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BULLETIN No. 91.

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1. Enemies of Cucumbers and Related Plants.
2. Experiments with Potato Scab.
3. The Food of the Toad.

LEXINGTON, KENTUCKY,
March 8, 1901.

KENTUCKY
Agricultural Experiment Station.

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KENTUCKY AGRICULTURAL EXPERIMENT STATION,

LEXINGTON, KY.

Bulletin No. 91.

1. Enemies of Cucumbers and Related Plants.

By H. Garman, Entomologist and Botanist.

The Striped Cucumber Beetle.

(*Diabrotica vittata.*)

The period immediately following the coming up of cucumber, melon and squash plants is one of anxiety to gardeners in Kentucky because of the liability of such plants to injury and even destruction by a small beetle 3-16 to ¼ inch long, with black head, yellow thorax, and several alternating black and pale yellow stripes along the back. It comes regularly each Spring, and can be found in most gardens and fields thereafter during the summer. If growers of these plants can escape or can ward off its visitations while the plants are young, but little further difficulty is experienced, during most seasons and in most sections of Kentucky, in carrying them to maturity. The beetles constitute our most formidable bar to the successful growing of melons and cucumbers.

While the mischief done by the adult beetle is most dreaded, it is only a part of that inflicted by the insect. Where adults are allowed free access to plants they place their eggs close about them in the soil, and in the latter part of June the young which hatch from the eggs begin to gnaw the underground

parts so as occasionally to complete the destruction of such as have escaped the adults. More commonly this injury simply weakens the plant and it becomes of less and less moment as the plants increase in size, because of the great extent of roots then available to the young; for the worms are not restricted to the main stem for food, but wander about with considerable activity in the soil.

LIFE HISTORY.

Common as the insect is, the complete life-history has not been worked out. Some facts that add to a knowledge of it have recently been obtained in the Vivarium of this Division of the Kentucky Station, and are given below, together with observations made by me in the State from time to time during the past ten years.

Adults are to be seen about cultivated ground throughout the fall months. September 1, 1900, an adult 29 days old from date of hatching, emerged in the Vivarium. December 6, 1894, a specimen was collected with a miscellaneous lot of insects hibernating under boards and stones. In the Fall of 1900 a large number of adults were collected and confined in the Vivarium for the winter. A recent examination (January 2, 1901) shows some of them still alive in soil.

These facts imply that the cucumber beetle hibernates as an adult hid away in the soil. The same inference is to be drawn from the early spring history of the insect. It appears as an adult as soon as cucumber or melon plants appear above ground. The earliest record I have of individuals that have wintered over is in a letter dated April 12, 1892, from Mr. G. P. Tippenhauer of Newport, Ky., who wrote enclosing specimens and complaining that they were then troublesome. Such complaints become frequent in May and continue until after the middle of June, when the adults have placed their eggs about the plants and disappeared. Some of these adults, however, are to be seen as late as July 7.

During the first half of July there seems to be some reduction in the number of adults abroad, but during the latter half of the month adults that hatch from the earliest-laid eggs be-

gin to emerge, and from this time until Fall the beetle is frequently seen in gardens, although from having everywhere an abundance of food, is not noticeably mischievous, as it would probably prove to be if it were restricted, as in Spring, to the very young plants.

It is possible that some of these early-maturing beetles lay eggs for a second brood that matures before Fall, since eggs have been obtained by us as late as July 26, a date subsequent to that at which some of the beetles mature. But I am satisfied that the suggestion sometimes made that three or more broods develop during a season is without foundation, and has probably resulted from the fact that the adults are engaged in egg-laying for some time, and that, consequently, eggs, larvæ, pupæ, and possibly, at times, recently-matured adults, the progeny of a single female, may be found about plants at the same time. When, added to this, the progeny of different individuals is considered, the problem as presented by the stages of the insect present about plants at any one time is still more perplexing, for during a couple of months there exists a complicated assortment of lappings due to different dates of egg-laying of the same and different individuals, as well as to the very different rates at which individuals hatched at one time grow to maturity.

The first adult reared in the Vivarium of this Division emerged July 23, twenty-four days from the time it hatched from the egg. Others emerged from August 14 to September 1, and varied in age from 26 to 33 days. The average age at which maturity is reached, obtained from ten different lots of reared beetles, is 28½ days. The last reared beetle emerged September 1, 1900, when 29 days old.

The beetles feed on a variety of plants, sometimes proving injurious to others besides cucumber, melon and squash. They may gnaw badly the leaves of cultivated asters. The "silks" of corn ears when tender are often eaten by them. Ashmead says they feed in the pollen of the cotton flower. Years ago they were reputed as very injurious to the blossoms of pear and cherry trees in Illinois. Beans are sometimes gnawed by them. Somewhat recently they have been charged with con-

veying a bacterial disease known as *wilt** from plant to plant, and since this attacks the plants after they begin to trail, it is possible they are responsible for a great deal of loss that has not commonly been attributed to them.

It is possible that the young also do mischief other than that with which we are acquainted. But the injury they were at one time accused of doing to corn roots in Maryland proved to be the work of a related beetle, sometimes called the spotted cucumber bug (*Diabrotica 12-punctata*) now a well known corn insect.

When ready to place their eggs, the beetles creep into crevices in the soil alongside the stems of the plants or near them. When confined about plants in flower pots they sometimes put the eggs at the outer edges of the pots, the separation of the soil from the pot affording them an opportunity to find a hiding place for them. They are not expert burrowers and as a rule the eggs are to be found near the surface, this depending somewhat on the looseness of the soil, or upon the character of the crevices that may be present. The number of eggs placed about any one plant is not large, which implies that when unconfined the females scatter them about a number of plants, thus more effectively providing for the young. From the appearance of young found about plants it is probable that some of the beetles that survive the winter begin to place their eggs before the middle of June, but the earliest date at which they have been seen by me is June 18, when examples were secured from earth about plants growing in the Vivarium. Subsequently they were obtained from time to time during a considerable period, extending by my records from June 18 to July 26.

The young begin to hatch during the latter half of June, and in 1900 larvæ of various sizes were collected from the roots of plants on June 26. The first young observed to hatch came from the eggs June 27, and others were noticed coming out June 28 and July 13, 26, and intermediate dates. Unlike the adults they are quite at home in the soil, moving about

*Due according to Dr. Erwin F. Smith of the U. S. Department of Agriculture to an organism he has named *Bacillus tracheiphilus*.

with considerable freedom in search of food, though probably never leaving the region occupied by the fibrous roots of the plants. In the Vivarium they were to be found not only in burrows which they cut in the interior of the stems, but often several inches from the stem and five to six inches from the surface, where they were probably at work on the fibrous roots. When ready to become pupæ, however, they approach the surface, making small oval cavities finally, by compacting the earth about them, in which to transform. These little chambers are generally less than an inch from the surface, and never, as far as observed, more than two inches. The youngest pupa obtained in the Vivarium was formed on the 15th day after hatching from the egg. The larvæ persist, however, in many cases longer than 15 days, and may be found even 27 days old. An average duration of larval life based upon my own observations will come pretty near 19 days. Before pupating, the worms become much shorter and thicker and in this condition remain inactive for a time, before the skin is moulted. When in this condition I am inclined to think the moulting of the skin is retarded or accelerated by the weather, since insect transformations show a marked dependence on weather conditions.

The latest date at which larvæ have been observed in the Vivarium is August 25.

The first pupa observed in 1900 was taken from the earth on July 20; the latest observed was taken up August 29. Taking the average duration of larval life as 19 days, and the average length of time which elapses from date of hatching to the emerging of the adults as 27 days (obtained from nine records ranging from 24 to 29 days) the period spent in the pupa state is only about eight days.

The following data are taken from reared specimens, collected specimens, notes and correspondence in my possession :

April 12, Adults received from G. P. Tippenhauer, Newport, Ky.

April 26, Adult collected at Lexington.

May 25, Adult received from Dr. C. M. Smith, Dixon, Webster Co.

June 1, Adults injuring melon and cucumber, Lexington.

June 2, Adults collected in blue-grass pasture.

June 15, Adults injurious at Bernstadt; received from Francois Sabatier.

June 18, Eggs obtained in Vivarium.

June 21, Adults injurious at Woodbine, J. W. Hart.

June 26, Eggs. Larvæ of various sizes collected.

June 27, Larvæ just hatched. Adult collected.

June 28, Larvæ just hatched.

July 7, Adults collected.

July 8, Larvæ (9 days old).

July 11, Larvæ (13 days old).

July 13, Larvæ (just hatched, and others 8 days old).

July 20, Larvæ (1, 15, 17 and 21 days old). Pupæ (15, 17 and 21 days old).

July 21, Larvæ (2 days old).

July 23, Larvæ (5, 15 and 25 days old). Pupæ (15 and 24 days old). Adult (24 days old).

July 25, Larvæ (15 and 16 days old).

July 28, Larvæ (3 days old).

July 29, Larvæ (4 days old).

July 30, Larvæ (6 days old).

August 1, Larvæ (7 days old).

August 2, Larvæ (22 days old). Pupa (22 days old).

August 3, Larva (23 days old). Pupae (22 and 23 days old).

August 6, Larvæ (10, 12 and 19 days old).

August 7, Larvæ (11 and 13 days old).

August 14, Larva (27 days old). Pupa (27 days old). Adult (just out, 27 days old).

August 15, Larva (18 days old).

August 17, Pupa (30 days old). Adult (30 days old).

August 20, Larva (20 days old). Pupæ (20 and 26 days old). Adults (26, 32 and 33 days old).

August 25, Adult (31 days old).

August 26, Pupa (26 days old). Adult (26 days old).

August 27, Adult (27 days old).

August 28, Pupa (28 days old).

August 29, Pupa (32 days old). Adult collected.
Sept. 1, Adult (29 days old).
Sept. 24, Adult collected on grasses.
Sept. 26, Adult collected.
Oct. 1, Adult collected.
Dec. 6, Adult collected with other insects under boards and stones.
Dec. 30, Adults hibernating in earth in Vivarium.
March 18, Adults active in Vivarium.

REMEDIAL TREATMENT.

The beetles are likely to prove most troublesome on places where accumulations of leaves, weeds, heaps of boards, and stones furnish convenient hiding places for the winter. When these are removed in the Fall they must go elsewhere for shelter, and are not so likely to be present in large numbers the following Spring. They fly readily and can thus travel long distances in search of food, hence plants are not entirely safe anywhere. Yet even where they are most abundant, by taking the matter in hand in season, most of the injury to the young plants can be prevented. Time is lost sometimes by making use of so-called remedies that long ago proved valueless. Here is a list of materials that have been recommended with "confidence" by one person or another during the past forty years as remedies for this insect: Plaster, lime, ashes, soot, powdered charcoal, sulphur, snuff, Glauber salts, tobacco dust, tobacco decoction, elder leaf decoction, walnut leaf decoction, aloes, tobacco water, soft soap and lime, pyrethrum, Paris green, white hellebore.

Plaster was one of the first of the list to be used, but proved not effective in the hands of growers of cucumbers and was abandoned. The same thing is to be said of lime, which has at times been strongly recommended as preventing injury when dusted on the leaves. Somewhat recently these materials have been recommended for use in sowing broadcast in fields, thus driving the beetles out. The insects are timid and take flight readily enough, yet it is questionable if the treatment is as complete a remedy for the injury as has been claimed.

Soot and powdered charcoal were long ago shown by Dr. Fitch of New York to be of no value whatever.

The mixture of tobacco water and soft soap to be sprinkled on the leaves which are afterward dusted with lime has been recommended by very competent men, and has the appearance of a good combination for the purpose.

In my own experience, as I have stated in other publications, the insect powder of drug stores, either pure or mixed with flour, ashes, or other material, has proved quite sufficient to protect the young plants from severe injury. But they must be dusted frequently until well started. For a garden this treatment is all that is necessary, since the cost for the required powder is not very great. Where an acre or more is is planted other treatment is to be preferred.

Bordeaux mixture answers very well for keeping this insect from gnawing plants, and since it protects them at the same time from mildew it is under some circumstances the best material we know for use in spraying cucumbers and melons. Its insecticide properties were demonstrated by me in 1889 in experimenting with the potato flea beetle and the margined blister beetle. At the outset the mixture was supposed to be simply a deterrent, rendering sprayed leaves unpalatable to insects, but experiments on insects kept in confinement (reported on page 125 of Agricultural Science, Vol. 6, 1892) showed that when they are compelled to eat the mixture it acts as a slow poison. Tobacco worms, grasshoppers, and Colorado potato beetles were killed with it.

Where the beetles alone are troublesome one of the most satisfactory means of keeping them from the young plants is by the use of covers made of four pieces of board nailed together at the ends to form a square, with tobacco muslin tacked over the top. These are set over the plants as long as the beetles are troublesome, when they can be stored in a dry place until another season. Similar covers are sometimes made from two willow twigs, bent so as that one crosses the other over the plants and with the ends thrust into the soil. A square of tobacco muslin is then thrown over these and the edges covered with earth.

A couple of sections of a keg hoop can be crossed over the plants and covered with muslin in similar manner.

The frames should be ready for use before the plants are up. If Bordeaux mixture is to be used the materials and pump should be secured before they are needed, since the mixture is very largely preventive in its action and must be applied early if the best results are to be obtained.

DESCRIPTION.

Egg.—The egg is of a pale but evident yellow color when fresh, and measures just about 1-50 inch in length, with a diameter a little more than half the length. The shape is as nearly that of a hen's egg as it well could be. Four specimens measured under the microscope give an average length of 0.54 mm. and an average diameter of 0.36 mm. The surface is reticulate in 5 and 6-sided areas like the eggs of the two corn root worms (*Diabrotica longicornis* and *D. 12-punctata*), which they greatly resemble in other respects. The eggs of the southern corn root worm are a little longer than those of either of the other species. As I remember the egg of the northern corn root worm from an examination made a good many years ago it is so much like that of the striped cucumber bug that it could only be distinguished by careful microscopic examination.

Larva or Worm.—White, with small oval dark brown head, partly covered by a wide smooth yellowish brown plate projecting forward from the next body division. Skin wrinkled, with series of rounded prominences along the sides; with numerous short forwardly-directed hairs. Body terminating in a blackish plate that bears at its hind edge near the middle line two erect teeth. Beneath the front portion of the plate is a downwardly-projecting fleshy false leg, which effectively aids the three pairs of jointed legs located just behind the head. Length when fully grown about one-half inch.

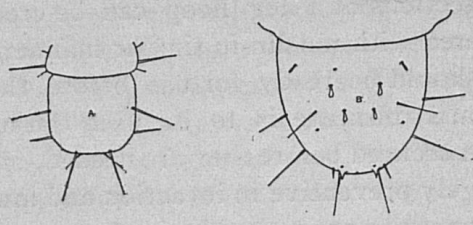

Fig. 1. *A*, last body segment of young striped cucumber beetle just hatched; *B*, last body segment of nearly grown larva of cucumber beetle, showing spines at tip, and four paddle-shaped appendages, about *B*. (Enlarged. Original.)

Immediately after hatching the larva measures a little more than 1-25 inch in length (1.30 to 1.72 mm.) and has a diameter of about one-fifth the length (0.26 to 0.28 mm.). It is white, with the head and neck plate brownish, while the tail plate is already blackish. The head is now relatively larger than it is later, and the tail plate is quite different in shape. Seen from above this latter is quadrate in shape. Looked at from the side it is seen to project beyond all the other structures, to be strongly arched above, and to be without a trace of the two teeth that later become a striking character of the plate. The false foot projects downward and generally a trifle forward in preserved specimens. It is a conspicuous structure in the newly hatched larva.

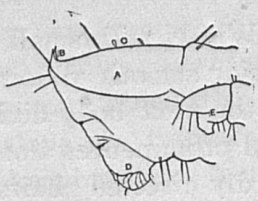

Fig. 2. Side view of last body segment of larval cucumber beetle. A, caudal plate, with spines at B, paddle-shaped appendages at C, and fleshy foot at *D*. E, the last segment of a larva just hatched. (Enlarged. Original.)

As the larva grows older the head becomes smaller relatively, the body more slender, while the tail plate becomes more rounded behind and two erect teeth gradually appear at its hind edge. Larvæ four days old measure 3 mm. in length. When five days old the tubercles are visible at the

hind edge of the caudal plate, but are very small, while the plate itself is quite different in shape from that of the recently hatched larva, though it has not yet assumed the shape it is yet to take. Larvæ eight days old measure 5 mm. in length and the tubercles at the edge of the caudal plate are noticeable in all examples. When twelve days old the larva has assumed all the characters that distinguish it from the larva of related beetles, and the changes which take place subsequently are but slight, consisting chiefly in increase in size. The length is now about 7 mm. The tubercles at the edge of the caudal plate are conspicuous. The head and caudal plate are decidedly blackish, while the neck plate is also dark in color. When 20 days days old the larva is about 10 mm. long, and subsequently may become shorter, when ready to become a pupa. The general color is still white. The head is quite small. The caudal plate is strongly arched above, with the two sharp spines at its tip turned up and a trifle forward. From the time the larva hatches this plate bears four very singular little spatulate scales or plates on the dorsal surface, as represented in the outline figures. What their function is is a matter of conjecture. They are present also on the plates of the two corn root worms (*D. longicornis* and *D. 12-punctata*), as I discovered a good many years ago, and may prove to be characteristic of larvæ belonging to this genus.

Pupa.—White, 4½ to 5 mm. long and 2 mm. in diameter. Head folded close against breast, so that it is invisible from above. Antennæ extending outward and backward around the extremities of the two forward pairs of femora, then at the tip turning toward the body again. Hind femora directed obliquely backward and folded against the sides of the abdomen. Front wing pads reaching the hind femora. Hind wing pads extending 1-50 inch beyond hind femora. Segments of body with series of erect hairs. Tip of abdomen blunt, with two slender, divergent, acute spines, the distal halves of which are black.

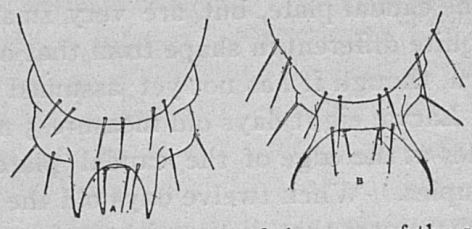

Fig. 3. A, extremity of abdomen of the pupa of the spotted cucumber beetle (*Diabrotica 12-punctata*). B, same of the pupa of the striped cucumber beetle (*D. vittata*); (Enlarged. Original.)

Smaller than the pupa of our corn root worm (*D. 12-punctata*), and noticeably different in the greater slenderness of the terminal abdominal spine, half of which is black, while in the pupa of *D. 12-punctata* only the extreme tips of these spines are black.

Imago or Adult.—Pale yellow with head, antennæ, feet, abdomen, and three stripes along the back black. Head small, bent downward. Thorax small, with two large and rather deep depressions on dorsal side. Body widening behind. Length of male, 5 to 5½ mm. Length of female 6 to 6½ mm.

The beetles are so well known as scarcely to call for description, but the following additional characters will serve to distinguish them from other striped beetles of the same family in any doubtful case. The antennæ are black excepting the three basal segments, which are yellow, the two first with some black at the tips. The front femora are yellow excepting the tips, while the tibiæ and tarsi are wholly black. The tips of the middle and hind femora, and also of the middle and hind tibiæ are black, while the tarsi of both these pairs are entirely black. All the ventral side of the body excepting that of the small thorax (prothorax) is black. The black on the back is in three longitudinal stripes when the wings are closed, but when the front pair is separated the middle stripe is seen to be partly on one and partly on the other. The stripes do not quite reach the hind margin. The whole surface of each wing cover is minutely longitudinally ribbed, the lines between ribs being rather coarsely punctured.

EARLY LITERATURE.

Most of the facts concerning the life history of the cucumber bug seem to have first been made out by Dr. Henry Shimer, of Illinois, and Dr. Asa Fitch, State Entomologist of New York. Dr. Shimer's account of the insect appeared in the Prairie Farmer in 1865. Subsequently, 1871, in volume 5, of the American Naturalist, he added facts concerning the early stages and described and figured a fly parasite which he named *Melanosphora diabroticæ* (now *Celatoria diabroticæ*). Dr. Fitch's article was published in his 10th report as State Entomologist, in 1867. This is one of the best of the early accounts of the insect, being based, as was usual with this author, on his own observations. But the figures were rather poor, and that of the pupa has the abdomen represented much too long. In his second Missouri report (1870) C. V. Riley gives a good account of the insect, with figures of larva, pupa and adult, and adds some data to what had previously been published. Briefer articles giving observations on food habits of the beetles appeared also in the Practical Entomologist, the American Entomologist, and in the agricultural journals from 1866 to 1875, but contributed little to what was known concerning the transformations, or of remedies for the injuries.

The recent literature of value is to be found chiefly in bulletins and circulars of the Department of Agriculture at Washington, and in Station Bulletins.

The Spotted Cucumber Beetle.

(*Diabrotica 12-punctata.*)

This is a near relative of the striped cucumber beetle, but is somewhat larger, and has the wings spotted instead of striped with black. It is sometimes seen about young cucumber plants, which it gnaws in much the same way as its relative. When it is disposed to be mischievous the plants may be covered with cloth, or sprayed with Bordeaux mixture. It is common in Kentucky, but does most of its mischief as a larva feeding on the roots of corn.

A full account of the insect was published in our annual report for 1890, under the title, The Corn Root-worm of Kentucky.

The Northern Squash Beetle.

(*Epilachna borealis.*)

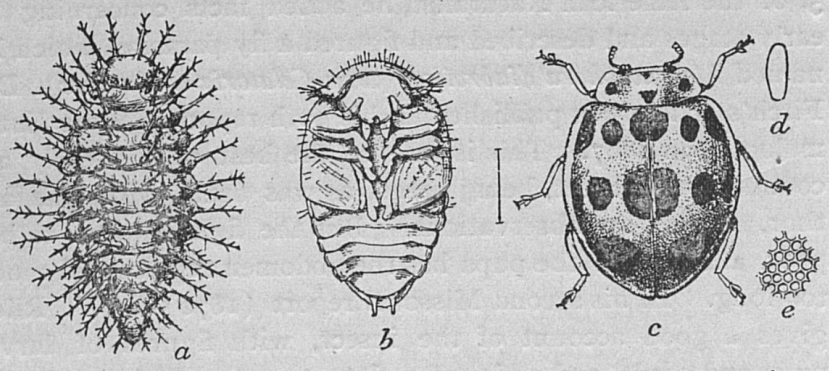

Fig. 4. The northern squash beetle (*Epilachna borealis*). *a*, larva; *b*, pupa; *c*, adult; *d*, egg; *e*, surface of egg magnified. (All figures enlarged. After Chittenden, U. S. Div. Ent.)

In the mountains of eastern Kentucky and in the Bluegrass region adjacent is found a spotted lady beetle about 0.36 inch long that at times in both adult and grub state gnaws the leaves of gourds, squashes and related plants so as to do some mischief.

Its depredations are local and periodical, however, so that it is not as well known to gardeners as are several other insects attacking the same plants. Stray individuals of the adult are to be observed in gardens during late summer, and are now and then found about buildings, where they wander when ready to hide for the coming winter. It was first observed and collected at Lexington, September 6, 1890. It was found at Pineville, Bell County, June 15, 1892. Under date June 21. 1892, Mr. J. W. Hart, wrote from Woodbine, Whitley County, complaining of its injuries to watermelon vines. August 22d of the same year, it was found to be common in the vicinity of Clay's Ferry in Fayette County. Since 1892 it has been less common, but a few may always be found by

careful collecting, and individuals are likely to be encountered at any time from June to November. The latest capture now in the Station collection was taken on a window ledge of the Station building November 22, 1900.

The injury done by this lady beetle consists in gnawing the leaves and rendering them ragged. It is an exceptional food habit for a lady beetle, all our other species feeding upon bark lice, plant lice and other small insects; but is not the only vegetable feeding lady beetle, species of similar habit having been observed in European countries. The injurious work begins as soon as the beetles come forth in Spring, and besides the injury to the leaves, the rind of melons is sometimes badly gnawed. Egg-laying begins during the latter half of June, when the eggs are placed in clusters on the under sides of the leaves. They hatch in about ten days the larvæ feeding exclusively on the under surface of the leaves, whereas the adults attack them at any point and leave nothing but the veins. Larvæ are ready to become pupæ in July, and pupate about the plants, emerging as beetles in a week or ten days. The whole development of the insect, from the time it hatches until it becomes adult, occupies about a month.

REMEDIAL TREATMENT.

The insect is not a difficult one to deal with owing to its large size and general stupidity. It creeps very slowly, does not take wing readily, and can be removed by hand with but little trouble. In case it attacks extensive plantings of squashes or melons at any time, Paris green and lime can in all probability be made to check it.

DESCRIPTION.

Adult.—The beetles measure 0.32 to 0.36 inch in length, by 0.22 to 0.28 inch in diameter. The back is strongly arched, the head and thorax (prothorax) small, the legs and antennæ rather short. Color whitish yellow to ochre-yellow, with sharply defined roundish black spots, as follows: Four on the thorax, of which the largest is median, somewhat triangular, and located at the hind margin; twelve on the wing covers,

ten of which form two transverse rows, the remaining two near the tips being largest except the median spot of the hindmost row. Body beneath yellow, marked with black. Legs yellow.

The only native lady beetle very likely to be confounded with this pest is the nine-spotted beetle. It is very often seen about squashes and melons feeding on the melon aphis. It averages much smaller, however, the largest examples being only about 0.28 inch long, has only nine spots on the wing-covers and is everywhere black beneath, including the legs.

Pupa.—About 0.35 inch long, clothed with short hairs, some white, some black.

Larva.—Oval in general shape. Length when ready to pupate 0.35 to 0.40 inch. Each division of body with six branched spines. Yellow; the basal half of each spine yellow, the rest black.

Egg.—About 0.06 inch in length. Elliptical. Yellow.

The Melon Aphis.

(*Aphis gossypii.*)

Cucumber and cantaloup vines are troubled in midsummer with a small plant louse, living in large numbers on the under surfaces of the leaves. As a result of the injury these curl up, cease to grow, and bear finally an abnormal color, the whole plant at length dying, it may be. The very young plants are not likely to suffer, but from the time the trailing stems are from a foot and a half to five feet long, the injury is continuous, and plants of large size often succumb to the injury. In 1896 the mischief done by the lice was exceptionally severe everywhere in the State, but was felt more especially by large growers of cucumbers and melons in Kenton and other adjacent counties in the vicinity of Cincinnati. A single grower in this region often plants 10 acres or more in one of these crops, while one Cincinnati firm has been known to contract for the product of 1600 acres in this part of Kentucky. It will be seen that the interests involved are of importance, and a remedy for the injury much to be desired.

The injury is not restricted to Kentucky. It has long been known in other states from California to Florida. In 1897 a large manufacturer of pickles at Pittsburg, Pennsylvania, wrote to the Station complaining of the injury in that State and asking for a remedy. It is prevalent in Illinois, Ohio and Tennessee and has been reported from Texas.

The melon aphis is a puncturing insect like the squash bug, but unlike the latter its puncture is not followed by a wilting of the leaves. The injury seems to be simply the result of the removal of the sap by the hundreds of small lice, this causing a general enfeeblement and somewhat gradual decline.

The beginnings of the mischief are not therefore so likely to attract attention and excite alarm as would the presence of a few squash bugs. Yet the injury is, because of its nature and the small size of the insects that cause it, much more to be dreaded.

REMEDIAL TREATMENT.

The way this insect takes its food must be kept in mind in experimenting with remedies. The failure of treatment employed by some of the growers about Cincinnati in 1896 could have been foretold by anyone familiar with the habits of the insect. Bordeaux mixture and London purple can not be expected to protect plants from its attacks, though they are excellent for certain other insect and fungus troubles. Only a fluid or a powder that is made to reach and attack the bodies of these insects, can be expected to kill them.

The two fluids which I have found most effective for aphides are tobacco decoction and coal oil emulsion. As commonly prepared from tobacco stems the decoction is likely to vary widely in "strength" and effectiveness. As an insecticide it is dependent on the quantity of nicotine it contains and to some extent on the oily matter extracted by the hot water used in making the decoction. The per cent. of nicotine present even in fresh stems is small, and as it is very soluble much of it may be removed from stems which have been left out of doors exposed to rains. The use of such stems in making a decoction may lead to disappointment. Then again the strength will

vary with the proportion of stems to water, and with the length of time they are soaked, so that it requires a little judgment and care to get an effective decoction. The very best one can get is not likely to destroy all the aphides at the first spraying. Protected as they are when on cucumbers and melons, under the leaves, these must be turned up so that the fluid will reach the under surfaces, and it is very difficult to reach every single aphis of the thousands present.

Two applications of a decoction made by pouring two gallons of hot water over one pound of good tobacco stems ought to prove effective against any exposed plant louse. Such a decoction is generally made by putting the stems in a wooden bucket and leaving the water on them over night.

Extracts of tobacco are now in the market that are more convenient than the stems. They are easily and quickly prepared for use, and the strength to be used is completely under one's control; so that once having determined the per cent. that kills the lice most completely, it can be strictly adhered to afterward. The Rose leaf Insecticide manufactured by the Kentucky Tobacco Product Company of Louisville is one of these and has been used successfully at the Station. In a circular before me it is quoted at 30 cents per pint, 50 cents per quart, $1.50 per gallon, and $5.00 for five gallons, in cans.

The Skabcura Dip Company of St. Louis also manufactures a preparation of nicotine that has in my hands proved excellent for aphides of various species. It contains 40 per cent. of nicotine, and must be greatly diluted before using. The same company manufactures what they call nikoteen punk, consisting of rolls of brown paper saturated with nikoteen. I find it just as effective for aphides and thrips as the vapor produced from the solution. By burning under a box a half inch cut from a roll, these insects can be destroyed in a few minutes. It leaves an odor, however, about treated plants to which a florist would object.

After having tried most of the preparations that have been recommended for aphides I must say that nothing gives better satisfaction as a spray for these insects than dilute coal oil emulsion. For many plant lice, such as those infesting chrys-

anthemums, one application of the emulsion, made by a careful man is enough. It is more effective than tobacco decoction. It can be made to injure the plants, but this is to be avoided by proper dilution, after which not the slightest injury follows. The emulsion used by me in most cases is prepared according to an accepted formula in use everywhere, namely ½ pound of soap (whale oil if possible), 1 gallon of water, 2 gallons of coal oil. One part of this emulsion to nine of water makes a suitable spray for most plants.

In Bulletin 53, p. 144, published by this Station in 1894, the use of two gases is considered as a means of destroying plant lice on low-growing plants, and as the result of some experiment it was stated that bisulphide of carbon fumes and hydrocyanic acid gas can both be made to destroy the melon louse when generated about plants covered with a tub or box. These gases search out and destroy all insects that may be about the enclosed plants, excepting mites, which are more easily destroyed by spraying with coal oil. In careless hands there is some danger of injuring the plants with either of the gases. But this is true of the coal oil and indeed of many of the best and most effective insecticides. The gas treatment appears to me well adapted to use with plants of small and medium size. After they begin to bear it is not so easy to confine them for fumigation.

The bisulphide of carbon is bought in the form of a fluid, commonly in pound bottles. In larger quantities it can be bought of manufacturers for from 10 to 12 cents per pound. A couple of table spoonfuls is required for each plant, and is simply poured in a saucer placed on the ground beside the plant under the inverted box or tub. The fluid is very unstable and in warm weather quickly vaporizes when exposed, so that the fumes soon fill the space about the plant. A small quantity may be left about the plant for an hour and a half. Large quantities are liable to injure the plants, and very short exposures only benumb the plant lice for a time. I have found them apparently dead after a half hour's exposure to the fumes, but when removed, in an hour or two they recovered and became active. These are the chief defects of this

fluid, and they are such as to deter many men who have large plantings of melons or cucumbers from using it. Hydrocyanic acid gas acts much more rapidly, but is also liable to do injury to the plants unless handled carefully.

The fumes of tobacco extracts have been used in the Vivarium of this Division for several years to destroy plant lice on lettuce, roses, and other plants, and have been found so completely effective that I have no hesitation in recommending the extracts, thus applied, as a complete remedy for the injuries of these insects; and I am prepared to say from our experience that the grower of greenhouse lettuce who allows these insects to destroy his crop has only himself to blame. In fumigating the heated part of our Vivarium greenhouse (25 ft. long, 18 ft wide, 11½ ft. to ridge piece) we have commonly used a large dish pan, putting in it about a quart of dilute tobacco leaf extract (one part extract, two parts water) then dropping into the fluid a red hot piece of iron weighing several pounds. The fumes are left about the plants all night, commonly, or until they have disappeared. It is much more effective than tobacco smoke, and once the house has been thoroughly aired, leaves no oder about the plants, which cannot be said of the smoke, or of nikoteen punk.

The 40 per cent. nicotine extract is the most effective preparation of tobacco for killing aphides that I have used. This requires more water than the others with which I am familiar, and in some recent tests has been used in the proportion of one teaspoonful in a pint of water.

Neither of these preparations injure plants when properly used, but by driving off the hot fumes directly against foliage it will be scalded of course, and it is desirable to set the pans in an open space.

Two fumigators have been devised by me and are in use in the Vivarium that are adapted to fumigating melons and cucumbers. The first consists of a can, to one side of which near the top is soldered a four inch tin cylinder (eight inches long) closed at the outer end, but with the upper half of the soldered end opening into the can. A screw-cap such as is used in oil cans, fixed in the upper side of the cylinder permits

pouring the nicotine preparations into the cylinder. The can lacks a bottom, and is placed over the plant to be treated, then heat from a burner is applied to the under side of the cylinder and the fumes pass through the opening into the can. This fumigator can be made of a lard can, with tight fitting cover. With the cylinder and screw cap it need not cost more than one dollar. If a number can be ordered at one time probably the cost could be reduced. For fumigating plants on a large scale it will be desirable to have at least a dozen going at once so that by the time the heater is applied to the last, the first will be ready to be taken up and transferred to another plant.

The second form need cost only about 35 cents. A small wooden box is nailed up closely and, if necessary, calked, to close the joints. This is inverted over the plant to be treated and a three quart tin pail, to one side of which is soldered a tin tube about a foot long and an inch in diameter, is connected with the box by thrusting the tube through an augur hole bored in the box near its bottom, or what may be styled its top after it is inverted. Heat is applied to the bottom of the pail, to drive the fumes of the nicotine it contains through the tin tube into the box and about the plant. Where the flame of the burner is applied the material should be strong and durable, and it will be wise therefore to make the cylinder of the can, and the bottom of the pail, of galvanized iron, or other material that will not soon burn through. With fifteen or twenty boxes, each with an augur hole bored in it, set over hills of cucumbers the pail with its tube can be applied to one after the other in rapid succession, the hole in each being closed with a cork when the tube is withdrawn.

In using these fumigating devices a good burner is essential in order that the fumes may be driven off quickly. A candle does not give heat enough. An ordinary alcohol lamp is but little better. The small oil "stoves" sometimes used for such work do not seem to me to be what is wanted, though they can be made to do the work. A blast lamp that delivers its flame vertically and costs $2.50 to $3.00 will prove a good investment to any one who may wish to fumigate plants in this

manner. At the Experiment Station I have used Barthel's brass gasoline burner (see figures), an excellent piece of apparatus for the purpose, but costing too much ($7.50). With this burner it is possible to drive off the fumes of nicotine sufficient to fill can or box in from 2 to 5 minutes from the time of applying the flame. Once the fluid in cylinder or pail is hot it requires less time. A few aphides are likely to recover after a couple of hours, when exposed for fifteen minutes. Twenty minutes exposure is enough to kill everything. Where not pressed for time, the fumes may be left as long as desired.

Box and can should be tall enough so that the fumes will not be delivered directly on the foliage, since they are likely to cook young and tender leaves under these circumstances.

These fumigators are excellent for removing aphides from potted plants, or those growing in benches, in hot houses, when it is not thought expedient to fumigate the whole house. In the Station Vivarium where a number of insects may be under observation which it is important to keep alive, they are of frequent use, since fumigation of the whole house is often out of the question.

PLANTS ATTACKED BY THE MELON LOUSE.

The melon aphis has been described as a new species (*Aphis cucumeris*) with the idea that it would prove restricted to plants of the cucumber family (Cucurbitaceæ). Mr. Pergande of the Division of Entomology of the United States Department of Agriculture published in 1895 an article in which he claimed that the insect is the same as that attacking cotton, described in 1854 by Townend Glover in the United States Patent Office Report under the technical name used at the head of this article. If Mr. Pergande's identification is correct, the species has a wider range of food plants than was at first suspected. He gives the following as those upon which it has been observed, though he expresses some doubt about the individuals found upon strawberry plants being identical with the melon louse.

Purslane, Shepherd's purse (*Capsella bursa-pastoris*), Pepper

grass (*Lepidium virginicum*), Amarantus sp? Dock (*Rumex crispus* and others), Burdock, Dandelion, Pigweed (*Chenopodium album*), Wormseed (*Chenopodium anthelminthicum*), Plantain, Chickweed (*Stellaria media*), Morning glory, Three-seeded mercury (*Acalypha virginica*), Button weed (*Diodia teres*), Ground ivy (*Nepeta glechoma*), Red clover, Indian strawberry (*Fragaria indica*), Mallow (*Malva rotundifolia*), Cultivated strawberry, Dwarf bean (*Phaseolus nanus*), Spinach, Hop, Cotton, Pear, European dogwood (*Cornus mas*), Orange (*Citrus aurantium* and other varieties), Hydrangea, Begonia, Jamestown weed.

This list, it will be observed, includes weeds very commonly found in cultivated ground, from which we may suppose the melon louse is sometimes established in fields before melons or cucumbers are planted there. Growers sometimes complain that planting on new ground affords them no relief from the injuries, and while the winged individuals can fly and thus make their way to new ground, it seems altogether likely that some of the instances of prompt infestation of new plantings is due to the fact that the aphides were already present, living on some one or more of the weeds mentioned in the above list.

Yet it has been observed that the injury is as a rule most severe where the cucumbers or melons have been grown for some time.

LIFE HISTORY.

Accepting Pergande's conclusion that the egg-laying aphis discovered by me in 1882 on the crowns of cultivated strawberries at Centralia, Illinois (referred to by Professor S. A. Forbes in his report as Illinois State Entomologist for the year 1882, p. 102) is identical with the leaf-infesting viviparous species of melon and cotton, we know where and in what condition the insect passes the winter. It becomes active early in Spring, but here in Kentucky I have had few complaints of it until the latter part of June and during July. Most of the injury occurs during the latter month. After July the melon louse is generally suppressed by its insect parasites, though it is to be seen until Fall. In his list of food plants

Pergande notes his dates of collecting, from which he appears to have found the aphides on various plants during the Fall and as late as December.

So far as I know the egg-laying form has only been found on strawberry plants,* but it is probable that it passes the winter on other perennials, also. Pergande, as has been already noted, found the insect on the ground ivy (*Nepeta glechoma*), a common weed in Kentucky fields, and possibly one of its winter food plants.

THE PROPER NAME.

The name melon aphis is very commonly used for the insect because the injuries are rather more severe to musk melons (cantaloup) than to other members of the family. Growers of cucumbers frequently refer to it in correspondence as the pickle louse, while growers of cotton farther south know it as the cotton louse or cotton aphis. These names are all allowable.

While Pergande is probably right in considering the cotton aphis identical with the melon aphis, the grounds for accepting Glover's name *Aphis gossypii* in place of Forbes' *A. cucumeris* do not appear entirely satisfactory. In his first account of the cotton louse (Patent Office Report, 1854.) the figures given in plate 3 might pertain to almost any member of genus Aphis. The description is also vague, and cannot be considered as characterizing the species. Indeed Glover was doubtful at this time about the proper genus for the insect. His description reads: "The young lice are extremely minute and of a greenish color; but when they become older, they are about a tenth of an inch in length, and often of a dull green, or, in some instances, almost black. * * * The end of the abdomen of both sexes is provided with two slender tubes, rising like horns from the back." * * * Glover evidently never saw the sexes of this insect, though he happens to be right about the presence of tubes (cornicles), since these are very generally present in aphides of both sexes in various

*Pergande found a winter egg on purslane in October, which implies that the egg-laying generation sometimes develops on annuals.

genera. This same description and similar figures are given in Glover's report for 1855, still without assigning a technical name. In the Report of the United States Department of Agriculture for 1876 other figures are given that might easily represent a distinct species, and the author says by way of description: "Their habits are much the same as the rest of the *Aphides*, and their colors vary from green to a decided yellow, striped with black on the upper side of the thorax. A more full description of them may be found in the Patent Office Agricultural Report for 1855." With this brief notice is given the name *Aphis gossypii* for the first time.

If the basis of a species name must be "(1) an identifiable published description, or (2) a recognizable published figure or plate, or (3) the original type specimen or specimens absolutely identified as the type or types," then it is to be supposed that Mr. Pergande had before him Glover's types, for the description and figures published by Glover are not a safe basis for deciding that the *Aphis cucumeris* of Forbes is the *A. gossypii* of Glover. Certainly the melon aphis is not striped with black, as Glover represents the cotton aphis in his latest description and figures.

DESGRIPTION.

Wingless form (from melon).—Body oval in general shape, widest near the middle of the abdomen. Length about 0.06 inch, greatest width about 0.025 inch. Antennæ slender, tapering, about 0.04 inch long. A short tubercle on each side of the body above the first pair of legs. Several smaller tubercles are ranged on each side of the abdomen and a rather large one is situated behind the honey tube. Honey tubes of medium length, rather stout, thickest at base, slightly contracting outwards to the flared tip, which does not surpass the tip of the abdomen. Color green, varying to greenish black. Feet (also tips of tibiæ) and honey tubes black.

Winged form (from melon).—More slender than the wingless form. Length of body about 0.06 inch. Greatest diameter of abdomen about 0.02 inch. Antennæ 0.05 inch long. Wings about 0.08 inch long. Tubercles along sides of body

as in the wingless form. Color yellowish green to black. Head, antennæ, most of the thorax, tip of beak, tips of tibiæ, feet and honey tubes black. Often with a black edging to the abdomen.

The immature individuals of this form resemble in general the wingless lice, but are to be recognized by the presence of a pair of wing pads on each side of the body.

Egg-laying form (from strawberry crowns and roots).—Oval in shape, back strongly convex. Length of body about 0.06 inch. Greatest width about 0.025 inch. Antennæ short, about 0.03 inch long. Tubercles present on sides of body. Adults dark green. Feet and tips of honey tubes dusky. The male has not been seen by me.

Specimens of this form were received from Louisa, Lawrence County, October 27, 1896, from Mr. Herbert Carr, who wrote: "I send you by this mail a box containing a strawberry plant that is infested with root lice. We have about ¾ acre almost entirely destroyed by what I suppose to be these lice. Part of it is this year's planting and part last year's planting. On the old bed the whole row, which was about two feet wide last Spring, has gradually died away till now nothing is left but a few brown and withered bunches and with scarcely any roots. This condition has prevailed all summer, as though they were suffering from drought, which was not the trouble, since the affected spots are on our most moist ground. On the new setting the appearance has been about the same—they have made no growth."

ENEMIES OF THE MELON LOUSE.

Great numbers of dead lice may be found in the latter part of July with the body brown and greatly swollen. Some of these dead bodies have a round hole of relatively large size cut out of the back, through which a parasite has escaped. These latter are small slender-bodied four-winged insects, with black head and brown thorax and abdomen, though in some preserved specimens appearing largely black.

A second insect very often seen about aphis-infested melon and cucumber leaves feeding on the lice is a brown beetle

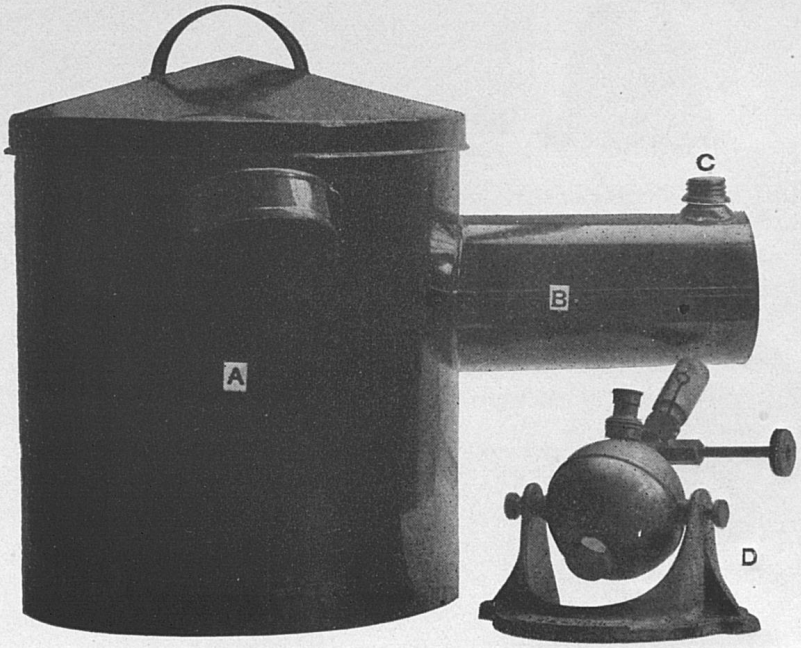

Fig. 5 A fumigator made of a lard can, *A*, by cutting out the bottom and soldering a cylinder, *B*, to one side near the top; *C*, a screw-cap by which fluid is introduced; *D*, Barthel burner. (Original.)

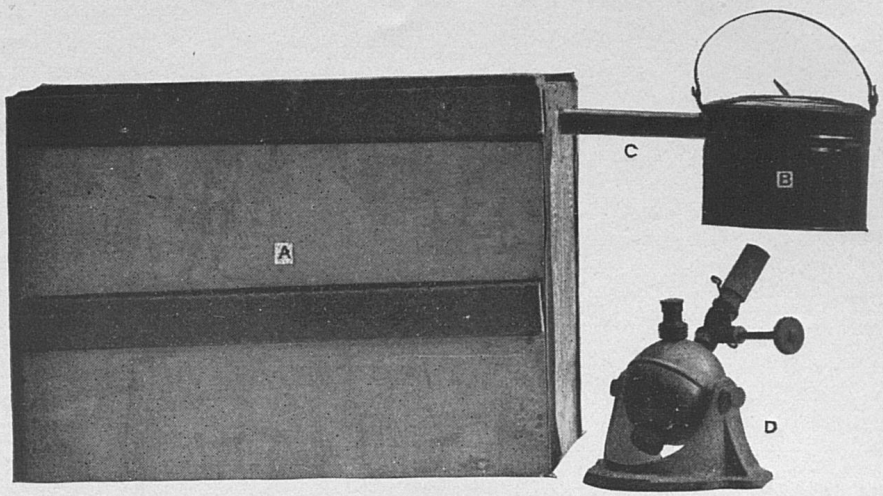

Fig. 6. A fumigator made of a pine box, *A*, and a three-quart pail, *B*, the two being connected by a tin tube, *C*, soldered into the pail and passing through an auger hole in the box; *D*, Barthel burner. (Original.)

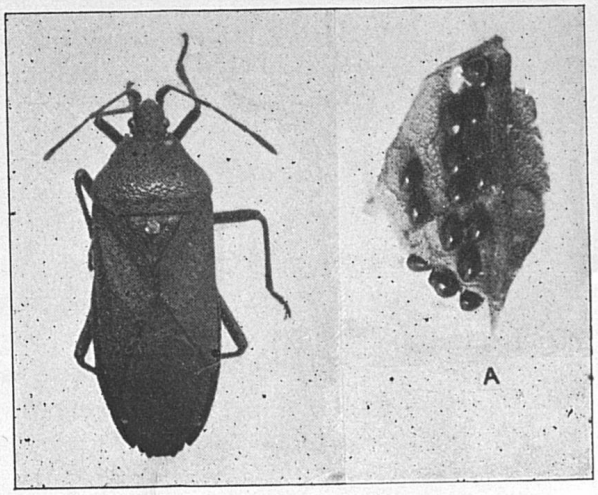

Fig. 7. The squash bug. *A*, eggs. (Enlarged to 2⅓ diameters.) (Original.)

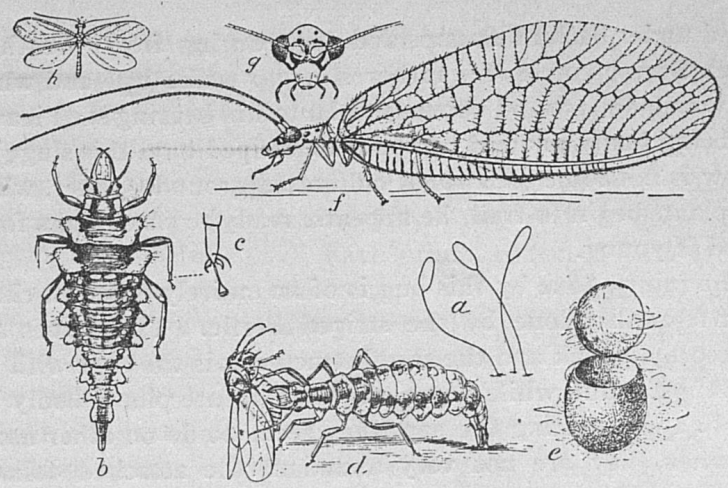

Fig. 8. The lace-wing fly (*Chrysopa oculata*), a well known enemy of plant lice. *a*, eggs, at extremities of threads by which the insect secures them to leaves; *b*, larva, seen from above; *c*, foot of larva; *d*, side view of larva holding insect in its jaws; *e*, cocoon; *f*, side view of adult; *g*, front view of head; *h*, adult seen from above. (All figures enlarged except *h*, which is reduced. After Marlatt, U. S. Div. Ent.)

(*Coccinella 9-notata*) about 0.28 inch long, with nine large black spots on the back. These two species are often largely instrumental in ridding plants of the aphides in late summer. They are helped to some extent by rather large creeping worm-like insects, the young of one or more species of Syrphus flies.

The Squash Bug.

(*Anasa tristis.*)

In the Fall of the year one sometimes encounters in dwellings and out-buildings a slow-moving, dull brown or blackish bug a little more than half an inch long, that gives off when disturbed a powerful odor of the sort commonly called "buggy." In such situations it is harmless enough to man, though it has a superficial resemblance to the far-famed kissing bug (*Melanolestes picipes*). Its purpose is to find a snug place to hide for the winter, for it passes this season as an adult under the floors of buildings, under loose boards and stones, and when woodland is near cultivated ground, is often

found under bark of stumps and logs during frosty weather. When Spring comes it is rather slow to wake up, and while the young squash and cucumber plants still bearing seed leaves are being badly gnawed by the little striped bug, this sluggish fellow is not to be seen about cultivated ground. Later, when the plants begin to trail, he appears, ready to place eggs for a brood of young.

The injury done by this bug is of an entirely different character from that done by the striped beetle. The leaves are pierced by a beak and the sap abstracted as is the case with all true bugs. But while some of them injure plants badly by simply appropriating the sap, they seem to do no other harm and when they are not very abundant the attacked foliage bears no evident appearance of injnry. This bug introduces something into the wound made by its beak which causes the leaves to wilt and hang limp immediately after being attacked, much as they do when the connection with the roots is destroyed. It is probably a fluid that accelerates the flow of sap to the wound, but, whatever its use to the bug, its effect is very destructive,* and may even result in the death of the plant. Since the insect undergoes no marked changes such as characterize the striped beetle, its injury is likely to be observed at any time during the season after the adults appear among the plants; for the young as soon as hatched feed in the same manner as the adults and continue to do so at all times until fully grown.

Egg.—The eggs are placed in the night on the under sides of the leaves in clusters of from 3 or 4 to 30 or more. They are seed like in character and so large that they can be readily seen. Quite often they are crowded in the angle formed by two diverging veins with some approach to a regular arrangement, but again may be irregularly scattered. Now and then

*In 1895 in a German periodical entitled Centralblatt fur Bakteriologie und Parasitenkunde, 1, p. 365, Dr. E. F. Smith, of the United States Department of Agriculture, in describing a wilt disease of cucumbers due, as he thinks, to bacteria which he names *Bacillus tracheiphilus*, states that the disease is conveyed from plant to plant in some cases by both the squash bug and the striped cucumber beetle.

one finds a few eggs on the upper sides of leaves. When engaged in placing the eggs the bugs are so sly that the task is likely to be accomplished before the mischief is detected, and by the time the plants begin to wilt badly, examination generally shows the presence of both eggs and young. Much of the egg-laying is done during July. My earliest date of observing eggs is July 5. I have others collected July 21, and still others that were taken from leaves August 28, though part of these are only empty shells, the young having escaped.

The egg measures 0.06 inch in length, by 0.04 inch in diameter and is about 0 05 inch deep, being thus somewhat flattened. It is, as commonly seen, oval in general shape being thickest at the middle, the two ends alike, and bluntly pointed. Each egg is firmly secured to the leaf by a glue secreted by the mother. The surface is smooth and shining, the color varying from white, when fresh-laid, to deep bronzy brown when old. The fully matured egg is of a bright rust color (ferruginous) before the developing young within begins to darken the color. A large oval cap or lid separates near one end of each egg at the time of hatching and is pushed off by the escaping young.

Young—(nymph).—The young leave the eggs soon after these are laid, and have been found by me on July 5 when the first eggs were observed. They hatch at intervals during a period of at least two months, for I have found them with the eggs during August, and in one case a lot of young were collected by an assistant September 15 that ranged in size from 0.20 inch to 0.48 inch, being thus in some cases but recently hatched and in others fully two-thirds grown. Unhatched eggs have been collected on August 28, so that it is safe to say that the young come from the eggs in this region at any time from July 1 to September 1.

When just hatched the squash bug is very different in shape and color from the adult. The head, antennæ, beak, legs, and the region of the back at the bases of the legs are of a pinkish or reddish cast, and change by the second day to black. The rest of the body is pale green, minutely dusted with black. The thorax is now rather slender, the greatest diameter being

at about the middle of the rounded abdomen. The antennæ are very conspicuous and the terminal division is noticeably enlarged. The length of specimens before me is 0.07 inch, and the greatest diameter 0.04 inch, while the antennæ measure 0.08 inch. No trace of wings is apparent. At the hind edge of the third and fourth divisions, respectively, of the abdomen is an oval area with raised hind margin and a small opening at each side. These are probably the outlets of defensive glands. They are bordered with black by which they are easily located. These structures are noticeable in the young bugs at all stages, but they appear to be replaced in the adult by a pair of outlets, one on each side, just outside and in front of the hind pair of legs. By lifting the wings of the adult the outline of the larval glands can still be detected, but the apertures appear to be closed.

The young bug casts its skin five times before reaching maturity, and commonly requires a little more than a month to complete its development. When half grown it is of a dull gray color; the antennæ are shorter relative to the body, the terminal division not thicker than the others; and small beginnings of wings are visible in the shape of short pads fastened closely to the back. The legs, antennæ and beak are still black, but the head and thorax are but little darker than the rest of the body.

Adult.—The winged adult measures from 0.54 to 0.70 inch in length, is rather flat along the back, obtusely angled at the shoulders, the well developed wings overlapping and lying close. Color ranging from umber to sooty brown (fuliginous) the head above with a central and marginal lines of yellow; thorax also with central and marginal lines of this color, but the former terminates at the middle; abdomen touched with yellow along the sides. Beneath dull yellowish everywhere. Limbs and other appendages sooty.

KINDS OF PLANTS ATTACKED.

While this bug is commonly most injurious to squashes and pumpkins, it is not restricted to them, but sometimes does mischief among cucumbers and other plants of the same botanical family. Practical men assert that it has a special fond-

ness for some varieties of squashes, the quick-growing succulent species suffering most, while the slower and tougher varieties are believed to be passed by when the others are at hand. The "American scollop bush" has been declared to be comparatively free from injury, while "Hubbard" squash plants are likely to suffer. Other varieties thought to be comparatively free from injury are "summer crook-neck" and "Yokohama."

PARASITES AND OTHER ENEMIES.

The odor given off by the insect is probably a protection to it against birds. Toads are not commonly deterred by little matters of this sort, and seem to gulp down insects possessing such means of defense as readily as any others. They should always be given the freedom of a garden because of the good they do in this way. Probably more of the bugs are destroyed by small insect parasites than by anything else. One of these has been known to infest as many as 80 per cent. of eggs under observation. Quite recently a bacterial parasite (*Bacillus entomotoxicon*) has been described* which causes an epidemic disease among the bugs. A large number of bugs kept in confinement at the Illinois State Laboratory of Natural History in 1895 was infected and destroyed, simply by introducing the torn bodies of bugs that had died of the disease.

REMEDIAL TREATMENT.

Squash bugs are very likely to spend the winter in the vicinity of gardens if suitable hiding places are at hand. If they are not, the bugs wander away in search of them, and the more widely they are compelled to range, the greater are their chances of being destroyed and of failing to make their way back the next season. They should not be allowed lurking places about land. When plants begin to show the effect of their punctures a search of the vines will quickly expose the bugs and their eggs, when they may be destroyed. Their large size makes them much easier to deal with in this way

*On a Bacterial Disease of the Squash Bug (*Anasa tristis*, Deg.) By B. M. Duggar.—Volume IV., p. 340, Bulletin of the Illinois State Laboratory of Natural History, 1896.

than are smaller insects, and commonly going over the vines and removing the bugs is all that is required to save the plants. They will be found during the day concealed under the vines lying on the ground and on the under sides of leaves, sometimes under pieces of boards, if such are at hand. This habit may be taken advantage of by placing about the plants bits of wood to attract the bugs, thus rendering the search for them less laborious.

It is useless to try to poison this insect with Paris green. Insect powder used as suggested for the striped beetle may do some good. Coal oil emulsion can be made to destroy all insects it reaches, but must be diluted and used with some caution to avoid injury to the plants.

The Horned Squash Bug.

(*Anasa armigera.*)

Mr. F. H. Chittenden of the Division of Entomology, U. S. Dep. Agr., observed in 1897 in Virginia, Maryland and the District of Columbia a squash bug very like the common species and likely to be mistaken for it. It has probably been overlooked hitherto because of its resemblance to the more common species. It may yet be found in Kentucky, as it was originally described from specimens collected in Missouri. Other examples have been found in Iowa and Florida. On the whole it appears to be a southern insect.

Mr. Chittenden describes the adult bug as of about the same size as the common species, but with a wider thorax, distinctly angled at each side; with a spine near the tip of each thigh (femur), and a rather stout spine in front of each eye. The very young are said to differ from those of the common squash bug in having the antennæ longer than the body and with the next to the last division widest. In the very young of the common bug, the terminal division is widest.

It appears a little later than the common species but otherwise its life history is similar, and treatment prescribed for one serves for the other.

Leaf-footed Plant-bug.

(*Leptoglossus oppositus.*)

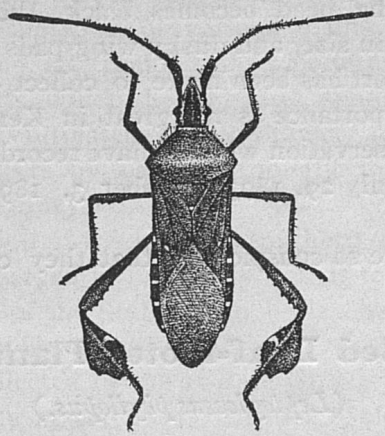

Fig. 9. Leaf-footed plant-bug (*Leptoglossus oppositus*). Enlarged. (After Chittenden, U. S. Div. Ent.)

While this insect has not been observed to attack plants of the melon and squash family in Kentucky it is occasionally encountered on other plants in our cultivated fields, and has been charged recently by Mr. Chittenden with injuring cantaloups. It is a rather large insect of the same family as the common squash bug, but with a more slender body, and is to be recognized readily by its greatly flattened, widened and toothed hind tibia, the division of the leg next the foot. Specimens collected at Lexington measure from 0.70 to 0.80 inch long and from 0.18 to 0.20 inch in width at the bases of the wings. The general color varies from chestnut-brown to sooty brown, with a very small yellow dot near the middle of each front wing, a third at the tip of the tip of the triangular plate (scutellum) between the bases of the wings, and a larger one at the inner edge of the widened part of each hind leg. Young were found in large numbers on Spanish bayonet (*Yucca filamentosa*), July 7, 1899, at Lexington. They are bright red in color, with black antennæ, beak, legs, and tip of the abdomen, the back with five pairs of erect black spines, the first of which arises from the division bearing the first pair of legs, and the

two hindmost from prominences on the abdomen which appear to bear also the openings from scent glands. Shorter spines are present along the edges of the abdominal segments. At a later stage the head becomes black, the spines become greatly reduced in size, and dusky wing-pads appear.

No special effort has been make to collect the insect, since its economic importance is not great in Kentucky, and the only dates of observation which I have recorded in addition to the above are, July 29, 1893; October 3, 1895; and July 25, 1896.

The insects are so conspicuous that they can easily be removed by hand.

Banded Leaf-footed Plant-bug.

(*Leptoglossus phyllopus.*)

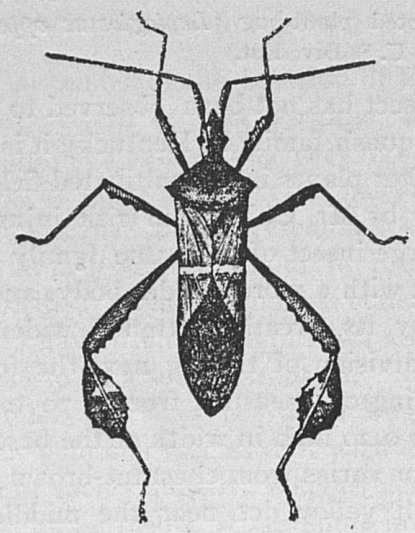

Fig. 10. Banded leaf-footed plant-bug (*Leptoglossus phyllopus*). Enlarged. (After Chittenden, U. S. Div. Ent.)

A second leaf-footed bug similar to the preceding, but with a narrow yellow band across each front wing has been reported by Professor A. L. Quaintance, of Florida, as injurious to melons and other plants in that section of the United States. Its puncture of the stems is followed by wilting, as

in the case of injury by other members of its family. In his Bulletin 34, published in 1896, Prof. Quaintance says that this insect passes the winter as an adult, and early in Spring is found about the blossoms of various plants including strawberry and peach. He thinks it has a preference for the thistle and related plants, which he suggests should not be allowed to grow about cultivated plants subject to attack. Removing the insects by hand is thought to be sufficient to prevent serious injury.

The distribution of the insect is southern in general, and it has not been observed in Kentucky. It is to be looked for in the western end of the State, since it has been found in Missouri and Indian Territory.

Specimens collected by me at Raleigh, North Carolina, July 4, 1882, and July 11-16, 1882, between Goldsboro and Wilmington in the same State, measure from 0.72 to 0.74 inch in length and 0.19 to 0.20 inch in width at the bases of the wings. The color is chestnut-brown above with a short yellow line across each front wing near the middle, not quite reaching the margin. The widened portion of the hind leg resembles that of the preceding species and is marked by a small spot of yellow on the inner margin, but the dots on the wings and triangular piece (scutellum) are wanting.

The Squash Borer.

(*Melittia satyriniformis.*)

A thick bodied, white grub, somewhat resembling the peach tree borer, and measuring when fully grown about one inch in length, is sometimes found in Kentucky within the stems of squashes and pumpkins. It appears early in Spring, and may have attained its growth and be ready to leave the plants by the middle of July, when it goes into the ground to the depth of a couple of inches, makes a cell of earth lined with silk and gum, and changes to a brown pupa a little more than half an inch long.

The life history has not been closely followed in Kentucky, since it has not in my experience proved very troublesome, but

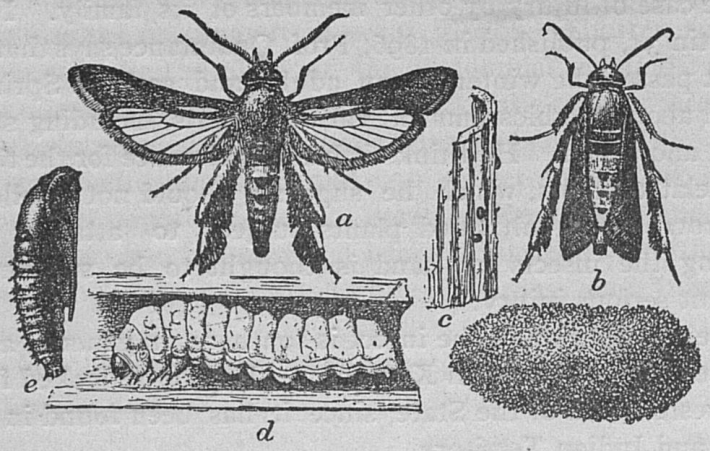

Fig. 11. Squash-vine borer (*Melittia satyriniformis*); *a* and *b*, adult; *c*, eggs, natural size; *d*, larva within stem; *e*, pupa; *f*, cocoon in which pupa lies. Enlarged one-third. (After Chittenden, U. S. Div. Ent.)

in the northern states where it appears to be more abundant, it produces but one brood during a season, the pupæ being formed late and remaining in the soil of cultivated fields over winter. Belated individuals may pass the winter as grubs. Farther south it appears to be two-brooded, which may prove to be the case in Kentucky.

The moths may be frequently seen in June and July in gardens and fields about Lexington, and appear to have a fondness for the flowers of the Bokhara clover (*Melilotus alba*). They fly in the sunlight, like other members of the family, and may be readily recognized when engaged in placing their eggs on the stems of squashes by the wasp-like form, the orange abdomen, with a series of black dots along the middle, and the greatly enlarged and fringed hind legs, the hairs constituting the fringe being partly tawny or deep orange, partly black. The front wings expand from about one inch in the male to 1.20 inch in the female and are of a bronzy green color. The hind wings are hyaline with black veins and a wide bronzy green fringe.

While apparently preferring the larger members of the squash family, the borer is known to attack other cultivated species, such as melon and cucumbers, and more rarely is observed infesting native members of the family. Mr. Chitten-

den of the United States Department of Agriculture, report it as attacking the wild cucumber (*Echinocystis lobata*) and thinks this may be its natural food plant.

The species is extraordinary in its distribution, occuring from Canada to the Central American States, and from Venzuela in South America to Argentina.

In gardens where the number of squashes grown is small it is only necessary to watch the plants for the appearance of the insect. The adults may be easily captured when engaged in egg-laying, and this in connection with cutting out such grubs as may succeed in getting into the plants, is commonly all that is necessary. Mr. Sirrine, of the New York Experiment Station, finds that fall harrowing has a good effect by exposing the pupæ to the weather and breaking up the cells in which they lie. In the following Spring deep plowing prevents the escape from the ground of such as were not destroyed by the the harrowing.

It is not advisable to plant on land that has borne badly infested plants during the preceding season.

The Pickle Worm.

(*Margaronia nitidalis.*)

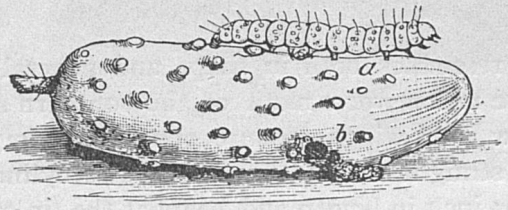

Fig. 12. Pickle worm (*Margaronia nitidalis*) Larva. Natural size. (After Riley.)

In the western half of Kentucky cucumbers are sometimes very badly infested with what is known as the pickle worm, a yellowish white or greenish yellow larva about one inch long when fully grown and about one-sixth to one-eighth inch in diameter. Each of its body segments is sometimes marked with a transverse row of black shining dots, but these are sometimes pale. The head is yellow, the mouth dark. These

worms bore round holes in the cucumbers, upon which they feed and render unmarketable, but have been observed to bore into the stems when first hatched.

The worms appear about the middle of July, and continue among the plants until cold weather approaches, some of them being active as late as November. When ready to change to pupæ they spin a thin whitish cocoon of silk in the fold of a leaf, the pupa lying in this shelter all winter when the change takes place very late, but in other cases emerging in about nine days as a moth. Some of these adults come forth so late that it is believed they continue in this condition over winter and place eggs on young plants the following season. The whole development after hatching may take place during warm weather in three or four weeks.

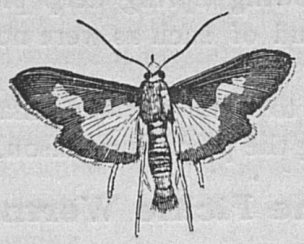

Fig. 13. Pickle worm (*Margaronia nitidalis*). Adult. Natural size. (After Riley.)

The moth resembles both in shape and general pattern of coloration the melon worm moth of the southern states. Its rather narrow front wings measure one inch from tip to tip when drawn straight out at the sides. The cylindrical body measures 0.64 inch in length and bears at the tip of the abdomen in the male a widely expanded brush composed of tawny hair-like scales, somewhat dusky at their tips. Front wings bronzy blackish brown, with an oblique central spot of yellow. Hind wings with the outer margin broadly black, the whole basal portion yellowish and hyaline. Brush of male black centrally beneath. Body brown above, pure white beneath. Legs largely white.

While this insect occurs throughout the southern states it is not so closely restricted to them as is the melon worm, and

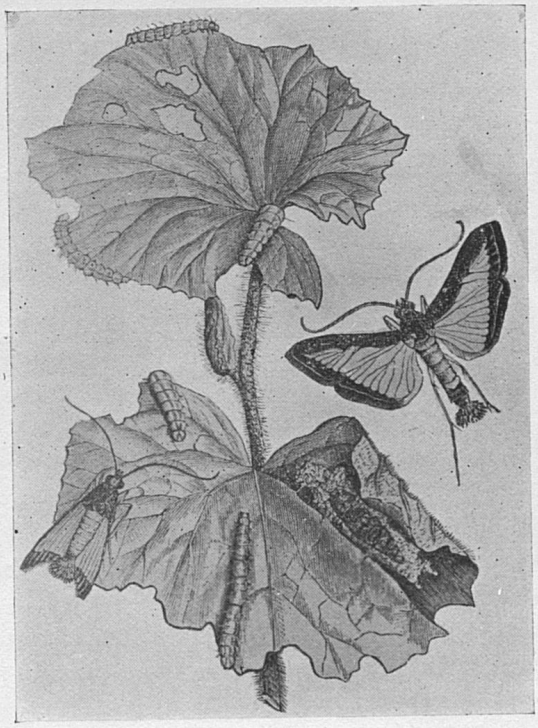

Fig. 14 The melon worm (*Margaronia hyalinata*), larva, pupa, and imago. (After Comstock.)

often becomes exceedingly troublesome in the upper Mississippi Valley, where the melon worm is not often seen.

Early planting and the use of Paris green and lime on the leaves before the insect has entered the fruit is the only treatment calculated to lessen its injuries. In connection with this, the wormy cucumbers should be gathered and fed to the hogs before the worms emerge.

The Melon Worm.

(*Margaronia hyalinata.*)

In the South Atlantic states occurs an insect that works great havoc among musk melons by eating into and rendering the fruit worthless. The adult is a pretty moth with pearly, black-bordered wings expanding about one inch, that has been observed in some of the northern states, but it has thus far been troublesome only in Georgia, Florida, and adjacent states. It is known to occur in the West Indies and South America, and has been thought to be of South American origin. It may, however, like the harlequin cabbage bug, sometime prove troublesome in Kentucky, and it is with this thought in mind that it is given a place in this bulletin.

The worms when grown are translucent yellowish green in color, and measure about one and a quarter inches in length. The chief mischief done is by burrowing into the fruit, sometimes a half dozen or more being found in every melon in a field, but the leaves also are at times badly gnawed and even destroyed. This seems to be especially true early in the season before the melons are developed. Later, it is said, the worms bore into the melons by preference. The brown pupa is sometimes formed in a fold of a leaf.

Probably the best treatment for the insect is spraying the leaves with Paris green in water early in the season, since at this time the worms work on the foliage and vines. After they leave the plants for the fruit, no treatment known will accomplish much. It is believed by growers that the injury can be avoided to some extent by giving the plants an early start so that the fruit is ripe before the worms are abundant.

The Squash Root-maggot.

(*Cyrtoneura cæsia.*)

In Bulletin 19 of the Colorado Station, Professor C. P. Gillette records the presence of the maggot of this fly in the underground portions of the stems of dying and dead plants, and considers it the cause of the trouble, although the squash bug was very abundant in the field. The species occurs in Europe as well as in America, but has been considered a scavenger and mushroom eater, like other members of its genus. Mr. Coquillett, of the U. S. Department of Agriculture, states that he has reared the same insect in California, in soil saturated with the juices of a decaying watermelon, and is disposed to think it is not an enemy of living squash plants. The species has not been observed in Kentucky.

The Cucumber Thrips.

(*Thrips tabaci.*)

In a letter addressed to the Station dated May 22, 1900, Mr. Edward F. Wetstein, of Louisville, complained of an injury to cucumbers grown in his greenhouses, and enclosed leaves upon which were found examples of this insect. He wrote: "The insect you will find on these cucumber leaves is a sucker that is very numerous in my greenhouses, and is destroying my vines, leaving the older leaves and going to the tender ones. The piece of leaf shows the way the entire vine appears after being exposed to their ravages." Subsequently the same insect was found about onions growing on the place of Mr. H. F. Hillenmeyer of Lexington, and which were reported to me as not having done well. It appears to be widely distributed in this State, but is so very small that its work probably goes on in many cases without the culprit being detected. Whether or not it attacks tobacco in Kentucky I am unable to say at present. From its history as a tobacco insect in Euro-

pean countries we may expect soon to witness injury to this plant here.

The species was first described scientifically by a Russian, Lindemann, in his Injurious Insects of Tobacco in Bessarabia.* But it had been observed as an onion insect in Massachusetts as early as 1872 by Dr. A. S. Packard, though it is believed not to be native to this country. In 1889 it was made the subject of an article by Prof. R. Thaxter in the annual report of the Connecticut Station, where the result of the injury to onions is known as white blast. Since then it has been noted by several authors, and its distribution has been found to extend from the Atlantic to the Pacific oceans.

The injury most commonly reported is that suffered by onions but it is known to attack besides, cabbage, cauliflower, turnip, squash, cucumber, tobacco, and numerous other less important plants. The rasping of the leaves is done by such slender mouth parts, and the insect is so small, that the injury has more the appearance of a fungus or bacterial disease than of insect work. The first result is small whitish spots which spread and unite so that the whole leaf becomes whitened, dies, and in the case of onions often rots at the base and falls. This was the condition of the plants on Mr. Hillenmeyer's place June 18 of last year.

Specimens of the insect received from Louisville are pale yellow in general color, and an example (female) measured under the microscope, 0.044 inch (1.104 mm.) long, with a greatest width of 0.008 inch (0.21 mm.). The slender long-fringed wings measure 0.02 inch (0.58 mm.) in length and do not reach the tip of the abdomen. Antennæ short (0.008 inch), composed of seven divisions, of which the first is thickest and white, the remainder slightly dusky and longer, except the last which is shorter and more slender than the rest. Eyes dark. Hairs on body, and fringe of wings, dusky. Two hairs at each outer hind angle of the division bearing the first pair of legs are noticeable from their size and erect position. The

*Bulletin of the Society of Naturalists of Moscow, 1888, p. 51.

front portion of each abdominal division is darker than the rest.*

It is not so difficult to get rid of this insect when infesting plants grown under glass as it is when it is about those grown out of doors. Mr. Wetstein who sent me the material from Louisville was advised to fumigate his houses with tobacco extract and syringe the plants worst affected with the same insecticide. He reported afterward that he had cleared the plants of the insects by "3 or 4 applications" of the extract used in the form of a spray. This method of using the extract has its disadvantages, however, for such plants as melons, and in the case of serious infestation of plants under glass the cheaper and better plan is to use the fumes of the extract, producing them by putting a hot iron in an open vessel containing the fluid. The Rose Leaf extract manufactured by the Kentucky Tobacco Product Company requires no dilution, as it contains only two per cent. of nioctine. The "nikoteen" manufactured by the Skabcura Dip Company of St. Louis, contains about 40 per cent of nicotine, and must be greatly diluted In experimental work I have used one teaspoonful of nikoteen in a pint of water, and find an exposure of twenty minutes sufficient to kill a thrips infesting sugar beets, so that this exposure would probably serve also for the cucumber-infesting species. It is a trifle more difficult to kill than the lettuce aphis.

Out of doors infested plants may either be sprayed with tobacco extract, coal oil emulsion, or, where possible to enclose them, they can be fumigated as suggested for the melon aphis.

The cucumber Thrips is attacked by at least one parasite capable at times of checking its depredations. It is a fungus belong-

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*Mr. Th. Pergande, of the U. S. Department of Agriculture, who has reviewed the literature of this species and was first in this country to recognize the fact that the onion Thrips is the same as the tobacco Thrips, says that the *hind* portion of each abdominal segment is dusky. In all other respects, including striation of head and prothorax, duskiness of limbs, etc., my material agrees with his description.

ing to the genus Empusa* and was observed to have attacked many of the specimens sent me from Louisville, which still adhere to the leaf, in the preservative, their bodies in some cases covered with the conidia, in others filled with the developing fungus. It is just possible its small size is the result of contracting in the preservative, otherwise it is much the smallest fungus of the genus I have seen.

The Greenhouse Pill-bug.

(*Armadillidium vulgare.*)

When flower pots containing plants have been left undisturbed for some time on the ground under a bench, on removing them one often finds gathered together beneath, numerous hard-bodied, short-legged, brown or slate-gray animals resembling a stout, short millipede. When exposed to the air and light they begin at once to conceal themselves, moving with a steady gliding motion by means of seven pairs of rather short legs. They are known as sow bugs, but this name is more often applied to a gray species (*Metoponorthus pruinosus*) common in cellars and sometimes on this account called cellar bug or cellar sow bug. This latter species also occurs in some greenhouses, but is not as common as the one we are considering, and is of less interest because it does not attack plants. Our bug can roll itself into a ball in such manner as to conceal its limbs and tender under parts, presenting only the hard arched crust of the upper surface to its enemies. If when the body has assumed this position it is dropped on a hard surface it rebounds and rolls away like round seed or pill, hence the name pill bug. The name pill-millipede has also been applied to this or a similar animal, with the idea that it is a relative of the long, many-legged myriapods, found in greenhouses; but

*The conidia present on the bodies of specimens preserved in alcohol resemble in shape those of *E. planchoniana*, as described and figured by Thaxter in his Entomopthoreæ of the United States, but they are only about half the dimensions of the conidia of the species named. Thaxter observed *E. sphærosperma* on a Thrips found on Solidago, but the conidia of this fungus are very different.

it is neither a myriapod nor a true insect, but belongs instead to the same group as the lobster and crayfish, being a land crustacean. It is very common in Kentucky, and while chiefly nocturnal in habit, may sometimes be encountered in Lexington running across brick walks in the day time. In the United States it appears to be rather southern in distribution. Fitch probably had reference to it or a related species when he mentioned in his first report as State Entomologist of New York (1856, p. 118) a species of "Armadillo" from southern New York. It is one of the commonest European pill bugs, and has been recorded from the Bermudas, the West Indies, South America, and Australia.

These pill bugs gnaw growing plants of various sorts and do some mischief in this way to young cucumbers, lettuce, and to the young growth of germinating seeds of other plants. In confinement they feed freely on lettuce leaves. Like many other pests they are to be feared only when neglected and allowed to multiply without check for several years. In a house with benches of iron and slate or tile, all that is necessary to avoid their attacks is to exercise care in getting soil to fill the benches. The side benches should be set out a little from the walls so that the bugs can not get to them by creeping up the walls. All rubbish under benches, such as trimmings from plants, bits of wood, tile, brick and the like, should be removed. They must have moisture, and can only thrive where sheltered, either in the soil or among rubbish.

They are somewhat difficult to kill by insecticides owing to the respiratory organs being concealed and protected under the arched segments of the abdomen. They live in 95 per cent. alcohol for several minutes. 40 per cent. formalin kills them but little sooner, though it is about as prompt in its deadening effect on living tisse as any fluid known. Tests made in the Vivarium of this Division show that a spray consisting of one teaspoonful of nicotine (40 per cent.) in a pint of water, does not kill them, though it is effective against plant lice. Coal oil emulsion diluted and used as a spray, is also not effective for pill bugs, judging by some recent trials made in the Vivarium. When in soil, perhaps the best plan is to pour

over it or in it a little bisulphide of carbon, when this can be done without injury to plants. The fumes of this fluid will kill tender plants, such as lettuce and young cucumbers, when confined about them, but it can be employed for disinfecting soil before the crop is planted, or after it has been removed. We find by tests made at the Station that the pill bug can readily be destroyed by this insecticide*

The greenhouse pill-bug is active at all times, having none of the abrupt changes of form and habit characteristic of many insects. The eggs have been found by me on occasional individuals as early as March 7, adhering to the bases of the forward pairs of legs.

Description.—Fresh eggs are translucent honey-yellow, with coarsely granular contents, and are enclosed in a very delicate hyaline shell, not visible to the unaided eye. They are oval in general shape, being generally a little wider at one end than at the other, and measure 0.027 inch long, by about 0.018 inch in greatest diameter.

When about one-third grown (0.16 inch long) the bugs are brown in general color, with four obscure longitudinal black lines, two near the middle of the back and one on each side about midway between a median line and the outer margin of the body. Some obscure lines and spots of sulphur-yellow can generally be seen with a hand magnifier, and several larger median spots and lines of this color become visible when the body is rolled up, being concealed by the overlapping crust when the body is extended. The largest specimen seen measures 0.60 inch in length and this size is exceeded, I understand, by some European specimens. Adults bearing eggs are often not more than 0.52 inch long, and perhaps the average will not exceed this length. These large examples are less evidently marked with lines than the young, the gen-

*In a letter recently received from Mr. Edward F. Westein, one of the foremost growers of garden stuff at Louisville, the writer states that he has succeeded in destroying the pill bugs by poisoning them with Paris green mixed with brown sugar. Catching and destroying them by hand, which he has also tried, is, he says, laborious and not as effective as it should be.

eral color having become darker, and in some cases the whole surface, also the antennæ and legs, are of uniform dark slate-gray, a narrow margin of each segment and the downward side extensions being paler than the rest.

The segments are strongly convex, glossy, but microscopically punctate, the general outline oval, with no evident break at the beginning of the the abdomen, though the abdominal segments are smaller, and the two first without lateral extensions. The first antennæ are rudimentary and minute, consisting of but three divisions; they are so small as to be easily overlooked unless a microscope is used in finding them. The second antennæ are much larger, reaching about to the hind margin of the first division following the head; its two terminal segments (the flagellum) are more slender than the others (scapus) the first being about two-thirds* the length of the last. A characteristic feature of the head is the closeness with which the triangular frontal area fits against the upper front margin and the absence of a median incision in the margin. The median terminal plate (pleotelson) of the abdomen is a little wider than long, its sides a little incurved, its tip cut off squarely, though the side angles are rounded. The terminal abdominal appendages (uropods) are not elongated as in the sow bugs that are unable to roll the body into a ball, but the outer division consists of two enlarged flattened pieces, the terminal, triangular, oval in shape and fitting in the space between the telson and the downward side extension of the fifth abdominal segment (the sixth abdominal segment is united with the telson). The inner branch is slender, elongate, blunt at the tip, lies beneath the telson, and its tip sometimes shows beyond it. The terminal margin of the external branch is represented by Mons. Dollfus as rounded, but in my material it is a trifle incurved, or nearly straight.†

*Mons. Adrien Dollfus, the French authority on Isopod crustaceans, says the two segments are about equal, excepting in the young. In our largest specimens the first is perceptibly the shorter.

†The differences noted between Kentucky specimens and those described by Dollfus from France appear to be constant, and seem to be of at least varietal importance. Latreille's description of the species

A Nematode Disease of Cucumbers.

In the seventh annual report of the Massachusetts State Experiment Station (1890, p. 229) Professor J. H. Humphrey reports a disease due to the attacks on the roots of a very small thread-worm (*Heterodera radicola*), whose presence in the roots is to be recognized by small knots or swellings. As a result of the injury the leaves become yellow and finally the plant dies. It was observed on plants grown under glass.

Professor Humphrey suggests a weak solution of permanganate of potash as a means of killing worms in the soil. It may be suggested in addition that when soil contains these parasites it is well to remove it as soon as possible, thoroughly cleanse and repaint the benches, and fill them with clean fresh soil. It is possible that in some cases it may be practicable to disinfect the soil when plants are not growing in it by the use of bisulphide of carbon. The use of steam for sterilizing soil containing this and other root-infesting pests has been highly recommended, and where steam is available can be employed with but slight cost, either introducing it by means of iron pipes or by means of tile. In case iron pipes are used holes should be drilled in them at intervals to allow the steam to penetrate the soil. The joints between tile allow the steam to escape without other outlets. The time required is variously stated by different persons, ranging between one and two hours. A very good recent account of this injury and of remedies for it is given in Bulletin 55 of the Hatch Experiment Station of Massachusetts Agricultural College. No complaints have been received from Kentucky growers with reference to injury by these thread-worms, but they appear to be spreading, and will probably soon be with us, if not already here.

(Hist. Nat. Crustaces et Insectes, 7, p. 48) occupies but two lines of an octavo page, and relates only to the color and the glossy surface, and by itself is not sufficient for a recognition of the species. In this connection it may be well to call attention to Dr. Fitch's descriptions of six American species of terrestrial Isopods in his first report as State Entomologist of New York (1856, p. 119). The descriptions are good, but relate very largely to coloration, not a very safe basis upon which to establish species in this group of animals.

Cucumber Mildew.

The fungus* causing this disease was first described from material obtained in Cuba by two English botanists. It probably occurs now everywhere in the United States on cucumbers grown under glass and on cucumbers, cantaloups, squashes, watermelons, and perhaps other cucurbitaceous plants.

This mildew does not produce close felt-like growths on the under sides of leaves as does the downy mildew of grapes. It is a more scattering growth evident as a slight downiness on the under side of ill defined brown spots showing on the upper surface. These spots spread and unite as the growth of the fungus within the leaf progresses, until finally all of the leaf is killed.

The fungus sometimes gives trouble to gardeners in Kenton, Pendleton and other Kentucky counties near Cincinnati. It was particularly destructive in 1897 and 1898, when it ruined the crops of some growers. The fungus accomplishes its destructive work very quickly once it appears, so that growers must be prepared to wage war upon it promptly if they expect to save their crops. Writing from Demossville, Kenton County, September 22, 1898, Mr. E. M. Mann says: "The cucumbers were planted about June 30th, grew nicely until about September 9, when they commenced to produce fruit. There were a few cool nights previous to that time, when spots began to appear on the leaves, and in about three days from the time the leaf showed the first discoloration, the spots were brown and dead. The vines ceased to bear when the disease first appeared."

The plants should be sprayed with liver of sulphur or Bordeaux mixture if possible before the mildew appears, and all growers in localities where the disease gives trouble should be provided with spraying apparatus and one or the other of these

*Berkeley and Curtis describe the conidia of *Plasmopara cubensis* as .001 inch long. The same length (0.025 mm.) is also given in Saccardo's Sylloge Fungorum (7,251). Conidia from material collected in New Jersey by Dr. Halstead, and by myself in Kentucky vary in size from 0.022 to 0.033 mm. in length, the Kentucky material giving a higher average than that from the East.

fungicides at all times, so that when an outbreak is threatened the plants can be treated without delay. Several applications are necessary to save the crop, but it has been demonstrated that the disease can be subdued and pickles raised at a profit by spraying as much as seven times.

The spraying can be done either with a knapsack sprayer or a barrel sprayer hauled in a cart. The work can be done most rapidly with the latter. Suitable pumps can be bought for from 8 to 10 dollars.

Cucumber Mildew.

(*Erysiphe cichoracearum.*)

This mildew commonly attacks cucumbers growing under glass, but has been observed by Professor Stewart, of the New York Station, on plants grown in the field, the material examined by him having come from Pennsylvania. The name powdery mildew is sometimes used to distinguish this fungus from that causing downy mildew. Affected leaves in the Station collection collected by Professor J. E. Humphrey, at Amherst, Massachusetts, are of a yellowish hue, the whole surface, upper and under, with a fine powdery coat, as if dusted with insect powder. The fungus occurs in Asia and Europe as well as in America, and thrives upon plants of several families. It is to be checked by spraying with Bordeaux mixture.

Melon and Cucumber Anthracnose.

(*Colletotrichum lagenarium.*)

Besides plants of the cucumber and melon family this fungus attacks beans, producing on the pods brown spots that lessen their value for the market. The dried leaf of an affected cucumber plant shows about fourteen large roundish brown areas, the largest, nearly half an inch in diameter, with a deeper brown marginal region, the older ones with the center broken away so as to leave a hole in the leaf. The surface of these diseased areas is not very different from that of other parts of the leaf. The parasite also works in the stems, where it produces blackish spots, and in the fruit of both

cucumber and watermelon. Watermelons from the Gulf States have been seen in the Lexington market with much of the skin roughened and discolored by the disease. This anthracnose is best known in Kentucky from its attacks on bean pods. Badly injured watermelons observed in the Lexington market August 7, 1894, had in some cases much of the surface scabbed. Single spots were round, and about one-fifth of an inch in diameter; but when abundant these fused, forming extensive areas of a brown color. The spots were surrounded with a green ring outside the brown central region, sharply contrasting with the pale green of the sound rind. At a later stage the diseased area was slightly sunken and a ring of orange pustules appeared near the outer edge, and others formed a spot at the center. Still later the cuticle became ruptured and numerous kidney-shaped spores (conidia), measuring from 0.0006 to 0.0007 inch long and 0.0002 inch in diameter, each with a pale central area (vacuole). The disease does not penetrate very deeply. In the melons examined the brown diseased tissue was from 0.06 to 0.08 in inch depth. The tissue just beneath the center of old spots becomes dry and spongy, and may break away so as to leave a vacant space.

But while the disease is somewhat superficial in character, it is severely injurious to the plants and fruit, and when the scabbed fruit is not rendered absolutely worthless it will still not command as good a price as that with a clean sound skin.

To avoid the possibility of getting the disease in seeds, these should always be taken from sound fruit. When it appears in a plant or two they should be burned at once. If the attack is general the only treatment likely to help is spraying with Bordeaux mixture. In regions where the disease is prevalent early applications of the mixture, beginning before the disease appears, are most likely to be beneficial.

Cucumber Leaf-spot.

Leaves of cucumbers sometimes become covered with numerous small round whitish spots ranging from 0.02 to 0.08 inch in diameter, with definite outline, and completed by a very narrow line of red. The disease has not yet been ob-

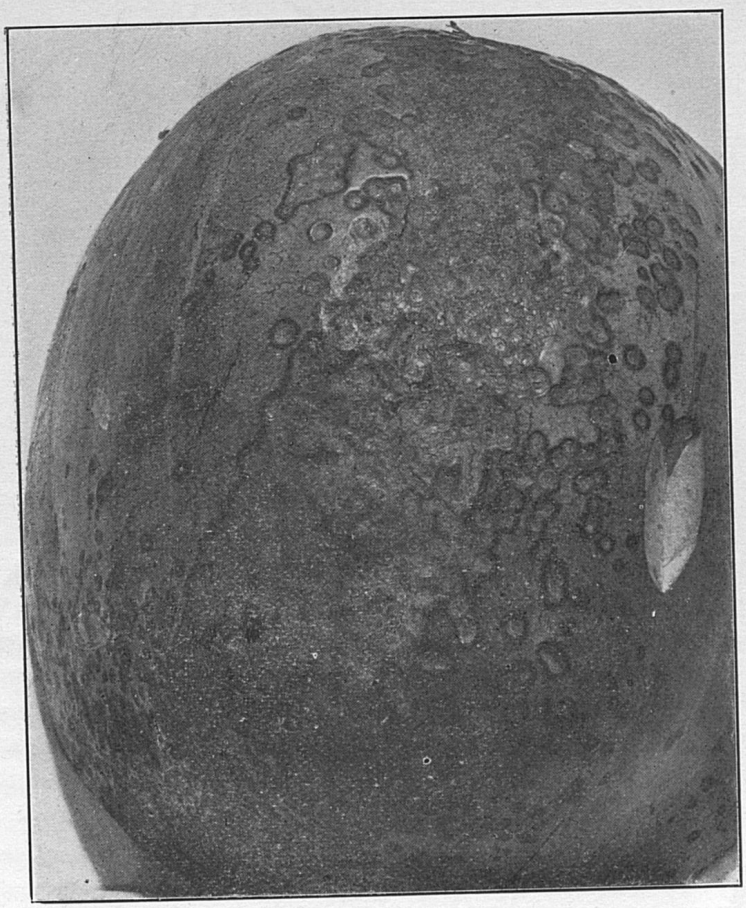

Fig. 15. A watermelon affected with anthracnose. Greatly reduced in size. (Original.)

served by me in Kentucky, but is common in states north of the Ohio River,—Indiana, Ohio and Wisconsin. The spots result from the attacks of a fungus known to botanists as *Phyllosticta cucurbitacearum*. Judging by the condition of a leaf before me from Wisconsin, the attack may result in very severe injury.

Cucumber Spot.

A fungus disease resembling in its affects the spot disease of peaches, so common in Kentucky, has been observed attacking the fruit of cucumber to such an extent as to render a crop worthless. Professor J. C. Arthur observed it at Geneva, New York, in 1887, and describes the injury as consisting of gray sunken spots at first, with velvety surface, forming large irregular patches finally and turning greenish black. The disease is the work of a fungus known as *Cladosporium cucumerinum*, being thus a near relative of the one attacking peaches.

It has not been observed by me in Kentucky, but should it appear at any time Bordeaux mixture or potassium sulphide are suggested as the fungicides most likely to prove effective in controlling it.

Cantaloup Leaf-spot.

In both Eastern and Middle States the leaves of cantaloup are affected with still another fungus (a species of Alternaria) that does at times a good deal of mischief. It has been observed in Ohio by Selby and in Connecticut by Sturgis. The former says that careful spraying with Bordeaux mixture will prevent much of the injury.

Rather large brown areas appear on the leaves, and in course of time the brown tissue falls out and leaves holes.

Damping Off.

Young plants of various sorts grown under glass are attacked in Kentucky and elsewhere by a fungus that kills the stems at the surface of the soil and causes them to drop. The fungus was some years ago determined to be identical with one known to European botanists under the name *Py-*

thium de baryanum. Professor Humphrey, of Massachusetts, has observed it on cucumbers, and suggests as a means of getting rid of it the removal of all affected plants, and where it becomes especially bad, the removal of the soil and refilling the benches with fresh.

Timber Rot and Leaf Glaze.

This was described in the Massachusetts Report for 1892, p. 212, as attacking cucumbers grown about Boston under glass. Professor Humphrey says that white growths of fungus threads appear first at the nodes of the the stem while this is still green and plump, but at a later stage it shrivels and dries up. He determines the fungus to be the European *Sclerotinia libertiana*.

Leaf glaze is another fungus disease discovered by Prof. Humphrey at Fitchburg, Massachusetts. The leaves turn yellow and on their lower surfaces bear a "glairy film," from which the common name is derived. The fungus is a species of Acremonium.

Cucumber Wilt.

Besides the wilts due to the punctures of several bugs mentioned above, there is a wilt disease caused it is claimed by Dr. E. F. Smith, of the United States Department of Agriculture, by one of the microorganisms which he names* *Bacillus tracheiphilus*. The wilting is due, it is thought, to the fact that the disease interrupts the flow of water to parts beyond those attacked.

When the diseased stems are cut a viscid fluid appears in which the bacteria are abundant. Pure cultures of the organism can be made, and inoculation with these produces the disease. Besides cucumbers this wilt affects cantaloups pumpkins and squashes. In some instances, during very dry

*Centralblatt fur Bakteriologie und Parasitenkunde, 1, p. 365, 1895. The Bacillus is said to be very variable, both in the host plant and when grown on artificial culture media. Taken from the diseased plants it ranges from 1.2-1.5 micron in length by 0 5-0.7 micron in diameter. It occurs singly, in doubles, or, more rarely, in chains of four. No spores are produced.

weather, it has been known to kill most of the plants in a field.

The disease was observed by me in Kentucky as early as 1892. Under date July 12, of that year, I find the following entry in my notes with reference to the disease: The trouble begins in a single shoot, it may be, the first symptom being a wilting of the leaves, one or two at a time, without any evident cause. Such leaves generally show slightly discolored regions of considerable extent between the veins. The trouble extends along the shoot until the whole is affected. Ultimately the plant dies and dries up. Cannot find any trace of insect work except occasional gnawed patches on stems and petioles, these being made, probably, by young *Dissosteira carolina* (a common road grasshopper) which occur in small numbers about the vines. It is barely possible that some Hemipter (true bug) punctures the vines, but I find none present. On some of the old dead leaves are occasional scab-like whitish patches, like an anthracnose, and under the microscope such tissue shows the presence of a brown mycelium and on the threads arising from the surface, elongated, club shaped, jointed spores, like those of common moulds.

Insects such as the striped cucumber beetle, the spotted cucumber beetle, and the common squash bug are known to carry the disease from plant to plant, on their jaws and beaks, and on this account should be kept from the plants by poisoning them, or by the use of cloth covers, when the disease becomes prevalent. Affected plants should be removed and burned.

Watermelon Wilt.

A very destructive wilt disease is, according to Dr. E. F. Smith and others, prevalent in the South Atlantic and Gulf states on watermelon, cowpeas and cotton. It has been found at one point in Arkansas, so that it is not improbable that it will yet be discovered in this State. Professor Smith is not disposed to consider the disease observed on cucumbers and cantaloups in Ohio by Professor Selby as the same as that described by himself, and proposes for the southern fungus the new genus Neocosmospora, and for the variety affecting water-

melons the full technical name, *N. vasinfecta*, var. *nivea*. The status of the disease and its relations with those affecting cowpeas and cotton have not yet been definitely established, but Doctor Smith advises the planting of infected land in crops not subject to the disease, and putting melons for some time on land upon which the disease has not appeared. Hay cut from melon fields and consisting of various grasses together with fragments of melon vines is apt to carry the disease to new localities, even when fed to stock and coming to the new land in the shape of manure.

Professor Selby's disease seems to have been the work of a Fusarium. The same or a similar disease is reported by Professor Sturgis of Connecticut.

Cucumber Dodder.

(*Cuscuta gronovii.*)

Prof. F. C. Stewart, of the New York Station, reports an instance of this parasite attacking cucumbers in the Station greenhouse. As a means of checking it he advises the prompt destruction of affected plants. So far as I know this is the only instance of its having been observed in doors. In the fields it is sometimes seen on weeds in Kentucky. It is a slender yellow or orange climbing plant with rudimentary leaves, commonly observed on rather damp ground growing over plants to which it is secured by small suckers. It may ultimately exhaust them. Its flowers are small and insignificant.

2. Experiments with Potato Scab.

(Record of Experiments made in 1900.)

By H. GARMAN, Entomologist and Botanist.

For several years experiments with reference to checking potato scab have been conducted at the Kentucky Experiment Station with the object of learning what treatment is most effective and convenient of time and labor. Soaking the seed

potatoes in corrosive sublimate solution (See our Bulletin 81, page 5.) has given us the best results thus far, but corrosive sublimate is so poisonous as to make its use objectionable to many people. From its activity as an antiseptic, and its relatively harmless character, formol has been suggested as a substitute. It was tried side by side with corrosive sublimate in 1898, but did not give as good results as the more poisonous material. It was tried again in 1899, but this proved not to be a scab year on the Farm, and the experiments gave us no results. These last experiments were repeated in 1900, and the results follow:

The variety planted was the Burbank. Twelve bushels of this variety, obtained by selecting the worst scabbed potatoes from a large quantity in the possession of one of our wholesale grocerymen, were planted on an acre of ground, April 19. The seed thus selected was an unsightly lot, without a sound potato in it. These potatoes, in bags, were set in the barrel containing the fluid with which they were to be treated, and after remaining the prescribed time the surplus fluid was drained off and they were spread out to dry, preparatory to cutting. As usual, each plot consisted of eight rows, four of which were from treated and four from untreated seed.

The corrosive sublimate was first dissolved in a small quantity of boiling water, and this solution was poured into the barrel containing the remainder of the water, just before the potatoes were treated. The slowness with which corrosive sublimate dissolves in cold water makes this procedure necessary. The corrosive sublimate crystals cost about 85 cents per pound, according to the most recently published list of chemicals at hand.

Formol is sold as a fluid, costing about 40 cents per pound. As bought, it contains 40 per cent. of formol, a strength sufficient to kill when taken internally in any quantity. Even when this per cent. comes in contact with the skin it may result in injury, shown later by a gradual peeling off of the outer layer. When greatly diluted, as it is for use on seed potatoes, it loses its biting properties, can be applied freely to the hands, and may even be employed as a wash for the teeth.

Plot.	TREATMENT.	Weight, pounds.	Per cent. Scabbed.	Per cent. Badly Scabbed.
1	Seed soaked 1 hour in corr. subl. 4 oz., water 30 gals	154½	46	None.
	None.	211	76	10
2	Seed soaked 1 hour in corr. subl. 4 oz., water 30 gals	166	9	None.
	None.	181	52	None.
3	Seed soaked ½ hour in corr. subl. 6 oz., water 30 gals	155½	38	None.
	None.	209½	82	20
4	Seed soaked ½ hour in corr. subl. 6 oz , water 30 gals	169½	33	None.
	None.	155	83	15
5	Seed soaked ½ hour in formol 1 pint, water 15 gals	129	25	None.
	None.	198½	66	None.
6	Seed soaked ½ hour in formol 1 pint, water 15 gals	133	29	None.
	None.	193	68	None.
7	Seed soaked 1 hour in formol ½ pint, water 15 gals	171	38	None.
	None.	214½	75	8
8	Seed soaked 1 hour in formol ½ pint, water 15 gals	236	37	None.
	None.	274	64	15
9	Seed soaked 2 hours in formol ½ pint, water 15 gals	214¾	27	None.
	None.	221½	66	10
10	Seed soaked 2 hours in formol ½ pint, water 15 gals.	139	21	None.
	None.	170	54	None.

Plots.	TREATMENT.	Weight, pounds.	Per cent. Scabbed.	Per cent. Badly Scabbed.
1 & 2	Seed soaked 1 hour in corr. subl 4 oz , water 30 gals.....	320½	27.5	None.
1 & 2	None.	392	64	5
3 & 4	Seed soaked ½ hour in corr. subl. 6 oz., water 30 gals.....	325	35.5	None.
3 & 4	None.	364½	82.5	17.5
5 & 6	Seed soaked ½ hour in formol 1 pint, water 15 gals.....	262	27	None.
5 & 6	None.	391½	67	None.
7 & 8	Seed soaked 1 hour in formol ½ pint, water 15 gals.....	407	37.5	None.
7 & 8	None.	488½	69.5	12½
9 & 10	Seed soaked 2 hours in formol ½ pint, water 15 gals.....	353¾	24	None.
9 & 10	None.	391½	60	5

Formol is the preservative frequently used by dairymen to prevent the souring of milk.

When the potatoes were gathered, it was found that the scab had not done as much harm as was to have been expected from the condition of the seed potatoes. Growths were frequent, however, on potatoes from untreated seed, while occasional small growths were found on potatoes from seed that had been treated. In every case there was a noticeable difference in the prevalence and extent of the disease in favor of the potatoes from treated seed.

The lots from seed treated with formol averaged about as free from scab as those from seed treated with bichloride of mercury. I am pleased to get this result because of the greater convenience with which formol can be used, though from some earlier experiments I was not led to expect it.

3. The Food of the Toad.

By H. Garman, Entomologist and Botanist.

While the farmer nods in his chair of warm summer evenings this wide-awake friend may be seen in the dim light hopping along the walk before his door. A rough coated fellow he proves to be when examined close at hand, of squat and ungraceful figure; but surely the poet never looked into his bright eyes who called the toad "ugly and venomous." In their clear depths the real "jewel" he wears can be seen, by looking with discernment, to be a gentle disposition.

But the farmer's son wants to know if it is true that the toad is fond of "lightnin bugs," and accordingly gets a live coal from the smouldering kitchen fire with which to test the question. And if the toad refuses this bait, he is more than likely to have it placed on his back. Sometimes his innocent life is crushed out by a ruthless heel, when persecution ceases further to amuse.

The common toad has not a poison fang or gland in his mouth. The worst that can be said of him is that he has on each side of his neck a wart-like mound which secretes a biting fluid to defend him against dogs and other enemies likely to to take him in their mouths. Would that the industrious and inoffensive were always as well defended against the encroachments of the rapacious!

While the farmer sleeps the toad is searching his lawn and garden and cornfield for insects and their relatives. He feeds upon nothing else. Cutworms, ants, potato bugs and chinch-bugs are delicacies to him, and he snaps them up steadily with his loose flap of a tongue until his sides stick out and he can hold no more. The number and variety of insects with which he fills his stomach during a night is astonishing. He would undoubtedly burst if he were not made of tough material. His industry is such that entomologists take advantage of it, and rob his collection of rarities to add to theirs, and thus he is

made a sacrifice to science—which is something better than being stamped into the ground or smashed with a board.

Occasionally he takes a hop during cloudy weather in the day time, and then the insects that commonly sleep at night are gobbled up left and right. He is fond of tiger beetles, and even gulps down an occasional bee.

In 1892, in a paper* on the reptiles and amphibians of Illinois I gave a list of the kinds of insects and other invertebrates found in the stomachs of 12 toads collected in Illinois, and taken from the large rough variety of the common toad which occurs on the black soil of the prairies. In order to bring the food of these examples into comparison with that of Kentucky toads the account there given is quoted, together with some remarks on the life history, which apply just as well to the Kentucky variety.

"Here (in ponds) the sexes meet, and not without some animated discussion, partners are chosen. Soon afterwards the spawn is to be seen suspended among dead water plants, or lying on the bottom, as strands of translucent gelatinous matter, in which at pretty regular intervals, the dark colored eggs are embedded. From these eggs small tadpoles or pollywogs are, a little later, excluded, and often in such numbers as to blacken the bottoms of pools. The tadpoles feed upon Algæ (the green scum of stagnant ponds) and other vegetable matter for several weeks, then acquire limbs, lose their tails by resorbtion, and appear on land as very small toads. Henceforth they live on land, excepting during the breeding season, and feed on animal food, chiefly insects. During the summer, toads lead the lives of hermits in shallow holes or under boards or stones, and are widely scattered. They are inactive during bright days and remain in their retreats, but at dusk and on cloudy days they may be seen in gardens and fields hopping about in search of insects. Of these nothing comes amiss. Stink-bugs, tumble-bugs, and even stinging Hymenoptera may be taken from their stomachs. Predaceous beetles (Carabidæ) form a conspicuous element of the food of adult toads,

*Bulletin Illinois State Laboratory of Natural History, Vol. 3, p. 338.

the common genera Harpalus, Evarthrus, Pterostichus, and Amara being most largely represented. In the food of young toads, ants take the place of beetles to some extent. Injurious insects are frequently eaten, among them Aphididæ; but the greater part of the food of toads taken at random consists of insects which do not attract the attention of economic entomologists. Beneficial insects are perhaps as frequently eaten as injurious ones. The variety of species eaten at one time is astonishing. Sixteen genera, representing two classes of arthropods and five of the seven orders of one of them, have been determined from the contents of one stomach. The following list gives in the order of their importance the elements of the food of twelve stomachs of toads from .37 inch to 3 inches in length.

Carabidæ, Formicidæ, Coleoptera (miscellaneous), Chrysomelidae, Hymenoptera (miscellaneous), Hemiptera, (Pentatomidæ, Lygæidæ, Aphididæ), Orthoptera, Lepidoptera (larvæ), Diptera, Myriapoda, and Arachnida."

Food of Kentucky Toads.

The economic relations of the toads were not at that time kept very prominently in mind, since the object was simply to learn what the toad eats. In the examination of the twenty stomachs reported below this side of the subject has been given special attention. The stomachs have been saved from time to time since 1890, preserved in alcohol, with the main purpose of learning what good, if any, our Kentucky toad does for the farmer, fruit grower and gardener.

Arranged in the order of frequency of occurrence the elements of the food in the twenty stomachs are as follows:

Ants (Hymenoptera), 16 stomachs.
Beetles (Coleoptera), 16 stomachs.
Bugs (Hemiptera), 6 stomachs.
Moths and caterpillars (Lepidoptera), 5 stomachs.
Crickets (Orthoptera), 4 stomachs.
Flies (Diptera), 3 stomachs.
Springtails (Thysanura), 3 stomachs.

Spiders (Class Arachnida), 3 stomachs.
Thrips (Thysanoptera), 2 stomachs.
Sowbugs (Class Crustacea), 2 stomachs.

Ants.—The frequency with which ants occur in the stomachs indicates that the toad is very fond of this kind of food. The young toads are especially addicted to it, and while it is one of the common elements of the food of adults, it is replaced to some extent with ground beetles and other larger insects. This ant-eating habit was observed by me years ago with reference to the pigmy toad* (*Bufo quercicus*) of the South Atlantic States.

The economic status of ants is not very evident. They are not commonly ranked among our most injurious insects, and some of the species appear to do no injury of any sort. The minute house pest (*Solenopsis molesta*) which often invades cupboards must be placed among injurious insects, however. Other species are probably hurtful to crops by protecting the root infesting plant-lice such as the corn root-louse.

On the other hand the immature stages of ants are greatly relished by birds, and the ruffed grouse, one of our finest game birds, is said to resort with its young, to ant hills where the chicks have great larks scratching out the fat larvæ and pupæ.

Beetles.—The beetles found in the stomachs belong in great part to four families, arranged in the order of their importance, as follows: Plant beetles (Chrysomelidæ), predaceous ground beetles (Carabidæ), click beetles (Elateridæ), and snout beetles (Curculionidæ). The first named family and the two last are undoubtedly in the main injurious, furnishing such well known pests as the Colorado potato beetle, the wireworms and the corn weevil. The predaceous ground beetles are themselves insect eaters, but have long been known to be to some extent seed eaters also.

I am disposed notwithstanding to regard them as in the main beneficial, since their larvæ are of predatory habit. With three families of injurious insects to one doubtfully beneficial the toad may be regarded as useful so far as it feeds on beetles

*See note by me with reference to this toad in the Johns Hopkins University circulars for 1881-82.

and this notwithstanding the occasional presence in its stomach of lady beetles and tiger beetles, both of which must be regarded as beneficial.

Bugs.—With a large proportion of the bugs found in the stomachs belonging to such families as the Aphididæ (plant-lice), Jassidæ (leaf-hoppers), Pentatomidæ and Lygæidæ (plant bugs), we cannot but regard the toad as useful to us in so far as it feeds upon insects of this family. The fact that it gets all its food on the ground or on low-growing plants fits it especially for service during outbreaks of the notorious chinch-bug, and I have no doubt but that toads taken from fields infested with this pest will be found in most cases to have derived much of their food from this source. In the states north and west of us this question can be quickly decided by any one who will take the trouble to examine the contents of a few stomachs. In Kentucky where this bug is relatively rare, the toad feeds upon chinch-bugs when it can get them, as the list of contents of one of the stomachs examined shows:

No. 20, a toad 1 1-8 inch long, obtained on the Experiment Farm, August, 1896. 2 *Drasterius elegans*, 1 *Diabrotica 12-punctata*, 1 *Systena tæniata*, 1 millipede (Polydesmus), 1 bug, fragments of ants, 6 chinch-bugs and fragments of others.

Moths and Caterpillars.—These insects are in the main injurious. I do not at this moment recall any notable exception among our native species.

Crickets.—Crickets are to be regarded as injurious in the main, although generally the injury they do to crops is not apparent. Occasionally they become very abundant among the mulching of strawberry patches and are then accused of eating into the berries. The species found in toads' stomachs belong to the genera Gryllus and Nemobius.

Millipedes.—The millipedes observed in the stomachs were in a fragmentary condition, but all belonged, as far as determined, to the genus Polydesmus. These creatures feed on dead vegetable matter in the main, hence the toad can not be credited with doing good in destroying them. Certain other closely related genera are known to eat into potatoes

and to injure germinating seeds, and it is entirely probable that these also are eaten when encountered. Still we should take the evidence as we find it, not as it might be if more stomachs were examined, and on the basis afforded by the 20 stomachs can not give the toad credit so far as its food consists of millipedes.

Flies.—The flies captured by toads are small species which occur on grasses and other vegetation growing close to the ground. But as a group the flies are lovers of sunshine, and since the toad avoids the sunshine the order is not of special importance as an element of its food.

Springtails.—Young toads seem to be fond of these insects, and all those noticed were from toads recently transformed from tadpoles. A few members of the group are known to be injurious, but most of those found out of doors are not of economic importance, as far as at present known.

Spiders.—Spiders are probably beneficial in the main from their destruction of insects of all sorts. They do not constitute a conspicuous element of the food.

Thrips.—Some species of this group of insects are very injurious in Kentucky to oats and wheat. Others are troublesome from their injuries to blossoms. The group is to be considered injurious as a whole. It is represented only in the stomachs of recently transformed toads.

Sowbugs.—These are crustaceans adapted to a life on land. They are troublesome in hothouses at times. Toads are fond of them.

Vegetable Matter.—Occasional bits of dead vegetable matter, and now and then a fresh bit, are swallowed by toads with other food. I believe they are never eaten intentionally.

Gravel.—Small bits of gravel and dirt often stick to the toad's tongue when it is thrust out to capture insects, and are to be found in its stomach. I do not think it needs them as an aid in grinding its food, and believe they are always swallowed by accident.

Conclusion.

It is interesting to note that the list of food elements obtained from a study of these Kentucky toads is very similar to that obtained from an examination of the Illinois variety more than ten years ago.* Ants appear more frequently in the Kentucky toad's bill of fare, but this is, very probably, because of the smaller average size of the toads examined.

In the stomachs of the Kentucky toads some of the most destructive of our farm pests were discovered, as the list below shows. An animal that will eat chinch-bugs and potato bugs would seem to deserve protection, without much regard for what else it eats.

Pests Recognized in the Twenty Kentucky Stomachs.

Chinch-bug (*Blissus leucopterus*).
Plant-lice (Aphididæ).
Leaf-hoppers (Jassidæ).
Colorado potato beetle (*Doryphora 10-lineata*).
Corn root-worm of Kentucky (*Diabrotica 12-punctata*).
Striped flea-beetle (*Systena tæniata*).
Cabbage flea-beetle (*Phyllotreta sinuata*).
Strawberry root-borer (*Colaspis brunnea*).
Wireworm beetle (*Drasterius elegans*).
Caterpillars and moths (Lepidoptera).
Crickets (Gryllus and Nemobius).
Sowbugs (Crustacea).

To put against this list and serving to offset it to some extent, the following beneficial insects must be mentioned:

Beneficial Insects Found in the Stomachs.

9-spotted lady beetle (*Coccinella 9-notata*).
Common lady beetle (*Megilla maculata*).
Parasitic Hymenoptera.
Spiders.
Black tiger beetle (*Cincindela punctulata*).

*The report on Illinois reptiles and amphibians was published in 1892 but had been written in great part prior to 1884.

Metallic tiger beetle (*Tetracha virginica*).

Black ground beetle (*Harpalus caliginosus*).

Ground beetles (Carabidæ, misc.).

Sexton beetles (Staphylinidæ, small and doubtful as to habits).

It will be observed that the list cannot be considered as completely offsetting the list of injurious insects, even when we include all doubtfully beneficial as really of service to us.

The evidence derived from these stomachs seems to me to justify the claim put forth in my introductory paragraphs, that the toad is a friend to the farmer.

Considering the fact that the toad remains at all times on the ground, the great variety of insects he captures is remarkable. The food of the common leopard frog (*Rana pipiens*) shows nothing approaching it. This is probably because the toad, while rather an awkward traveller is a persistent one, and ranges widely without regard for his nearness to water, whereas the frog does not often leave the damp ground adjacent to ponds and streams. Sixteen genera representing two classes of invertebrates and five orders of one of them is a remarkable showing. The number of individual insects eaten at a meal is quite as remarkable. A few instances will illustrate:

No. 1, a toad of medium size, captured beneath an electric burner, Lexington, Ky., Oct. 1, 1894, had eaten 27 ants, 19 sowbugs, 3 spiders, 1 caterpillar and 10 plant-lice; total, 60.

No. 2, a toad 1 inch long, captured in a celery patch, Lexington, Sept. 2, 1891, had eaten 14 ants and 1 caterpillar; total, 15.

No. 3, captured in a strawberry patch, Lexington, Aug. 5, 1890, had eaten 2 large ground beetles, 1 tiger beetle, 1 corn root-worm beetle, 1 lady beetle, 8 small ground beetles and 9 ants; total, 22.

No. 4, taken at Lexington, July 26, 1890, had eaten 2 Colorado potato beetles, 1 click beetle, 4 bugs (Cydnidæ), 1 tiger beetle, 1 moth, 7 ground beetles, 6 ants, 1 millipede and 1 sowbug; total, 24.

NOTE.—With the toads used in the above study I happen to have saved a few stomachs of two other amphibians, the common spotted frog and the spring frog.

The spotted frog or leopard frog (*Rana pipiens*) is so much more completely aquatic than the toad that its presence in cultivated ground is not to be expected except in the case of fields lying adjacent to streams or ponds, and its usefulness to the farmer is not calculated to be as great as that of the toad. Five stomachs examined furnish the following food elements:

Crickets and grasshoppers (Orthoptera), 4 stomachs.
Spiders (Class Arachnida), 2 stomachs.
Beetles (Coleoptera), 2 stomachs.
Bugs (Hemiptera), 1 stomach.
Millipedes (Class Myriapoda), 1 stomach.

The spring frog (*Rana clamitans*) is always found in or near cold water, and judging by the contents of the stomach of a small example captured in a spring below White's Cave, Edmonson County, Ky., Nov. 3, 1890, the food consists of aquatic insects. Four entire whirligig beetles (Gyrinus sp.) were taken from this one.

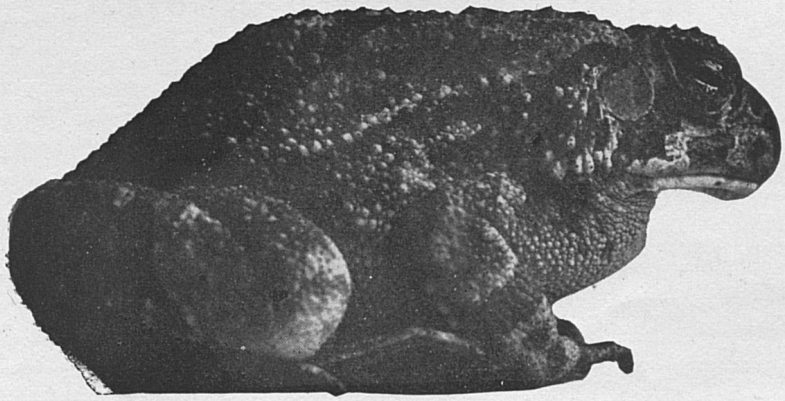

Fig. 16. The common toad (*Bufo lentiginosus*). (Original.)