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# THE "STING" IN THE APPLE.

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## BULLETIN NO. 64

# THE "STING" IN THE APPLE—THE WORK OF THE PLUM CURCULIO IN THE APPLE.

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*Conotrachelus nenuphar, Hbst.*

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By J. M. Stedman, Entomologist.

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## SUMMARY OF RESULTS.

I. The "sting" in the apple is caused by the common Plum Curculio, which as an adult beetle makes minute holes through the skin for the purpose of feeding and also for the purpose of depositing eggs.

II. There is but one brood of these beetles each year, the new adults emerging in the late summer and hibernating over winter in sheltered places.

III. In the spring the beetles feed on the developing leaves and petals of the flowers, and later on the apple itself.

IV. The male beetles feed by puncturing the apple throughout the season, while the female beetles not only do likewise but also puncture the apples for the purpose of laying eggs.

V. The number of "stings" which the beetles cause on the apples are far in excess of the production of young, and a very small per cent only of the eggs deposited ever succeed in producing adult beetles—

probably not more than two per cent.

VI. The apples containing young larvae must fall by the time the larvae are half grown otherwise they perish.

VII. The full grown larvae leave the fallen apples and enter the soil an inch or two and there transform to delicate pupae which remain in this stage for two weeks or longer.

VIII. The young beetles emerge from the soil in the late summer and feed by puncturing or "stinging" the apple, and later seek winter hibernating quarters.

IX. There are three methods of procedure we can follow, each one of which will greatly lessen the insects and therefore the "sting," but all three of which should be used. They are:

X. Spray the trees once or twice with arsenate of lead before the blossoms open, and then after the blossoms fall, spray every ten days for three or four sprayings. Destroy once every seven days all apples that drop to the ground. Plow the orchard very shallow and harrow it very thoroughly the middle of July, and harrow it again thoroughly the first of August and again the middle of August.

XI. By following all the above three methods the plum curculio can be completely controlled in the apple orchard and damage from the "sting" prevented.

## INTRODUCTION.

During the latter part of the summer of 1900 my attention was called to the unusually prevalent and injurious effect of the so-called "sting" in the apples throughout the entire State of Missouri and especially in the Ozark region. Hundreds of letters and many affected apples were being received at this office. Some correspondents claimed that every apple in their large commercial orchards were thus "stung" and thereby

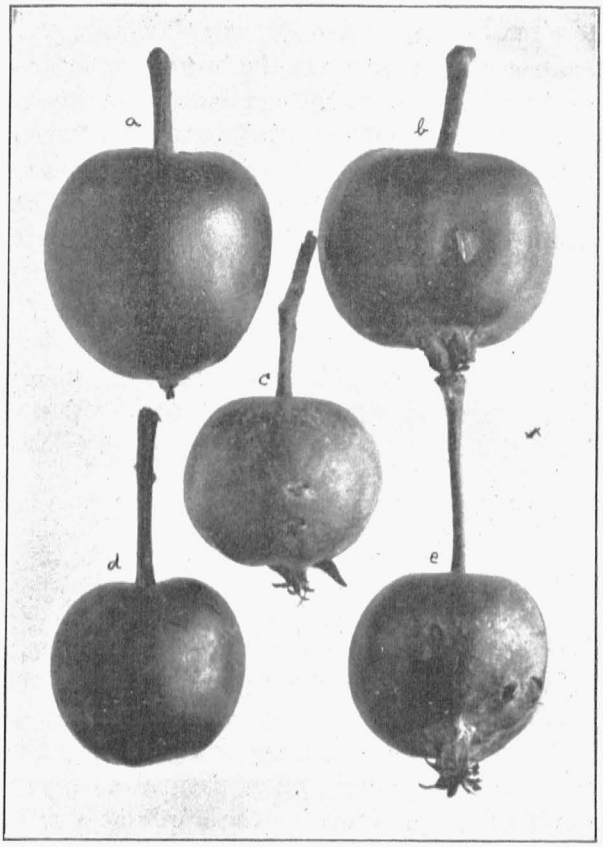


**Fig. 1.**—Young apples "stung" by the Plum Curculio: a.—apple rotting at the "sting"; b, c.—apples recovering from the "sting"; d.—feeding puncture; e.—egg punctures and one large hole made by the Plum Gouger. Natural size. (Original.)

reduced from a number one grade to a number two grade, while the greater per cent were reduced to a number three grade and to culls. Since in commercial orcharding the profits are made on number one apples, it was very easy to understand the serious situation confronting our apple industry. Several correspondents, some owning large commercial orchards, said that this trouble was more serious with them than that of all

other insects and fungous diseases combined, not except the bitter rot.

A trip was made through the larger apple growing sections of the State, a general survey obtained and plans laid for experiments with this trouble the following season. It was evident from what was seen on the trip that, in a general way, our correspondents had not exaggerated the destructive work of this insect. These experiments were carried on for three years with the result herein given. The years 1900, 1901 and 1902, during which time these experiments were being conducted, were fortunately just the years in which this insect did its most destructive work.

## THE CAUSE OF THE "STING" IN THE APPLE.

It was found that practically all the so-called "stings" were the work of the common Plum Curculio, *Conotrachelus nenuphar, Hbst.,* in feeding upon and in despositing eggs in the apples. This insect is a beetle belonging to the family Curculionidae, of the order Coleoptera. By referring to figure 1, which is a photograph of five young apples natural size, you will observe a feeding puncture on the apple at *d* and four egg punctures on the apple at *e*. The large hole eaten into the apple at *e* was caused by another insect known as the Plum Gouger—*Anthonomus prunicida.*

While the Plum Curculio was responsible for practically all the "stings," a very few "stings" were found to be those of the apple curculio—*Anthonomus quadrigibbus,* but as these were so extremely rare, they could be eliminated from our attention—the real damage to the apples being done by the common plum curculio, which is the insect treated of in this bulletin.

## HOW THE INSECT WORKS.

The adult Plum Curculio are alone responsible for the "stings." A photograph showing one of these beetles natural size is seen at *a* in figure 2, while at figure 3 is shown a photograph of the same adult magnified five diameters, and at figures 4 and 5 drawings also magnified five diameters. The beetles begin to cause the "sting" on the apples about the middle of May, while the young apples are about the size of large cherries, and by the first of June become so numerous as to attract attention by the many punctures or "stings" they now make. The male beetles make only

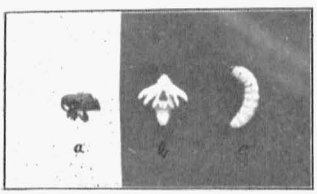


**Fig. 2.**—The Plum Curculio: a.—Adult; b.—Pupa; c.—Larva. Natural size. (Original.)

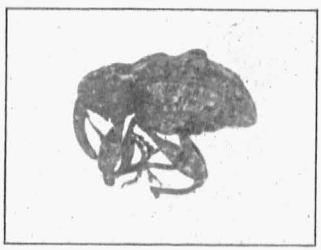

**Fig. 3.**—The Plum Curculio; adult, magnified five diameters. (Original.)

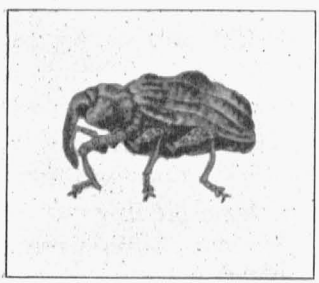

**Fig. 4.**—The Plum Curculio: adult, magnified five diameters. (Drawing.)

**Fig. 5.**—The Plum Curculio: adult, magnified five diameters. (Drawing.)

the feeding punctures in apples, while the female beetles make both feeding punctures and egg punctures. From our observations we estimate that during May the females make from four to five times as many feeding punctures as egg punctures, and that as a result of the work of both male and female beetles we find about twelve times as many feeding punctures as egg punctures on the apples. In all cases these punctures, whether for purposes of feeding or for the depositing of eggs, are known as "stings" among the horticulturists. During June the females make almost as many egg punctures as feeding punctures.

In making the feeding punctures the beetle eats a small round hole through the skin by means of its mandibles or jaws, which are situated on the extreme end of its long beak or snout. This hole is about one-tenth of an inch in diameter. It then eats the pulp about one-tenth of an inch in depth, thus leaving a small cylindrical hole in the apple. As the apples are now small and growing rapidly, it frequently happens that, if fungoid and other diseases do not attack it at this point, the apples recover from this puncture, the tissues growing over it and leaving a scar only, as is shown by the natural size photograph at *c* in figure 6, and at *l* in figure 7. A single apple may have many such feeding punctures on it.

During July and August the beetles have the habit of also eating the pulp back under the skin as far as they can reach all around the hole. These feeding holes then become very conspicuous, since the undermined skin withers, shrinks and turns dark and the apple usually commences to rot at this place. As at this season apples are not able to outgrow these feeding punctures, they are absolutely ruined for storage purposes.

In making punctures for the purpose of depositing eggs, the females also eat the tissues of the apple, and this is probably the reason why during the egg-laying

season they do not make as many purely feeding punctures as they do earlier and later in the season. The female first eats a small hole through the bark and then eats the pulp back about one-sixteenth of an inch, thus making a small cylindrical hole, usually quite parallel to the skin. She then turns around and deposits an egg in this hole, which is just large enough to receive the

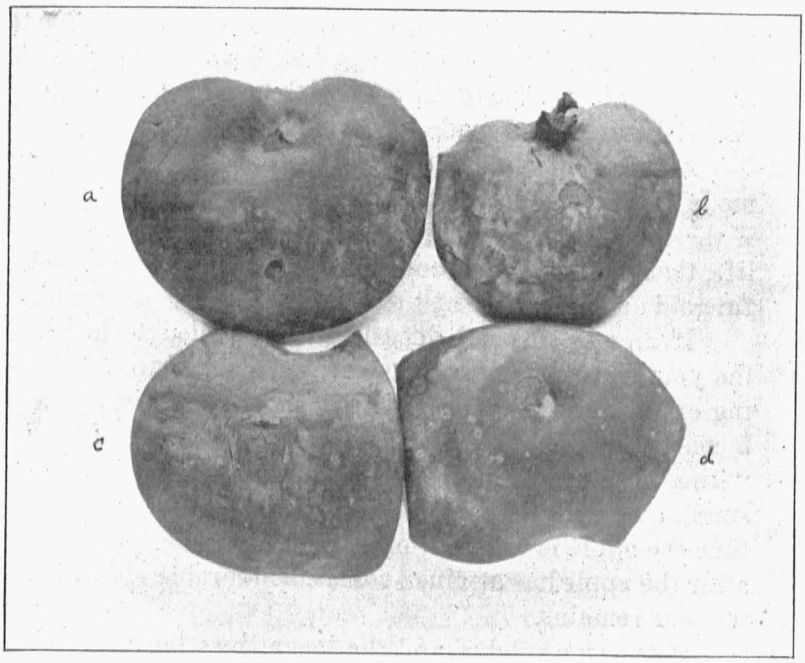


**Fig. 6.**—Portions of apples recovering from the "sting": a, d.—scars in depressions caused by the larva entering the pulp a short distance before dying; b.—scar caused by an egg-depositing puncture, the egg never having hatched; c.—scar caused by a feeding puncture. Natural size. (Original.)

egg nicely. Having accomplished this, she then eats the tissue while cutting a small crescent shaped hole through the skin and into the pulp so as to partly surround and partly undermine the egg. Such complete egg punctures or "stings" are shown at *a, b, c, e, f, g,* in figure 7, which is a photograph natural size of portions of apples cut out for this purpose. By observing figure

8, you will notice at *a, b, c, d,* and *f,* the same punctures more distinctly, as they are here photographed enlarged two and a half diameters.

While the above description of "stings" for egg depositing purposes can be said to be the normal method for this plum curculio and to be peculiar to this species, we noted many variations from it; we found many egg cavities containing eggs where the beetle had neglected to cut the characteristic crescent, and we also found many crescents in which the egg had been deposited in the crescent instead of in a special pocket, no special pocket having been made.

As most of these egg punctures or "stings" are made during the rapidly growing season of the apple, if the eggs fail to hatch or the larvae die early in their life, then the apple may outgrow the "stings," provided fungoid and other diseases do not attack it at this point.

If an egg was not deposited or it failed to hatch, the young apple gradually outgrows the "sting," leaving only a scar in its stead, as is shown at *b,* in figure 6, and at *d,* and *k,* in figure 7 and *e,* in figure 8. If the "sting" be made while the apple is comparatively small, all traces of even the scar may disappear by the time the apple is full grown, but if the "sting" be made after the apple has attained some considerable size, then the scar remains.

If the egg hatches and the larva lives long enough to eat its way into the pulp for a distance of from a quarter to a half inch and then dies, the apple whether young or medium size may, if no diseases enter at this point, outgrow the "sting" and leave a scar, which will be situated in a depression of greater or less extent according to the age of the apple when "stung" and to the length of the life of the larva and the depth to which it burrowed in the pulp before it died. Such scars in their depressions are shown natural size in *h, i,* and *j,* figure 7, and magnified at *a,* and *d,* in figure 6, and *g,*

figure 8. By cutting open such depressed scars, one will observe that the course of the young larva can be easily traced by the darker colored and harder tissue that forms a short thread where the larva ate its way. This tissue has a very bitter taste, becomes quite dense and does not enlarge as does the surrounding tissue, and hence the depression increases as the apple becomes

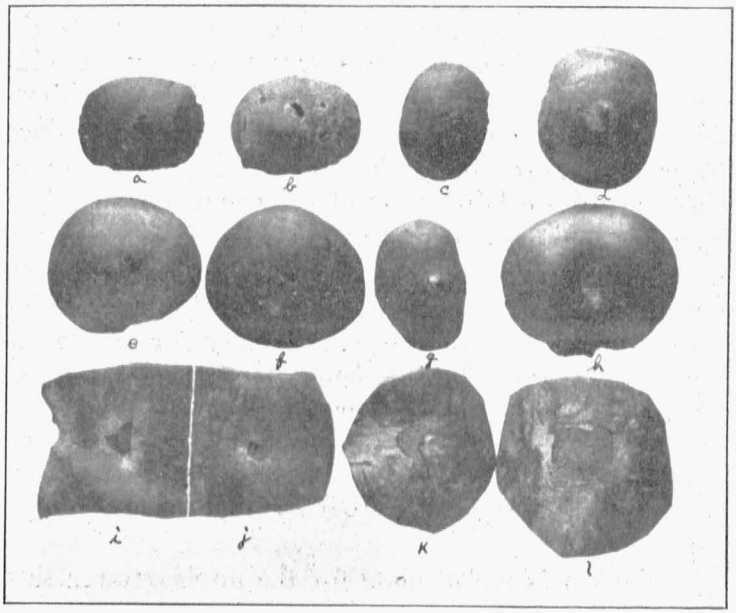

**Fig. 7.**—Portions of apples showing "stings" and scars, a, b, c, e, f, g.—egg-depositing punctures; d, k.—scars showing where the apple is recovering as the egg did not hatch; h, i, j.—scars in depressions showing the apple recovering after the larva had mined a short distance in the pulp and then died; l.—scar showing the apple recovering from a feeding puncture. Natural Size. (Original.)

larger. It is in this way that the bulk of our knotty apples are formed. Of course such knotty apples can not be sold as number ones.

A single apple may have from one to many feeding and egg or crescent punctures or "stings" and these may be distributed throughout the season, so that we have single apples covered more or less with scars, depres-

sions and "stings." Such apples, even though not attacked in these places by fungoid or other diseases cannot be sold to be placed in cold storage.

But it must be borne in mind that these various "stings" open up the way for diseases to enter and cause the apples to rot or decay at such punctures and absolutely ruin them while yet on the trees. When "stung" apples are placed in storage they soon decay at the places punctured, and since the adult beetles begin to make the feeding punctures or "stings" by the middle of May while the apples are very small and continue to do so throughout the apple growing season, and since the egg punctures or "stings" are made in great numbers during the latter part of May and during all of June and the fore part of July, and also since the young beetles emerging along in August also make feeding punctures, thus resulting in the "sting" of the apples throughout the entire season, it is easy for one to see the serious nature of this trouble—the "sting"—caused by these plum curculio in our apples.

## FACTS IN OUR FAVOR.

While it is unfortunate for the apple grower that these beetles make so many punctures for purposes of feeding pure and simple, yet it is extremely interesting, and of the utmost importance and fortunate for us that, for reasons we do not exactly understand, these plum curculio beetles are not able to multiply readily in the apple. Each female beetle is capable of laying from two hundred and fifty to four hundred eggs, and if a reasonable per cent of these could reach maturity, as they do in the plum, peach and cherry, they would overrun our apple orchards and cause us even more serious trouble. But while the female beetles make numerous egg punctures and their characteristic crescent shaped

cuts, which are a part of the egg-laying process peculiar to this beetle, nevertheless, very few eggs ever hatch in the apple. From my observations, extending over a period of three seasons, and the examinations of thousands and thousands of apples, I find that for some reason the beetles do not deposit an egg in more than half the egg punctures, even though they make the crescent shaped cuts; that in many cases the eggs are eaten or destroyed by other insects, after being deposited and before they have time to hatch; that in the great majority of cases the eggs, not so destroyed, never hatch any way; and that on an average not more than fifteen per cent of the eggs deposited ever hatch. Why this is so I am not able to explain to my own satisfaction as yet. From the few eggs that do succeed in hatching the young larvae eat their way down into the pulp of the apple for a quarter to a half inch, and then for some unaccountable reason the bulk of them die long before they have reached half their larval growth. We have opened thousands of apples with larvae in this condition, and from all we can see, are not inclined to believe the growth of the tissue of the apple pressing on the larvae can account for this mortality, as some people think. On an average of our observations, only twenty-four per cent of the larvae that hatch ever reach the full grown larval stage, even when the apples were picked or fell off the trees naturally. If the apples remain on the trees, as the most of them will, the larvae always perish. The apple must fall before the larva is much more than half grown or it will not live longer. If the apple falls, the larva may attain its full growth within the apple on the ground.

After a careful estimate, we find that on an average only two per cent of the eggs deposited by the adult female Plum Curculio in the apples ever reach the adult beetle stage. This would mean that each female beetle can normally produce in the apple only from five to eight beetles.

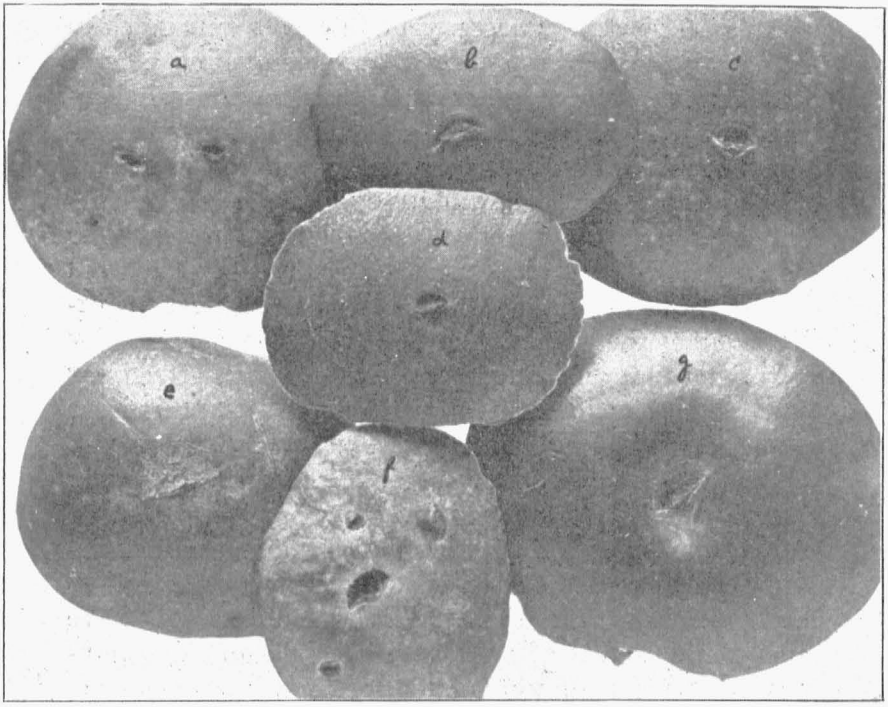


**Fig. 8.**—Portions of apples showing "stings" and scars; a.—egg punctures with larvae living in the pulp and the puncture beginning to decay; b, c, d.—egg punctures beginning to heal as the eggs never hatched; f.—badly "stung" portion of an apple, showing two punctures healing and two starting to decay; e.—egg puncture nearly healed; g.—scar in a depression as a result of the recovery and healing of an egg puncture where the larva had mined a distance in the pulp and then died. Magnified two and one-half diameters. (Original.)

## WHAT THE INSECT EATS.

The Plum Curculio is a native of North America east of the Rocky Mountain system, and will live and breed in the fruit of the Plum, Peach, Nectarine, Prune, Apricot, Cherry, Apple, Pear, Quince, Wild Plum, Wild Crabapple and Hawthorn. It prefers our cultivated plums to other fruit, and breeds better in them. It also breeds well in the peach; the plum and peach being its principal food and breeding place. Hence it is that if

plum and peach orchards are placed near apple orchards, such apple orchards suffer more from this insect than would otherwise be the case. Early in the spring the beetles feed on the developing leaves, later on the petals of the flowers, and still later entirely on the fruit.

## LIFE HISTORY OF THE INSECT IN THE APPLE.

There is only one brood of the Plum Curculio each year.

*The adult* beetles emerge for the most part during August, and feed for a time by puncturing the apples as described above. A photograph of an adult beetle natural size is shown at *a*, figure 2, and magnified five diameters in figure 3. Figures 4 and 5 are drawings of the beetle magnified five diameters. As this Plum Curculio beetle is so well known, we will not describe it, the figures being sufficient for our purpose. The young beetles may be seen in the latter part of the summer, feeding in connection with the old beetles. At the approach of fall the old beetles die and the young beetles fly about in search of suitable places in which to hibernate and pass the winter. They may fly a considerable distance, and are very fond of seeking the timber or forests, where they crawl under leaves, and also under stones, matted grass and rubbish of all kinds, and even enter the soil a short distance. They also hibernate in similar situations about the orchard or neighboring fields.

In the spring, as soon as settled warm weather appears, these hibernating beetles fly in search of food. Alighting in the apple orchard, they begin to feed a little on the young developing leaves and later on the petals of the apple flowers, and when the apples are as large as large cherries or hazelnuts begin to feed on them as before described, thus causing the "sting."

*The egg.* About the middle of May the females begin to deposit their eggs by making the characteristic puncture or "sting" for this purpose, as heretofore described. The females continue this egg-laying until the middle of July, and may work during a part of the day and a part of the night, or all day if it be cloudy, but do not appear to enjoy egg-laying during the heat of the day. They frequently drop to the ground during the middle of the forenoon and hide until late in the afternoon, then fly up into the trees and begin work again. The eggs are large enough to be seen with the naked eye, and appear quite white and rather long oval in shape. The eggs hatch in from five to seven days according to the weather.

*The larva,* when full grown, is a footless, grub-like creature about three-eighths of an inch in length, and of a white color with a brown head. A photograph of one is shown natural size at *c,* in figure 2, while figure 9, is a photograph of two full grown larvae magnified five diameters. When first hatched the larvae eat their way straight into the pulp of the apple from a quarter to

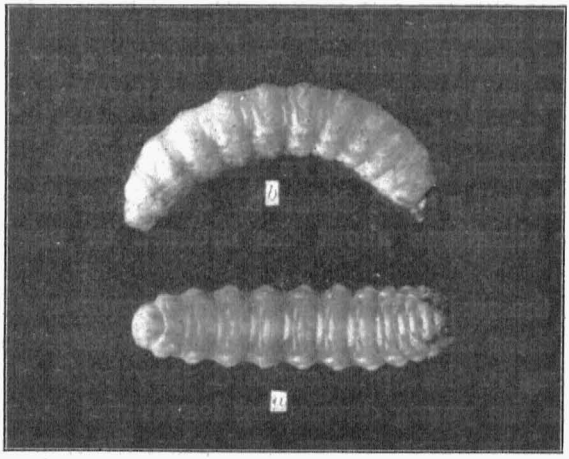

**Fig. 9.**—Larvae of the Plum Curculio: a.—ventral view; b.—lateral view. Magnified five diameters. (Original.)

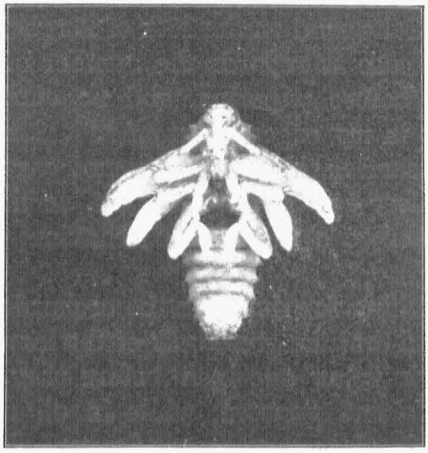

**Fig. 10.**—Pupa of the Plum Curculio ventral view. Magnified five diameters. (Original.)

half an inch, and then begin to mine in a zigzag direction, often doubling up on their course, but as a rule finally reaching the core, where frequently they eat into the seeds. It seems necessary for the life and growth of these larvae that the apples fall to the ground by the time the larvae are about half grown, otherwise the larvae appear to die. If the apple drops, the larva continues to live and grow, and after becoming full grown, eats its way out and enters the ground. The entire larval stage in the apple lasts from eighteen to twenty-one days. When the larva leaves the apple it is full grown and feeds no more, but immediately burrows in the ground from one to two inches, wiggles its body so as to pack the earth away and make a little cell, and there remains quiet from eight to fourteen days, then changes to the pupa stage. In one of our breeding cages, which had a glass bottom covered with two inches of sand, one larva left the apples on the 20th of June and at once burrowed to the bottom of the sand, where it could be distinctly observed without disturbing it. This larva pupated on the 9th of July, transformed to an adult

on the 1st of August and crawled out of its earthen cell to the top of the sand on the 10th of August. This was an extreme case as regards the number of days spent in the soil before pupating, and no other larva approached it in my cages. Out of the nine larvae that entered the sand in this glass bottomed cage, all but one burrowed clear to the glass bottom, so that it was a simple matter to observe their behavior while in the soil.

In searching for pupae in the orchards, I was surprised to find that the great bulk of the larvae there did not go much below one inch before they made their earthen cells and pupated, while in all my breeding cages the bulk of the larvae went deeper. I can account for this only on the supposition that they found the moist sand easier to enter.

*The pupa* stage is represented in the photograph, natural size, at *b*, figure 2, and magnified five diameters in figure 10. This stage of the insect is also an uncertain one in the life of the beetle, since the pupae are easily killed if disturbed too much by cultivating the soil while they are in it. The pupa stage lasts from fifteen to twenty days, then transforms to an adult beetle, which at first is light brown in color and quite soft, but gradually becomes darker and harder, and remains in its earthen cell about ten days before it digs its way out to the surface of the soil.

*The adult* beetle on emerging from the soil is lighter in color than the older beetles, but gains its normal color in a few days. It soon seeks its natural food and can be found in good numbers during the latter part of July and during all of August, feeding on the apples by making the punctures or "stings" already described. At the approach of fall, these young beetles seek hibernating quarters and thus pass the winter, while the old beetles that have not already died, perish.

It will thus be seen that many of the old beetles are

still at work in the apples by the time the young beetles emerge and begin to puncture them also, but that there is but one brood of these insects each year. As the female beetles are quite slow in depositing their eggs, and vary somewhat in the time of beginning, we have some of them laying eggs in apples as late as the last of July or the first of August, at which time the young beetles are beginning to emerge in great numbers.

From what has been said one can see that from the time an egg is deposited in the apple until the time that egg should result in the production of an adult beetle, would require from fifty-six to seventy-two days, according to circumstances.

## HOW IT CAN BE CONTROLLED.

During the two years we were studying the habits and life history of the plum curculio in the apple, we were also experimenting in many orchards with various means and methods of killing and of controlling its ravages, and these experiments were carried on during the third season also.

As a result of the entire work we now know that it is perfectly possible, practical and comparatively easy to successfully fight this pest in the apple orchard and to prevent its doing undue injury. In order to do this, we must take advantage of some weak points in the insect's economy which we have described.

The four principle habits we can take advantage of are: First, the fact that the adults hibernate during winter under rubbish and the like; second, that in the spring the adults feed to a certain extent on the developing leaves before the trees bloom; third, that the larvae, in order to live and reach their complete larval stage, must be in apples that drop to the ground before the larvae are much over half grown, otherwise they die;

fourth, the fact that the full grown larvae leave the apples and enter the ground an inch or two, and there transform to pupae that are easily killed.

It is well known to horticulturists that an apple orchard near the forest suffers more from the "sting" than one out in the clear, and that the part nearest the forest is "stung" first. This is because of the fact that the Plum Curculio is found in certain wild fruits which grow abundantly in our forests, and also because the beetles seek the timber to a large extent during the fall for hibernating places, and seek the nearest food early in the summer. This should be taken into account in setting out an orchard, as there are many other injurious insects attacking orchards that come originally from forests. It is also well known that apple orchards near plum or peach orchards suffer more from the "sting" than those remote, and that the part nearest to a plum or peach orchard is sooner and more severely "stung," because this insect breeds most readily in the plum and peach. Hence it is well to have the plum and peach orchards as far as possible from the apple orchards.

In visiting the various apple orchards during our studies, we noticed that those orchards that receive thorough or only slight cultivation suffered less from the "sting" than those that were allowed to grow up to grass and weeds, or orchards in the sod. This fact is easily accounted for by the removal of hibernating quarters and the destruction of the pupae.

*Spraying.* We carried on experiments in three different apple orchards to test the practicability of killing the beetles while they were feeding upon the developing leaves before the trees bloomed. For this purpose one-half of each orchard was sprayed twice from the time the leaves appeared until the blossoms opened, using arsenate of lead, while the other half of each orchard was left as a check. The arsenate of lead

was made by dissolving eleven ounces of acetate of lead in a bucket of water and four ounces of arsenate of soda in another bucket of water, and when all was thoroughly dissolved the two were thoroughly mixed together in a tub and allowed to stand over night. The next day all this was stirred and added to a barrel of water, stirred again, and sprayed thoroughly by means of a fine spray on both sides of the trees.

While we found it practically impossible to determine the exact per cent of the beetles killed, yet it was very apparent that we had greatly lessened their numbers in the sprayed trees for the time being; but as these beetles fly readily, it soon became apparent that they were reinfesting the sprayed portion of the orchard when the apples were of the proper size, and hence the following year these same experiments were repeated, and the spraying also carried on for four sprayings after the blossoms had fallen, at intervals of ten days, as well as receiving two sprayings before the blossoms opened. As a result of this last experiment, it was apparent that we were preventing about sixty per cent of the apples from the "sting;" but here again the curculio reinfested the sprayed portion later in the season, but did not do the serious damage they did in the checks which were not sprayed. If one is going to spray for bitter rot, apple scab and other diseases before the blossoms open and for codling moth after the blossoms fall, the addition of an arsenical poison to the Bordeaux mixture, sprayed before the blossoms open, will also kill large numbers of the curculio, and the spraying with the arsenical poison after the blossoms fall will not only kill the codling moth, but will also greatly lessen the curculio "sting." If the entire orchard is thus treated, and it be not too near other infested orchards, especially plum and peach orchards, then the results of the arsenical spraying for the plum curculio in the apple orchard are very marked and profitable, and the great bulk of

the "sting" will be prevented. As near as we could estimate from the second year experiments, we saved seventy-five per cent of the apples from injury by the "sting," and to this must be added the fact that we also held the codling moth in check.

*Destruction of Wind-Falls.* Other experiments were carried on in different orchards to test the result and practicability of destroying all wind-falls, since it was found that the larvae will not live unless the apples fall, and as the larvae remain in the fallen apples for a week or so, it appeared to be a very vulnerable point. To this end the fallen apples were gathered by hand each week from one-half of two orchards, the other half in all cases being left as a check; while in two other orchards the fallen apples from one-half of each orchard were destroyed by keeping hogs in that part of the orchard, and allowing them to eat all such wind-falls. In all cases, it was evident from the scarcity of young beetles and fresh feeding punctures in that part of the orchard where the wind-falls were destroyed, as compared with the other half, that this method had resulted in practically preventing the development of the curculio beetle; and this contrast would no doubt have been much greater, had it not been for the fact that probably the greater number of the young beetles found in the treated half of the orchard, came directly by flight from the untreated half. It was noticed by those present that the beetles and the fresh feeding punctures became scarcer the further we went from the untreated half.

*Cultivation.* With a view to the destruction of the pupae and recently transformed beetles in the soil, several experiments were conducted in still different orchards by shallow plowing and harrowing during the middle of July, and then harrowing the first and fifteenth of August. It was evident that as a result of this method of procedure, vast numbers of the in-

sects were killed, but it was practically impossible to get at a satisfactory estimate of the exact per cent thus destroyed and the per cent not so destroyed. We tried to sift the earth in order to pick out the dead from the living pupae; but this was such a laborious and slow process, that we finally abandoned it and made our estimations by observing the young beetles and the freshly made feeding punctures in the cultivated and uncultivated halves of the orchard. We noted the fact that poultry were eager to roam over the freshly cultivated orchards, and feed and scratch about, and no doubt they destroyed many larvae, pupae and young beetles. If enough poultry could be kept in the orchard they would greatly lessen the number of curculio to ultimately reach the trees. It is well known that plum trees in a chicken run-way are not seriously attacked by the curculio.

*All Three Methods Combined.* During the first year of our experiments, we tested the three methods of combating the beetles independently; but during the two succeeding years we carried on several extensive experiments in six different orchards with a combination of all three methods. We selected large commercial orchards for this purpose, and used only one-fourth of each orchard as a check, in order not to have our treated portion so badly reinfested from the check trees, and also in order to have the check trees further away from the bulk of the treated portion.

In all cases, the method carried out was as follows: The trees were sprayed twice before the blossoms opened with arsenate of lead and four times after the blossoms fell with the same arsenical poison at intervals of ten days; when the apples began to fall hogs were turned into the orchards to pick them up, the check portion being fenced off; the middle of July the orchards were plowed very shallow and harrowed very thoroughly, and then harrowed again on the first and fifteenth of August.

The results of these experiments were, very marked indeed, and demonstrated beyond a doubt that by following all the three methods here used, one can hold the Plum Curculio in check in the apple orchards, as completely as we do any other injurious insect. Indeed, in our experiments we found very few apples "stung" in the treated orchards, and these stings were mostly confined to trees bordering or near the check portions, while in the check trees, the "stings" were serious. No doubt most of the "stings" in the treated portion were the result of the beetles coming over from the check trees, and, on the other hand, no doubt the check trees were "stung" less than they should have been because some of the beetles left for other parts of the orchard.

From our experiments, then, we know that by following all three methods of procedure—early spraying with arsenical poison, destruction of wind-falls, and shallow cultivation from 15th July to 15th August—that the Plum Curculio in the apple can be held in check and serious damage from the "sting" prevented.