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United States Department of Agriculture,

BUREAU OF ENTOMOLOGY.

L. O. HOWARD, Entomologist and Chief of Bureau.

THE STRAWBERRY WEEVIL.

(*Anthonomus signatus* Say.)

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GENERAL APPEARANCE AND NATURE OF ATTACK.

Just before the blossoms of the strawberry expand they are attacked by an insect which severs them from the stem. This insect is the strawberry weevil, and the severing of the buds is accomplished by the female in the process of oviposition. The weevil first deposits an egg in the bud and then punctures or cuts the stem below it so that in a few days it drops to the ground. Within the severed bud the larva hatched from this egg develops, and transforms to the pupa and afterwards to the beetle.

The strawberry weevil measures only a tenth of an inch in length, and is provided with a slender, slightly curved snout, about half as long as the body, to which are attached its jointed antennæ. The color varies from nearly black to dull red, and each elytron or wing-cover is ornamented just behind the middle with a dark spot surrounded with whitish pubescence, (see figs. 1 and 2).

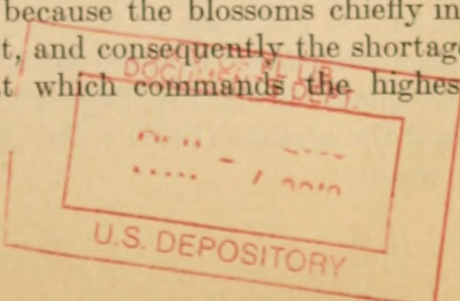
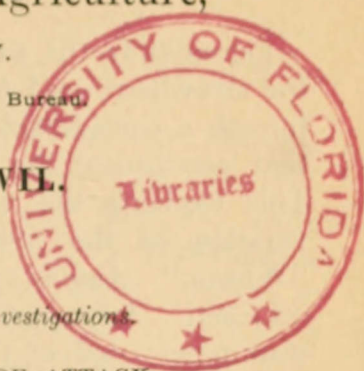


FIG. 2.—Strawberry weevil (*Anthonomus signatus*): Adult beetle. Greatly enlarged (from Riley).

The presence of the weevil in strawberry beds is manifested by the decreased number of blossoms and the severed buds and stems, the diminutive size of the beetle protecting it from general observation. Nor is the destruction of the buds likely to be noticed until some time after the insect has been at work. Hence it happens that injury, even over wide areas, is often attributed to hail, frost, or to some other cause than the right one. Appearing, as the insect so often does, in great numbers almost from the outset, its injuries are severe even in seasons when only a moderate percentage of a crop is lost, because the blossoms chiefly injured are the earliest, and consequently the shortage is largely in the early fruit, or that which commands the highest market price.



FIG. 1.—Strawberry weevil (*Anthonomus signatus*): Adult beetle. Greatly enlarged (author's illustration).



FOOD PLANTS AND RAVAGES.

Fortunately the weevil is restricted to the staminate varieties of the strawberry and to such pistillate varieties as are imperfect and furnish a considerable quantity of pollen, since it is this substance that constitutes the chief food supply of both larvæ and adults. This explains the well-known preference of the insect for such varieties as the "Sharpless," "Charles Downing," "Jessie," and "Wilson." Among imperfect pistillates "Crescents" are often attacked. A frequent source of damage is by the destruction of the staminate used in the fertilization of the pistillates, the product being dwarfed and unsalable fruit. The susceptibility of different varieties appears to be in direct proportion (1) to the quantity of pollen produced and (2) to the amount of exposure of the buds and flowers to the sun.

It is fortunate also that this weevil, like so many other troublesome species, is more or less intermittent in its attack, appearing in great abundance for one or more seasons in certain districts and doing a vast amount of damage, and then without any apparent reason relapsing into comparative obscurity only to reappear after a number of years and in perhaps some new locality.

This insect does not confine itself to the cultivated strawberry, although this appears to be its favorite food, but attacks in like manner wild strawberry, blackberry, dewberry, and occasionally the black-cap raspberry. The buds of the common yellow-flowered cinquefoil (*Potentilla canadensis*) and of the red-bud tree (*Cercis canadensis*) are similarly destroyed by the weevil. All of the above-mentioned plants serve as food for the larva. The beetle frequents also other flowers for feeding purposes. It is a lover of light and warmth and works most actively during bright, sunshiny days.

DISTRIBUTION AND INJURIOUSNESS.

The strawberry weevil is a native species and widely distributed. Its present known distribution includes Canada from Prince Edward Island to Alberta, the Atlantic States, and a portion of the Southern States, and it probably occurs in all of the Middle States. Its precise limits southward and westward have not been ascertained. At present it occupies what are known as the Upper Austral and Transition zones and a portion of the Boreal zone.

This weevil was first noticed as injurious in 1871, at Silver Hill, Md. In the next twenty years injuries were reported during different seasons in localities in Missouri, Michigan—in both the upper and lower peninsulas—Staten Island, New York, the Provinces of Ontario and Quebec in Canada, Pennsylvania, and Virginia. From that time until the present (1908) rather general injury has been noted in the

berry-growing portions of Virginia, Maryland, North Carolina, and Delaware, and instances of attack have been reported from New Hampshire, southern New Jersey, Pennsylvania, New York, Connecticut, Rhode Island, Arkansas, and Texas.^a

As previously intimated, many fruit-growers are so little familiar with the strawberry weevil that our exact knowledge of its injuriousness is limited to reports from correspondents who have the worst experience with this pest. It is fairly positive that the strawberry, and occasionally the blackberry crop, of Maryland and Virginia is annually levied upon by this pernicious little creature at a rate of from 5 to 20 per cent, a loss that would seldom be felt, or, if noticed, might not be attributed to this weevil. We have creditable information that such has been the condition in Virginia since about 1888, and in Maryland since 1885. Dr. James Fletcher, Dominion entomologist, states that he has occasional reports of injury by this insect every year in Canada.

The greatest amount of loss from the strawberry weevil was reported in 1892, when a shortage of two-thirds of the yield in portions of Maryland and Virginia was incurred, a considerable proportion of which was without doubt referable to this insect. In 1896 half of the strawberry crop of Maryland, according to W. G. Johnson's estimate, was destroyed.

In 1898 a less serious outbreak occurred, injury being most pronounced in Delaware and Maryland. In 1902 the insect returned in numbers to the same district. In 1904 the injury to the strawberry by this species in North Carolina was estimated at \$100,000, the loss varying from 10 to 50 per cent. Considerable injury in that State has been reported during 1908; in Columbus County and vicinity a shortage of 50 per cent was estimated, from which the money loss was placed at \$700,000.

NATURAL HISTORY AND HABITS.

At, or a few days before the time of the first blooming of the earliest staminate varieties of strawberry, this weevil emerges from its winter quarters and flies to the nearest flowers and strawberry beds. This period begins in the latitude of the District of Columbia as early some seasons as the middle of April, but farther north the insect does not appear until May. The beetles evidently continue to issue from their places of hibernation for at least a month, though their principal damage is done during the first two or three weeks. After feeding and making provision for the continuance of their species the

^a Complaints are sometimes made of this species in the Rocky Mountain region, especially in Montana, but the culprit in such cases is undoubtedly a different species, viz, the so-called strawberry crown girdler (*Otiorynchus ovatus* L.).

beetles die and are replaced by a new brood which hibernates in its turn.

Injury, as already stated, is due to the work of the female in the course of oviposition. Selecting an unopened, nearly mature bud

she perforates with her beak the corolla or outer husk and turning about deposits in the hole thus formed a single egg (shown in outline, greatly enlarged, at figure 3, *c*). She then crawls to the pedicel or flower-stem just below the bud and with the microscopic but scissors-like mandibles at the extremity of her beak deliberately punctures or cuts it in such manner that the portion containing the bud hangs by a mere shred of the epidermis and soon afterwards falls to the ground.

The object attained by the parent insect in puncturing the stem is twofold: (1) The development of the bud is arrested, and

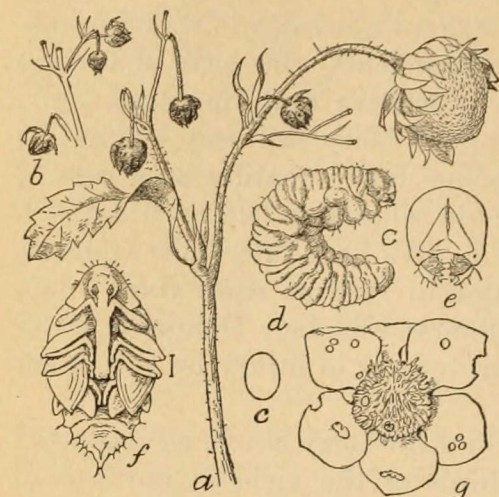


FIG. 3.—Strawberry weevil (*Anthonomus signatus*): *a, b*, Strawberry spray, showing work in bud and stem, natural size; *c*, outline of egg; *d*, larva; *e*, head of larva, much enlarged; *f*, pupa; *g*, open bud, showing egg on left and punctures made by snout of beetle on petals. (Author's illustration.)

its outer envelopes of sepals and petals remain folded, thus retaining the eggs or growing larvæ of the insect and the pollen on which the latter feed; (2) the bud falling to the ground is kept moist, whereas if permitted to remain upon the stem it would eventually have become so dry as to prevent the development of the insect within. Ordinarily a single larva inhabits a bud, but in exceptional cases two individuals may develop in one bud.

In from four to six or seven days after the eggs are deposited the minute whitish or yellowish larvæ are hatched. These begin to feed upon the pollen within the buds, and when this is devoured attack the harder portions. In three or four weeks' time they have attained full growth and present the appearance shown, enlarged, at *d* (fig. 3). The larva now forms in the bud a hollow cocoon-like receptacle in which the pupa (*f*), and afterwards the adult condition, is assumed. The pupal stage lasts from five to eight days, depending, as do all these periods, upon the temperature, whereupon the adult beetle develops and cuts its way out of the bud.

The entire life cycle requires only twenty-eight or thirty days.

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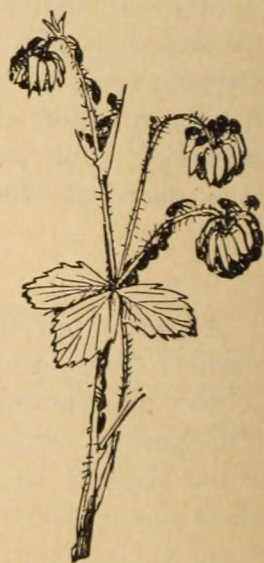


FIG. 4.—Spray of strawberry plant showing weevils at work. Natural size (from Riley).

In the vicinity of the District of Columbia the first mature insects of the new generation begin to issue from the severed buds toward the end of May, continuing through the month of June and even in some cases into July. The beetles of this new generation sometimes congregate on the flowers of the strawberry in immense numbers, as shown in figure 4. The wild bergamot or horse-mint (*Monarda fistulosa*) is also frequented by the beetles in like manner.

After feeding for a few days the beetles disappear in quest of suitable places for passing the winter. Hibernation evidently begins very early, as the beetles are seldom seen after the middle of July.

Our observations indicate only a single generation annually.

The adult beetles often perforate the buds for the sole purpose of feeding, although they feed also upon the pollen in the flowers, and upon the petals.

Under ordinary circumstances they do not attack the foliage, and never the fruit.

NATURAL ENEMIES.

Four species of hymenopterous insects are parasitic on the strawberry weevil, and to a certain extent help to reduce its numbers, but they are useful only as they limit the generation that hibernates and which may or may not survive in sufficient numbers to be troublesome in the ensuing year. The species thus far bred from severed buds are *Sigalphus tibiator* Cress., *Bracon anthonomi* Ashm., *Catolaccus anthonomi* Ashm. (fig. 5), and *C. incertus* Ashm.

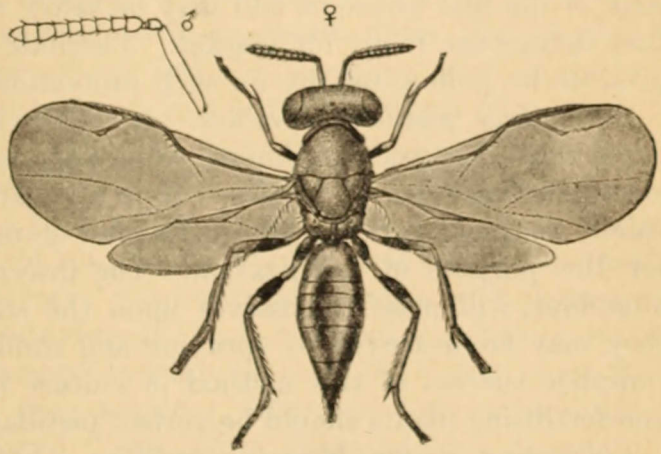


FIG. 5.—*Catolaccus anthonomi*, a parasite of the strawberry weevil: Adult female and antenna of male. Greatly enlarged (original).

Two species of predaceous ants have

also been observed, actively engaged in destroying the larvæ within the buds, and where ant hills are present in strawberry beds it is probable that few beetles will develop from the buds. The species of ants observed are *Formica fusca* L. and *Aphænogaster fulva* Rog.

No insect, bird, or other animal has yet been seen to prey upon the adult beetles. Fowls, even chicks, are of no service whatever, as they roam through infested patches of berries without offering to molest the weevils, which are so small and so quick as apparently to entirely escape their watchful eyes.

METHODS OF CONTROL.

The strawberry weevil is an extremely difficult insect to combat. The very nature of the insect and its life economy enable it to evade most measures that are in successful use against leaf-feeding species. The fact that the larvæ live concealed within the buds places the insect, in its earlier stages, beyond the reach of the arsenicals, and the further fact that the adult derives its chief sustenance from the pollen within the buds and does not feed upon the leaves limits the effectiveness of any direct poison.

PREVENTIVES.

Covering the beds.—Owing to the difficulty of contending with the insect when once it has invaded a strawberry bed, it is necessary to have recourse to preventive measures.

A nearly perfect preventive consists in covering the beds. This covering, which may be of muslin or some similar light material, if properly applied will not only exclude the weevil and other noxious insects, but will secure immunity from frost and is moreover a positive benefit to the berries, which ripen a week or ten days earlier and are superior also in quality and size. Whatever covering is employed should be put in place over the beds at least a week before the appearance of the first blossoms and may be safely removed as soon as the first berries are ready for market. Pistillate plants, or those which produce no pollen, require no such protection.

Cultivating pistillate varieties.—It is obviously unsafe, in districts where the weevil is known to be abundant, to trust entirely to staminate varieties of berries. It is advisable, therefore, to grow chiefly pistillate varieties and just as few staminate as are necessary for the purpose of fertilization. The insects, when they become abundant, will mass themselves upon the staminate plants, where they may be destroyed by spraying and similar measures. For the complete success of this method of culture it is essential that the non-fertilizing plants should be perfect pistillates and bear no pollen.

Cultivating profuse-blooming varieties.—According to the general opinion of strawberry growers on the eastern shore of Maryland, as expressed by Dr. F. P. Herr, Ridgely, Md., the most satisfactory method of securing freedom from injury by the strawberry weevil is to plant very profuse-blooming varieties, and many have agreed that the following, in the order named, are the best that have been tested to secure this end: Rio, Superior, Tennessee Prolific, and Gandy.^a

Trap crops.—In the same manner that the rows of staminate used for fertilization constitute a protection for the other rows, cer-

^a A. L. Quaintance, Report Md. State Hort. Soc., Baltimore, 1902, p. 100.

tain varieties, particularly such as bloom early, may be used to protect later-blooming plants. One of the best for this purpose is the "Charles Downing," as it blooms early and its blossoms are exposed to the sun. By laying out beds with "Downings" or other early staminate on the sides that experience has shown to be most susceptible to attack—*e. g.*, in protected sunny spots or near woodland in which the beetles might have hibernated—the insects will be attracted from the other portions of the beds and can be the more readily controlled by spraying with the arsenicals.

The red-bud, which blooms several days earlier than the strawberry, attracts the earliest arrivals and might also serve as a trap. From this tree the insects can be jarred upon sheets saturated with kerosene, and destroyed, together with the buds containing the insect's eggs.

As a lure for the new brood the wild bergamot is of value. When the beetles gather upon this plant they may be killed by spraying the flowers or may be captured and destroyed by thousands, thus lessening the chances of infestation for the ensuing year. For their capture large pans of water covered with a thin scum of kerosene will be found useful.

Both red-bud and wild bergamot are ornamental plants.

Clean culture.—It is reasonable to presume that good is always accomplished by clean culture, such as results from the clearing away of wild or volunteer plants and the "burning over" in early spring of underbrush and weeds. But in regions where wild strawberry and blackberry, *Potentilla*, and red-bud grow in such profusion as in the neighborhood of Washington, D. C., it would appear that little benefit would accrue from such a course.

Unsuccessful remedies.—A number of remedies that have been tried are found to be unsatisfactory. Capturing the beetles with a sweep-net has been suggested, but this species is not readily taken by this method. Among the various substances that have been used in experiments and found unsatisfactory, either as deterrents or insecticides, may be mentioned: Lime, ashes, dissolved bone, ammonia (in the form of hen manure), kerosene and plaster, Paris green and plaster, a mixture of "tobacco dust, lime, Paris green, and coal oil," pyrethrum, whale-oil soap, and a solution of sulphate of copper and lime. Even kerosene emulsion has been only partially successful. Pyrethrum has little or no effect when used in the open field.

REPELLENTS.

A good repellent needed.—From the nature of the insect's work it is obvious that whatever is used must be of rapid action. What is most needed is a good repellent. For this purpose we would advise

a trial with a spray of crude carbolic acid, used in the proportion of 1 part to 100 of water. This preparation has been reported a successful protection against the rose-chaffer in vineyards.

Bordeaux mixture.^a—One of our correspondents has reported some success with Bordeaux mixture, and as this substance has been found effective against other species of beetles, where Paris green failed, it is well worthy of further trial. It affords protection to plants by rendering the foliage distasteful to the insects. Bordeaux mixture has the advantage of being a fungicide, for which purpose it is mostly used, and should the plants be also affected with blight, as is so often the case, it will fulfill a double purpose. In case Paris green is used the Bordeaux mixture should be employed as a diluent in the place of lime and water in the preparation of this arsenical.

ARSENICAL SPRAYING.

The arsenicals, as already stated, can not be depended on to produce as good results as against leaf-feeding insects, for the reason that the adult weevils do not feed on the foliage, and hence may be reached only when they feed on the open blossoms or cut through the corolla of the buds or flower-stems during oviposition. The larvæ can not be affected at all by any other known insecticide.

The arsenicals do not commend themselves to the average strawberry grower, because of the fear of poisoning the consumer, but experiment has shown that there is not the slightest possibility of the poison remaining upon the fruit, since the spray, to have any effect on the weevil, must be applied while the plants are in bud or blossom, the last application being made two or three weeks before the first berries ripen. One of our correspondents has met with sufficient success with arsenicals to justify further tests.

Paris green may be used at the rate of from 1 to 2 pounds of poison to 100 gallons of water, and arsenate of lead at the rate of from 1 to 2 pounds to 25 gallons of water. In their preparation it will be advisable to use Bordeaux mixture as a diluent, particularly if blight is present in the beds.

It should also be remembered that the arsenicals act with good success on other insects that may be present on the vines; for example, on the strawberry slugs, leaf-rollers, and the adults of the root-borers.

Directions for spraying.—To obtain the best results it is necessary to spray the vines a day or two before blooming, again two or three days after the first bloom, and again five or six days after that, at

^a Directions for the preparation of this fungicide and the arsenicals here discussed are given in Farmers' Bulletin 127, U. S. Department of Agriculture, which can be obtained gratis on application.

least three applications being made at intervals, the different applications being graded with a view to keeping the buds and blossoms constantly covered with a thin coating of whatever substance is used. Thus, if the variety of berry to be treated begins to bloom April 27, it might be sprayed on the 24th or 25th, again on the 29th or 30th, and a third time, say May 5. It is doubtful if a fourth spraying would be profitable, unless more frequent applications be made, except in the event of rain or heavy dew fall after spraying, as the chief damage is done usually during the first two weeks of blooming.

The best form of apparatus for spraying garden plants is a knapsack sprayer, fitted with the finest Vermorel spray-nozzle, but for larger beds a spray tank mounted on a cart or wagon should be used.

The periodical or intermittent nature of this insect has always militated against its successful treatment. Fruit-growers are too prone to "trust to luck" until it is too late for the application of remedies with any degree of promise. It should be borne in mind that whatever course of remedial or preventive treatment is pursued must be begun *before* the insect appears. Two weeks' uninterrupted work on the part of the insect is sufficient, during its years of abundance, so to damage a crop as to make it unprofitable for picking.

SUMMARY.

It may be well to summarize briefly what has previously been said under the heading of "Methods of Control." No single remedy will entirely eradicate this insect from an infested locality, and after a strawberry bed is once badly infested the crop can not be saved that year unless remedial measures are at once instituted. Preventives are preferable to direct remedies. These are, in brief, as follows:

(1) Covering the beds with muslin or similar material. (See p. 6.)
 (2) Cultural remedies, including the cultivation of pistillate and profuse-blooming varieties of the strawberry, the use of trap crops, and clean culture. All of these should be put into operation wherever possible. (See pp. 6 and 7.)

(3) The repellents advised, and especially Bordeaux mixture (see p. 8), should be given a thorough test.

(4) In addition to Paris green, and Paris green combined with Bordeaux mixture, arsenate of lead should be thoroughly tested, as it may in the end prove to be the best direct remedy.

Finally, a good word should be added for the cultivation of pistillate varieties. These have been thoroughly tested, as advised on page 6, in Maryland and Virginia in the vicinity of the District of Columbia for many years, with the result that practically no complaints

of serious injury from the strawberry weevil are now made. This is the result of advice given to all growers in this section who could be reached, they in turn passing on the information to their neighbors. Cooperation is absolutely essential in the treatment of most injurious pests, and the strawberry weevil is a striking example of this.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *June 26, 1908.*

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