was found infested, while the normal fruit on the trees showed an infestation of 2.06 percent. The infestation in the fallen fruit was made up of 13 dead larvae, 5 live larvae, 5 live pu-
pae and 2 live adults. The heat from the sun was apparently responsible for some of the deaths in fruits that were in exposed places.

Five hundred of the yellow fruits were picked June 20 and taken to the laboratory where the sun would not interfere with the developing larvae. After the season for the emergence of the beetles, all the fruits were examined. The infestation was found to be 10.4 percent, but only two adults emerged and those were inactive and very evidently under-developed. The others were represented as follows: Thirty-two dead larvae, 3 parasitized larvae, and 15 dead adults that failed to get out of the fruit. It was very evident that the small dropped fruits do not carry food enough to develop the insect normally and the laying of eggs in such cherries acts to the detriment of the insect. In the contrast with this, it might be stated that Fulton (9) has shown that the survival of T. q. magna, n.subsp. on cultivated varieties of apple is dependent upon the instinct of the female to detect the "June drop" apples and to lay her eggs in these.

**The Possible Total Damage**

Since the different types of injury have been discussed separately, it might be well to make a summary statement of the possible, total, seasonal injury. The different injuries are: 1. Blossom injury from feeding of overwintering beetles; 2. food punctures on the growing cherries; 3. egg punctures; 4. feeding of larvae; 5. exit holes made by adults; 6. feeding of new beetles.

The total injury in a case of heavy infestation can be illustrated best by describing the loss in the George Brittell orchard during 1926 and 1927. The blossom injury of 1926 was not observed but it must have been heavy. The 1927 blossom injury in a 5-acre block of Montmorency amounted to fully a 25 percent loss of crop. The mature cherries in 1926 showed, by actual count, an infestation of 52 percent. In several counts not a single fruit was found that was free from food or egg punctures of the overwintering beetles, the average per cherry being 4.1 injuries. After the new beetles appeared, it was difficult to find a cherry that did not have from 1 to 4 new punctures that not only further blemished the cherry, but made an opening for other insects to feed upon the juice of the ripening cherry. No marketable fruit could be taken from the orchard. The condition was almost as serious in the unsprayed portions in 1927 and was almost duplicated in five commercial orchards in Jefferson County in 1930.

The general infestations have been much lighter and the injury proportionately less. A glance at Tables 9, 10 and 11 will show the injury that occurred in the unsprayed blocks of certain experimental orchards. These tables do not indicate the blossom injury. It will be noted that many more fruits are injured by food punctures than
by larval injury. For instance, the check in one of the George Brit-
tell orchards in 1927 showed 11.23 percent wormy fruit and 72.46
percent injured by food punctures, or a total of 83.69 percent. An-
other showed a total injury of 94.7 percent, 28.1 percent wormy and
66.6 percent injured by food punctures. In the Henri McClelland
orchard in 1929, with 1.69 percent wormy, 47.2 percent were other-
wise injured.

These data show that, with the cherry curculio, like it is with
the plum curculio, apple curculio, and the plum gouger, the actual
infestation can be low and yet the total injury be quite high. This
is illustrated further by the results obtained when beetles were placed
in bags upon limbs having a definite number of cherries. Table No.
4 gives these results in 11 cages during 1929. In these tests thin
cheesecloth was used so as to permit as much light and as free circula-
tion of air as possible. The results do not indicate the blossom injury
as the limbs were not bagged until after the blossoming period. As
soon as the blossoms had fallen and it was felt certain the bags would

<table>
<thead>
<tr>
<th>Cage No.</th>
<th>Number of cherries with beetles</th>
<th>No. cherries when bagged</th>
<th>No. cherries picked</th>
<th>No. of cherries free from injuries</th>
<th>Progeny from beetles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>24</td>
<td>3</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>29</td>
<td>-</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>30</td>
<td>8</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>25</td>
<td>-</td>
<td>-</td>
<td>4</td>
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<tr>
<td>5</td>
<td>2</td>
<td>40</td>
<td>11</td>
<td>-</td>
<td>2</td>
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<td>6</td>
<td>2</td>
<td>45</td>
<td>11</td>
<td>-</td>
<td>13</td>
</tr>
<tr>
<td>7</td>
<td>10</td>
<td>138</td>
<td>5</td>
<td>-</td>
<td>21</td>
</tr>
<tr>
<td>8</td>
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<td>-</td>
<td>4</td>
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<td>10</td>
<td>4</td>
<td>97</td>
<td>18</td>
<td>-</td>
<td>19</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>82</td>
<td>2</td>
<td>-</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td>575</td>
<td>67</td>
<td>1</td>
<td>101</td>
</tr>
<tr>
<td>Check</td>
<td>52</td>
<td>46</td>
<td>46</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

not interfere with the pollination, representative limbs on a Montmor-
ency tree were selected, all fruits counted, and the bag containing the
desired number of beetles put in place. At the time, May 30, most of
the fruits were just bursting the husks and any that did not appear
normal were removed. The bags were allowed to remain in place
until the fruit was ready to harvest. They were removed and the
counts made July 26 and 27. Two limbs were handled in the same
manner, as checks, only beetles were not introduced into the bags.
It will be noted that the check limbs carried 52 fruits at the start
of the experiment, 46 of which apparently matured normally. The
other 6 were accounted for as small "June drops" which were found
in the bags. A total of 37 beetles was used and all were accounted
for in the bags at the end of the experiment except 5 that apparently
had escaped from cage 7. At the start of the experiment, 575 fruits
were on the limbs, but only 67 at the close. If we consider that the
natural drop was the same as on the check, this would account for 66
or leave a total for the experiment of 509. At picking time, 68 cher-
ries remained, or, in other words, the 37 beetles caused a complete
destruction of 441 cherries or an average of 11.9 per beetle. Of the
68 cherries remaining at picking time, 9 were found to have exit
holes, showing beetles had developed in them; 58 had from 4 to a
great many food punctures and one showed no injury. This one
would represent the total marketable portion of the crop. Cages 2
and 4, which contained 29 and 25 fruits respectively, with only one
pair of beetles in each, had no fruits at picking time. In some cases
the fallen fruits were found to have cut stems but most of them fell
from the effect of many food and egg punctures.

All of the progeny that were found did not reach maturity. Many
individuals died in the larval stage on account of their host fruit be-
ing so badly damaged, and falling so early that there was insufficient
food for complete development.

Parasites

Since the cherry curculio is a native insect of the section, one
would expect that during its long period of development some natural
enemies would also have developed. This has proved the case. Insect
parasites have been by far the most important. At times these have
destroyed enough of the curculio to be considered a factor for control.
Tables 5, 6 and 7 give the parasitism found by counts made during
the years 1927, 1929 and 1930. For the most part these counts were
made when records were being made on the different control blocks.
Since the parasites were, many of them, found in the larval and pupal
stages, the data will not show exactly the percentage parasitism by
the individual species. The different counts made on the same date
represent either different orchards or different control blocks in the
experimental orchards.

It will be noted that the total parasitism in 1927, Table 5, varied
from nothing to 19.79 percent, with an average of 12.7 percent. In
Table 5.—Percentage of cherry curculio parasitized in 1927.

<table>
<thead>
<tr>
<th>Date made</th>
<th>No. of curculio examined</th>
<th>No. of parasites</th>
<th>Percentage curculio parasitized</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 8</td>
<td>80</td>
<td>10</td>
<td>12.5</td>
</tr>
<tr>
<td>July 9</td>
<td>50</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>July 9</td>
<td>12</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>July 11</td>
<td>74</td>
<td>10</td>
<td>13.51</td>
</tr>
<tr>
<td>July 12</td>
<td>171</td>
<td>19</td>
<td>11.11</td>
</tr>
<tr>
<td>July 12</td>
<td>233</td>
<td>58</td>
<td>19.79</td>
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<tr>
<td>July 13</td>
<td>49</td>
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<td>July 13</td>
<td>46</td>
<td>2</td>
<td>4.34</td>
</tr>
<tr>
<td>July 14</td>
<td>20</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>July 14</td>
<td>161</td>
<td>16</td>
<td>9.93</td>
</tr>
<tr>
<td>July 15</td>
<td>142</td>
<td>17</td>
<td>11.97</td>
</tr>
<tr>
<td>July 15</td>
<td>9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>1107</td>
<td>141</td>
<td>12.07</td>
</tr>
</tbody>
</table>

1929, Table 6, it varied from nothing to 49.36 percent, average 26.4 percent. One of the counts made July 23, consisting of 106 individuals, 51 or 48.1 percent of which were parasitized, was made from chokecherries collected in the Poudre Canon, about 22 miles west of Fort Collins, altitude about 5600 feet. The count made August 25 was made from chokecherries collected in Devil’s Gulch, about 25 miles southwest from Fort Collins, altitude about 5800 feet. These and other smaller counts indicate that parasitism is quite general in the foothills as well as in the orchards.

In 1930, Table 7, the parasitism varied from zero to 78.7 percent, average 39.38 percent. During the three seasons a complete record was made of 2622 individuals, 609 or 22.8 percent of which were parasitized.

The following is a brief discussion of the various species reared:

*Eurytoma tylodermatis* **ASHM.**

Ashmead (1) described *Eurytoma tylodermatis* (Fig. 16) in 1896 as a parasite of *Tylodera foveolatum* Say, a weevil breeding in the stems of *Omaegra biennis*. Dickerson and Weiss reported it from the same host in New Jersey in 1920. Most of the references associate it with hosts belonging to the weevil group. Pierce (23) in 1908, stated that it was one of the six most important parasites of
Table 6.—Percentage of cherry curculio parasitized in 1929.

<table>
<thead>
<tr>
<th>Date count made</th>
<th>No. of curculio counted</th>
<th>No. of parasites</th>
<th>Percentage curculio parasitized</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 11</td>
<td>21</td>
<td>6</td>
<td>28.5</td>
</tr>
<tr>
<td>July 13</td>
<td>65</td>
<td>22</td>
<td>33.8</td>
</tr>
<tr>
<td>July 16</td>
<td>30</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>July 19</td>
<td>21</td>
<td>3</td>
<td>14.28</td>
</tr>
<tr>
<td>July 19</td>
<td>181</td>
<td>34</td>
<td>18.08</td>
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<td>July 19</td>
<td>29</td>
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<td>10.34</td>
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<td>July 21</td>
<td>3</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>July 22</td>
<td>87</td>
<td>15</td>
<td>17.24</td>
</tr>
<tr>
<td>July 22</td>
<td>7</td>
<td>1</td>
<td>14.28</td>
</tr>
<tr>
<td>July 22</td>
<td>9</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>July 22</td>
<td>7</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>July 22</td>
<td>12</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>July 23</td>
<td>59</td>
<td>12</td>
<td>20.33</td>
</tr>
<tr>
<td>July 23 (1)</td>
<td>106</td>
<td>51</td>
<td>48.1</td>
</tr>
<tr>
<td>July 24</td>
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</tr>
<tr>
<td>July 24</td>
<td>56</td>
<td>12</td>
<td>21.42</td>
</tr>
<tr>
<td>July 29</td>
<td>25</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>July 29</td>
<td>4</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Aug. 7</td>
<td>79</td>
<td>39</td>
<td>49.36</td>
</tr>
<tr>
<td>Aug. 7</td>
<td>34</td>
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<td>32.35</td>
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<tr>
<td>Aug. 8</td>
<td>6</td>
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<td>33.33</td>
</tr>
<tr>
<td>Aug. 8</td>
<td>3</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Aug. 25 (2)</td>
<td>44</td>
<td>19</td>
<td>43.1</td>
</tr>
<tr>
<td>Total</td>
<td>990</td>
<td>292</td>
<td>28.4</td>
</tr>
</tbody>
</table>

(1) Taken from chokecherry, altitude 5600 feet.
(2) Taken from chokecherry, altitude 5800 feet.

the cotton-boll weevil, and at that time was the most important one in North Texas.

Chittenden (3) reared it from the potato-stalk weevil, *Trichobaris trinotata* Say. Hunter and Pierce (13) wrote in 1912 that
Figure 16.—Eurytoma tyloderma Ashm., a parasite on the cherry curculio: A, antenna of female; B, abdomen of female, dorsal view; C, abdomen of female, side view; D, pupa of male; E, side view of abdomen of male; F, dorsal view of the male.

Table 7.—Percentage of cherry curculio parasitized in 1930.

<table>
<thead>
<tr>
<th>Date count made</th>
<th>No. of curculio counted</th>
<th>No. of parasites</th>
<th>Percentage curculio parasitized</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 22</td>
<td>125</td>
<td>37</td>
<td>29.6</td>
</tr>
<tr>
<td>July 22</td>
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<td>50</td>
</tr>
<tr>
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<td>80</td>
<td>43.7</td>
</tr>
<tr>
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<td>33</td>
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<td>78.7</td>
</tr>
<tr>
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<td>8</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>Aug. 7</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Aug. 7</td>
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<td>40</td>
</tr>
<tr>
<td>Aug. 7</td>
<td>4</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>528</td>
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<td>39.38</td>
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</table>

it was known to attack 14 other species of weevils besides the cotton-boll weevil and that it ranked among the five most important boll-weevil parasites. The same year Pierce (24) gave a list of 16 weevil
hosts. It ranked fourth numerically among the 20 species reared from the cotton-boll weevil during the period of 1906 to 1910, inclusive, and its distribution was found to be co-extensive with that of the boll weevil. It was found to winter in the immature stages. At Victoria, Texas, the first adults appeared from overwintering material on February 3 and the last on April 17. Of 433 individuals, 64.9 percent were females and 35.1 percent males. Myers (20) reared it from the larva of the moth, *Lophoptilus cloisella*. A number of other workers have mentioned the species especially in connection with the cotton-boll weevil, but have added no new hosts to the list.

The writer has found it to be one of the more important parasites on the cherry curculio. It was responsible for from 25 to 30 percent of the total parasitism. It feeds as an external parasite, principally upon the curculio larvae, but a number have been found feeding upon pupae (Fig. 17) and in two cases, upon newly emerged adults. From this it would appear that the injury to a curculio larva that is almost mature is not so great but that it may enter the pupal stage or even live to complete the transformation and appear as an adult. Such adults, in all cases, were much shriveled and had barely life enough to emerge. The feeding, however, usually results in the death of the curculio before the pupal stage is reached.

The parasite larva apparently has the ability to transform and produce an adult without feeding thru its normal larval period. Those that were found upon small host larvae produced very small individuals. In a number of cases what appeared to be partly grown larvae were taken from their food and instead of dying as one might expect, they would transform. The pupation of such individuals would be delayed and the transformation slower. It was not uncommon for such larvae to go without food for from 6 to 10 days, then transform. In one case an individual larva transformed after going without food for 12 days. The adult was a very small but apparently normal male. This may be Nature's way of protecting the species against the death, transformation or loss of its host.

The parasite larva is a footless grub, sluggish in action, water-white to cream colored. Occasionally they may be found darker in color when feeding upon a dead larva that is decomposing. The
length of the mature ones is usually about 3 mm., width 1.2 mm., altho they are found much smaller and larger than this. They taper slightly anteriorly and more markedly posteriorly. Only a small part of the head region is visible and this can be retracted. The only mouth parts visible are two sharp curved hooks that are apparently used for piercing the skin of the host and for anchorage while feeding. They apparently remain attached to the host only while feeding, as the same individuals may be found attached or free within the cavity made by the curculio larvae. Their feeding has been watched under the microscope on a number of occasions. Some notes taken July 11, 1929, are interesting in this connection.

"Watched a parasite larva feed upon a curculio larva. The mouth parts are retracted so there appears to form a sucking pad; this was placed against the host and the two curved hooks could be seen to pierce the skin. The head of the parasite was repeatedly pressed against the host, making a very marked depression as if nursing, soon liquid could be seen to pass into the parasite and some free liquid collected about mouth parts. After parasite moved there was no bleeding of host and no abrasion could be seen."

In this case the host larva made no effort to protect itself, but in cases where larvae that have not been fed are placed with a parasite they will endeavor to fight off the parasite. The larvae may continue to feed after the death of the host. In the case just noted the host was apparently dead on July 12, and the parasite was feeding. On July 13 the host was very brown or black in color and the parasite was dark in color from the food taken. Feeding was observed again July 15, when the old body was almost dried and pupation of the parasite did not start until July 17. It is thought, however, that as a general thing the host lives until the maturity of the parasite larva is reached.

The larva is quite inactive for about 24 hours before actual pupation is noticed. During this time it is shortened and takes on a slightly more yellow color, and voids the contents of the alimentary canal. The pupation takes place in the feeding cavity made by the host.

The pupae (Fig. 16, D) that were measured, varied in length from 2 to 2.42 mm. in width, head .51 to .77 mm., thorax .62 to .97 mm., and abdomen .45 to .85 mm. The color is at first white with the appendages and eyes outlined but difficult to distinguish. On the third and sometimes on the second day the appendages and wing pads begin to take on a light-amber color and continue to darken. The entire pupa, except the eyes which are reddish in color, is almost black about 24 hours before emergence of the adult.

Table 8 gives the date of pupation, length of pupal period, the date of emergence and the host stage of 20 individuals observed.
The emergence date alone was secured on many more individuals. During 1929 the emergence extended from July 23 to August 5, and the pupal period ranged from 7 to 15 days with an average for the two seasons of 9.35 days.

During the course of the work the parasite was bred from Grapholitha packardi Zell., Grapholitha prunivora Walsh, and Eutenedon tachypterelli Gahan, the last record definitely establishing it as a secondary, as well as a primary parasite. The larvae were found feeding upon both larvae and pupae of Eutenedon tachypterelli Gahan, which is an internal parasite of the cherry curculio.

Habrocytus piercei Crawford

This species (Fig. 18) has also been mentioned frequently as a

<table>
<thead>
<tr>
<th>Date pupation started</th>
<th>Date adult emerged</th>
<th>Pupal period in days</th>
<th>Stage of curculio found feeding on</th>
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<td>July 11, 1927</td>
<td>July 19</td>
<td>8</td>
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<tr>
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<td>Aug. 2</td>
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<td>Aug. 2</td>
<td>13</td>
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</tr>
<tr>
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<td>July 24</td>
<td>10</td>
<td>Pupal</td>
</tr>
<tr>
<td>July 16, 1929</td>
<td>July 24</td>
<td>8</td>
<td>Larval</td>
</tr>
<tr>
<td>July 17, 1929</td>
<td>July 27</td>
<td>10</td>
<td>Larval</td>
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<td>July 27</td>
<td>9</td>
<td>Larval</td>
</tr>
<tr>
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<td>July 27</td>
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<td>Pupal</td>
</tr>
<tr>
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<td>8</td>
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</tr>
<tr>
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</tr>
<tr>
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<td>Larval</td>
</tr>
<tr>
<td>July 22, 1929</td>
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<td>Larval</td>
</tr>
<tr>
<td>July 23, 1929</td>
<td>July 30</td>
<td>7</td>
<td>Larval</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td><strong>9.35</strong></td>
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parasite of the cotton-boll weevil. Pierce (24) reported it as ranking tenth numerically among the parasites reared from the boll weevil during the period of 1906 to 1910. Only females were secured and these only in the fall and from hibernating material in the spring. It was found to winter in the immature stages. Hunter and Pierce (13) reported one other weevil host and Wellhouse (33) reared it from Anthonomus nebulosus Lee.

It is of about equal importance with the above species in the destruction of the cherry curculio. It feeds externally and has been found feeding upon larvae and pupae, but being a slightly larger parasite than Eurytoma tylodermatis Ashm., very few of the hosts developed to the pupal stage. They have been seen to feed upon blackened larvae that had been dead at least a day or two. In some cases they continued to feed upon the host remains as long as any liquid food could be secured.

Figure 18.—Habrocythus piercei Crawford, a parasite on the cherry curculio. A, adult female; B, pupa of same; C, larva of same.

The parasite larva is a footless grub (Fig. 18, C) almost white in color unless given a dark, muddy color by the contents of the digestive tract. The length of mature ones varied from 2.2 mm. to 3.5 mm., width from 1 mm. to 1.7 mm. Their method of feeding is very similar to that described for the preceding species, and pupation takes place in the food cavity made by the host. The pupa (Fig. 18, B) is at first white to yellowish in color, with eyes and appendages showing only by outline, but these soon begin to darken and about the third day are of an amber color. As the emergence is approached the color is almost black. The pupal period varied in length from 6 to 8 days, the average of all recorded being 7 days. The season of emergence is somewhat earlier on the average, than the preceding species. In 1927 emergence began July 12 and all material had transformed by July 24, and in 1929 all emerged between July 12 and 21. On account of this early development, but very few were taken in the larval form when the harvested cherries were being examined.
This species was more common in the cherry orchards than in the chokecherries growing in the mountains. In fact the writer has never reared one from the curculio feeding on the wild cherry. The insect must undoubtedly have one or more other host species to carry it thru the year, so it may be that such other hosts are more plentiful under orchard conditions than in the mountains.

*Entedon tachypterelli* Gahan

The type specimens of this species were reared during the progress of the project. Dr. A. B. Gahan’s description was published Feb. 4, 1931, in the Journal of The Washington Academy of Sciences, Vol. 21, No. 3.

*Entedon tachypterelli* Gahan, (Fig. 19) has been the most important parasite of the cherry curculio. It has been responsible for almost 50 percent of the total parasitism, and in curculio collected from the chokecherry in the mountains it is even more important. For instance, in chokecherries taken July 23, 1929, in the Poudre Canon, 39 pupae of *Entedon tachypterelli* Gahan, and 12 larvae and pupae of *Eurytoma tylodermatis* Ashm., were found. In this same fruit there were 48 unparasitized curculio. In a count made from the Henri McClelland orchard in 1930, 57 *Entedon tachypterelli* were found and 38 of other species.

The larva feeds internally upon the curculio larva and reaches maturity about as does its host. Their feeding apparently does not delay the development of the host as they are found most abundant in full-sized larvae about as the curculio larvae are beginning to pupate freely. The feeding of the parasite brings about an almost complete destruction of the host body. In most cases the remains have almost the appearance of the moulded skin. Parasitism can first be detected by the sluggishness and a yellowish, unnatural color of the host. The feeding of the host then ceases, but the parasite continues to feed on the body contents of the dying or dead host. The death is a slow one caused by the gradual absorption of the body content. The host may appear to be alive for some time longer than it is, due to the activity of the parasite within the body. At this time the outline of the parasite larva can often be seen thru the body wall.

The length of the parasite after leaving the host may be as great or greater than that of the host. The measurements of a host on July 13, 1929, were, length 2.85 mm., width 1.14 mm. The measurements of the parasite larva that left the body July 14 were, length 3.14 mm., width 1.14 mm.

The larva is a water-white, opaque, footless grub, well illustrated in (Fig. 19, D). It is quite active when it first leaves the host, but
usually the body begins to shorten and pupation starts within 24 hours. The measurements of the pupa from the one mentioned above, were, on July 15, length 2.71 mm., width of anterior half .91 mm., of posterior half 1.14 mm. On July 16 the definite form of the pupa could be seen. At this time all parts were still white, but during the next few hours the change was very marked, the color the next morning being intense, shiny black. The length of those measured varied from 2 to 3.42 mm. and the width from .77 to 1.42 mm. The pupae are much flattened as shown in Figure 19, B and C, and have all appendages enclosed in the black, tough pupa case. Since they feed until the time the curculio larvae would normally be maturing, the period of pupation coincides with that of the host. During 1927 large numbers were found going into pupation between July 13 and 20. Pupation takes place within the hollowed-out pit of the cherry and the pupa remains here until the following spring. There is but one generation. The mortality of the pupae taken from the pits has been high and as a result our data on emergence of adults are limited. The only emergence date of which the writer is certain, for material kept under outdoor conditions, is May 19, 1927.

Attention has been called to the fact that the larva of *Eurytoma tylodermatis* Ashm. will feed upon and destroy the larva and pupa of *Entedon tachypterelli*. The indications are that when a curculio larva is attacked by the two species of parasites, *E. tylodermatis* Ashm. is the only survival. If this is true, *E. tylodermatis* Ashm. brings about the same percentage reduction of *Entedon tachypterelli*, as of the curculio and thus much reduces its own worth.
Habrocytus lividus Gahan

This is another species, reared from the cherry curculio, that proved to be new to science. The description, by Dr. A. B. Gahan, was published in the Journal of The Washington Academy of Sciences, Vol. 21, No. 3, February 4, 1931.

Seven specimens of this were reared during 1929. In life habits and the appearance of the larvae and pupae, it must be much like Habrocytus piercei Ashm., at least there is enough resemblance that the writer, in handling them in the laboratory, mistook the pupae for those of the latter species. The only individual that was followed thru from the larval stage pupated July 11 and the adult emerged July 18, or in 7 days. The pupa was at first white, gradually taking on an amber color, and the eyes becoming red. On the morning of the seventh day it was almost black. The first of the seven specimens emerged July 13 and the last July 22.

The larva feeds externally and pupation takes place in the food cavity made by the host.

Microbracon tachypteri Mues.

One specimen of this species was taken July 19, 1927, along with several other parasites, from a breeding cage containing a miscellaneous lot of cherries that were known to be infested with the curculio. Nothing further was learned in regard to it and no more were found during the other years of work. Dr. A. B. Gahan of the United States National Museum wrote, under date of November 19, 1920:

"With regard to the Microbracon tachypteri will say that the species was described from one specimen. We have the type, another female from Storry Island, N. Y., and one male from Fort Pendleton, West Virginia. These three specimens plus your single female are all the specimens so far known. Your specimen from Colorado not only extends the known range of the species but it shows some differences in color . . . ."

Zatropis incertus (Ashm.)

Zatropis incertus (Ashm.) was reported by Pierce (23) in 1908 as second in importance of the cotton-boll weevil parasites, and that it had been reared from 13 species of Curculionidae and two species of Bruchidae. Hunter and Pierce (13) in 1912 reported it as an important parasite throughout the boll-weevil infested area. The same year Pierce (24) ranked it third numerically among the 20 species of boll-weevil parasites reared during the period of 1906-1910. Of the 429 specimens reared by him, 81.12 percent were females and 18.88 percent males.

Two specimens of Zatropis incertus (Ashm.) were reared in 1927. One was taken in the pupal stage from a curculio-infested
cherry pit July 13, and the adult emerged July 15. The other was taken July 24 from a cage in which a number of infested cherries had been placed.

*Eupelminus saltator* (Lindeman)

This species (Fig. 20) was described from Russia by K. Lindeman (15), who stated that it was probably widespread in Europe as a parasite of the Hessian fly. McConnell (16) first recorded it in America when he reported it as a parasite of the Hessian fly in Pennsylvania, Maryland and Virginia. In 1927 Phillips and Poos (22) reported a careful study of the species as a parasite upon the joint worms, and stated that it probably occurs thru the wheat-growing regions of the United States. The eggs are always deposited on the outside of the host and the larvae feed as ectoparasites. In 1919 six generations were reared in the laboratory. The winter was passed as full-grown larvae in the cells of the joint worms.

No males were found to occur in the species. The wings are small and do not function. That the species is a hyperparasite of importance has been established by Muesebeck and Dohanian (19). They report it as one of the two most important hyperparasites upon *Apanteles melanoscocles* (Ratzeburg), a valuable primary parasite on the gipsy moth, *Porthetria dispar* L. In this role it generally has three generations.
Only one specimen of this species has been taken during the work with the cherry curculio and it was secured in such a way that there is no evidence as to whether it was a primary or secondary parasite. It was taken July 14, 1929, from a cage containing cherries known to be infested with the curculio.

_Tetraustichus sp._

Four specimens of this form were taken July 25 and 26, 1930, from a cage of curculio-infested cherries being held for parasite collection.

**Predacious Enemies**

Thrips have been reported by Riley (17) to destroy eggs of the plum curculio. During 1929 they were quite numerous in one cherry orchard under observation, so were observed closely to see if they were destroying any considerable number of cherry-curculio eggs. They were very frequently found in the unsealed egg punctures, but there was no evidence that eggs or small larvae had been injured. They did feed to some extent upon the broken tissue of the fruit and probably prevented a normal healing.

Birds were never observed taking the insect as food, but undoubtedly some are so destroyed. In one heavily infested orchard, robins and the red-headed woodpecker were carrying many of the infested cherries away. If the pits were not eaten, the birds may have been spreading the insect more than destroying it. Both of these birds are reported to eat and regurgitate the seed of cherry. It is not likely that this would destroy an insect within the pit.

**Control**

**Discussion of the Cherry-Growing District and Orchard Practices**

Since the control upon orchard insect pests may involve many accepted orchard practices or may depend upon a reorganization of these practices, it might be well to outline briefly the cherry-growing conditions and methods of Northern Colorado. The territory under consideration, where the cherry curculio is rapidly becoming a problem, consists of a region from a few to several miles wide along the foothills of the Rocky Mountain range, extending thru Jefferson, Boulder and Larimer counties. All of this is not adapted to cherry growing, but successful orchards have been developed throughout the length of the area and certain regions seem to be peculiarly adapted to the production of certain varieties. The most successful areas now in use are in the small valleys immediately in the foothills or on the more or less rolling land within a few miles of the foothills. Some land immediately around some of the irrigation storage reservoirs has
been especially favorable. The altitude ranges from 4800 to 6000 feet and the annual rainfall is from 15 to 18 inches.

A few orchards on certain soils and in favored localities are producing profitably without irrigation but for the most part irrigation is practiced. In order to conserve moisture it is necessary to keep the non-irrigated orchards thoroly cultivated and free from weeds. The irrigated orchards are, as a rule, cleanly cultivated, but they are found in all degrees of cultivation and cleanliness. The trees are usually headed low in order to protect the trunks by shade as much as possible. This makes it difficult to cultivate close to the trees other than by hand, and usually results in a strip of land that produces weeds or grass in each tree row when cultivated in only one direction, or in squares of such land about each tree when cultivated in both directions. The disc is the tool most generally used for cultivation.

The Montmorency is the variety most generally grown, with the English Morello ranking second. A very small percentage of the fruit is picked with the stems and placed on the markets of Colorado, Wyoming and Nebraska, especially, as fresh fruit, but the big outlet for it is to the canneries. For this purpose it is picked without stems and hauled immediately to the factory.

**THE CONDITION OF SOME REPRESENTATIVE ORCHARDS.**—The following notes on a few typical orchards in the cherry-curculio-infested sections will throw some light on certain conditions that may favor the insect.

Orchard No. 1.—This is an irrigated orchard consisting of about 5 acres of Montmorency, cleanly cultivated and receiving careful attention. Two apple orchards adjoin this. A hedge of chokecherries grows by an irrigation ditch along each of two sides. Excellent hibernating conditions exist along these ditches but not in the orchard. Curculio injury has occurred in this cherry orchard each year since 1915, being most severe on the first few rows next to the chokecherries and irrigation ditches and gradually decreasing toward the opposite side of the orchard. Usually from 15 to 20 percent of the fruit on the first rows shows food punctures. In 1929, 1.09 percent of the fruit was wormy and 14.93 percent was injured by the food punctures. No injury has ever been found on the apples.

Orchard No. 2.—This consists of about 4 acres of mixed varieties growing just across an irrigation ditch and a chokecherry hedge from Orchard No. 1. It has been in sod for a number of years and apparently has received no attention other than irrigation. Cattle and horses are allowed to run in the orchard during all seasons. The grass
is always pastured very closely, probably so closely that hibernation of the insect is interfered with. From 30 to 60 percent of the fruit is injured each year. The injury has been worse on the side next to the ditch and chokecherries.

Orchard No. 3.—About 4 acres are in this orchard of 18-year-old Montmorency trees on irrigated land lying on a southern slope. The soil is rather rocky and difficult to cultivate. It is usually disked both ways two or three times during the season, but considerable sweet clover and some grass matures, especially about the trees. On the north there is a large irrigation ditch with considerable waste land which is allowed to grow to grass and sweet clover. On the south and west sides there are a few rods of cultivated land, part of which has recently been set to young trees and beyond this lies a large area of native sod land, which extends to the foothills. Irrigated pasture land lies on the east. The closest chokecherries are about 1.5 miles away. This orchard lost the entire crop from currulio injury in 1926 and was heavily infested in 1927. In 1928 a freeze destroyed all fruit and so reduced the infestation that no injury occurred during 1929 and 1930.

Orchard No. 4.—This consists of about 8 acres of 16-year-old Montmorencies on irrigated land, lying on a southern exposure. It is cultivated by diskng, with the result that some weeds and sweet clover grow about the trees altho no sod has been allowed to form. There is a rather closely pastured irrigated pasture on the north, native pasture on the west and south, and a cultivated field on the east. In the south part of the orchard there is probably one-fourth of an acre of land where the irrigation water does not drain off readily and the trees died. Some brush has been dumped here and grass and weeds allowed to grow. The closest chokecherries are about 1.5 miles away. The orchard lost fully 50 percent of the crop in 1926 and was heavily infested in 1927, but protected to a considerable extent by spraying. The infestation has been uniform over the orchard. The fruit was destroyed by freezes in 1928, with the result that the infestation has not been bad since.

Orchard No. 5.—This consists of 8 acres of 12-year-old Montmorency and English Morello trees on non-irrigated soil. They are thoroughly cultivated by diskng both ways and all weeds and grass are hoed away from the trees. Native sod land exists on the west and south, with cultivated non-irrigated land on the other two sides. Infested chokecherries grow within one-half mile of the orchard. The insect has never been taken within the orchard.

Orchard No. 6.—This consists of about 6 acres of 14-year-old English Morello and Montmorency trees on irrigated land having a
south and east exposure. Cultivation is by disking. Wild morning glory and other weeds grow in the uncultivated squares about the trees. A railroad track with the usual weedy conditions is on the west, with pasture land on the other sides. No chokecherries grow within 3 miles. The infestation was reported to be heavier on the west side in 1928 when it was first noticed. The crop that year was refused by the canning factories. In 1929 the infestation was quite uniform and the unsprayed portions showed 28.44 percent injured. The unsprayed portion in 1930 showed 38.69 percent injured.

Orchard No. 7.—This orchard consisted of about 4 acres of about 25-year-old Montmorency trees. They were some of the oldest cherry trees in Northern Colorado. The cultivation consisted of disking, and this mostly in one direction, which resulted in a strip of grass and weeds in each tree row. The orchard was irrigated often enough to produce a rank growth of the grass and weeds. The block of trees was triangular in shape, with alfalfa on the north side, a road on the east, and a drain ditch, with from 1 to 3 rods of grassy waste land, forming the long side of the triangle. Wild plums grew along this ditch and several apple trees just across from it. The closest chokecherries were about 3 miles away. No beetles nor injury could be found in the orchard in 1926. In 1928, injury was quite noticeable and was partly responsible for the crop being refused by a canner. In 1929 an unsprayed portion showed 48.9 percent injured and this was after several hundred beetles had been collected for experimental work. The trees were cut after the 1929 harvest.

Orchard No. 8.—This consists of about 6 acres of probably 14-year-old Montmorency, English Morello and Early Richmond trees on irrigated soil having a southern exposure. The cultivation has been by disking both ways, but this usually consisted of the early spring cultivations with little attention later, with the result that considerable growth of weeds developed even tho little attention had been paid to irrigation. Some injury was reported in 1928; in 1929 the injury involved an estimated 12 percent of the fruit after two light applications of spray had been applied. The injury in 1930 was about the same with one application of spray.

Orchard No. 9.—This consists of about 4.5 acres of 12-year-old Montmorency and a few English Morello trees on irrigated soil. The orchard is thoroly cultivated in the spring by disking but this is mostly in one direction. There is a square of grass about each tree with almost a solid strip of grass in the tree rows in the direction of cultivation. The farm buildings and farm lot form the north boundary and cultivated fields the others. The writer did not know of the infestation in this orchard until after the harvest time for Mont-
morencny fruit in 1930. At the time many of the trees had from 60 to 85 percent of the fruit unpicked. It was estimated that in places fully 50 percent of the crop had been infested and almost all of it must have shown injury. The owner had noticed some injury in 1929 but harvested almost a full crop. There are a few chokecherries growing along a small stream about one-half mile away. Some English Morello trees growing a few rods from this orchard and where they were thoroly cultivation, with crops about them, showed about 20 percent of the fruit injured, mostly by food punctures.

Orchard No. 10.—This orchard consists of 10 acres of about 18-year-old Montmorency trees on irrigated land. The orchard has not been cultivated for years and has a solid sod of blue grass with some sweet clover. These are mowed and allowed to remain on the soil. The barn lot forms the north boundary, a private lane and an apple orchard form the west, and cultivated fields the south and east ones. No chokecherries are known to be growing within 5 miles. The orchard was not visited until August 12, 1930, at the time the trees were full of dried or drying cherries that were too badly injured to pick. Picking had been started early to save as much of the fruit as possible, but the orchardist’s estimate was that from 60 to 75 percent of the fruit had been left on the trees. Some trees were not picked at all. While it was too late in the season to make accurate counts of the infested and damaged fruits, it was thought that approximately 50 percent must have been infested and the remainder injured by food punctures. The orchardist remarked that he was disappointed with the set of fruit in the spring, so it is likely that the blossom injury by the beetles was responsible. Some injury had been noticed by the grower in 1929, but almost a normal crop had been harvested. No injury could be found on apples in the orchard just across the lane.

Orchard No. 11.—This consists of about 8 acres, 4 acres of 16-year-old trees, and 4 acres of 10-year-old trees, on irrigated land within a generally infested area. The trees are cleanly cultivated and are surrounded by cultivated fields. Only one infested cherry was found.

Orchard No. 12.—About 5 acres are in this orchard of 12-year-old Montmorency trees on irrigated soil. A highway is on the north, grain and cultivated fields on the east and south, and cherry Orchard No. 13 on the west. The orchard is given some cultivation in the spring with a disk but much grass and sweet clover develops. It is not known how long the infestation has existed, but a visit after the harvest indicated that from 2 to 10 percent of the fruit had been left on many of the trees as unfit to pick. One would expect rather severe injury to occur another season.
Orchard No. 13.—This consists of from 16 to 20 acres of 12-year-old Montmorency and English Morello trees on irrigated land. Grain and cultivated fields are on the south and west, a highway on the north, and Orchard No. 12 on the east. Sweet clover is allowed to grow, then is mowed and disked into the soil. No grass sod has been permitted to grow, but the heavy mulch of sweet clover probably affords good hibernating quarters for insects. On the side of the orchard next to Orchard No. 12 the infestation was about like that in No. 12, but it decreased to almost nothing in the far side of the planting. This would indicate that the infestation in orchards No. 12 and 13 is not of long standing.

**RELATION OF THE ORCHARD CONDITIONS AND THE PRESENCE OF NATIVE HOSTS TO THE INSECT.**—The seriousness of the plum curculio in the East and South is largely determined by the conditions for hibernation in and near the orchards and by the proximity of the wild hosts. The indications are that this is just as true with the cherry curculio. It will be noted from the descriptions of the orchards just given that in all cases where noticeable injury occurred there were good hibernating conditions in and about the orchards. The most favorable hibernating conditions seem to be furnished by a grass especially an unpastured blue grass.

The immediate presence of the wild hosts is not necessary to maintain an infestation in an orchard, some of the most heavily infested orchards are from 1 to 3 miles from any known chokecherries. However, the two known extensive infested areas extend into territory where the wild host is plentiful. In the Larimer County infested area the spread has been watched to move from the wild host area into the orchards of the plains area. The Jefferson County infested area lies between Clear Creek and Dry Creek, along which scattered growths of chokecherries occur, and extends into the foothills.

These facts offer information of value in the control of the insect, yet the cherry curculio will probably be no more effectively controlled by an attempt to eliminate such conditions than has the plum curculio. Often conditions surrounding an orchard are beyond the control of the orchardist, and clean cultivation is difficult, if not almost impossible, on some of the rolling and rocky soils often found in the best orchard locations. Then the growing of some cover crop for humus seems to be the only practical way of providing this much needed material where large acreages are involved.

The destruction of the chokecherry in the immediate vicinity of an orchard would be advisable, but the wholesale destruction of this interesting shrub in the entire foothill and lower mountain regions would be a very difficult undertaking that would hardly seem justified.
PRELIMINARY TESTS OF INSECTICIDES, 1926

When the very severe infestation was found in the George Brittell orchard in 1926 and the new beetles were completely destroying all fruits that matured, a few preliminary tests were made with a number of insecticides in the laboratory and in the orchard to see if the beetles could be destroyed before they went into hibernation and thus reduce the overwintering population, as well as get some possible suggestions for control the next spring. In each case in the laboratory 10 beetles were used. A fruit-bearing cherry twig and an apple twig, with their stems in a small vial of water, were placed in each cage after being sprayed or dusted. All treatments were made July 21 and 22. The dusts were applied by means of a small hand duster and the sprays by means of a hand bucket pump. The following tests were made in the laboratory:

Cage 1. Dusted with calcium arsenate.
Cage 2. Dusted with lead arsenate 1 part, hydrated lime 9 parts.
Cage 3. Dusted with lead arsenate 1 part, hydrated lime 5 parts.
Cage 4. Dusted with acid lead arsenate.
Cage 5. Dusted with sodium fluosilicate 1 part, hydrated lime 9 parts.
Cage 6. Sprayed with arsenate of lead used at the rate of 1.5 pounds to 50 gallons of water.
Cage 7. Sprayed with magnesium arsenate used at the rate of 1.5 pounds to 50 gallons of water.
Cage 8. Sprayed with calcium arsenate 1 pound, hydrated lime 2 pounds, water 50 gallons.
Cage 9. Sprayed with sodium fluosilicate used at the rate of 2 pounds to 50 gallons of water.

Cage 10. Check. The cherry and apple twigs were untreated.

Only four beetles died in the entire series of tests; these were all in Cage 1 where calcium arsenate dust had been applied. The beetles became quite inactive during the time of the test, many of them clustering in the stem end of the apples or other places where some protection was available. The beetles in the check cage did the same, so it was taken as an indication of their desire to go into hibernation. Beetles in other cages where hibernating conditions were provided were going into the rubbish during this time and feeding but little.

On July 22 five trees in the George Brittell orchard were treated with different insecticides after the ground beneath them had been covered with white cloth that any beetles falling might be found. The trees carried their entire crop, which was so badly damaged that it was not worth picking. More than 50 percent of this fruit had been infested and the new beetles were feeding on the remainder. The following treatments were made with a hand-power duster:
Tree 1. Calcium arsenate.
Tree 2. Calcium arsenate 1 part, hydrated lime 9 parts.
Tree 3. Magnesium arsenate.
Tree 4. Sodium fluosilicate 1 part, hydrated lime 9 parts.
Tree 5. Arsenate of lead.

The cloths under the trees were examined daily for several days with the result that only three dead cherry curculio were found, one under each of the trees 2, 3 and 4.

It might be said that some of the beetles were leaving the trees for hibernation at the time the applications were made. There was a noticeable decrease in the numbers on all trees in the orchard during the next few days and it was difficult to find any by August 1. It is likely that some dead beetles were taken from the ground by ants.

TESTS OF INSECTICIDES, 1927

DESCRIPTION OF ORCHARDS.—Thru the cooperation of Mrs. George Brittell, the two orchards that were so heavily infested in 1926 were made available for control tests in 1927. These are spoken of as the "east orchard" and "west orchard."

The east orchard consists of 8 acres of about 12-year-old Montmorency trees on a rather rolling piece of irrigated land. The curculio injury in the orchard in 1926 was heavy, probably not more than 50 percent of the fruit being harvested, and most of this showed food punctures. In 1927 the beetles appeared in numbers from hibernation, and the infestation seemed quite uniform over the orchard. The crop of blossoms was from medium to heavy and a uniform crop set. The spraying was done with a small power sprayer that carried a pressure of 200 to 250 pounds. A spray gun was used and all spraying done from the ground. The trees were headed low, few of them being over 12 feet tall.

The dusts were applied by a hand-power rotary-fan type of duster. This was not entirely satisfactory, but by selecting a time when the air was quiet it was felt a thorough application was made.

The west orchard consists of about 4 acres of 16- or 18-year-old Montmorency trees on irrigated ground. On account of the type of soil, some of these trees were beginning to deteriorate so the orchard was not as uniform as the east orchard. The same equipment was used here as in the other orchard. The infestation during 1926 had been very heavy, more than 50 percent of the fruit had been infested and the remainder so badly damaged by food punctures that none was harvested. Due to the difference in infestation it was thought best to handle the two orchards separately for experimental data.

MATERIALS AND METHODS USED.—Under the agreement by which the orchards were made available for the experimental work, it was
necessary to limit the number of tests to the more hopeful ones and to make the work fit in with the regular orchard plans as much as possible. Due to the heavy feeding of the beetles just after they come out of hibernation, which is as the trees are blossoming, it was felt the best results would be obtained by concentrating on the control tests at this time. The orchards were watched daily to observe the appearance of the beetles. The first beetles appeared when the trees were beginning to blossom freely and were present in large numbers when the trees were in full bloom. An application at this time would have been desirable, but was not advisable on account of the danger of poisoning honey bees and other pollinators. The first applications were made May 19 and 20, when the blossoms were about three-fourths off the trees and it was thought pollination had taken place. The plan for the second applications was to make them just as soon as the husks or calyx tubes were off the fruit. They were in about the proper condition May 31 and June 1.

The east orchard was given the following treatment:

Block 1. Sprayed May 19 with arsenate of lead used at the rate of 1 pound to 50 gallons of water.

Block 2. Check. This consisted of 40 representative trees that received no treatment.

Block 1A. Sprayed May 19 and May 31 with arsenate of lead used at the rate of 1 pound to 50 gallons of water.

Block 3. Dusted May 20 with a mixture of arsenate of lead 1 part, and hydrated lime 9 parts.

Block 3A. Dusted May 20 and June 1 with a mixture of arsenate of lead 1 part, and hydrated lime 9 parts.

The west orchard was divided into 7 blocks that were handled as follows:

Block 4. Sprayed May 20 with arsenate of lead used at the rate of 1.5 pounds to 50 gallons of water.

Block 4A. Sprayed May 20 with arsenate of lead used at the rate of 1 pound to 50 gallons of water.

Block 4B. Sprayed May 20 and June 1 with arsenate of lead used at the rate of 1 pound to 50 gallons of water.

Block 5. Sprayed May 21 and June 1 with sodium fluosilicate used at the rate of 2 pounds to 50 gallons of water.

Block 6. Dusted May 21 and June 1 with a mixture of sodium fluosilicate 1 part and hydrated lime 9 parts.

Block 7. Dusted May 21 and June 1 with a mixture of calcium arsenate 1 part and hydrated lime 9 parts.

Block 8. Check. These trees were untreated. The block was located between Blocks 5 and 6.
RESULTS.—The cherries examined in making the records on the different blocks were picked as the fruit was being harvested for the canning factory. If the beetle had matured and escaped from the pit, the fact could be determined by the presence of the exit hole, but in all such cases the pits were cracked to make certain. Where there was any indication that the fruit might still contain a worm or the curculio might be parasitized, the fruits were cut open and the pits split. The counts were made during the period of July 7 to 15. When the first counts were made, only a few beetles were leaving the fruit, but before the work was completed a large percentage had emerged. The development stages that the insect was found in are shown in Table 3. Before the counts were completed some injuries from the new beetles were occurring; these were not recorded separately as they were in 1929 and 1930. The early injury that caused the dropping of much small fruit could not be accurately determined. Attempts were made to determine this thru the yield per tree, but the trees varied a great deal and the harvesting was done in such a way that this could not well be worked out for a large number of trees.

The infestation was not as high as in 1926 nor as great as was expected from the number of beetles that appeared from hibernation. It was felt that some cold, rainy weather that occurred between May 28 and June 6 was responsible for a very low egg deposition at the period it is normally the highest. Figure 15 shows that egg laying started May 28 and reached the highest point of the season May 30. It would undoubtedly have gone higher and remained so over a period of several days if the weather had been suitable.

DISCUSSION OF THE RESULTS.—Table 9 gives the results of the harvest counts made on the various blocks in the two orchards. In Block 2, the check for the east orchard, 11.23 percent of the fruit was infested and an additional 72.46 percent injured by food punctures, or there was only 16.29 percent of the fruit uninjured. Block 1, which received one spray of arsenate of lead, used at the rate of 1 pound to 50 gallons of water, May 19, just after the blossoms fell, had the infestation reduced to 2.75 percent and the total injured fruit to 53.59 percent, or 30.32 percent more of the fruit was free from injury.

Block 1A received the same spray on May 19 as Block 1 and, in addition, received on May 31 another application of lead arsenate at the same rate, 1 pound to 50 gallons of water. This shows a marked additional control. The infestation was reduced to 0.6 percent and the total injured fruit amounted to 24.38 percent or 75.8 percent of the crop was free from curculio injuries. This was considered a very good commercial control. The crop went to the cannery with but
Table 9.—Results of experiments in the control of the cherry curculio in the Brittell orchards in 1927.

<table>
<thead>
<tr>
<th>Block No.</th>
<th>Treatment</th>
<th>Total Number cherries</th>
<th>Uninjured cherries. Number and percentage</th>
<th>Total injured cherries. Number and percentage</th>
<th>Wormy cherries. Number and percentage</th>
<th>Cherries injured by food punctures only. Number and percentage</th>
<th>Weight of fruit</th>
<th>Cherries per pound</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 East Orchard</td>
<td>Lead arsenate 1-50 (a) May 19</td>
<td>2924</td>
<td>1563</td>
<td>46.61</td>
<td>1567</td>
<td>53.50</td>
<td>2.73</td>
<td>1487</td>
</tr>
<tr>
<td>2 Check East Orchard</td>
<td>No treatment</td>
<td>2608</td>
<td>425</td>
<td>16.29</td>
<td>2183</td>
<td>83.7</td>
<td>293</td>
<td>1890</td>
</tr>
<tr>
<td>1A East Orchard</td>
<td>Lead arsenate 1-50 May 19 and May 31</td>
<td>1903</td>
<td>1511</td>
<td>75.81</td>
<td>486</td>
<td>24.38</td>
<td>12</td>
<td>474</td>
</tr>
<tr>
<td>3 East Orchard</td>
<td>Lead arsenate 1-9 (b) May 20</td>
<td>1758</td>
<td>835</td>
<td>47.49</td>
<td>923</td>
<td>52.50</td>
<td>74</td>
<td>849</td>
</tr>
<tr>
<td>3A East Orchard</td>
<td>Lead arsenate 1-9 May 20 and June 1</td>
<td>1781</td>
<td>924</td>
<td>51.88</td>
<td>857</td>
<td>48.12</td>
<td>50</td>
<td>807</td>
</tr>
<tr>
<td>4 West Orchard</td>
<td>Lead arsenate 1½-50 May 20</td>
<td>1242</td>
<td>644</td>
<td>51.85</td>
<td>508</td>
<td>48.15</td>
<td>20</td>
<td>578</td>
</tr>
<tr>
<td>4A West Orchard</td>
<td>Lead arsenate 1-50 May 20</td>
<td>1108</td>
<td>394</td>
<td>27.43</td>
<td>804</td>
<td>72.57</td>
<td>46</td>
<td>758</td>
</tr>
<tr>
<td>4B West Orchard</td>
<td>Lead arsenate 1-50 May 20 and June 1</td>
<td>2257</td>
<td>993</td>
<td>44.08</td>
<td>1282</td>
<td>55.92</td>
<td>40</td>
<td>1213</td>
</tr>
<tr>
<td>5 West Orchard</td>
<td>Sodium fluosilicate 2-50 May 21 and June 1</td>
<td>1400</td>
<td>783</td>
<td>54.5</td>
<td>637</td>
<td>45.5</td>
<td>9</td>
<td>628</td>
</tr>
<tr>
<td>6 West Orchard</td>
<td>Sodium fluosilicate 1-9 May 12 and June 1</td>
<td>869</td>
<td>77</td>
<td>8.86</td>
<td>792</td>
<td>91.14</td>
<td>142</td>
<td>650</td>
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<tr>
<td>7 West Orchard</td>
<td>Calcium arsenate 1-9 May 21 and June 1</td>
<td>1070</td>
<td>164</td>
<td>15.32</td>
<td>906</td>
<td>84.68</td>
<td>161</td>
<td>745</td>
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<tr>
<td>8 Check West Orchard</td>
<td>No treatment</td>
<td>1075</td>
<td>57</td>
<td>5.30</td>
<td>887</td>
<td>94.7</td>
<td>171</td>
<td>716</td>
</tr>
</tbody>
</table>

(a) One pound of powdered lead arsenate to 50 gallons of water.
(b) One part of lead arsenate to 9 parts hydrated lime.
little culling, while fully 50 percent of the fruit on the cheek was left on the trees by the pickers.

The one application of calcium arsenate as dust on Block 3 reduced the percentage of infested fruit to 4.2, while two dusts on Block 3A further reduced it to 2.8 percent. The totals of injured fruit on these blocks were 52.59 and 48.12 percent, respectively.

On the basis of the reduction in total fruit injured, the one dust of calcium arsenate gave as good results as one spray of lead arsenate, but the two dusts were not as effective in this respect as the two sprays. The percentage of infested fruits was not reduced as low by the dusts as by the sprays.

The infestation in the west orchard was heavier, the cheek (Block 8) showing 28.1 percent infestation and an additional 66.6 percent injured by food punctures. Only 5.3 percent of the fruit was uninjured, and, even tho the block was picked early to avoid injury from the newly emerged beetles, practically none of it was marketable. In addition to the injury shown by the harvest counts, there was the heavy drop of fruit due to the cutting of stems and injury to the small fruits. While this occurred to a varying extent on all the blocks, it was heaviest on the cheek.

Blocks 4 and 4A were each sprayed May 20 with arsenate of lead and received no other treatment. At this time about 90 percent of the blossoms had fallen and the beetles were active. The arsenate of lead was used at the rate of 1.5 pounds to 50 gallons of water on Block 4, and 1 pound to 50 gallons on Block 4A. The results were much in favor of the stronger rate. The infested fruit was reduced to 1.62 percent by the 1.5 pounds and to 4.16 percent by the 1 pound to 50 gallons. The total injured fruit was 48.15 percent on the former and 72.57 percent with the latter, and the percentage of uninjured fruit in Block 4 was about double that in Block 4A. There was some fear that the greater strength might cause some arsenical burning to the foliage but none was detected.

Block 4B received the same treatment as 4A and, in addition, was given another application of arsenate of lead, 1 pound to 50 gallons of water, June 1. The cherries at that time had just shed their "husks." This second application reduced the infestation to 2.18 percent and the total injured fruit to 55.92 percent. It increased the uninjured fruit from 27.4 percent to 44.08 percent. However, the two sprays of this strength did not give as good results as did the one application of 1.5 pounds to 50 gallons used in Block 4.

The results secured on Blocks 5 and 6 are exceedingly interesting. Block 5 was sprayed May 21 and June 1 with sodium fluosilicate used at the rate of 2 pounds to 50 gallons of water, and Block 6 was
Figure 21.—A. Showing the proportion of the cerulillo injured cherries harvested from the untreated trees in the Brittell orchard, 1927. The pile of fruit on the right, representing 5.3 percent of the crop, was free from injury. The fruit on the left, 94.7 percent of the crop, was injured, 28.1 percent of the entire crop being infested. B. Representing the proportion of the fruit injured in 1927 by the cherry cerulillo in the portion of the Brittell orchard receiving one application of arsenate of lead, used at the rate of 1 pound to 50 gallons of water, just after the blossoms fell. The pile on the right representing 27.43 percent was uninjured. The fruit on the left, 72.57 percent of the crop, was injured, 4.16 percent of the entire crop being infested. C. The fruit on the right, 44.08 percent of the total, represents the uninjured and that on the left, 55.92 percent, the injured portion of the crop from the part of the Brittell orchard receiving a spray of arsenate of lead, 1 pound to 50 gallons of water, just after the blossoms fell, and a second one just after the husks were off the fruit, in 1927. Only 2.18 percent of the crop was infested. The injury from food punctures was much less severe than to the fruit shown in A and B.
dusted on the same dates with sodium fluosilicate 1 part and hydrated lime 9 parts. The spray showed the best results secured in the west orchard; the infestation was reduced to 0.65 percent and 54.5 percent of the fruit was free from injury. The dust gave very little control, the actual infestation was reduced from 28.1 percent as shown on the check to 16.35 percent, but 91.14 percent of the fruit showed insect injuries or only 3.5 percent less than were injured on the check. It is interesting to note that the sodium fluosilicate, in both the dust and spray forms, failed to control the cherry slug, Eriocampaoides limacina Retzius. This pest was effectively controlled in all cases where arsenicals were used.

Calcium arsenate applied as a dust May 21 and June 1 on Block 7 gave very poor control of the curculio. Only 15.32 percent of the fruit was free from injury and 15.06 percent was infested.

Table 9 calls attention to a loss from the work of the curculio that is usually overlooked—this is the effect of the injuries upon the size of the cherries. Attention has been called to the fact that the healing of the food and egg punctures leaves scars. These scars may vary from only a black speck in a slight depression to a much deformed or one-sided fruit, but the reduction in weight of the total fruit on a tree is considerable. Of course there would be some variation in samples from the same orchard, but there is a close correlation with the amount of injury. The check fruit from the east orchard, that was 83.7 percent injured, averaged 217.7 cherries to the pound. The fruit from Block 1, where the injured fruit was reduced to 53.59 percent, averaged 180.1 fruits per pound, and that from Block 1A, where only 24.38 percent was injured, 151.5 fruits per pound.

The difference in the number of fruits per pound in the west orchard was even more marked. The check, with 94.7 percent injury, ran 259.5, while Block 7, with 84.6 percent of injured, ran 196.6, and Block 5, with 45.5 percent injury, ran 161.6 cherries per pound. In other words, a tree that produced 100 pounds of fruit in Block 5 would have produced only 63 pounds if unsprayed. It was felt that the reduction in the pounds of fruit per tree in the check of the west orchard, due to the decrease in the size of the fruit, was fully 50 percent.

**General Summary of the Season's Results.**—All dust applications failed to give as good control as sprays. Arsenate of lead and sodium fluosilicate as sprays gave very encouraging controls. Two sprays of arsenate of lead gave better control than one, and 1.5 pounds to 50 gallons of water gave better control than 1 pound.
DESCRIPTION OF ORCHARDS AND PLAN OF TESTS.—Some extreme weather killed the entire cherry crop in the Brittell orchards in 1928. This prevented control experiments that year and so reduced the infestation that the orchards could not be used in 1929. Arrangements were made in 1929 with Mr. Henri McClelland for some tests in his orchards, 4 miles south of Fort Collins. Mr. McClelland had four separate orchards that were used. Since the infestation and conditions in these varied, it was necessary to handle them as separate units. All spraying was done with power sprayers, using guns from the ground. The dusted blocks, which were comparatively small, were treated with a rotary-fan type of hand duster.

Following is a description of the orchards and an outline of the treatments given the various blocks:

Orchard 1.—This consisted of about 4 acres of some of the oldest Montmorency trees in Northern Colorado. The trees were rather large and close together and considerable grass and weeds were permitted to grow. The curculio infestation was of rather recent origin. The writer found no injury in 1926. In 1928 Mr. S. C. McCampbell found 27.3 percent of the Montmorency injured and 68.5 percent of the English Morello. There were only a few small trees of the latter variety on one side of the orchard. The crop from the entire orchard had been refused by the canners in 1928. The first beetle in 1929 was taken in the orchard May 17; only an occasional blossom could be seen at the time. The beetles were numerous by May 24 and it would have been desirable to have sprayed at that time, but the trees were about in full bloom and being visited by many bees. The blooming period was very extended on the old trees, so it did not seem advisable to spray until May 31. At this time probably 90 percent of the blossoms had fallen. On June 8 when the second applications were made, the small fruits had in most cases shed their husks so the insecticides could be applied directly to the small fruits. The applications of June 18 were made when the fruits were about one-half grown.

Block 1.—Sprayed May 31 and June 8 with arsenate of lead, used at the rate of 1.5 pounds to 50 gallons of water.

Block 1A.—Sprayed the same as Block 1 with a third application of arsenate of lead, 1.5 pounds to 50 gallons of water, June 18.

Block 2.—Sprayed May 31 and June 8 with sodium fluosilicate used at the rate of 2 pounds to 50 gallons of water.

Block 2A.—Sprayed May 31, June 8 and June 18 with sodium fluosilicate used at the rate of 2 pounds to 50 gallons of water.

Block 3.—This block received the same treatment as Block 6. It consisted of some isolated trees growing under somewhat different
conditions. The results showed plainly that it could not be compared with the check block, so the data are not included.

Block 4.—Dusted May 31, June 7 and June 22 with sodium fluosilicate 1 part and hydrated lime 9 parts.

Block 5.—Dusted May 31 and June 7 with calcium arsenate 1 part and hydrated lime 9 parts.

Block 5A.—Dusted May 31, June 7 and June 22 with calcium arsenate 1 part and hydrated lime 9 parts.

Block 6.—Sprayed May 31, June 10 and June 19 with arsenate of lead 1.5 pounds to 50 gallons of water.

Orchard 2.—This orchard consists of about 5 acres of 14-year-old Montmorency trees and 3 acres of English Morello of the same age. The Montmorency crop was refused by the canners in 1928, largely due to the curculio injury. The English Morello were injured as badly, but were picked later and, as they could be sorted better, were acceptable for canning. The injury to the unsprayed checks in 1929 was not as great as to the check in Orchard 1. Two checks were kept to represent the two varieties.

On account of the large acreage of apples and cherries to be sprayed with the two power sprayers available, it was impossible to make the blossom-fall spray in this orchard. The first applications were made June 7, and the second on June 18. On June 7 practically all of the fruit had shed the husks, and on June 18 it was almost one-half grown.

Block 1.—Montmorency variety. Sprayed June 7 with arsenate of lead used at the rate of 1.5 pounds to 50 gallons of water.

Block 2.—Montmorency variety. Sprayed June 7 and June 18 with arsenate of lead used at the rate of 1.5 pounds to 50 gallons of water.

Block 3.—English Morello variety. Sprayed June 7 with arsenate of lead used at the rate of 1.5 pounds to 50 gallons of water.

Block 4.—English Morello variety. Sprayed June 7 and June 18 with arsenate of lead used at the rate of 1.5 pounds to 50 gallons of water.

Orchard 3.—McClelland’s orchard No. 3 consists of about 8 acres of 10-year-old English Morello trees. The object of the spraying was to see what control could be secured of Grapholitha packardi Zell., as well as of the cherry curculio. The curculio infestation was low, as the 2.28 percent of injured fruit on the check indicates.

Block 1.—With the exception of a small check, the entire orchard was included in the one block. (It is hoped the orchard can have a similar treatment for a period of years to determine if it will keep
the insect under control.) It was impossible to apply the blossom-fall spray, so the first one was applied June 10, just after the husks fell, and a second one June 21, using arsenate of lead, 1.5 pounds to 50 gallons of water each time.

Orchard 4.—This consists of 2.5 acres of 12-year-old English Morello trees in which the infestation is just getting started. It will be handled with the idea of determining if the infestation can be held to a very low point over a period of years.

Block 1.—The entire orchard, with the exception of a small check, was sprayed as Block 1, using arsenate of lead, 1.5 pounds to 50 gallons of water, on June 10 and June 22.

Orchard 5.—This was the 5-acre Montmorency orchard of C. G. McWhorter of Masonville. The orchard had been infested over a period of years, but the infestation had apparently been held down by unfavorable hibernating conditions in the orchard. However, at times the injury had involved as high as 20 percent of the fruit. The spraying was done entirely by Mr. McWhorter, but a definite check was maintained and the writer allowed to make harvest counts.

Block 1.—The entire orchard, with the exception of a small check, was sprayed just after the husks fell and when the fruit was about half grown, with arsenate of lead used at the rate of 1.5 pounds to 50 gallons of water.

Discussion of Results.—Table 10 gives the results secured in the various blocks of 1929. It will be seen that the heaviest infestation occurred in Orchard No. 1 and the spray program was the most extended there, from an experimental standpoint. A total of 48.9 percent of the fruit on the check was injured, 1.69 percent being infested. In Block 1 a spray of arsenate of lead just after the blossoms fell and another just after the husks fell gave a very encouraging control, the injured fruit being reduced to 13.99 percent. A third application, as represented by Block 2, gave no additional control, the uninjured fruit in Block 1 being 86.01 percent, and in Block 2, 86.05 percent. Two sprays of sodium fluosilicate applied to Block 2, May 31 and June 8, gave about the same results as sprays of arsenate of lead on these dates, the percentage of uninjured fruit being 85.64 percent compared with 86.01 percent. A third spray on Block 2A, applied June 18, apparently gave additional protection as the uninjured fruit was increased to 93.89 percent. Here again, as in 1927, the sodium fluosilicate failed to give a satisfactory control, thruout the season. of the cherry slug. It did not show as good control as arsenate of lead of Grapholitha packardi Zell., which was common in these orchards.

Three applications of sodium fluosilicate as a dust gave about the
same control as two sprays of the same material or two sprays of arsenate of lead, the uninjured fruit being 85.95 percent.

The calcium arsenate applied as a dust, two times on Block 5, and three times on Block 5A, failed to give a very effective control, the two dusts giving 62.66 percent uninjured fruit and the three applications 74.55 percent. It should be noted, however, that the percentage of infested fruits in these blocks was slightly higher than in the check block, which would indicate that the infestation might have been somewhat heavier. These two blocks were located on the side of the orchard and next to a strip of sod ground.

Block 6 received a duplication of the treatment given Block 1A, three applications of arsenate of lead as a spray. The percentage of uninjured fruit was higher than in 1A, being 92.69 as compared with 86.05. It is quite likely that the infestation was not as heavy there as in the remainder of the orchard. That portion was on higher land and received less irrigation and, as a result, had less grass and weeds for hibernation of the insect.

The Montmorency check in Orchard 2 had 3.1 percent of the fruit infested and a total of 26.55 percent injured. One spray of arsenate of lead, 1.5 pounds to 50 gallons of water, applied just after the husks fell, reduced this to 0.867 percent wormy and 13.92 percent total injured. A second application as made on Block 2, June 18, gave no reduction in the infestation, but apparently prevented many food punctures as the injured fruit was reduced to 7.76 percent.

The results secured on the English Morello in Orchard 2 were very similar to those just cited for the Montmorency. The English Morello check (Check 2) was 2.06 percent infested and 28.44 percent injured. The one spray of arsenate of lead June 7 on Block 3 reduced the infestation to 1.23 percent and the total injured cherries to 18.83 percent. An additional application made June 18, as represented by Block 4, further reduced the injury to 0.17 percent infestation and 6.08 percent total injured.

As stated before, the infestations in Orchards 3 and 4 were light, and a principal object was to inaugurate a spray program that it was hoped would control the cherry curculio, the cherry slug, and *Grapholitha packardi* Zell. The two sprays of arsenate of lead reduced the curculio-injured cherries in Orchard 3 from 2.28 percent to 0.75 percent, and in Orchard 4 from 2.76 percent to 1.03 percent.

Orchard 5, which was the C. G. McWhorter orchard, Masonville, Colorado, was handled about as Orchards 3 and 4. The two sprays of arsenate of lead reduced the percentage of infested fruit from 1.09 to 0.18 and the total injured fruit from 16.02 to 6.81.

Table 10 gives many other data of interest besides those mentioned. The average number of punctures per cherry could be used
in determining the efficiency of a treatment as well as the percentages of injured fruits. In Orchard 1, where the best series of tests was run, the greatest reduction in the average punctures per cherry came in Block 2A with Block 1A ranking next. Or, if the percentage reduction of the average number of punctures per cherry is taken, all blocks are placed on a common basis irrespective of any differences in infestation and they can be better compared. This shows the greatest efficiency, 92.67 percent reduction in the injuries per cherry, with three sprays of sodium fluosilicate in Block 2A. The three sprays of arsenate of lead on Blocks 1A and 6, Orchard 1, rank next with 83.3 and 87.6 percent, respectively. On this basis of comparison the results in the three dust blocks, 4, 5 and 6, fall considerably below the results in the spray blocks. The sodium fluosilicate dust gave better results than the calcium arsenate.

The results in Orchard 2 are interesting and give some light on the comparative value of the different applications. These, of course, do not indicate the protection from the blossom-fall application that resulted in a heavier set of fruit. But, without crediting that to the first application, it is still important in preventing injuries. In Block 1, Orchard 1, lead arsenate spray applied May 31 and June 8 gave a percentage reduction of punctures per cherry of 80.9, while one application on June 7 in Block 1, Orchard 2, gave a reduction of 56.2 percent, and another application June 18, as represented in Block 2, Orchard 2, increased this only to 67.5 percent. This would indicate that the third application was of considerably less importance than either the first or second.

The Montmorency cherries were picked in all the experimental orchards before all the feeding of the new generation of beetles had ceased, so they do not show as many "late" punctures as did the English Morello, which were not picked until after all new beetles had gone into hibernation. All punctures that did not heal before the fruit ripened were classed as "late."

GENERAL SUMMARY OF THE SEASON'S RESULTS.—Arsenate of lead and sodium fluosilicate as sprays gave a marked control of the insect. Sodium fluosilicate as a dust gave better results than calcium arsenate dust, but neither of the dusts gave as good results as the two sprays just mentioned. The applications made just after the blossoms fell and just after the husks fell were of more value than the one made when the fruit was about half size. The first two are of about equal importance.

TESTS OF INSECTICIDES IN 1930

DESCRIPTION OF ORCHARDS AND PLAN OF TESTS.—The orchards of Henri McClelland were again used for experimental purposes. The
Table 10.—Results of experiments in the control of the cherry curculio in 1929.

<table>
<thead>
<tr>
<th>Block and Orchard No.</th>
<th>Treatment</th>
<th>Total No. cherries</th>
<th>Uninjured cherries. No. and percentage</th>
<th>Total injured cherries No. and percentage</th>
<th>Wormy cherries. No. and percentage</th>
<th>Cherries injured by food punctures only. No. and percentage</th>
<th>Cherries injured by early punctures only. No. and percentage</th>
<th>Cherries injured by late punctures only. No. of early punctures</th>
<th>Cherries injured by late punctures only. No. of late punctures</th>
<th>Cherries in the flesh</th>
<th>Average No. punctures per cherry</th>
<th>Percentage reduction of average No. punctures per cherry</th>
<th>Variety</th>
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<td>149</td>
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(a) 1.5 pounds of powdered lead arsenate to 50 gallons of water.
(b) 2 pounds sodium fluosilicate to 50 gallons of water.
(c) 1 part sodium fluosilicate to 9 parts hydrated lime.
(d) 1 part calcium arsenate to 9 parts hydrated lime.
(e) Blossoms 90 percent off.
(f) Husks or calyx tubes 95 percent off fruit.
(g) Cherries half grown.
regular equipment of the orchards, consisting of two power sprayers equipped with spray guns, was used. No applications of dusts were made.

Since a large part of the orchard that was designated as No. 1 in 1929 had been cut down and the stumps pulled, the orchards are renumbered for 1930. The following identifies the orchards and outlines the treatment given the different blocks:

Orchard No. 1.—This was Orchard No. 2 of 1929. No material changes were made in its general care and condition. The most important tests of the season were planned for this orchard, the principal point in mind being to get as much information on the timing of the applications as the conditions would permit. It had seemed from the study of the insect and the earlier tests of sprays that the most important times were just as soon after the blossoming as spraying could be safely done and just after the small fruits were made naked by the bursting of the calyx tube or husk. These two stages of development occur within a 7 or 8-day period. The third application should follow the second in a very few days to give protection to the rapidly growing fruits. With this in mind, Orchard 1 was divided into 14 blocks, with one check for the Montmorency variety and one for the English Morello. Blocks 2, 4 and 6 were to give a test of a fluorine compound when applied in 1, 2 and 3 applications to the Montmorency variety, and Blocks 11, 13 and 15 to give a similar test on English Morello. Since barium fluosilicate was being reported by some workers to be more effective than the sodium fluosilicate, it was used in all these applications and at the rate of 1 pound to 50 gallons of water. Arsenate of lead was used on the Montmorency in Blocks 3, 5 and 7, and on the English Morello in Blocks 12, 14 and 16. The blossom-fall application on all blocks consisted of 1.5 pounds to 50 gallons of water and the later applications 1 pound. Blocks 5 and 12 received only the blossom-fall application. Blocks 5 and 14 received the blossom-fall and husk-fall applications and Blocks 7 and 16 received in addition a third application when the fruit was about half grown.

Orchard No. 2 consisted of the Montmorency trees that were in Block 6, Orchard 1, in 1929. Block 8 was kept as the check and the remainder of the orchard sprayed just after the husks were off and when the fruit was about half grown, with arsenate of lead, one pound to 50 gallons of water.

Orchard No. 3 was designated by the same number in 1929. It was given the same treatment as in 1929, which consisted of an application of lead arsenate just after the husks fell and again when fruit
was about half grown. The arsenate of lead was used at the rate of 1 pound to 50 gallons instead of 1.5 pounds as in 1929.

DISCUSSION OF THE 1930 RESULTS.—The results of the season's work are given in a tabulated form in Table 11. It will be noted that the unsprayed Montmorencies (Check 1) had 2.65 percent wormy and a total of 28.16 percent injured, while the English Morellos (Check 2) were 4.18 percent wormy and 38.68 percent blemished by all forms of injury; or the average number of punctures per cherry, which includes both egg and food punctures, was .568 in Check 1 and .779 in Check 2.

The blossom-fall spray of barium fluosilicate, as used in Blocks 2 and 11, reduced the percentage of injured cherries to 25.43 in the Montmorency trees and 23.0 in the English Morello, or the percentage reduction in the average number of punctures per cherry was 12.5 in the former case and 46.5 in the latter. The blossom-fall spray and the husk-fall spray as applied to Blocks 4 and 15 gave a percentage reduction in the injuries per cherry of 42.5 in the Montmorency and 87.9 in the English Morello. An additional application of the same material when the fruit was about half grown, as represented by Blocks 6 and 15, increased the percentage reduction in the injuries to 75.5 in the Montmorency and 86.9 in the English Morello. These results are not so good as secured with the sodium fluosilicate in former years.

The blossom-fall applications of lead arsenate were made at the strength of 1.5 pounds to 50 gallons of water, and all later applications at the strength of 1 pound. This change, over 1929, was to keep down the spray residue on the harvest fruit as much as possible. The blossom-fall spray alone reduced the percentage of injured cherries in Block 3 to 19.65 and in Block 12 to 4.97. or the percentage reduction in the average number of injuries per cherry was 33.8 and 90.3, respectively. The blossom-fall and husk-fall application on Montmorency in Block 5 reduced the percentage of injured fruit to 10.33 and on English Morello in Block 14 to 3.6. The three applications on Blocks 7 and 16 reduced the percentage of injured fruit to 8.61 and 1.93, respectively. The percentage reduction in the number of injuries per cherry by the 1. 2 and 3 application schedules on Montmorency was 33.8, 69.2 and 75.1, respectively, and on the English Morello 90.3, 93.0 and 97.3. This would indicate a slightly better control on the English Morello than the Montmorency.

The results with the lead arsenate are considerably better than with barium fluosilicate. Two applications of arsenate of lead in Block 9. Orchard 2. applied just after the husks fell and when the fruit was about half grown, gave a 69.2 percent reduction in injur-
Table 11.—Results of experiments in the control of the cherry curculio in 1930.

<table>
<thead>
<tr>
<th>Block and Orchard No.</th>
<th>Treatment</th>
<th>Total No. cherries</th>
<th>Uninfused cherries, No. and percentage</th>
<th>Total injured cherries No. and percentage</th>
<th>Worn cherries, No. and percentage</th>
<th>Cherries injured by root punctures only, No. and percentage</th>
<th>No. of early punctures</th>
<th>Cherries injured by late punctures only</th>
<th>No. of late punctures</th>
<th>Curculio in the flesh</th>
<th>Average No. punctures per cherry</th>
<th>Percentage reduction of average No. punctures per cherry</th>
<th>Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check 1 Block 1 Orchard 1</td>
<td>No treatment</td>
<td>4746</td>
<td>3410</td>
<td>1336</td>
<td>125</td>
<td>1211</td>
<td>967</td>
<td>1745</td>
<td>244</td>
<td>827</td>
<td>4</td>
<td>.568</td>
<td>Montmorency</td>
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<tr>
<td>Block 2 Orchard 1</td>
<td>Barium fluosilicate 1-50 (a) May 20 (c)</td>
<td>3520</td>
<td>2625</td>
<td>895</td>
<td>59</td>
<td>886</td>
<td>674</td>
<td>1280</td>
<td>162</td>
<td>461</td>
<td>1</td>
<td>.497</td>
<td>12.5</td>
</tr>
<tr>
<td>Block 3 Orchard 1</td>
<td>Lead arsenate 1.5-50 (b) May 20</td>
<td>3751</td>
<td>3014</td>
<td>737</td>
<td>19</td>
<td>718</td>
<td>585</td>
<td>1027</td>
<td>133</td>
<td>367</td>
<td>2</td>
<td>.376</td>
<td>33.8</td>
</tr>
<tr>
<td>Block 4 Orchard 1</td>
<td>Barium fluosilicate 1-50 May 20, June 3 (d)</td>
<td>2351</td>
<td>1961</td>
<td>390</td>
<td>8</td>
<td>382</td>
<td>291</td>
<td>485</td>
<td>91</td>
<td>274</td>
<td></td>
<td>.326</td>
<td>42.5</td>
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<td>Block 5 Orchard 1</td>
<td>Lead arsenate 1.5-50 May 20: 1-50 June 3</td>
<td>3197</td>
<td>2867</td>
<td>330</td>
<td>13</td>
<td>317</td>
<td>259</td>
<td>412</td>
<td>58</td>
<td>132</td>
<td></td>
<td>.174</td>
<td>69.3</td>
</tr>
<tr>
<td>Block 6 Orchard 1</td>
<td>Barium fluosilicate 1-50 May 20, June 3, June 13 (e)</td>
<td>3752</td>
<td>3488</td>
<td>261</td>
<td>9</td>
<td>255</td>
<td>201</td>
<td>347</td>
<td>54</td>
<td>166</td>
<td>1</td>
<td>.139</td>
<td>75.5</td>
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<tr>
<td>Block 7 Orchard 1</td>
<td>Lead arsenate 1.5-50 May 20: 1-50 June 3, June 13</td>
<td>3556</td>
<td>3250</td>
<td>306</td>
<td>18</td>
<td>288</td>
<td>270</td>
<td>433</td>
<td>18</td>
<td>51</td>
<td></td>
<td>.141</td>
<td>75.1</td>
</tr>
<tr>
<td>Check 8 Orchard 2</td>
<td>No treatment</td>
<td>3435</td>
<td>2855</td>
<td>550</td>
<td>30</td>
<td>550</td>
<td>531</td>
<td>278</td>
<td>19</td>
<td>45</td>
<td>1</td>
<td>.102</td>
<td>Montmorency</td>
</tr>
<tr>
<td>Block 9 Orchard 2</td>
<td>Lead arsenate 1-50 June 3, June 13</td>
<td>3613</td>
<td>3338</td>
<td>75</td>
<td>2</td>
<td>73</td>
<td>67</td>
<td>98</td>
<td>6</td>
<td>15</td>
<td>1</td>
<td>.031</td>
<td>69.6</td>
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<tr>
<td>Block</td>
<td>Orchard</td>
<td>Treatment</td>
<td>April</td>
<td>May</td>
<td>June</td>
<td>July</td>
<td>Aug</td>
<td>Sept</td>
<td>Oct</td>
<td>Nov</td>
<td>Dec</td>
<td>%</td>
<td>Year</td>
</tr>
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<td>-------</td>
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</tr>
<tr>
<td>Block 10</td>
<td>Orchard 1</td>
<td>No treatment</td>
<td>4369</td>
<td>2679</td>
<td>1690</td>
<td>183</td>
<td>1507</td>
<td>1167</td>
<td>2219</td>
<td>340</td>
<td>1003</td>
<td>2</td>
<td>.779</td>
</tr>
<tr>
<td>Block 11</td>
<td>Orchard 1</td>
<td>Barium fluosilicate 1-50 May 20</td>
<td>3336</td>
<td>2733</td>
<td>813</td>
<td>33</td>
<td>780</td>
<td>570</td>
<td>735</td>
<td>210</td>
<td>668</td>
<td>.416</td>
<td>46.5</td>
</tr>
<tr>
<td>Block 12</td>
<td>Orchard 1</td>
<td>Lead arsenate 1-50 May 20</td>
<td>2877</td>
<td>2734</td>
<td>143</td>
<td>143</td>
<td>107</td>
<td>162</td>
<td>36</td>
<td>55</td>
<td>.075</td>
<td>90.3</td>
<td>English Morello</td>
</tr>
<tr>
<td>Block 13</td>
<td>Orchard 1</td>
<td>Barium fluosilicate 1-50 May 20, June 3</td>
<td>1628</td>
<td>1530</td>
<td>98</td>
<td>8</td>
<td>90</td>
<td>74</td>
<td>104</td>
<td>16</td>
<td>41</td>
<td>.994</td>
<td>87.9</td>
</tr>
<tr>
<td>Block 14</td>
<td>Orchard 1</td>
<td>Lead arsenate 1-50 May 20; 1-50, June 3</td>
<td>3051</td>
<td>2922</td>
<td>100</td>
<td>2</td>
<td>107</td>
<td>104</td>
<td>151</td>
<td>3</td>
<td>5</td>
<td>.052</td>
<td>93.0</td>
</tr>
<tr>
<td>Block 15</td>
<td>Orchard 1</td>
<td>Barium fluosilicate 1-50 May 20, June 3, June 13</td>
<td>3474</td>
<td>3310</td>
<td>164</td>
<td>10</td>
<td>154</td>
<td>120</td>
<td>233</td>
<td>25</td>
<td>114</td>
<td>.102</td>
<td>86.9</td>
</tr>
<tr>
<td>Block 16</td>
<td>Orchard 1</td>
<td>Lead arsenate 1-50 May 20; 1-50 June 3, June 13</td>
<td>3381</td>
<td>3316</td>
<td>66</td>
<td>1</td>
<td>64</td>
<td>59</td>
<td>64</td>
<td>5</td>
<td>8</td>
<td>.021</td>
<td>97.3</td>
</tr>
<tr>
<td>Check 17</td>
<td>Orchard 3</td>
<td>No treatment</td>
<td>1777</td>
<td>1732</td>
<td>45</td>
<td>3</td>
<td>42</td>
<td>30</td>
<td>63</td>
<td>12</td>
<td>25</td>
<td>.051</td>
<td>English Morello</td>
</tr>
<tr>
<td>Block 18</td>
<td>Orchard 3</td>
<td>Lead arsenate 1-50 June 3, June 13</td>
<td>1749</td>
<td>1744</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>10</td>
<td>2</td>
<td>2</td>
<td>.006</td>
<td>88.23</td>
<td>English Morello</td>
</tr>
<tr>
<td>(a)</td>
<td>One pound of powdered barium fluosilicate to 50 gallons of water.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(b)</td>
<td>One and one-half pounds of powdered lead arsenate to 50 gallons of water.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>Blossoms 90 percent off.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>(d)</td>
<td>Husks or calyx tubes 95 percent off fruit.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(e)</td>
<td>Cherries half grown.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ies, or 0.3 percent greater reduction than from a blossom-fall and a husk-fall spray in Block 5, Orchard 1. This is the only case where the application when the fruit was half grown seemed to be as effective as the blossom-fall spray.

The work in Orchard 3 was a continuation of the program started in 1929 to see if a light infestation could be kept under control by two sprays that were also being tested against *Grapholitha packardi* Zell. This year the amount of lead arsenate was reduced to 1 pound to 50 gallons of water and the first application made June 3, as soon as all the husks were off the fruit, and the second June 13, when the fruit was about half grown. The 1929 check showed 2.28 percent of the fruit injured and the 2 sprays reduced this to 0.75 percent, and the 1930 check showed 2.54 percent injured, which was reduced to 0.29. The indications are that this program will keep the insect from increasing.

A GENERAL SUMMARY OF THE SEASON’S RESULTS.—Barium fluosilicate spray did not give as good results as lead arsenate, nor as good results as did sodium fluosilicate in 1927 and 1929.

If we disregard the blossom injury, which is not indicated in the harvest examinations, the husk-fall application appears to be the most important one. The fact, however, that the blossom-fall spray prevents much early injury that would result in dropped fruit, in addition to giving about as much later protection as the second one, makes it the most effective single application, with the husk-fall application ranking second.

A schedule, planned as a possible control for the cherry curculio and *Grapholitha packardi* Zell., consisting of a spray of arsenate of lead when the husks are off and another when the cherries are about half grown, seems to be preventing a light infestation of the curculio, from increasing under rather favorable conditions.

GENERAL SUMMARY OF ALL INSECTICIDE TESTS

The application of poisons as a spray has been more effective than as dusts. Lead arsenate, used at the rates of 1.5 and 1 pound to 50 gallons of water, has been slightly more effective against the cherry curculio than any other material used, and has given the best control of two other species of insects occurring in the same orchards. Lead arsenate, 1.5 pounds to 50 gallons of water, is slightly more effective than 1 pound to 50 gallons. Sodium fluosilicate as a spray is almost as effective against the curculio as lead arsenate, but does not give as good control of the other species occurring in the orchards. Barium fluosilicate was not as effective as the sodium fluosilicate.
The most important times for applications seem to be just after the blossoms have fallen, just after the small fruits have shed the husk, and when they are about half grown. The second application follows the first in from 6 to 8 days and the third follows the second in not over 10 days. The first application is probably the most important and the third the least, but all three are very valuable in a heavy infestation, and the first two essential for anything like effective control.

**Arsenical Residue on Cherries Sprayed for Cherry Curculio Control**

**Amount of Arsenic Trioxide Permitted per Pound of Fruit**

During recent years pure-food and health officials have taken an active interest in the amount and nature of the spray residue left upon fruits and vegetables following the application of insecticides and fungicides. Their action in a regulatory way has been directed largely toward arsenic, but it is very likely that other constituents of insecticides may be included as more information is gathered. In the case of arsenic, definite maximums that can be permitted in or on food products have been established by the United States Food, Drug and Insecticide Administration. The maximum or tolerance permitted in canned or other prepared food products has generally been .01 grain of arsenic trioxide per pound of food. In the case of fresh fruits, such as apples, pears and cherries, the tolerance has been a decreasing one in order to give fruit growers an opportunity to reorganize their spray practices and to develop cleaning processes in a way that a probable final tolerance of .01 grain can be met without too great a hardship upon the industry. With this situation confronting the producers, all spray programs should be developed accordingly or else definite methods of removal of any excesses of objectionable materials from the food products should be developed.

**Studies Made**

A study has been made of the arsenical residue upon a number of samples of cherries, both fresh and canned, during the course of the work of 1929 and 1930. The samples were all taken by the writer, largely from the experimental orchards, and all analyses were made at the Denver Station of the United States Food, Drug and Insecticide Administration. The writer wishes to express his thanks to L. D. Elliot and J. Edw. Kimel of that office for their cooperation and interest in this part of the work, and to J. A. Sampson, Manager of the Fort Collins Plant of the Kuner-Empson Canning Company, for being permitted to follow fruits thru the factory and to take samples wherever desired.
Table 12 gives the arsenic trioxide residue found upon 26 samples, along with the time of application, strength and kind of spray material used, and variety of fruit. All samples taken in the orchard were taken at the time the fruit was being harvested. They were picked with stems and placed directly into sacks, with as little handling as possible, boxed and mailed to the laboratory. The stems were removed at the laboratory before the weight was computed. An effort was made to pick fruits that showed the most spray material, as is the custom of the inspectors who take regular samples for residue analysis. The samples taken at the factory, unless otherwise designated, were taken as average samples representing several hundred pounds of fruit. Such fruit is picked without stems and hauled to the factory in flat boxes, holding about 20 pounds each. The samples were made up by taking a few cherries from each of several of these boxes.

Table 12.—Results of analysis for arsenical residue on cherries sprayed with lead arsenate.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Variety</th>
<th>Treatment</th>
<th>Grains $\text{AS}_2\text{O}_3$ per pound of cherries</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Early Richmond</td>
<td>Block 1, Orchard 3, 1929. Lead arsenate spray 1.5-50 (a), husks off, one-half grown. Taken in orchard</td>
<td>.038</td>
</tr>
<tr>
<td>2</td>
<td>Early Richmond</td>
<td>A. C. Abbot orchard. Lead arsenate 1.5-50, two sprays—dates not known. Taken in orchard</td>
<td>.013</td>
</tr>
<tr>
<td>3</td>
<td>Early Richmond</td>
<td>R. N. Plummer orchard. Lead arsenate 2-50, full bloom, husks off. Taken in orchard</td>
<td>.023</td>
</tr>
<tr>
<td>4</td>
<td>Early Richmond</td>
<td>Cheatwood orchard. Lead arsenate spray 1.5-50, husks off. Taken in orchard</td>
<td>.008</td>
</tr>
<tr>
<td>5</td>
<td>Early Richmond</td>
<td>Same as Sample 1. Taken at factory</td>
<td>.003</td>
</tr>
<tr>
<td>6</td>
<td>Early Richmond</td>
<td>Same as Sample 1, after being washed at factory</td>
<td>.0028</td>
</tr>
<tr>
<td>7</td>
<td>Early Richmond</td>
<td>Same as Samples Nos. 5 and 6 after being pitted and canned</td>
<td>.004</td>
</tr>
<tr>
<td>8</td>
<td>Montmorency</td>
<td>Block 1, Orchard 2, 1929. Lead arsenate spray 1.5-50, husks off. Sample taken in orchard</td>
<td>.01</td>
</tr>
<tr>
<td>9</td>
<td>Montmorency</td>
<td>Block 2, Orchard 2, 1929. Lead arsenate spray 1.5-50, husks off, one-half grown. Sample taken in orchard</td>
<td>.025</td>
</tr>
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<td>10</td>
<td>Montmorency</td>
<td>Block 1, Orchard 1, 1929. Lead arsenate spray 1.5-50, blossom-fall, husks off. Sample taken in orchard</td>
<td>.018</td>
</tr>
<tr>
<td>11</td>
<td>Montmorency</td>
<td>Block 1A, Orchard 1, 1929. Lead arsenate spray 1.5-50, blossom-fall, husks off, one-half grown. Sample taken in orchard</td>
<td>.035</td>
</tr>
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<td>12</td>
<td>Montmorency</td>
<td>Block 5A, Orchard 1, 1929. Calcium arsenate dust 1.0 (b), blossom-fall, husks off, one-half grown. Sample taken in orchard</td>
<td>.005</td>
</tr>
<tr>
<td>No.</td>
<td>Variety</td>
<td>Details</td>
<td>Pounds</td>
</tr>
<tr>
<td>-----</td>
<td>-------------</td>
<td>-------------------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>13</td>
<td>Montmorency</td>
<td>Block 5, Orchard 1, 1929. Calcium arsenate dust, 1-9, blossom-fall, husks off. Sample taken in orchard</td>
<td>.006</td>
</tr>
<tr>
<td>14</td>
<td>Montmorency</td>
<td>Block 6, Orchard 1, 1929. Lead arsenate spray 1.5-50. Blossom-fall, husks off, one-half grown. Sample taken in orchard</td>
<td>.039</td>
</tr>
<tr>
<td>15</td>
<td>Montmorency</td>
<td>Same as Sample No. 14. Washed in 2 waters</td>
<td>.019</td>
</tr>
<tr>
<td>16</td>
<td>Montmorency</td>
<td>C. G. McWhorter orchard. Lead arsenate spray 1-50, blossom-fall, husks off. Sample taken in orchard</td>
<td>.006</td>
</tr>
<tr>
<td>17</td>
<td>English Morello</td>
<td>Block 3, Orchard 2, 1929. Lead arsenate spray 1.5-50, husks off. Sample taken in orchard</td>
<td>.011</td>
</tr>
<tr>
<td>18</td>
<td>English Morello</td>
<td>Block 4, Orchard 2, 1929. Lead arsenate spray 1.5-50, husks off, one-half grown. Sample taken in orchard</td>
<td>.03</td>
</tr>
<tr>
<td>19</td>
<td>English Morello</td>
<td>Block 1, Orchard 3, 1929. Lead arsenate spray 1.5-50, husks off, one-half grown. Sample taken in orchard</td>
<td>.04</td>
</tr>
<tr>
<td>20</td>
<td>English Morello</td>
<td>Same as Sample No. 19. Taken at factory</td>
<td>.016</td>
</tr>
<tr>
<td>21</td>
<td>English Morello</td>
<td>Same as Sample No. 20 after being washed at factory</td>
<td>.008</td>
</tr>
<tr>
<td>22</td>
<td>English Morello</td>
<td>Same as Sample No. 20 after being washed, pitted and canned</td>
<td>.009</td>
</tr>
<tr>
<td>23</td>
<td>English Morello</td>
<td>Block 3, Orchard 1, 1930. Lead arsenate spray 1.5-50, blossom-fall. Sample taken in orchard</td>
<td>.002</td>
</tr>
<tr>
<td>24</td>
<td>English Morello</td>
<td>Block 5, Orchard 1, 1930. Lead arsenate spray 1.5-50, blossom-fall; 1-50 husks off. Sample taken in orchard</td>
<td>.009</td>
</tr>
<tr>
<td>25</td>
<td>English Morello</td>
<td>Block 7, Orchard 1, 1930. Lead arsenate spray 1.5-50, blossom-fall, 1-50 husks off, one-half grown. Sample taken in orchard</td>
<td>.017</td>
</tr>
<tr>
<td>26</td>
<td>English Morello</td>
<td>Block 18, Orchard 3, 1930. Lead arsenate spray 1-50, husks off, one-half grown. Sample taken in orchard</td>
<td>.014</td>
</tr>
</tbody>
</table>

(a) Lead arsenate 1.5 pounds, water 50 gallons.
(b) Calcium arsenate 1 part, hydrated lime 9 parts.

**DISCUSSION OF RESULTS**

A study of the results will indicate that it is going to be difficult to develop a very definite program of spray with arsenical insecticides without having more than the tolerance of .01 grains of arsenic to the pound of cherries. In Sample 1, two applications of 1.5 pounds of arsenate of lead left .038 grains or almost four times the tolerance.

Since most of the cherries are canned, it was important to know the arsenic content of some of this same fruit after being canned. Sample 5 was a composite sample taken after a load of the fruit came to the factory. This shows a very marked decrease in the residue, the .003 grain being well below the tolerance. This difference is partly accounted for by the fact that the fruit showing the most spray was taken for Sample 1, and Sample 5 was handled more. Many of the cherries were wet from leaking of juice where the stems
pulled out. The residue is further reduced to .0028 grain in Sample 6, which was taken after this same fruit had gone thru the washing process used at this factory. The washing consisted of dumping the cherries directly into a vat of water that had fresh tap water running into it all the time. The fruit remained in this from 2 to 10 minutes, then was lifted by a cleated belt and dropped onto another long belt, on which it passed under four nozzles, each spraying tap water under from 60 to 80 pounds pressure. Sample 7 represents a can of this same fruit. It shows a marked increase in the arsenic content over Sample 6, probably due to a concentration of the portion carrying spray by the removal of pits.

Samples 2 and 3 represent fruit from growers’ orchards that were probably not as heavily sprayed as were the experimental blocks. Yet both of these runs over the tolerance in arsenic, the one being sprayed with 2 pounds to 50 gallons showing considerably more than where 1.5 pounds were used.

One application of arsenate of lead, 1.5 pounds to 50 gallons of water, just after the husks were off, brought the residue just to the tolerance in Sample 8, and a second application, applied when the fruit was about half grown, as shown in Sample 9, increased the residue to .025. The application at the half-grown stage left 1.5 times as much residue as did the husk-fall application.

Samples 10 and 11 represent 2 and 3 applications in Orchard 1, 1929. It will be noticed that the three applications left .035 grain per pound or almost twice what was left by 2 sprays. In these cases the first 2 sprays were made at the same time on each block and the third one on Block 1A came when the fruit was larger or about half grown, and had a larger surface area to hold poison. The third spray added almost as much arsenic as the other two.

Samples 12 and 13 represent 2 and 3 applications of calcium arsenate dust. Both are below the tolerance. The small amount of the insecticide that adhered probably is responsible for the poorer control shown on these blocks.

Sample 14 received 3 applications of 1.5 pounds of arsenate of lead to 50 gallons of water, and carried 3.9 times the tolerance. Sample 15 was some of the same fruit, washed much as a housewife might wash it. About 5 pounds of the fruit that had been picked with the stems were placed in a pan and the pan filled with tap water. The fruit was then agitated with the hands, the water poured off and the process repeated. The two washings apparently reduced the residue almost one-half or from .039 to .019.

Samples 17 and 18 are interesting in that they show again the increased residue left by the later applications. A husk-fall spray of
lead arsenate 1.5 pounds to 50 gallons of water, showed a residue of .011, while another application when the fruit was about half grown, increased this to .03 grain.

Samples 19, 20, 21 and 22, represent fruit from Block 1, Orchard 3, 1929, that was sprayed with 1.5 pounds of arsenate of lead to 50 gallons of water, just after the husks fell and again when half grown. The sample of the most heavily sprayed fruit taken in the orchard carried .04 grain and an orchard-run sample taken at the factory, .016 grain. The washing process at the factory removed just one-half of this, the washed sample showing .008 grain. The amount of arsenic per pound in the finished food product was again slightly higher than before the cherries were pitted and canned, the amount being .009 or only .001 grain below the tolerance.

With the spray residue problem in mind the spraying in 1930 was done with 1.5 pounds of the arsenate of lead to 50 gallons of water, for the blossom-fall spray, when the cherries would be small and protected by the husks and 1 pound to 50 gallons for the two later applications. Samples 23, 24 and 25 give us an idea of the amount left by each of the three applications. The blossom-fall spray alone left only .002 grain, the husk-fall application increased this to .009 or added .007 grain, and the third application added .008, bringing the total on the fruit with three sprays to .017 grain.

A strict enforcement of the tolerance would prevent this fruit that was sprayed three times from going on the market to be sold as fresh fruit. The canned product from it, if handled as in the Fort Collins factory of the Kuner-Empson Company, would very likely carry arsenic below the tolerance.

Samples 26 and 19 each received the husk-fall spray and another when the fruit was half grown. The strength used on 19 was 1.5 pounds of the arsenate of lead to 50 gallons of water, while on 26 it was 1 to 50. The residue on 19 was .04 and on 26 it was .014 grain. Sample 19 represents the 1929 season when very little rain fell on the growing fruit, and Sample 26 represents 1930 when some very heavy rains occurred shortly before picking time.

**RELATION OF THE RESIDUE PROBLEM TO THE SPRAY PROGRAM**

These results would indicate that the most desirable spray programs for cherry curculio leave more than the tolerance of arsenic residue. Even tho 1.5 pounds of arsenate of lead to 50 gallons of water give somewhat better control than 1 pound to 50, the latter strength should be used in all applications later than the blossom-fall. Fruit that is to be sold as fresh fruit without any cleaning, should not receive more than the blossom-fall and one later applica-
tion. It would appear that the full schedule of three applications could be safely used if the fruit is to go thru the canning factory, but the strength should not be over 1 pound of the arsenate of lead to 50 gallons of water, especially in the last two applications.

**Cleaning the Fruit**

The results indicate that a careful washing of the fruit in tap water greatly reduces the amount of spray residue. On account of the nature of the fruit, this must be done just before using. While this is practiced at the factories, greater attention in many cases could be given to this part of the canning process.

There is little doubt but that washing the fruit in a dilute (1 percent) solution of hydrochloric acid, as practiced in many sections for spray removal by the apple and pear growers, would remove the arsenic to below the tolerance. This would probably not be practical with fruit going to the market as fresh fruit, but could undoubtedly be developed for use in factories where the cherries could be immediately washed in pure water and used at once.

**Sorting of the Fruit**

*sorting by hand*

The question has arisen in a number of cases as to the best way of salvaging the marketable portion of the crop in a heavily infested orchard. In many cases the infested cherries cannot be detected with certainty. The egg punctures may have healed until they might be mistaken for food punctures. In some cases beetles have been observed to emerge from fruits where external injuries could scarcely be detected. Probably the most careful hand sorting can be done at picking time, altho this is usually discouraging when the pickers are paid by the pound as is the usual custom. By leaving the smaller fruits and all that show pronounced blemishes on the trees, a fairly marketable product can often be harvested from a rather heavily infested orchard. Since practically all the larvae feed and pupate within the pits, the insect is not the menace in the factory that a species that feeds in the flesh can be. Most of the insects are removed with the pits. In the case of the English Morello variety, the picking comes late enough that all beetles have emerged and the exit holes are easily distinguished.

The picking of the Early Richmond is usually completed before many beetles have escaped and late injury is avoided. Much of the late injury on the Montmorency can be avoided by picking early. The extent to which blemished fruits can be marketed depends upon the use to which they are to be put. The factories that make cherry cider, can often use blemished fruit that would not make a satisfactory
canned product, as long as it is not wormy. Where the infested and
badly blemished fruit is left on the tree, it is a good control practice
to go over the trees the second time and pick and destroy all of this
before the beetles escape. This should have been done in a number
of orchards in Jefferson County this last season.

SORTING BY FLOTATION

Many undesirable fruits can be removed at the factories by flo-
tation. Some of the factories have made good use of this. In most
places the fruit is dumped into a small vat of water, from which it is
lifted by a belt to the sorting belt, which in turn takes it to the pit-
ters. These water vats could, in some instances, be larger and have a
greater overflow of water, which would carry off many undesirable
cherries. In some cases the dipping of the floaters off the surface
helps. This is especially practical in the factories where the fruit,
before being pitted, is chilled in large vats of ice water. The differ-
ent varieties vary in specific gravity. The English Morellos have a
rather solid flesh and a large and thick-shelled pit, that make them
rather heavy. Very few of these, even the wormy ones, will float.
The Montmorencies are not quite so heavy for their size, but there
is a great variation even among these. However, few of the un-
injured ones will float.

In 1929 some specific gravity tests were made to determine the
possible value of flotation in selecting out wormy fruits. An entire
sample from one of the Montmorency spray blocks was sorted into
blemished and unblemished fruit. There were 2484 unblemished and
975 injured. The injured cherries were all placed in a vat of tap
water having a temperature of about 55 degrees F. Of the 975 cher-
ries 211 came to the surface. Of those that floated, 203 were wormy
and 8 uninjured. Of those that sank, 183 were infested and 581 un-
infested. Less than 1 percent of those that were uninjured by in-
serts came to the surface. This rather crude test and the observa-
tions in some of the factories indicate that few of the uninjured Mont-
morencies will float and probably not more than 50 percent of the in-
fested ones could be selected out by this method. However, since the
cherries usually go thru water vats at the factories, it would seem
worth while to take all advantage possible of the sorting by flotation.

It was thought that it might be possible to cause a larger per-
centage of the infested fruits to float without the loss of many un-
infested cherries, by increasing the specific gravity of the liquid.
This was done by adding common salt. It was first added at the rate
of 10 grams to each 1000 cubic centimeters and increased 10 grams
each time until a total of 110 grams was being used. The specific
gravity of the liquid in the first test was 1.008 and in the last one
1.070. It is hardly necessary to give the detailed data on all the tests, but it will probably suffice to say that even the specific gravity of 1.008 began bringing uninfested fruits to the surface. Ninety grams of salt for 1000 cubic centimeters of water were used and a specific gravity of 1.056 produced before the last infested cherry floated. This same specific gravity, however, had brought to the surface approximately 80 percent of the uninfested fruits. So it would appear from this that the tap water is the most efficient and certainly the most practical to use.

**Control Recommendations**

It is evident from the data presented that the cherry curculio is the most serious where hibernating conditions in and near the orchard are favorable. The infested orchards, wherever possible, should be thoroughly cultivated to destroy all the grass, weeds and crop refuse that is on the surface. The working of the weeds or a cover crop into the soil late in the fall should suffice for that part of the control. Adjacent fence rows and grassy places should be burned over in the fall or early winter.

Growth of the chokecherry near the orchard should be destroyed.

In the more heavily infested orchards, all cherries remaining on the trees after the marketable fruit has been picked should be picked and destroyed. This applies especially to those varieties that can be harvested before all the beetles leave the fruit.

Considering all things, lead arsenate is the most desirable of the insecticides tested. Applications at three different times in the development of the cherry have shown results. These are just after the blossoms have fallen, just after the husks have been shed by the fruits, and about one week later or when the cherries are about half grown. These probably rank in effectiveness in the order named. All three applications are recommended for the heavily infested orchards. In the lightly infested orchards where Grapholitha packardi Zell. is a problem, the two later applications are suggested. Where Grapholitha packardi Zell. is not a problem, the earlier applications are preferred. The lead arsenate should be used in the blossom-fall applications at the rate of 1.5 pounds to 50 gallons of water, and in the two later ones, 1 pound to 50 gallons. The spraying should be thorough, as it can be effective only against the beetles and they eat only small surface areas.

**SUMMARY**

The genus *Tachypterellus* is represented from the Atlantic to the Pacific in the United States and Canada. Only one species, *T. quadrigibbus* (Say) has been generally recognized. This has been
looked upon as a very variable and unusually widespread native species. Another species, *T. consors* Dietz, was described in 1891 from a single specimen, but has not been generally recognized.

A study of material from 22 states and 4 points in Canada, has been made and the conclusion is drawn that four distinct forms exist. Two of these represent the species mentioned above and two are described as new.

Male and female genitalia characters of the four forms have been studied. The new forms are not considered distinct enough to be given the rank of full species. They are described as *T. quadrigibbus magna*, n.subsp., and *T. consors cerasi*, n.subsp.

The type material of *T. quadrigibbus magna* came from Mitchellville, Iowa, and Troy, Kansas. The type locality for *T. consors cerasi* is Fort Collins, Colorado.

*Tachypterellus quadrigibbus* (Say) is redescribed and neotypes designated. The neotypes are from Pennsylvania, New York and Massachusetts.

True specimens of *T. consors* Dietz were examined from Hotchkiss, Colorado, and Rexburg, Idaho. Dietz’s type was from Oregon.

While these forms are distinct in their several localities, there appears to be definite regions of intergradation.

All feed upon fruits. The native hosts of *T. quadrigibbus* (Say) and *T. q. magna*, n.subsp. are Craetagus and wild crabs.

*T. quadrigibbus* (Say) is often a pest upon the apple and pear and breeds readily upon the hawthorn and wild crab. It has been reported on the plum, cherry, shadbush and cotton. *T. q. magna*, n.subsp. is a pest upon the apple, breeds readily upon the hawthorn and wild crab, and has been reported from pear and plum. Little is known of the hosts of *T. consors* Dietz. It has been taken on apple and probably feeds on hawthorn and chokecherries.

The native host of *T. consors cerasi* n.subsp. is the chokecherry, *Prunus melanocarpa* (A. Nels.) Rhdb. It has recently become a serious pest upon the cultivated sour cherries. One specimen has been bred from the apple in a breeding cage, but attempts to rear it from the hawthorn have been unsuccessful. It has been observed to feed on and oviposit in the wild plum.

A study, extending over several years, of the life history, habits and control of *T. consors cerasi*, n.subsp. as a cherry pest, is reported.

The insect was first noted as attacking the cultivated cherry in 1914. Since that time it has increased to the point where serious loss has occurred in two counties.
The term "cherry curculio" is suggested as the common name. Descriptions are given of the egg, larva, pupa and adult.

It winters as an adult under rubbish in and about the orchard and appears from hibernation as the standard varieties of sour cherries are blooming. The adults feed heavily upon the blossoms and small fruits. Eggs are deposited in the cherries in cavities eaten out by the female. Egg laying begins when the fruit is about the size of a small pea and continues for 2 or 3 weeks. The larva goes into the pit and feeds upon the kernel. Pupation takes place within the pit and adults begin to emerge about as the mid-season varieties, such as Montmorency, begin to ripen. The new adults feed heavily for a few days upon the ripening fruits, then go into winter quarters. There is but one generation in a year.

The insect does not take readily to captivity. This, coupled with the fact that cherries break down so quickly that they cannot be used as laboratory food for the larvae, has made it difficult to get satisfactory detailed data on some points in the life history.

Life-history studies were made in the laboratory and by caging insects on the tree. The habits of the adults in the orchard and cages are discussed.

From 25 to 40 percent of the cherry crop may be destroyed during the blossom period, in a heavily infested orchard, from the feeding of the adults. This feeding cuts many stems and destroys the ovaries of many blossoms. In the later feeding on the fruit the adults cut a circular hole large enough for the long snout and feed to as great a depth as the length of the snout will permit. When the cherries are small the cavity may extend into the pit.

Some injuries may heal to the extent that only a black speck is detectable, but there is usually a sunken area and in many cases the skin may be "tied" to the pit, or the fruit made very much one-sided. The number of food punctures per beetle during the season is well over 150.

Eggs are deposited in cavities eaten into the fruit by the female. When the fruits are small the cavities may extend into the pit, but later they may not reach the pit. The number of eggs per female in breeding cages ranged from none to 19. Egg laying begins when the cherries are shedding their husks, and reaches the peak when the fruit is about half grown. Some eggs may be deposited as late as when the earlier varieties are almost full grown.

Some of the overwintering beetles live until August, but the most of them die during the last of June and fore part of July.

The incubation period of the eggs has varied from 3 to 11 days. The average in 1927 was 6.37 days and in 1929, 5.36 days.
The larvae are primarily seed eaters. Only 3.3 percent have been found to develop outside the pits. The feeding upon the kernel does not materially affect the growth of the cherry. Only a small entrance hole into the pit is made by the larva. This is enlarged for the exit of the beetle by the mature larva. The larval feeding period varies from 18 to 24 days.

Pupation takes place within the pit. The average pupation period is 6.9 days. The adults remain in the pits from 1 to several days after emergence, then eat their way thru the fleshy portion of the fruit. Emergence begins about as the Montmorency cherries are ripening. In 1926 the first beetles left the fruits on July 2, and practically all were out by July 20. On July 15, 1927, 70 percent had left the fruit, and 97 percent were in the adult stage. The season of 1929 was somewhat later; 27 percent were yet in the fruit July 24.

The newly emerged adults feed ravenously for about a week or 10 days upon the ripening cherries, then go into winter quarters. Active beetles are very difficult to find in the orchards, after July 25 or August 1.

Hibernating beetles have never been taken in the orchards. When confined, the beetles go under grass or other covering on the ground for hibernation.

The feeding of the newly emerged beetles blemishes many ripening fruits and makes it possible for other insects to feed upon the juice.

The curculio shows no marked preference for any variety grown in the infested districts. The time of blossoming, hardening of the pits, and ripening of the fruit have a bearing upon the extent of injury to the different varieties. There is something of a tendency to oviposit in small dwarfed fruits that later drop. This is a detriment to the insect as few larvae mature in fallen fruits.

The injury is summarized as of six kinds: 1. Blossom injury caused by the feeding of the beetles just out of winter quarters. 2. Food punctures on the growing fruits. 3. Egg punctures. 4. Feeding of larvae. 5. Exit holes made by the new generation of adults. 6. Feeding of the new adults. The total injury has varied from a point where it is hardly noticeable to a total loss of crop. The greatest amount of injury comes from Nos. 1 and 2.

Eight species of parasites, two of which were new to science, were reared from the cherry curculio. The parasitism varied from nothing to 78.7 percent. The average for 1930 was 39.38 percent and for a 3-year period, 22.8 percent. The species reared were Eurytoma tylodermatis Ashm., Habrocytus piercei Crawford, Entedon tachypterelli Gahan, Habrocytus lividus Gahan, Zatropis incertus (Ashm.),
Tetrastichus sp., Eupelminus saltator (Lindeman) and Microbracon tachypteri Mues.

A brief description of the cherry-growing conditions and practices in the infested counties is given. The conclusion is drawn that the most heavily infested orchards are those that have an undergrowth of grass, weeds or other material that affords desirable hibernating places for the insect. The proximity of the chokecherry has a bearing on the curculio infestation, but does not present an important problem.

Tests of insecticides were made during four seasons. The results are presented in tabular form and discussed. The best results were secured with arsenate of lead and sodium fluosilicate. The arsenate of lead is to be preferred as it gave better results in the control of the cherry slug and Grapholitha packardi Zell., two other pests common in the orchards. Sprays gave much better results than dusts.

Probably the most important time to make a spray is just after the blossoms have fallen. At this time the beetles are cutting stems and eating into the base of many small fruits. An application just after the husks have fallen from the small fruits is of about equal importance. A third application about 7 to 10 days after the second or when the fruits are about half size is of value. All three applications should be used in a heavily infested orchard. In an orchard with a medium to light infestation, the first two will suffice.

If Grapholitha packardi Zell., is also a problem, the last two make the more desirable schedule. One and one-half pounds of arsenate of lead to 50 gallons of water, gave somewhat better results than 1 pound.

Analyses were made of samples of fruit from many of the experimental spray blocks to determine the amount of spray residue on harvested fruit. Most of the samples carried more than the proposed tolerance of .01 grain of arsenic trioxide per pound of fruit, one having .04 grain. The handling and washing of the fruit at the canning factories removes some of the residue. No samples of the canned cherries carried more than .01 grain per pound. The later applications left the largest amounts of residue.

It appears from the data that the three sprays can be used only on such fruit that is to be carefully washed at the factory. Fruit that is to be sold as fresh fruit should not receive more than the first two sprays, and 1 pound to 50 gallons of water should be the maximum strength used.

About 50 percent of the infested fruits can be sorted out by
water flotation. Many of the infested fruits can be detected at picking time. These, if left on the trees when harvesting the marketable fruit, should be picked later and destroyed.

Control recommendations include the destruction of hibernating places in and about the orchards, in some cases the destruction of nearby growths of chokecherries, the spraying with arsenate of lead, and the destruction of infested fruits when these can be picked before the beetles escape.

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