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United States Department of Agriculture,

BUREAU OF ENTOMOLOGY,

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

THE STRIPED CUCUMBER BEETLE

(Diabrotica vittata Fab.)

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GENERAL APPEARANCE AND NATURE OF ATTACK.

Early in the season, with the first appearance of cucumber, squash, and melon plants, often before they are above ground, they are attacked by a little yellow and black-striped insect, known as the striped cucumber beetle, "striped bug," "melon bug," etc. The principal injury is effected by the mature insects at this time, and is also caused later by the larvæ feeding underground upon the roots and stems of the same plants.

The beetle, illustrated at figure 1, *a*, is quite small, measuring about two-fifths of an inch in length and half as much in width. Its color is yellow above, with black head and a black

stripe running longitudinally on each side of each wing-cover, producing the effect of a three-striped back. The under surface is mostly black and portions of the legs and antennæ are marked with black.

The striped cucumber beetle is indigenous to this country and inhabits the entire eastern United States from the Canadian border to Mexico. It has been reported as injurious in all except a few States east of the Rocky Mountains and to occur in the State of Washington.

The most apparent form of injury effected is through the first appearing or hibernating generation of beetles burrowing down to meet the plants before they show above ground and in feeding upon the tender plants before they have fairly started. The beetles are also destructive to older plants, by eating the leaves and especially by gnawing around

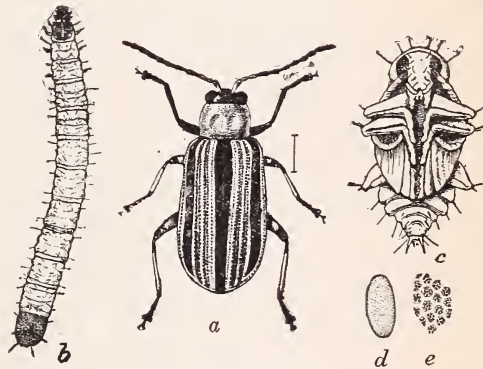


FIG. 1.—Striped cucumber beetle (*Diabrotica vittata*): *a*, Beetle; *b*, larva; *c*, pupa; *d*, egg; *e*, sculpture of same. *a*, *b*, *c*, Much enlarged; *d*, more enlarged; *e*, highly magnified. (Author's illustration.)

and consuming the epidermis of the stems, and the larvæ are often the cause of injury through their unseen but none the less pernicious work at the roots. Another form of mischief is caused by the beetles acting as carriers of the bacterial wilt¹ of cucurbits, cotton, and cowpea.

The subterranean habit of the larvæ makes it certain that they are more often than not at the roots of cucurbits without the knowledge of the farmer or gardener, the outward manifestation of their presence being the wilting of the leaves and the failure of the plants to develop perfect fruit. Far too often the debility or death of the vines through the presence of this insect is attributed to dry weather or some similar natural cause. Injury, then, is threefold, due (1) to direct attack by the beetles to the plant above the roots; (2) indirectly to the beetles as transmitters of disease germs; and (3) to the work of the larvæ upon the roots underground.

FOOD PLANTS.

The striped cucumber beetle is rarely absent from the farm and garden, occurs over an area which embraces nearly our whole country, and is by far more common and more destructive than any other cucurbit pest with which we have to deal. Hubbard and marrow squashes are favorite host plants, followed by cucumbers and cantaloupes. Other cucurbits, such as pumpkins and watermelons, are also subject to injury by the beetles and larvæ. It is not alone in the field and garden that this species is troublesome, as serious injury is sometimes done in greenhouses in midwinter, both by larvæ and beetles. So far as we know, the larvæ are restricted to the Cucurbitaceæ, but the beetles attack other plants. They are flower feeders naturally, but eat also nearly every other portion of a plant, and even cause injury to cucurbits by gnawing the rinds of the fruit. Among other cultivated crops, beans are favorites, and the beetles often congregate in numbers upon bunches of these plants, killing the leaves and rendering the pods so unsightly that they are useless for market. Peas are similarly attacked, as also ripe apples, apple blossoms, and the leaves, silk, pollen, and unripe kernels of corn.

Of wild plants the beetles evince a partiality for the flowers of golden-rod, aster, and sunflower, devouring the colored portions, stamens, pistils, and ray flowers. They also frequent the flowers of chokeberry, Juneberry, cherry, and related plants, and they feed freely upon the prickly cucumber or wild balsam apple (*Echinocystis lobata*), which is probably a natural food plant.

LIFE HISTORY AND HABITS.

The beetles make their appearance in April or May, earlier or later according to locality and climate, feed upon such flowers as may be in

¹ *Neocosmospora vasinfecta* Atk. (*Bacillus tracheiphilus* Erw. Sm.).

season or on other vegetation, and when cucurbits are set out attack and injure them in the manner previously described.

The egg was unknown until 1899, a singular fact, considering that this is one of the commonest and best known of injurious insects. It measures 0.6 mm. in length, and varies in color from bright lemon yellow to orange, the length being about twice the width (fig. 1, *d*). The surface, as viewed under a high-power microscope, is finely sculptured, arranged in hexagonal pits (*e*).

Eggs are deposited, either singly or in groups, in the soil about the roots and stems, the female frequently laying them in a crack or crevice. In experiments conducted in New Hampshire at an average temperature of 74° F., the eggs hatched in about nine days. The number deposited by a single female varies, 117 being the highest number observed.¹

The larva (fig. 1, *b*) is a very slender, white, wormlike creature, with dark-brown head and anal plate and lighter brown thoracic plate.²

The larval period is passed in the moist earth, about the base of the stalks, and larvæ may be found within the stems as also upon the fruit where this comes in contact with the earth. This period lasts about a month, and there is an active stage of this duration in which the larvæ working in numbers have ample time for injuring the vines. When full grown, just before transformation, the larva contracts, having the appearance of being much stouter. Larvæ observed in July remained for three days in this contracted position, and this is probably the usual warm weather quiescent period before assuming the pupal stage. The pupa (fig. 1, *c*) is of nearly the same color as the larva, and its surface is sparsely beset with long spinelike hairs, those on the dorsal surface arising from small but prominent piliferous warts. The pupal period will vary with climate and season, from six or seven days in warm weather to two weeks when colder.

In experiments in New Hampshire the entire life cycle consumed between forty-eight and fifty-six days in a temperature of 70° F. Between twenty-six and thirty-eight days were required in the larval

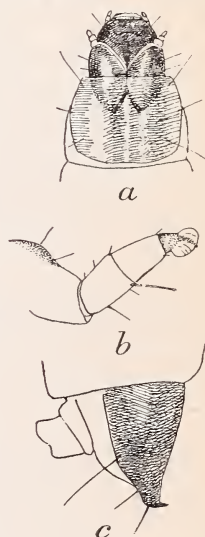


FIG. 2.—*Diabrotica vittata*: *a*, Head of larva; *b*, leg of same, anal segment from side; *c*, anal proleg. All greatly enlarged. (Author's illustration.)

¹ See account of T. J. Headlee, *Journal of Economic Entomology*, Vol. I, pp. 203-209, 1908.

² When fully matured it measures about three-tenths of an inch in length, thus being about ten times its width, and presents the appearance illustrated in figure 1 at *b*. It is provided with three pairs of thoracic legs and an anal proleg. Figure 2 illustrates the head and thoracic plate (*a*), a true leg (*b*), and the anal proleg and plate in profile (*c*).

period, which has previously been considered to last about a month. In a warmer climate, as, for example, in the District of Columbia, where the summer temperature usually ranges between 80° and 90° F., the life cycle might be passed in a much shorter period, which may be estimated as at least as low as forty-two days.

The entire life history of this insect has evidently never been ascertained. Considering its long season and the fact that newly transformed beetles have been observed from the second week of July till the first week of October, there is, as generally admitted, comparative certainty of two generations each year in the northernmost locality inhabited by the species, and it is safe to assume the possibility of three generations annually for the District of Columbia and southward.

Toward the end of the season the beetles congregate under the stems, prostrate portions of plants, and withered leaves of cucurbits, often as many as fifty or sixty individuals assembling about a single plant, and later they seek other places of shelter. The beetles begin to disappear near Washington during the first cold nights of October, though hibernation may commence earlier.

NATURAL ENEMIES.

The beetle is parasitized by a tachina fly (*Celatoria diabroticæ* Shim.) which develops in the abdomen of its host and sometimes kills considerable numbers.

METHODS OF CONTROL.

Direct applications of poisons will destroy the beetles when they occur in moderate numbers, but have not proved entirely efficacious when the insects are most abundant; hence recourse must be had to (1) preventives, (2) repellents, (3) cultural methods, and (4) insecticidal and other methods. Living as the larvæ do, underground, it is more difficult to reach them than the beetles. Their destruction could be effected by saturating the surface soil about the roots of infested plants with kerosene emulsion.

PREVENTIVES.

Covering young plants.—To prevent injury to young plants early in the season, coverings are used. A cheap frame may be made by cutting a barrel hoop in two so as to form two semicircles, which are then placed at right angles to each other, and the lower ends inserted in the ground with the curve uppermost. Two strong wires bent in the form of croquet arches can also be used. The frame is covered with gauze or similar material, held in place with earth packed about the edges, to prevent the beetles working under it. It is necessary to keep the plants covered only while they are young, and the same covering may be used year after year.

Wire-gauze covers, such as are used for protecting plates of food from house flies, would also answer the purpose of protecting cucumbers against the ravages of this cucumber beetle. They can be purchased at about 8 cents apiece, and probably cheaper at wholesale, and will be found useful in the case of choice plants.

Various forms of covers have been proposed by Mr. L. C. Corbett, of the Bureau of Plant Industry, and by Mr. Headlee and others, but the two forms described above appear to be the most easily prepared or most available and are, moreover, certainly more serviceable than others of which the writer has positive knowledge.

CULTURAL METHODS.

Early planting, etc.—Where no covering is used it is advisable to start the plants in frames or in hothouses, or to plant the earliest varieties and set them out as soon as possible so as to get the plants well established before the appearance of the beetles. In combination with this, the setting out of the late varieties should be postponed until after the first appearing beetles have laid their eggs and dispersed.

Planting an excess of seed.—In lieu of the above practices a certain degree of relief can be secured by planting an excess of seed so as to distribute attack. After the first danger is passed the hills are thinned out to the desired number.

A method which has furnished good results in some localities consists in planting the seeds in squares, one each week as shown in the diagram. The first planting, "1," is frequently killed, and may be followed by the second, and sometimes the third. As long as the insects are seen they are poisoned, and this is continued until a stand of plants is obtained, as it is seldom that all four plantings are destroyed.

1	2
3	4

Clean culture and trap plants.—Much injury from this as well as other cucurbit enemies would be prevented by closer attention to clean methods of cultivation. As soon as a crop is harvested the vines should be covered with straw or other inflammable material and burned, and it would be a wise precaution to have certain plants (e. g., such as might be desired for seed) left standing here and there throughout the fields, so that such insects as may not have been reached by the fire will concentrate on them where they can be easily destroyed with a spray of strong kerosene emulsion or Paris green. As traps for the last or hibernating generation, it would be well to plant later or to use later varieties. By destroying the beetles at this time the numbers for the ensuing year will be greatly diminished.

Some exemption from injury, it is claimed, may be attained by growing beans in connection with cucumbers, for example, in alternate rows. The beans are planted before the cucumbers and the beetles con-

gregate on these plants, and having an abundance of food are not forced by hunger to attack the young cucurbits.

Gourds planted in the vicinity of other cucurbits are claimed to act successfully as a trap, and wild cucumber might produce good results.

INSECTICIDAL AND OTHER METHODS.

Arsenicals, with ashes, dust, or plaster.—A remedy frequently advised, when insects occur on low-growing plants, is to dust the majority of them with sifted wood ashes, road dust, or land plaster, and cover the remaining plants with a solution of Paris green or other arsenical, in the proportion of one-fourth of a pound to about 60 gallons of water. The beetles will concentrate on the clean plants, where they will be killed by the poison, not always, however, before they have fed to such an extent that the plants will be more or less damaged.

Dry arsenicals.—Paris green and other arsenicals, alone or mixed with plaster in the proportion of 1 to from 20 to 50 by weight and dusted over the plants, will effectually protect them in many cases.

Arsenate of lead.—This insecticide, which has recently come into general use as the best remedy for the Colorado potato beetle, should be given thorough tests against the striped cucumber beetle under different local and other conditions.¹ Arsenate of lead, as is well known, is more adhesive than Paris green; hence more useful where rain is to be feared at the time that it is applied. Where cucumbers are transplanted, as is done in some States, tests should be made of the value of this combined insecticide and fungicide, and of arsenate of lead alone, as a dip for the plants before setting out. It should be used at the weaker strength at first and afterward, if found desirable, at a greater strength, not, however, in excess of 1 pound in 10 to 20 gallons of water. Arsenate of lead was used in 1907 at the New Hampshire Experiment Station by Mr. T. J. Headlee, who reports that it gave the most efficient protection and injured the plants of cucumber and squash least of any of several preparations tried, and that 3 pounds seemed almost as successful as 6 pounds to 50 gallons of water. In connection with this remedy he advises the employment of trap crops, and, after the plants begin to run, spraying them with Bordeaux mixture, prepared according to the 3-4-50 formula.

All poisonous preparations must be frequently applied, particularly when rainfall necessitates their renewal, until the plants have obtained a good start or the insects have dispersed, and they are not generally to

¹ During June, 1908, Mr. C. H. Popenoe, while working under the writer's direction at Diamond Springs, Va., made a practical test of this remedy with complete success, the beetles being treated on a large patch of cucumbers. Arsenate of lead was used at the rate of 2 pounds in the 4-6-50 (4 pounds copper sulphate, 6 pounds lime, and 50 gallons water) solution of Bordeaux mixture.

be relied upon when the beetles are exceedingly numerous. In case Bordeaux mixture is sprayed upon the plants as a protection against disease, Paris green should be added, as it necessitates no additional labor and the mixture will prove more effective against the beetles than would either when used alone.

Stimulating growth.—A considerable degree of exemption from injury accrues from the stimulation of a crop by heavy manuring and frequent cultivation. Fertilizers should be productive of the same results. In parts of the South, ground fish is used as a fertilizer and is reported by some as being a useful deterrent of insects attacking cucurbits.

Driving with air-slaked lime.—In the melon and squash growing sections of New Jersey driving is resorted to as a means of controlling this pest. In the morning, when the beetles are active, air-slaked lime is dusted over the plants with the wind and the beetles fly with it to the next patch, where similar methods must be employed or the crop will suffer the consequences.

Pyrethrum.—Pyrethrum powder dusted on the plants with a powder bellows is reported successful if applied early in the morning when the dew is on. This remedy, however, is too expensive for use on a large scale.

REPELLENTS.

Kerosene and turpentine.—Land plaster, or gypsum, thoroughly saturated with kerosene or turpentine is much used as a repellent. The vapor of turpentine is reported to be particularly distasteful to this insect.

Tobacco dust.—One of the oldest remedies still in vogue consists in sprinkling the hills, particularly when the soil is moist, with refuse tobacco dust. It has the advantage of being, like turpentine and plaster, a good repellent, and it also acts as a fertilizer and mulch.

Naphthalene.—Naphthalene and camphor balls have been proposed as a deterrent for this species, but since reports as to results differ, naphthalene can scarcely be recommended. Mr. D. K. McMillan, engaged in truck-crop investigations in this Bureau, reports it as having produced negative results in practical experience against the striped cucumber beetle in Pennsylvania. On the other hand, Mr. F. M. Pattington, Scipioville, N. Y., reports having planted 3 acres of cucumbers, using 50 pounds of moth balls, placing a few on every other row, 3 feet apart, with the result that the cucumbers escaped injury.¹

SUMMARY.

Of the remedies which have been discussed in previous pages, arsenate of lead is deserving of more extensive experimentation than a complete

¹ At that time the balls cost 2½ cents a pound, wholesale, in lots of 50 to 100 pounds. Mr. Pattington claimed that they serve as a deterrent also for the squash bug and for root-maggots in cabbage fields.

test may be made of its effectiveness under all possible conditions. Of other remedies which give the greatest promise of success and which have been reported on, more or less favorably, by various competent persons, preventives, repellents, and farm practice take a prominent place. To summarize, the principal of these are as follows:

1. Protection of young and choice plants with coverings.
2. Planting an excess of seed to distribute attack.
3. Clean cultural practice, in connection with trap plants, beans, gourds, etc.
4. Driving with the wind by dusting air-slaked lime on the plants.
5. Dusting the majority of the plants with ashes or dust and covering the remainder with an arsenical.
6. Arsenate of lead, alone and in combination with Bordeaux mixture.
7. Stimulation of growth of plants by manures or other fertilizers.

With the exercise of good judgment in planting, and combined effort among growers of cucurbits over a considerable tract of country in the use of such of the above-mentioned remedies as may be best adapted to local conditions, the total damage from the striped cucumber beetle should be greatly lessened.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *April 28, 1909.*

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