

# Ohio Agricultural Experiment Station.

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## BULLETIN 51.

WOOSTER, O., DECEMBER, 1893.

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### MISCELLANEOUS ENTOMOLOGICAL PAPERS.

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THE ASPARAGUS BEETLE.  
THE WESTERN CORN-ROOT WORM.  
THE BROAD-STRIPED FLEA-BEETLE.  
BLISTER BEETLES.  
THE BAG OR BASKET WORM.  
THE CABBAGE APHIS.  
THE APPLE PLANT LOUSE.  
SOME INSECT IMMIGRANTS IN OHIO.  
INSECT FOES OF AMERICAN CEREALS.

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SECOND SERIES.

DECEMBER, 1893.

MISCELLANEOUS ENTOMOLOGICAL PAPERS.

BY F. M. WEBSTER.

THE ASPARAGUS BEETLE.

*Crioceris asparagi* Linn.

Ord. COLEOPTERA: Fam. CHRYSOMELIDÆ.

The species was described by Linnæus<sup>1</sup> in 1796 as a *Cryptocephalus*, the habitat being given as Europe, but the statement is made that gardeners thought it to have been brought from Russia, though Fr. Th. Keppen<sup>2</sup> states that it is sometimes common in that country and the Caucasus, but never proves destructive. As asparagus is indigenous in some portions of Asia, and in Europe about the Mediterranean, and was cultivated prior to the Christian Era, therefore we may expect the insect to have been rather an ancient depredator of this plant.



FIG. 1. Stalk with eggs attached; adult and larva. Lines beneath indicate natural length. After Linnæus.

It was first observed in this country at Astoria, near the western end of Long Island, New York, in 1859, and not unlikely occurred sparingly about New York City a year or so earlier, having been introduced from Europe, or England where it had also occurred for many years. Mr. Robert E. Mathewson, in his special Report on Insects, Fungi and Weeds Injurious to Farm Crops, p. 12, 1889, says there is no record of its appearance in Ireland.

<sup>1</sup>Faun. Suec. Ed. I, p. 151; Ed. II, p. 172.

<sup>2</sup>Obnoxious Insects of Russia, Fr. Th. Keppen, p. 273, 1880.

Miss Ormerod, however, states that it has been known in England for about 40 years.

Its spread over the eastern United States has not been rapid, as it has so far only extended permanently, south to Virginia and West to Cleveland, Ohio. Professor Claypole, of Akron, tells me it occurred at Salem, Columbiana county, some six years ago. This county borders on Pennsylvania, and is at the point where the Ohio river begins to form the boundary line between the two states. As I do not hear of the species elsewhere along the lake shore, the inference is that it was first brought down the Allegheny river from New York and thence into the Ohio, though Dr. Hamilton, an old and experienced collector about the junction of this stream, where it begins to form the Ohio, has never found it in his locality. It will most likely spread slowly westward over this State, but just now seems to keep well to the northward.

Mr. A. Bolter, an old and experienced collector of Chicago, however, informs me that he captured five specimens of the beetle, near that city, about twenty-five years ago, but has not observed the species since. He has specimens collected by the late Mr. B. D. Walsh, at Rock Island, Illinois. Mr. Walsh died November 18th, 1869. As far as I am aware, these collections have never before been placed on record, and the species was not known to occur further west than eastern Ohio. As now appears, it has once before been introduced into the west and disappeared, the present being, probably, a second invasion, and one that has the appearance of having come to stay.

#### DESCRIPTION OF THE VARIOUS STAGES.

These I shall copy from Dr. Lintner's carefully written statement in his first Report:

**"THE BEETLE.**—The beetle is a very pretty insect in its trim form, contrasting colors of yellow, red and shining-black, and its conspicuous ornamentation. Its average length is a little less than one-fourth of an inch. The head is black, with the first three joints of the short antennæ smaller and differently colored from the remainder. The finely punctured thorax is tawny-red, marked more or less distinctly on its crown with two black spots. The wing-covers are punctured in rows, and usually appear of a lemon color, broken into three spots on each, as in the accompanying figure 2, by a black stripe along their junction, a black transverse band a little behind their middle, and an interrupted one near their tips. Outwardly the wing covers are bordered with orange. The body beneath and the legs are shining black, the latter sometimes showing a yellowish band upon them. Examples having the wing-covers marked as above, suggest the representation of a black cross upon the back, for which reason it is sometimes known in England as the 'cross-bearer.'"

"In some of the beetles the wing-covers may be described as blue-black, with an orange margin on the sides and at the tip, and above with six small yellow spots.

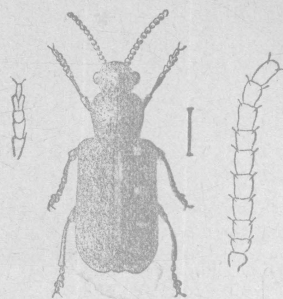


FIG. 2. Asparagus beetle with section of foot and antenna enlarged. After Lintner.

Fig. 2, from examples received from a market in New York city, is the variety which Dr. Fitch seems to have had before him for his careful description. Along the middle of each wing-cover is a row of three lemon-yellow spots. The anterior one of these is placed upon the base of the wing-cover, and is usually egg-shaped with its pointed end directed backward. The middle spot is placed at a third of the distance from the base to the tip of the wing-cover. It is transverse, being a third more broad than long, and is thicker toward its inner end, which terminates at the third row of punctures from the suture, its opposite or outer end being confluent with the orange border. The hind spot is placed

nearer to the middle spot than to the widened orange tip of the wing-cover. It is similar in most respects to the middle spot, but is frequently smaller and placed somewhat obliquely, its inner end inclining backward, and its outer end uniting with the orange border by a narrow neck."

"The above variety would hardly be recognized as identical with the form usually figured. The elytral spots have been described in general terms as very variable in shape and size. Fitch notes their great variation. It is interesting to find that such marked variation in individuals can co-exist with such permanency of feature, that the pattern so minutely described by Dr. Fitch is exactly that shown by the example figured from my collection."

"*The Larva.*—The young larva and the mature form are represented upon the upper portion of the stem, and on the left in the figure 1, it is given enlarged. Its greatest length is about one-fourth of an inch. 'It is of an obscure olive or dull ash-gray color, often with a blackish stripe along the middle of the back. It is soft and of a flesh-like consistency, about three times as long as thick, thickest back of the middle, with the body much wrinkled transversely. The head is black and shining, and the neck, which is thicker than the head, has two shining black spots above. Three pairs of legs are placed anteriorly upon the breast, and are of the same shining black color with the head. As will be seen when it is crawling, the larva clings also with the tip end of the body; and all along its under side may then be seen two rows of small tubercles, slightly projecting from the surface, which serve as prolegs in addition to the tip of its body. Above these tubercles on each side is a row of elevated shining dots like warts, above which the breathing pores appear like a row of minute black dots.' (Fitch.)"

"*The Egg.*—The eggs of the beetle are of the size and form shown at the middle of Fig. 3. At the right, they are given in enlargement. Their color is blackish-brown. They are placed on end on the young plant, usually in rows of from two to seven. When the plants are grown, the eggs are deposited on the leaves near the end of the delicate branches."

#### LIFE HISTORY.

"The history of *C. asparagi* is, in brief, as follows: The beetles destined to continue the species, survive the winter in dry, sheltered places, as beneath bark, in

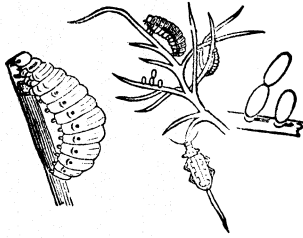


FIG. 3. Larva eggs and adult of Asparagus Beetle. After Fitch.

crevices of wood, and under the clapboards of buildings. Simultaneously with the appearance of the asparagus shoots in early spring, they emerge from their winter quarters, and commence to feed upon the tips of the plants. The sexes pair, and the female deposits her eggs upon any portion of the exposed shoots. The eggs hatch in an average period of eight days. The larvæ eat voraciously and grow rapidly, so that they complete their growth in about twelve days. They then leave the plants and enter the earth for a short distance, or merely conceal themselves beneath dead leaves or other material on the surface. Constructing a slight cocoon, they undergo their transformation, and remain in their pupal state for about ten days. Thirty days complete the cycle from the egg to the perfect insect. Almost as soon as the beetles emerge, they pair, as the sexual instinct is strongly developed in them, as is shown in the frequency in which they come under our observation mated. The eggs are then deposited, and the beetles continue to feed upon the plants, eating holes into the bark of the more tender branches for several days; one was found by Dr. Fitch to feed for a fortnight in confinement. A second brood results from these, appearing about the first of July, followed by a third, probably in August. Hence we have the larvæ and the beetles with us, in their successive broods, through the spring and summer, into September."

#### REMEDIES AND PREVENTIVES.

No practical measure for destroying this pest is known in Europe the best known being hand-picking. Dr. Fitch advised giving barnyard fowls range of the asparagus beds, in order that they might devour the pests.

"Mr. A. S. Fuller, of Ridgewood, N. J., has furnished to the American Entomologist, for January, 1880, a method for destroying this pest, which as it presents the result of his personal experience, seems to be all that is needed for the purpose. Shortly after its appearance on Long Island, it was discovered, according to Mr. Fuller, that freshly-slacked lime, scattered over the plants, would instantly kill every larva that it touched. The lime may be conveniently applied by using an old broom for a duster, or a Paris green sifter. With a pail full of dry lime, a man could in a short time dust an acre of asparagus. 'The lime is best applied in the morning while the dew is on, for then a portion will adhere to the plants as well as the grubs, and during the day or days following it will be constantly dropping down or blowing about among the leaves and branches, thereby making the escape of any of the larvæ all the more uncertain. \* \* \* \* \* For the past sixteen years, I have used lime as described, upon my asparagus beds, to keep the insect in question in check, and it has done it so effectually that about one application every alternate season has been sufficient' (Fuller). Not only is lime cheap and readily procurable everywhere, but it is also of benefit to the asparagus roots. It has also the additional merit as in insecticide, that it can be used upon the young plants while they are being cut for market, for the destruction of the first brood of larvæ, while Paris green or London purple may not safely be used."

According to Dr. Lintner:

"The Long Island gardeners have found great relief from the excessive ravages of this insect by cutting down in the spring at the time when the beetle is ready to deposit its eggs, all the young seedlings which are usually selected for

oviposition as well as for food, and thus forcing the beetles to deposit their eggs upon the new shoots. These being cut for market almost daily do not permit the eggs to hatch, and by this means, the greater portion of what would be the second brood are destroyed."

In my own correspondence, I have always recommended Pyrethrum, to be used either mixed with flour, or in water in the proportion of one ounce to three gallons of water, and all reports of the effect have been favorable.

### THE WESTERN CORN ROOT-WORM.

*Diabrotica longicornis* Say.

(FIGS. 4, 5, 6, 7, 8.)

Ord. COLEOPTERA: Fam. CHRYSOMELIDÆ.

During September, 1892, these beetles were received from Mr. W. C. Cone, of Sater, Hamilton county, with the complaint that they were injuring his sweet corn by eating the silk, before the kernel had been fertilized. This, so far as I am aware, is the first time the insect had been observed in Ohio in destructive numbers, if, indeed, it had been observed at all. Some correspondence, later in the season, revealed the fact that it was present in Van Wert county also, though not known to have done any damage. During August of the present year, a personal investigation showed the pest to be present in the corn fields of Putnam, Allen, Auglaize, Shelby, Miami, Montgomery, Butler and Hamilton counties, there being no doubt whatever of their presence in the counties bordering on Indiana. In fact, Mr. Giffin, of Van Wert, had personal knowledge of them as far north as Paulding. With an acquaintance with this pest covering a period of eighteen years, in both Illinois and Indiana, I was not a little concerned when I found it here in Ohio, this year, precisely as I did in Illinois, in 1875, and in about the same numbers; for, as will be seen from the subsequent history, within five years thereafter it began to be one of the worst pests of the cornfield, and there does not appear to be any reason why, if it is not vigorously taken in hand, the same may not prove true in Ohio.

The fully developed insect, Fig. 4, is a green or greenish yellow beetle about a quarter of an inch long and resembling in form the striped squash beetle, to which it is nearly related. This is the stage in which it is most likely to be noticed, though it is comparatively harmless.

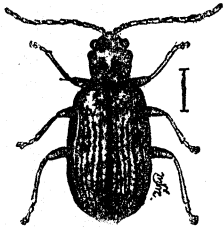


FIG. 4. Adult.

These beetles may be found in the fields from the latter part of July until after the pollen has fallen and the silk becomes dry and brown, either on the tips of the ears, on the tassels, or among the mass of pollen that usually collects about the stalk at the bases of the upper leaves, this pollen and the silk being their principal food. When ready to oviposit, the female de-

ascends into the ground about the roots of the corn and there lays a considerable number of minute, white eggs, Fig. 5, greatly enlarged, which to the unaided eye resemble grains of white sand. After doing this the insect dies.

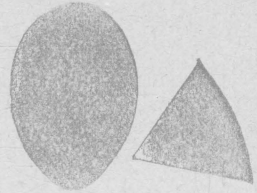


FIG. 5. Egg greatly enlarged, with triangular section more highly magnified.

These eggs lie in the earth, apparently unaffected by climatic or such abnormal conditions, as overflow, etc., until the following spring or early summer, when they hatch out minute, active grubs, which at once begin to feed on the small fibrous roots of the corn, in case this crop has succeeded itself. Following these smaller roots and eating them entire, on reaching a larger one the worms change their mode of attack somewhat and now burrow parallel channels in them which often extend to the base of the plant itself. These channels seldom show from without, but on breaking the roots, the worm will be found as shown in Fig. 6. In cases of severe attack, late in the season, the brace roots will be



FIG. 6. Larva in root.

found on examination to contain little besides the worms and their castings.

When full grown the worms are nearly white in color and of the form shown in Fig. 7, the length being a little less than one-half an inch, while in diameter they are about the size of an ordinary wheat straw immediately below the head. Often, where the soil is very rich and a good growth of stalk has been obtained, nearly every root will be amputated, leaving the plant to be blown over by the winds. In Illinois I have seen fields where there had been a stalk growth sufficient to have produced at least seventy-five bushels per acre, yet by the middle of August hardly a plant was standing upright, the remainder lying prostrate on the ground in every direction, the ears shriveled and worthless. Where soils are only of ordinary fertility or poor, the effect on the ear is to foreshorten it, in case of a light attack, and dwarf it to unproductiveness in more severe cases, while the stalk may or may not have made half its normal growth, the general result being almost the counterpart of that consequent upon impoverished soil combined with dry weather.

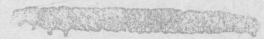


FIG. 7. Larva.

After reaching their growth in the worm stage these larvæ leave the soil and crawling to one side, by working their bodies about construct an earthen cell wherein they transform into pupæ, in which condition they required no food. The pupa is also of a white color, and its form is indicated by Fig. 8, the line at the right indicating the natural length. After remaining in this state for a short time the pupæ transform to adult beetles, and these make their way to the surface and thence



FIG. 8. Pupa.



to the ears and tassels, or to the bases of the leaves, as has been previously stated, there being but a single generation each year.

Although provided with wings and amply capable of flying from one field to another, there is little disposition among them to travel about, and so long as the supply of fresh pollen and silk furnishes them food, the beetles are little apt to be observed outside the corn fields; and, as they do not appear until after the crop is laid by for the season, they may not attract attention even there. After forsaking the fields, they may be observed on thistles, golden rod and other late flowering plants, including clover. From what follows it appears that, under certain conditions, females that have not oviposited previously, may do so in these clover fields, and in case the succeeding crop is of corn, the larvæ work some injury the following year, though I think this is unusual.

The adult beetle was described in 1823 by Mr. Thomas Say, from specimens taken by him while connected with the Major Long expedition to the Rocky Mountains, and its habitat was given by him as the Arkansas Territory.<sup>3</sup>

No facts concerning the habits of this insect were recorded until the year 1866, when specimens of the beetles were referred to Mr. B. D. Walsh by Prof. W. S. Robertson, of Kansas, who found them in large numbers on Imphee or Sorghum, their natural home being a large thistle. Mr. Walsh, in acknowledging the receipt of the specimens, stated that he had taken three specimens many years before on flowers, in Central Illinois.<sup>4</sup> Eight years later, in August, 1874, Mr. H. Webber, of Kirkwood, Missouri, sent some larvæ and papæ to Prof. Riley, with the complaint that the former were burrowing into the roots of his corn, and doing considerable damage. In July, 1878, larvæ were again received by Prof. Riley,<sup>5</sup> this time from Mr. G. Pauls, of Eureka, Missouri,<sup>6</sup> and from these he reared adult beetles, on the 14th of the following month.

During the spring of 1874, the writer began to collect Coleoptera in the vicinity of Waterman, DeKalb county, Illinois; but during this and the two following years obtained only a single specimen. In September, 1877, quite a number of the beetles were taken in cornfields. Mr. Frederick Blanchard, the well-known coleopterist of Lowell, Massachusetts, at that time informed me that he possessed specimens from New York, Kansas and Central America. I have since seen specimens from Arizona, while Mr. Dury, of Cincinnati, has collected it in New Mexico. Mr. Ottomar Reinecke, of Buffalo, N. Y., recently wrote me that he collected the species about Buffalo prior to 1880, and found them in numbers on willow growing along the margin of a small creek, having never looked

<sup>3</sup>Journal Phil. Acad. Nat. Sciences, Vol. III, p. 460.

<sup>4</sup>Practical Entomologist, Vol. II, p. 10, 1866.

<sup>5</sup>American Entomologist, Vol. III, p. 247, 1880. (Note. See "Roots of Corn injured by some unknown insect." Am. Entomologist 1870, p. 275, Vol. 2.)

<sup>6</sup>Report Comm. Agr., 1878, p. 208.

for them elsewhere. It is, however, not included in the list of Coleoptera of Florida and Michigan by Messrs. Hubbard and Schwarz. The season of 1878, 1879, 1880, found the beetles occurring in increasing numbers in Illinois, so much so that in September, 1881, I was led to express the fear that they would prove a worse pest than the chinch bug;<sup>7</sup> fears that have since been fully realized in that locality.

The Western Rural (Chicago, Ill.), in its issue of May 18, 1879, contained a communication from "N. A.," of Swan Creek, Warren county, Illinois, who stated that for the last few years, cornfields in that section had been infested by a small, white worm, which, except in size, color and habits, resembled the yellow wire worm. But, instead of these worms attacking the kernels they entered the roots at the base of the stalk and burrowed under the bark of the roots, thereby destroying them.

In September, 1882, Mr. Wamock, whose fields near Mason City, Mason county, Illinois, were at that time seriously injured, stated to me that he had noticed the larvæ in corn for ten or twelve years previously, and remembered of serious damage being done at least seven years before. This statement was indorsed also by several other farmers in that neighborhood.<sup>8</sup>

"R. S. B." writing to the Prairie Farmer from LaSalle county, Illinois, states in the issue of that paper for September 7, 1880, that the pest had been known in that county for several years.

In July, 1880, the late Dr. E. R. Boardman, of Elmira, Stark county, Illinois, found great numbers of small white worms destroying both the fibrous and brace roots of corn, in fields in his vicinity.<sup>9</sup> Some of these larvæ were forwarded to Prof. G. H. French, at that time assistant State Entomologist, with the suggestion that they might belong to some species of Scarabæidæ. The damage being done by these worms, in some fields, amounted to one-third of the crop. The similarity of these larvæ to those of *Diabrotica vittata* led Prof. French, who had overlooked Prof. Riley's notice in the Report of the Commissioner of Agriculture for 1878, to suspect that they were of some species of that genus, and suggested to Dr. Boardman that such might be the case. To this the Doctor replied that *D. longicornis* was very abundant on the corn, and also the beetles had been very troublesome to vines that season—more so than *D. vittata*. On the 17th and 18th of the August following two adults of *D. longicornis* emerged from the larvæ sent by Dr. Boardman in July. A few days later he again writes Prof. French that the damage in many portions of Stark county, was quite serious, and also that he had been informed by Hon. J. H. Lewis, of Knox county, that serious loss had also been sustained in that section of the State. In this letter the Doctor observed that such fields as had been exempt from attack had the

<sup>7</sup>Eleventh Report State Entomologist of Illinois, pp. 68, 69.

<sup>8</sup>Twelfth Report State Entomologist of Illinois, p. 13.

<sup>9</sup>Loc. cit. Eleventh Report, p. 65: Prairie Farmer, Aug. 8, 1880.

previous season been in grass or sown to oats. Still, a few days later, he again wrote Prof. French that the adults were very abundant on the blossoms of *Ambrosia trifida*, and also they were devouring the silk on the ends of the ears of corn, probably before the kernels had been fertilized; and later they seemed to feed on the kernel itself. "R. S. B.," in his letter to the Prairie Farmer, previously quoted, stated that they not only ate off the silk at the end of the ear, but also some of the kernels, while the latter were in a soft state. Prof. French, in 1881, found adults in considerable numbers in his garden on black wax beans.

During the spring of 1882 Prof. S. A. Forbes, the then recently appointed State Entomologist of Illinois, with myself as his assistant, began a systematic study of this pest and its life history.<sup>10</sup> The species was found to occur generally in the fields of corn, from Centralia northward to DeKalb county—as far as examinations were made—and they were reported also in southeastern Iowa. The damage to the corn crop, by reason of the attacks of the larvæ, being variously estimated at from five to fifty per cent., with a few instances where the destruction was nearly total. Fields that had been planted after grass, or any of the smaller cereal grains, were not injured; but where the land had been devoted to corn for three years and upward, the loss was as previously estimated. And this was true even where the new and old grounds had been thrown into one field, and planted with the rows running transversely, as the old dividing line between the two former fields could be easily detected by the difference in the abundance of the larvæ about the roots of the corn. In a less marked degree the same difference could be detected in the relative number of adults.

The eggs were first observed by me near Normal, McLean county, Illinois, on the 18th of October; but the period during which oviposition takes place has never been exactly defined. From the fact that Dr. Boardman observed the adult beetles on June 25th in southeastern Iowa, and in Stark county, Illinois, on July 1st, while I found them quite abundant in 1886 about Lafayette, Indiana, a few days later, it would seem that oviposition should begin at least as early as August, while Prof. Forbes found females early in October with eggs still in their ovaries.<sup>11</sup>

The eggs have so far only been observed about the roots of corn, and while it seems probable that this is the place usually selected for oviposition, that the insect does not hesitate to place her eggs about the roots of other plants is apparent. As illustrations, Prof. Forbes finds the larvæ destroying corn in fields following crops of both broom-corn and sorgum,<sup>12</sup> while, during the fall of 1886, I received complaints from Mr. James McCleery, of Waterman, Illinois, and others in that section, stat-

<sup>10</sup>Twelfth Report State Entomologist of Illinois, pp. 10-31.

<sup>11</sup>Loc. cit. p. 25.

<sup>12</sup>Miscellaneous Essays, p. 20.

ing that the first crop of corn following a crop of clover had been seriously injured by the root-worms. Mr. Samuel Drago, of Macedonia, Indiana, also states that they injured one of his fields, that was previously in timothy and clover and pastured, but both of these latter statements were unverified by specimens.<sup>13</sup>

When found about the roots of corn, the eggs are from one to five inches from the surface of the ground, and scattered about loosely in cracks and crevices, wherever a cavity is offered in which to place them, the female evidently taking no pains to protect or secrete them. In some instances, the dead body of the female will be found in such places among the roots, in the midst of her eggs. While the larvæ have never been reared from eggs found in such localities, a comparison of a great number by Prof. Forbes, including those first discovered by me, with others taken from the ovaries of females, showed conclusively that they were identical.

The exact time when the eggs hatch is not known, but the larvæ are found in the ground from June to August. Their appearance, as indicated by the effect upon the growth of the corn, in all probability does not occur earlier than June. Their food, so far as has been observed, consists of the roots of corn, but Dr. Boardman states that he has observed them in the roots of rag-weed, while Mr. D. S. Harris, of Cuba, Illinois, makes a similar statement; and adds that he found them also on the stems of garden purslane, *Portulaca oleracea*, and the roots of lamb's quarter, *Chenopodium album*.<sup>14</sup>

The adult beetles were observed as previously stated by Dr. Boardman on June 25th in southeastern Iowa. The same gentleman reports them flying in Stark county, Illinois, as late as November 9th, and thinks he has observed them under rubbish as late as December,<sup>15</sup> while I observed them in De Kalb county, Illinois, as late as early in November, among shocked corn. No one however is known to have observed them early enough in the season to indicate a possibility of their having hibernated in this stage. Their food, as studied by Prof. Forbes, consists of the pollen of corn, thistle, smart-weed, rag-weed, clover, corn, both kernel and silk, spores of fungi, and fragments of the petals of clover. Several of these had been recorded previously by others.<sup>16</sup> To this list must be added beans, on the authority of Prof. French,<sup>17</sup> cucumber and squash vines, on the authority of Dr. Boardman.<sup>18</sup> Besides, we have observed them feeding upon the flowers of compositæ, helianthus and cotton, the pollen of the squash, and on that of sorgum; while Mr. Sidney Lat-

<sup>13</sup>Indiana Agricultural Report 1885, p. 188.

<sup>14</sup>Loc. cit., Twelfth Report, p. 19.

<sup>15</sup>Loc. cit., pp. 21-22.

<sup>16</sup>Loc. cit., pp. 22-23.

<sup>17</sup>Loc. cit., Eleventh Report, p. 68.

<sup>18</sup>Loc. cit., Twelfth Report, p. 23.

tin, of Shabona Grove, Illinois, accuses them of eating the pulp of apples, when the skin had been broken through other causes.<sup>19</sup> As previously stated, there is nothing to indicate that these adults live through the winter, even in limited numbers, or that the insect hibernates in any other than the egg state. And while adults occur from June until November, no larvæ or pupæ have been observed later than the last of August.<sup>20</sup> Hence, while the adult insect has never been reared from the egg, on account of serious difficulties to be overcome, it is not likely that there is more than one brood during a season.

The damage done by the insect is, as previously indicated, nearly all due to larvæ, and since 1882, in localities where no preventive measures have been used, the destruction to the corn crop has been very serious. In 1885, Mr. Moses Fowler, a very extensive land owner of Lafayette, Indiana, estimated his loss, during that season, through the ravages of the pest, at \$16,000, or about 15 per cent. of the entire crop. On the basis of this estimate, the loss sustained in twenty-four of the corn producing counties of that state, for that one year, would amount to nearly \$2,000,000.<sup>21</sup> Although much more destructive on high, or tile drained lands, Prof. Forbes, in 1866, reported serious injury to a field in southern Illinois, which had been under water for three weeks during the spring.<sup>22</sup> There is no indication that the insect is susceptible to meteorological influences, although the effect of its ravages is aggravated by an extremely dry season. In fact, the extreme effect of the larvæ upon the plants is very similar to that of severe drouth.

There seems to be equally little aid in prospect through the influence of natural enemies. The occurrence of the larvæ of *Drasleria amabilis* as reported by Dr. Riley<sup>23</sup> as being found in company with the root-worm in Missouri, is very suggestive, especially as the latter are known to be of carnivorous habits, but, so far, not a single instance has been recorded where the pest has been attacked in any of its stages by other insects. Prof. Forbes states that he has never found their remains in the stomachs of any of the birds whose food habits he has studied.<sup>24</sup>

During the entire history of the ravages of the insect in the cornfields of the United States there has not been a single instance recorded where the larvæ have injured corn planted on lands which had the previous season grown and matured a crop of wheat, rye or barley, no matter how seriously the field had previously been affected. This is largely true of grass lands also, but where the cornfields are literally overrun with the adults, many doubtless seek food and deposit their eggs in other fields. While the young larvæ may not be able to survive on the

<sup>19</sup>Loc. cit., p. 68.

<sup>20</sup>Loc. cit., p. 25.

<sup>21</sup>Indiana Agricultural Report 1885, p. 188.

<sup>22</sup>Entomologica Americana, Vol. II, p. 174.

<sup>23</sup>American Entomologist, Vol. III, p. 247.

<sup>24</sup>Eleventh Report State Entomologist of Illinois, p. 68.

roots of grass, if these are displaced, and corn planted instead, the result would be, as in the cases of some Illinois and Indiana farmers, previously cited, that the first crop would suffer to a greater or less extent. Rotating the crop with small grain has proved so effective that no trouble is now experienced by those who faithfully practice the measure.

### THE BROAD STRIPED FLEA-BEETLE.

*Systema tæniata* (Say).

Ord. COLEOPTERA: Fam. CHRYSOMELIDÆ.

This species was first described in 1824, under the genus *Altica*<sup>25</sup> from the Northwest Territory, with the statement that the describer had not met with it in the Atlantic States. Variety *blanda* Mels, according,

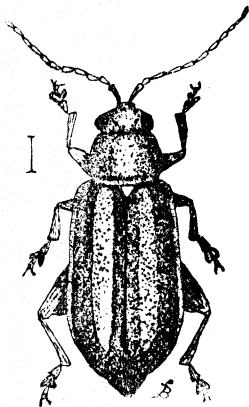


FIG. 9.

to Dr. Horn, occurs from New Mexico to the Dakotas and east to New England; *ligata* Lec, is found in California and Nevada; *mitis* Lec, is abundant in California, Nevada and Arizona. Hence, as the Doctor remarks, the species is an inhabitant of the northern half of our territory from the Atlantic to the Pacific, and from Oregon and Dakota to Arizona, extending to Mexico where it has received several additional names.<sup>26</sup>

All of the varieties here given have been described as distinct species, *blanda* having been described in 1848, by Melsheimer,<sup>27</sup> those by Le Conte later.

#### HABITS OF THE DIFFERENT VARIETIES.

The most common and wide spread variety, as will appear from the above, is *blanda*, which has been exceedingly abundant in Ohio the past year, and according to Prof. Smith, the same has been true of New Jersey. The beetles have been known since 1873, to destroy corn, the first notice of their depredations being recorded by Mr. Townsend Glover, the fact having been communicated to him, accompanied by specimens, by Mr. J. S. Nixon, of Chambersburg, Pennsylvania, during the month of June. It is this that gave rise to the oft-repeated statement that the species is injurious to corn in the Middle States. In 1878 or 1879, Dr. Thomas, then State entomologist of Illinois, informed the writer that this insect had

<sup>25</sup>Narrative of an expedition to the source of St. Peter's River, etc., under command of Stephen H. Long, U. S. T. E., Vol. II, p. 295, Philadelphia, 1824: Say's Am. Ent., Le Conte Ed. Vol. I, p. 195.

<sup>26</sup>Trans. Am. Ent. Socy. Vol. XVI, pp. 273-4, 1889.

<sup>27</sup>Proc. Acad. Nat. Sci. Phila., III, p. 164.

that season ravaged fields of young corn in Illinois. In *Spirit of the Farm* for June 16, 1883, published at Nashville, Tennessee, a correspondent complains of the destruction of his young corn by "striped fleas" which might apply to this species. In the *Prairie Farmer* of November 15, 1879, I recorded the species as feeding on the leaves of *Ambrosia*, and have since observed them in both Indiana and Ohio feeding on the leaves of young corn. Prof. Forbes has found it injurious to the foliage of the strawberry and melon, in southern Illinois,<sup>28</sup> while I, myself observed them working serious injury to growing potatoes in Indiana, in June 1887.<sup>29</sup> Dr. J. A. Lintner records their depredations on the cotton plant, he having received them from Jackson county, Georgia, in May.<sup>30</sup> Prof. Lawrence Bruner states that in Nebraska, they of all the flea-beetles are the most destructive to sugar beets, and gives the following additional food plants: *Amarantus*, *Chenopodium*, *Purslane*, white clover, and, sparingly on the *Cruciferae*.<sup>31</sup> The beet feeding habit of the species had also been observed by myself in Indiana, in June 1890,<sup>32</sup> and variety *mitis* had been observed depredating on the potato, beet, bean and tomato, the beet and other *Chenopodiaceæ* suffering most, by Prof. James Cassiday, at Fort Collins, Colorado, in 1888.<sup>33</sup> What was in all probability variety *blanda*, was reported to the Entomologist of the U. S. Dept. Agriculture, July 26, 1890, as destructive to beans in New Mexico, by John F. Weilandy, of Santa Fe.<sup>34</sup>

In none of these notices, is there any reference to any stage other than that of the adult. The only notice of the early stages and development of the insect that I am able to find is that of Prof. S. A. Forbes,<sup>35</sup> who reared the adult from slender white larvæ feeding on kernels of sprouting corn in the earth, specimens collected May 17, pupating May 26-June 10, and adults emerging June 17. The adult is here recorded as feeding on the leaves of the common *Xanthium strumarium*. Prof. C. P. Gillette, in Bulletin 24, of the Colorado Experiment Station, states that this is one of the worst pests that Colorado gardeners have to deal with, feeding as he observes they do, not only on the plants previously mentioned, but also on alfalfa, lettuce, parsnips, egg plant and summer savory, also, on the following weeds: *Iva axillaris*, *I. xanthiifolium*, *Salvia lanceolata*, *Verbena bracteosa*, *Solanum trifolium*, *S. rostratum*, *Helianthus annuus*, *H. petiolaris*, *Portulaca oleracea*, *Amarantus blitoides*, *Chenopodium* spp.

<sup>28</sup>Thirteenth Rept. Ins. Ill., 1884, p. 86: Sixteenth Rept., p. XI, 1887 and 1888.

<sup>29</sup>Rept. U. S. Dept. Agr., 1887, p. 151.

<sup>30</sup>Fourth Rept. State Ent. N. Y., p. 155.

<sup>31</sup>Bull. Agl. Exp. Sta. Nebr., No. 16, p. 60, 1891.

<sup>32</sup>Insect Life, Vol. III, p. 149.

<sup>33</sup>Bulletin No. 6, p. 18, January, 1889.

<sup>34</sup>Insect Life, Vol. III, p. 122.

<sup>35</sup>Entomological America, Vol. II, 174, 1886.

## FOOD OF OTHER SPECIES OF SYSTEMA.

The red-headed Systema, *S. frontalis*, though feeding largely on knot weed, *Polygonum*, does not hesitate to satisfy its appetite with more valuable food. Prof. William Saunders recorded it in 1882 as a depredator on the foliage of the grape<sup>36</sup> while I observed it in Indiana, in 1887, associated with *blanda* in the destruction of potatoes.<sup>37</sup> In 1889, Mr. James Fletcher complained of its depredations in the shrubbery and seed beds of the Botanic Garden of the Experimental Farm at Ottawa, Canada, the depredations being especially noticeable upon some species of *Allhea*, *Hibiscus*, *Weig-Lia* and young grapes.<sup>38</sup> Prof. Lawrence Bruner found it destructive to beet leaves and also those of *Hibiscus militaris*, in Nebraska.

*Systema elongata*, which I also recorded as feeding on the leaves of *Ambrosia artemisiifolia* in Illinois (Prairie Farmer Nov. 15, 1879), was observed by Mr. Wm. H. Ashmead, injuring cantaloupes and sweet potatoes, in Maryland, frequently killing the plants by skeletonizing the leaves.<sup>39</sup> The Margined Systema, *S. marginata*, was reported by Prof. Saunders,<sup>40</sup> as very abundant late in September of the previous season, on the leaves of small oaks, which were much eaten by them. The same species was stated to have been very common on elm, hickory, etc., and Mr. James Fletcher<sup>41</sup> reports it attacking the leaves of the service berry, *Anelachier Canadensis*, leaving only the ribs, and giving the bushes a rusty and seared appearance.

## DEPREDATIONS IN OHIO.

Late in June, it became apparent that this broad-striped depredator meant to annoy us considerably, and reports of its depredations came in from the whole length and breadth of the State. Potatoes, cabbage, beets, corn, beans—whole acres of the latter in sections where this is an important crop—were eaten to the stems or leaf stalks. As previously stated the invasion reached New Jersey, but it appeared to us as though Ohio was the "storm centre," so to speak. However, their abundance this year does not necessarily imply that they will visit us in any such numbers another year.

## REMEDIES.

Mr. Fletcher found a mixture of one part Paris green mixed with twenty parts of flour and dusted on the plants thoroughly effective, and Prof. Bruner reports equally good success with kerosene emulsion.

<sup>36</sup>Canadian Entomologist, Vol. XVI, p. 147.

<sup>37</sup>Rept. U. S. Dept. Agr., 1887, p. 151.

<sup>38</sup>Experimental Farms Reports, 1889, p. 87.

<sup>39</sup>Insect Life, Vol. III, p. 55.

<sup>40</sup>Report Entomological Society of Ontario, 1882, p. 61.

<sup>41</sup>Experimental Farms Report, 1889, p. 88.



## DESCRIPTION OF THE BEETLE.

This is so exceedingly variable both in color and sculpture that any written description would be practically worthless to the ordinary reader, some specimens being nearly black while others are as nearly yellowish white. The accompanying figure (9), greatly enlarged, with the natural length indicated by the line at the left, will render the pest at once recognizable.

## BLISTER BEETLES.

*Epicauta vittata* Fab.

*E. pennsylvanica* DeG.

*E. lemniscata* Fab.

*E. cinerea* Forst.

*Macrobasis unicolor* Kirby.

Ord. COLEOPTERA: Fam. MELOIDÆ.

These are the most abundant species, east of the Mississippi river, and are given in the order of their destructiveness. They are all closely allied to the Spanish fly (Cantharides of our druggists' shops), and it is claimed have some of the medical properties of their foreign congeners, though this has not yet been utilized in this country. Dr. Harris called attention to their medical properties as long ago as 1824.



FIG. 10. *Epicauta cinerea*. After Harris.

The several species indicated above may be distinguished by their various colors, though in two cases it will be observed the same species may be either ash-colored or black.

There are in this country about 175 species of these beetles, not all of which are abundant. With us there are but six species that at any time become destructive, viz.: A species that may be either ash-gray or black (*Macrobasis unicolor*, Kirby), a larger, wholly black species, (*Epicauta Pennsylvanica*, DeG.); a smaller species, usually black but sometimes ash-gray, always, however, with a red head (*E. trichrus*, Pall.); a larger species also black but with gray margins to the wing covers, more commonly known as the Margined Blister beetle (*E. cinerea*, Forst.), Fig. 10; the striped or old-fashioned potato beetle (*E. vittata*, Fab.), Fig. 11. This is yellow with four quite wide, black stripes on the wing covers. Intermixed with these in the fields is another, looking almost like the last mentioned, but having six stripes on the back instead of four. (This is *E. lemniscata* Fab.).

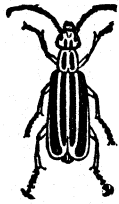


FIG 11. *Epi-cauta vittata*.

In Europe, the larvæ or grubs of a number of species, closely allied to those of our own country, have long been known to be parasitic on bees. The development of these insects is exceedingly interesting. Instead of four stages of development, as is the case with most insects, there are here seven, viz. the egg, first larva, second larva, coarctate or pseudo-pupa, third larva, the true pupa, and the imago. The female deposits a great number of eggs in loose, irregular masses in the ground, that hatch out small, very active larvæ, which climb up the stems of various flowering plants, and, getting among the blossoms, attach themselves to the bodies of the bees that come to these blossoms to collect the honey, and in this way are conveyed to the home of the bees, where they live and develop on the honey.

Some years ago Prof. Riley found that the species given above differed in their habits from the European species in that the larvæ instead of climbing plants, burrowed at once into the ground, where he afterwards found them in the egg masses of several species of grasshoppers, engaged in devouring the eggs, and, in fact, reared several species found feeding in this manner to the adult.

Of the striped and margined species, the two most destructive with us, he says that the eggs are laid in the loose ground, in masses of about 130, from July till the middle of October, the female excavating a hole for the purpose and afterwards covering up the eggs by scratching with her feet. She prefers to lay her eggs in the very same warm, sunny localities that are chosen by the grasshoppers for a similar purpose, and, seemingly, places her eggs in close proximity to those of the grasshoppers. In about ten days the delicate shell of the egg bursts and the young grub makes its way forth to seek its food. Though very young, and we would naturally suppose easily destroyed, yet these young appear to be able to travel about for a fortnight without food with little inconvenience. As soon as the young finds a deposit of grasshopper eggs it at once eats through the outer covering or sack, from which it often makes its first meal. Later, it attacks the egg, devouring both shell and contents. If two or more grubs find the same egg mass, there is a fight to the finish and only one remains in possession. After having eaten a couple of eggs, or in about eight days after first taking food, the larva moults and begins its second larval or grub stage, which lasts about a week, when it again casts its skin, another moult occurring six or seven days after. It is now in the pseudo or false pupal stage, which corresponds in some respects to the flaxseed stage of the Hessian fly, and in which it can remain for a long time without food, and usually passes the winter in this stage of development. In spring, this outer covering splits and another moult takes place, the grub being now in the third or final larval stage, during which it may feed if food is at hand, but if not it burrows into the ground and in the course of a few days passes into

the pupal state. This last stage is short, lasting but five or six days. Thus the entire larval period is passed in about twenty-four days, a part in fall and a part in spring, the whole time required for their development being about a month. Just how long the fully developed beetles live is not known, the fact of their occurring from June until October not necessarily implying an extended period of existence, as, in all probability, the season of emerging in spring is more or less protracted.

From an economic as well as a scientific standpoint, these insects are of very great interest. We always have an abundance of them during seasons following other seasons when there are great numbers of grasshoppers, showing that there has been an abundance of food for the larvæ, and that, owing to this abundance, myriads of the blister beetles developed. That the larvæ of those that have caused so much injury this summer will, or, in fact, are even now destroying eggs of grasshoppers, scarcely admits of a doubt. It is a good illustration of the fact that we cannot separate our friends from our foes on a single year's acquaintance. The farmer who this year has suffered from the ravages of these insects in his potato field, naturally feels a desire to see the pests exterminated; yet it is somewhat of a question if, in a series of years, he would be any better off were his desires realized. What is wanted is not the extermination of these insects, but some means of protecting certain crops from their voracious appetites, when they become overabundant.

#### REMEDIES.

Since we cannot prevent or restrict the breeding of these insects, even if it were desirable to do so, our only hope of relief lies in either destroying them or rendering their food distasteful to them.

Spraying with arsenical poisons, while it probably does kill many of the beetles, fails of protecting the crop. But the same may be said of almost any other known measure that has the destruction of the insect for its object, unless repeated applications are resorted to. All individuals of a species do not appear simultaneously, and some species occur earlier than others, so that applications of even so deadly a measure as fire must often be repeatedly applied.

In Spain and Italy, the cantharides of commerce are collected by being shaken from trees in early morning on to cloth spread on the ground beneath. The four corners of the cloth are then gathered up and the whole plunged into a tub of water diluted with vinegar, which kills them. I do not know of this vinegar mixture being tried on our native species and indeed its effect is somewhat doubtful. I have tried a solution of carbolic acid and water with little effect. Kerosene emulsion and whale-oil soap are too expensive for general use. In my own experiments fire has proved the most effective. Straw is placed along the edges and the beetles are easily driven across the rows and on to the

straw where they can be burned. Mr. Green, of this Station, tells me that where he applied the Bordeaux mixture the beetles appeared to abandon the potatoes and go elsewhere, and where he did not apply the mixture they did serious injury. This, then, may be just the measure we want, and it has this year been demonstrated that the application of this mixture to growing potatoes results in an increased yield, even though unaffected with either blight or insects.

It will of course require further experimentation to settle this question of the actual effect of Bordeaux, with exactness. As the matter now stands there appears a possibility of awarding off their attacks with a measure that will pay the expense of application in an increase of yield, under normal conditions. For isolated plants on the lawn and in the garden a suds of whale or fish-oil soap will be found thoroughly effective.

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### THE BAG OR BASKET-WORM.

*Thyridopteryx ephemeraformis* Haw.

(FIGS 12, 13, 14.)

Ord. LEPIDOPTERA: Fam. BOMBYCIDÆ.

Over its area of distribution in Ohio, as also in Indiana, this insect has been exceedingly abundant the present season, and so many inquiries regarding it have come to me that a full account of its development and injuries seems desirable for the benefit of those who reside in the southern part of the State. (There is another and much smaller Bag or Basket worm that occurs in Ohio, *Psyche confederata*, but easily distinguished by its being only about half the size of this one. It was reported this season in great abundance in the vicinity of East Liverpool, Columbiana county.)

The pest is, commonly, best known in the state in which it is illustrated in Fig. 14, from a photograph from life, and the various stages of development are further portrayed in Fig. 13, while the manner of constructing of the first sack or basket by the newly hatched young is shown in Fig. 12.

### EARLY HISTORY.

Dr. J. A. Lintner has so carefully looked up and recorded this in his First Annual Report of the State Entomologist of New York, that I shall copy largely from his pen, prefacing what he says only by the statement that the species was described from England in 1810.<sup>42</sup>

<sup>42</sup>Lepidoptera Britannica p. 72. 1810.

"The singular appearance of this insect, so unlike most of the Lepidoptera, was the occasion of much perplexity in its classification for a number years after its discovery. As may be seen from its synonymy, it was originally described as a *Sphinx*, although possessing none of the characteristic features of the Sphingidæ. Previous to this, it had been believed to be a species of Tinea. Later it was regarded as belonging to the Ægeridæ. An interesting paper upon the species, assigning it to its true position among the Bombycidæ, was communicated by Mr. J. F. Stephens to the Trans. Ent. Soc. Lond., I, 1836, p. 76, under the title of 'On the Apparent Identity of *Sphinx ephemeraformis* of Haworth with *Psyche plumifera* of Ochsenheimer,' of which the following is the substance:

"It appears that the original specimen was found in Yorkshire by Mr. Boton, and was placed in Mr. Drury's collection. At the sale of this collection, it was purchased by Mr. Donovan, and at an auction sale of some of Mr. Donovan's insects, in the catalogue of which it was announced as 'an undescribed *Cossus ligniperda*,' it came into Mr. Stephens' possession. Mr. Stephens was able to see, upon a cursory inspection, notwithstanding its mutilated condition, that it was not a *Sphinx* or even one of the Sphingidæ. He referred to 'the singular group known by the name of Sackträger by the Germans, and considered by some writers as belonging to another order of insects—*Trichoptera* Newman, *Phrygania* Scopoli, and *Tenthredo* by Roda; in fact it appears to be a *Psyche* of Ochsenheimer [*Psyche plumifera*], so far as can be ascertained by the remains of the unique specimen.' Reasons are given why it could not be classed among the Ægeridæ where it had been placed in the first volume of Illustrations of British Insects, 1834, 'nor had it any alliance with *Zeuzera*, to which genus it would appear Donovan had assigned it.' It did not fully agree with *Psyche*, and a new genus *Thyridopteryx*, was constituted for it."

"The above genus had been published by Stevens prior to the above paper, in Vol. IV, of his Illustrations, page 387, printed in 1835."

In our own country the early history of the species is like that of many others, involved in obscurity. According to Doubleday,<sup>43</sup> Mr. Gosse found the "cocoon, or rather larva-cases," plenty in Alabama in 1838. Mr. Doubleday himself found it at Charleston (State not given) as early as 1839, in abundance,<sup>44</sup> while Dr. Harris in 1841<sup>45</sup> says a case or cocoon, smaller than those found in the West Indies, had been presented him from Long Island. In the second edition of his work (1852, p. 319), he repeats this statement and says in addition that in the vicinity of Philadelphia cocoons of a similiar kind were very common, and that the inhabitants of these cocoons were called drop-worms, or basket-worms. In Harris' letter to Doubleday dated October 29, 1849, he discusses this species at length as *Oiketicus [coniferarum* Harr. MS.]<sup>46</sup> and says that in Philadelphia they are called "drop-worms" and sometimes "basket-worms." In this letter Harris expresses the determination to rear the larvæ another year. That he succeeded in doing so with larvæ sent him from Philadelphia, is shown by his letter to Miss Morris dated September 25, 1850. If, as Harris supposed,<sup>47</sup> it was this species that

<sup>43</sup> Harris' Correspondence, p. 141.

<sup>44</sup> Loc. cit., p. 122.

<sup>45</sup> Insects of New England Injurious to Vegetation, 1841, p. 299.

<sup>46</sup> Correspondence, p. 177.

<sup>47</sup> Loc. cit. p. 242.

was so unskillfully figured in Smith and Abbott's work, then it was an inhabitant of Georgia nearly or quite one hundred years ago.

#### GEOGRAPHICAL DISTRIBUTION.

This has been pretty well outlined in a succeeding paper. It occurs from Massachusetts to Texas except Florida, and north to the vicinity of the boundary line shown in Fig. 17. In Ohio, it is found in Montgomery county and east to Washington county; if it has been found north of this I am not aware of the fact.

#### HABITS AND LIFE HISTORY.

On these points I quote from Dr. C. V. Riley's Bulletin 10, U. S. Department of Agriculture:

*"The Eggs.*—During winter time the dependent sacs or bags of this species may be seen hanging on the twigs of almost every kind of tree. If they happen to be on coniferous trees, and they are usually more abundant on these than on deciduous trees, they are not infrequently mistaken for the cones. In reality they are the coverings spun by our worm, and they serve not only as a protection to it, but also to the eggs. Upon cutting open the larger of these bags in winter time they will be found to contain the shell of a chrysalis (technically called the puparium), which is filled with numerous small yellow eggs (Fig. 13*e*). Each of these is a little over 1 millimeter in length, obovate in form, and surrounded by a delicate, fawn-colored, silky down. In this condition the eggs remain from fall throughout the winter and early spring.

*"The Larva and Its Bag.*—About the middle of May in the latitude of Washington the eggs hatch into small but active larvæ, which at once commence to

construct a portable case or bag in which to live. The way in which this bag is prepared is curious (Fig. 12). The young larva crawls on a leaf, and gnawing little bits from the surface, fastens these together with fine silk, produces a narrow, elongate band, which is then fastened at both ends to the surface of the leaf by silk threads. Having secured itself from falling down by some threads, it now straddles this band and, bending its head downward (Fig. 12*b*), makes a dive under it, turns a complete somersault and lies on its back, held down by the band (Fig. 12*c*). By a quick turning movement the larva regains its feet, the band now

extending across its neck (Fig. 12*d*). It then adds to the band at each end until the two ends meet, and they are then fastened together so as to form a kind of narrow collar which encircles the neck of the worm. Far from resting, it now busies itself by adding row after row to the anterior or lower end of the collar, which thus rapidly grows in girth and is pushed further and further over the maker (Fig. 12*e*). The inside of this bag is now carefully lined with an additional layer

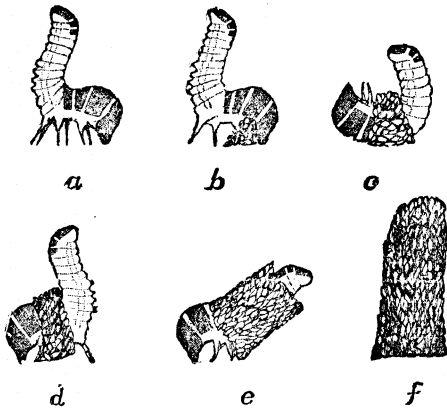


FIG. 12. Showing the way in which the young caterpillars construct their sacks. After Riley.

of silk, and the larva now marches off, carrying the bag in an upright position (Fig. 13*f* and Fig. 12*f*). When in motion or when feeding, the head and the thoracic segments protrude from the lower end of the bag, the rest of the body being bent upward and held in this position by the bag. As the worms grow they continue to increase the bags from the lower end and they gradually begin to use larger pieces of leaves, or bits of twigs or other small objects for ornamenting the outside. Thus the bags will differ according to the different kind of tree or shrub upon which the larva happens to feed; those found on coniferous trees being ornamented with the filiform pine leaves, usually arranged lengthwise of the bag, while those on the various deciduous trees are more or less densely and irregularly covered with bits of leaves interspersed with pieces of twigs. When kept in captivity the worms are very fond of using bits of cork, straw or paper, if such are offered to them. When the bags, with the growth of the larva get large and heavy, they are no longer carried, but allowed to hang down (Fig. 13*f*). The worms undergo four molts, and at each of these periods they close up the mouth of their bags to remain within until they have cast their skin and recovered from this effort. The old skin, as well as the excrement, is pushed out through a passage which is kept open by the worms at the extremity of the bag.

"The young larva is of a nearly uniform brown color, but when more full grown that portion of the body which is covered by the bag is soft, of light-brown color and reddish on the sides, while the head and thoracic joints are horny and mottled with dark-brown and white (Fig. 13*a*). The numerous hooks with which the small, fleshy prolegs on the middle and posterior part of the body are furnished, enable the worm to firmly cling to the silken lining of the bag, so that it can with difficulty be pulled out.

"The bag of the full-grown worm (Fig. 13 and Fig. 14) is elongate-oval in shape, its outlines being more or less irregular on account of the irregularities in

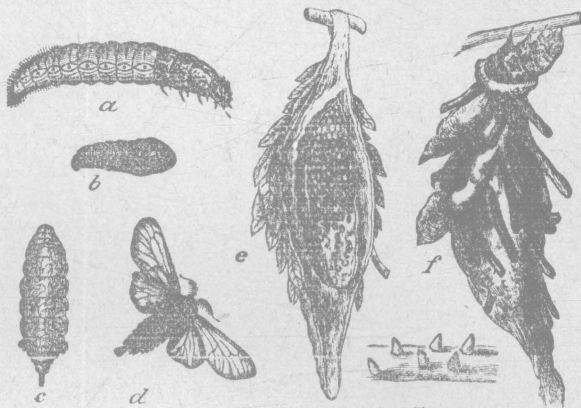


FIG. 13 The Bag or Basket Worm; *a*, full grown caterpillar; *b*, chrysalis of male; *c*, female; *d*, adult; *e*, sack containing female filled with eggs; *f*, sack or bag of full-grown caterpillar; *g*, group of very young worms in their minute sacks. After Riley.

the ornamentation above described. The silk itself is extremely tough and with difficulty pulled asunder.

"The larvæ are poor travelers during growth, and though, when in great number, they must often wander from one branch to another, they rarely leave the tree upon which they were born unless compelled to do so by hunger through the defoliation of the tree. When full-grown, however, they develop a greater activity, especially when very numerous, and, letting themselves down by a fine silken

thread, travel fast enough across sidewalks or streets and often for a considerable distance until they reach another tree, which they ascend. This migratory desire is instinctive; for should the worms remain on the same tree they would become so numerous as to necessarily perish for want of food.

*Pupation.*—The bags of the worms which are to produce male moths attain rather more than an inch in length, while those which produce females attain nearly double this size. When ready to transform, the larva firmly secures the anterior end of the bags to a twig or branch, and instinct leads it to reject for this purpose any deciduous leaf or leaf-stem with which it would be blown down by the winds. The inside of the bag is then strengthened with an additional lining of silk, and the change to chrysalis is made with their heads always downward. The chrysalis is of a dark-brown color, that of the male (Fig. 13*b*) being only one-half the size of that of the female (Fig. 13*c*).

*The Imago or perfect Insect.*—After a lapse of about three weeks from pupation a still greater difference between the two sexes becomes apparent. The male chrysalis works its way to the lower end of the bag and half way out of the opening at the extremity. Then its skin bursts and the imago appears as a winged moth with a black, hairy body and glassy wings (Fig. 13*d*). It is swift of flight, and, owing to its small size and transparent wings, is rarely observed in nature. The life-duration of this sex is also very short. The female imago is naked (save a ring of pubescence near the end of the body of yellowish-white color), and entirely destitute of legs and wings (Fig. 13*e*). She pushes her way partly out of the chrysalis, her head reaching to the lower end of the bag, where, without leaving the same, she awaits the approach of the male. Fertilization being accomplished, the female works her way back within the chrysalis skin and fills it with eggs, receding as she does so toward the lower end of the bag, where, having completed the work of oviposition, she forces, with a last effort, her shrunken body out of the opening, drops exhausted to the ground and perishes. When the female has withdrawn the slit at the head of the puparium and the elastic opening of the bag close again, and the eggs thus remain securely protected until they are ready to hatch the ensuing spring."

#### FOOD PLANTS.

Of these Dr. Lintner gives the following list:

"The caterpillar is a very general feeder, readily feeding on a large number of our fruit, forest and other trees. It has been observed on apple, pear, plum, cherry-choke-cherry, apricot, quince, linden, maple, locust, oak, elm, poplar, osage orange, spruce, hemlock, larch, red cedar and arbor vitæ. For the last two, it seems to manifest a decided preference."

While of the trees not affected, Dr. Riley has the following to say:

"The hard maples are, as a rule, avoided by the worms, and it is also quite noticeable that they are not particularly fond of oak leaves and those of the Paulownias. The Ailanthus trees are also generally exempt from their attacks, either on account of the unpleasant taste of the leaves, or perhaps on account of the compound nature of the leaves, the worms fastening their bags to the leaf stems which fall to the ground in fall. The China trees of our southern cities are entirely exempt from the worms. With these exceptions, the worms, when sufficiently numerous, do great damage to most other kinds of trees used in our cities as shade and park trees."

"The Bag-worm is so well protected in all its stages that no insectivorous bird nor predaceous insect is known to attack it. In spite of the absence of predaceous enemies, the Bag-worm suffers from the attacks of at least six true parasites, while



two others, which may be primary but are probably secondary, are reared from the bags. Three of these are Ichneumonids, viz.: (1) *Pimpla conquisitor* Say; (2) *Pimpla inquisitor* Say, and *Hemiteles thyridopterigis* Riley. Of these, the last named is most abundantly bred, and we have always considered it as the most important parasite of the Bag-worm. The past season, however, we have ascertained that three species of the genus *Hemiteles*, viz.: *H. utilis*, and two undescribed species, are unquestionably secondary parasites, and this renders it quite likely that *H. thyridopterigis* may also be secondary, or, in other words, a parasite of one of the true parasites of the Bag-worm. It is a question, however, which only the most careful study, with abundant material, can decide, as the law of unity of habit in the same genus finds many exceptions in insect life. The other parasites are as follows: (4) *Chalcis ovata* Say. This parasite is a very general feeder on Lepidopterous larvæ, and we have bred in from seven widely different species. (5) *Spilochalcis marizæ* (Riley). This species, while parasitic on *Thyridopteryx*, is more partial to the large silk-spinning caterpillars, as we have reared it from the cocoons of all of our large native silk-worms. (6) *Pteromatus* sp. This undescribed Chalcid is found very abundantly in the Bags, but may be a secondary parasite. (7) *Dinocarsis thyridopterygis* Ashmead. This parasite was bred from the Bags in Florida by Mr. William H. Ashmead, who believes it to be parasitic on the eggs. (8) *Tachina* sp. We have bred a large bluish Tachinid from the Bags. Its eggs are commonly attached to the Bags externally, near the neck, and the young larvæ, on hatching, work their way into the case. They frequently fail, however, to reach the Bag-worm."

At North Bend, near Cincinnati, I found larvæ that had been parasitized by a Tachinid, but did not succeed in rearing the adult. The pres-



FIG. 14. Bags of full grown caterpillars of *Thyridopteryx ephemeriformis*, attached to a twig of cedar. From photograph from nature, by F. J. Falkenbach, of Ohio Experiment Station.

ence of the parasite could be determined by the pupa protruding from the lower extremity of the sack and strongly resembling the anterior portion of the chrysalis of the male.

In regard to Prof. Riley's statement with respect to the attacks of birds, while I have no direct proof to the contrary, there is a strong suspicion, however, that the species has one or more enemies among the feathered tribes. Some years ago I received, from Prof. Curtis, of Texas, a number of these larvæ in their baskets, and being alive and active when received, they were placed on a tree in my yard. They with one exception soon fastened their baskets permanently to a twig, in a cluster, the exception, after rambling about for a day or so, located at a distance from the others and on a twig that was well sheltered from the wind by an angle of the house. I watched them for a considerable time and they were plainly located for good. Some weeks later, on going to the tree to secure them, intending to take them indoors for further observation, I was unable to find the isolated individual anywhere, either on the ground or on the tree. Knowing that it had been securely anchored and could not have been torn loose by the wind, it was a puzzle to me as to how it became detached.

The present summer, Mr. Davis L. James, of Cincinnati, stated to me in conversation that he had recently observed sparrows engaged in pecking at some of these baskets that had, in some unaccountable manner been detached from the limbs of a box elder and were lying on the ground. Now, all of this proves nothing in regard to the birds, but, it seems to me to be a point well worth following out by observation, in localities where both the insect and sparrows abound, and is, therefore, given here to be accepted for what it is worth. The English sparrow is known to attack the Periodical Cicada, and threatens to exterminate some of the weaker broods, especially where the latter are already much reduced in numbers, and I have repeatedly observed these birds pecking the *Lachnosterna* or May Beetles that had fallen beneath electric lights during the night. In the case of the Cicadas, the first move of the bird, after capturing its prey, was to adroitly clip off its wings, after which it would leisurely extract and devour the contents of the abdomen, rejecting the balance.

In his admirable little book, "Tenants of an Old Farm," pp. 52-54, Rev. Henry C. McCook, records the fact of these sparrows pecking at the cocoons of *Samia cynthia*, but says that he does not know, from actual observation, that the birds wished to tear open the cocoons for the sake of the contents, and thinks that in early spring their motive might be to secure material for their nests. It will be noticed, however, that the observations of both Mr. James and myself were made in late summer or autumn.

## REMEDIES.

Collecting and burning the bags or baskets, during the fall or winter, will prevent their appearance another season. This is somewhat laborious, and a spraying of infested trees with arsenical poisons, as for the codlin moth will be found thoroughly effective. A pound of Paris green and twenty pounds of lime, mixed with two hundred gallons of water, will make short work of these caterpillars, if applied late in June or even early in July, and if faithfully done, no other measure will be necessary.

## THE CABBAGE APHIS.

*Aphis brassicæ* Linn.

Ord. HEMIPERA: Fam. APHIDIÆ.

This is another imported insect, coming to us from Europe, and whence it has become diffused over many countries, being found in Australia and other distant localities. It has been known in this country since 1791, and was described in 1767.

It is quite probable that the life history of this insect is much like that of *Aphis mali*, as we are fast learning that the old idea of these Aphides having but a single food plant is fallacious. There are good reasons for believing that the Cabbage Aphis migrates in the fall, largely at least, to some plant on which it oviposits, and on which the first generations develop in the spring, and from which they migrate to the cabbage. The Apple-tree plant louse, noticed elsewhere, and the Hop Aphis, which originates in spring on the plum, are sufficient illustrations, but they apply to the northern portions of the country only.

Before going farther it will be necessary to explain something of the methods of reproduction among Aphides. There are two; (1) by giving birth to their young, after the manner of animals, and (2) by depositing eggs. Eggs are deposited in the fall only, and it is only at this time that there are both males and females. The eggs hatch in spring and produce females exclusively, and continue in this way until fall. The egg-laying females and the females originating from the eggs are wingless and the latter are termed stem-mothers. While this is true in the main, yet it is equally true that as we go southward, and the cold season is shorter and milder, there is less oviposition and the viviparous females remain on the summer food plant during the winter. In southern Texas I found this species very abundant in February on old cabbage that had wintered in the fields. I might also add that these very peculiar methods of reproduction are not of recent origin nor are these insects in the act of changing their habits in this respect. Geological investigations show us that at least as long ago as the Miocene period these insects had practically the same metamorphosis that they have at present. In fact we

find that the genus *Pemphigus* then, as now, was a gall-maker on various species of cottonwood. Besides these insects are found in the fossil resins of northern Europe.

My predecessor found eggs of the Cabbage Aphis on cabbage late in the fall, and from the fact reasoned that the destruction of these eggs would result in a reduction of the pest another year. After having studied the matter very carefully and reasoning from the same premises I can only arrive at precisely the opposite conclusions. While I do not in the least doubt that eggs are frequently deposited on the cabbage in the fall, I feel very sure that it is only the delayed females, which really constitute only a reserve force as it were, that oviposit thus, while the majority of ovipositing females have originated on some other plant, from adults that had left the cabbage at an earlier date. It certainly requires no great effort to see that lice emerging from eggs on a perfectly dead plant will be very apt to perish, and, indeed, the loss of these does not affect the continuity of the species. So, then, by destroying the cabbage in the fall we would only precipitate an event that would naturally come about later. But the matter does not end here. There are many insect parasites that do winter over on the leaves, and with the coming of spring, emerge and seek out the Cabbage Aphis, probably destroying more or less of them. By destroying the old cabbage these will also be destroyed, when if unmolested they would seek out hosts and go on with their work of destroying the pest. In other words, we would have sacrificed a large number of natural enemies for the sake of destroying a few eggs, when the young hatching from them, if left to themselves, would have perished through natural causes. In the northern states the only precaution necessary is to see that no young cabbage sprouts are sent out by the old the following spring, which can be prevented by simply pulling them up in the fall, letting them lie on the ground. In the far south, where the conditions are different, Dr. Weed's suggestions might be more appropriate, though this statement must not be construed to mean that there are no egg-laying females in the warmer portions of the country.

#### REMEDIES.

While a number of measures have been tried with a view of killing the lice on the young plants none have given satisfactory results, except kerosene emulsion and tobacco dust. The emulsion will be found much more effective if made with whale-oil soap. I have tried to destroy the pests by evaporating bi-sulphide of carbon among the infested plants covered with a heavy canvas, but the result only proved a failure.

Below are given the formulas for making kerosene emulsion and also one for making fish-oil soap; the last as given by Prof. Smith, of the New Jersey Experiment Station:

For standard emulsion:

Kerosene .....	2 gallons.
Water.....	1 gallon.
Soap.....	half pound.

Make a suds of the soap and water, and pour boiling hot into the kerosene. Churn with a force pump for ten minutes, until it forms a thick cream. Dilute with 12 to 15 parts of water when cold.

By the Cook formula this is made as follows:

Kerosene.....	1 gallon.
Water.....	4 gallons.
Soap.....	quarter pound.

Churn as in the preceding and dilute with 4 to 6 parts water when cold.

The fish-oil soap may be bought for about twelve cents per pound, or can be made much more cheaply as follows:

Hirsh's crystal potash lye.....	1 pound.
Fish oil.....	3 pints.
Soft water.....	3 gallons.

Dissolve the lye in the water, and when brought to a boil add the oil. It should boil about two hours, and when done can be filled up to make up the loss by evaporation.

"It is effective at the rate of one pound to eight gallons of water.

#### NATURAL ENEMIES.

As with the apple-tree louse, this species has numerous insect enemies which prey upon it, reducing it in numbers greatly. Dr. Riley has reared an Ichneumon, *Trioxys piceus* Cresson, from the lice.<sup>48</sup> I have reared *Allotria brassicae* Ashmead and *Lysiphlebus raphæ*, Curtis from these lice infesting Scotch kale, at La Fayette, Indiana, and also from the same host on cabbage in Ohio. From these lice infesting mustard, at Columbus, Ohio, I reared *Diplosis aphidiphagus* Webster MS., and also here at Wooster from lice on cabbage. Of the Coccinellidæ, *Megilla maculata*, *Hippodamia glacialis* and *Coccinella 9-notata*, have in my observation, been the most efficient in destroying these lice. Of the Syrphus flies and Lace wings, there are a number of species of each, that aid materially in holding the pest in check.

#### THE APPLE PLANT-LOUSE.

*Aphis mali* Fabr.

(FIG. 16.)

Ord. HEMIPTERA: Fam. APHIDIDÆ.

This is the little green louse that is so abundant on both leaf and fruit buds of the apple, appearing usually just as these are expanding, in early spring. These insects are especially noticeable when the season is

<sup>48</sup>Rep. Comm. Agr., 1884, p. 318.

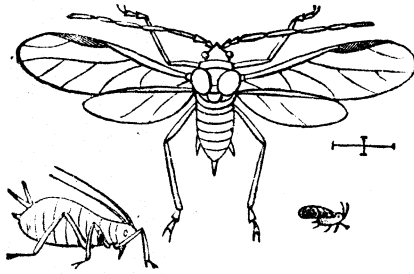


FIG. 16. *Aphis mali*; winged adult: at the left, young enlarged; at the right, adult about natural size. After Fitch.

cold and backward, as has been the case for the last two years. If any injury is done by them in the orchard, it is during such seasons, as, under favorable conditions for plant growth the buds unfold too rapidly to be checked by any influence these lice are likely to have on them. By the third week from the time the eggs begin to hatch, these lice begin to acquire wings and then abandon the trees and go

to the grasses and probably some of the common weeds.

The species was described many years ago, and was long since introduced into this country. I give here the statements of Dr. Asa Fitch, which, with some exceptions, notably the time required for development from the egg to the adult, will I believe be found correct.<sup>49</sup>

"In many instances it is extremely difficult to determine whether the lice upon our American trees and plants are identical with those which occur upon the same or similar vegetation in Europe, the descriptions given by them by the old authors being so very brief, and often drawn up from a superficial examination of the species. And I have heretofore been in much doubt whether this common *Aphis* of our apple trees was the same insect which similarly infests the orchards of Europe, named *Aphis Mali* by Fabricius; that species being described by him, by Kollar and others, as being of a green color, whereas, our insect in its winged state is almost invariably black, its abdomen only being green. But having recently been favored with specimens of the European insect, from my esteemed friend Dr. Signoret, of Paris, and also on comparing our *Aphis* with the description given of the European by M. Amyot (*Annals Entom. Soc., France, 2d series, vol. v., page 478*), and the detailed account of the veins of its wings, furnished by Mr. Walker (*List of British Museum, page 985*), not the slightest doubt remains in my mind, but that the insects of the two continents are identical, and that upon this side of the Atlantic it has been introduced by the trees brought hither from Europe.

"The history of this species and its annual career is as follows: Early in the spring, sunk deep in the cracks and crevices and in the bark of the apple trees, may be seen numbers of small, oval, black, shining eggs, from which these insects are produced. Scraping off the dead bark of old trees, and coating the trunks of all the trees with whitewash at that period of the year is a practice of much utility, since thereby most of the eggs and some other insect depredators will be destroyed and the health of the tree promoted. These eggs hatch quite early, as soon as the buds begin to expand, and the young lice locate themselves upon the small, tender leaves, inserting their beaks therein and pumping out their juices. All of the lice thus hatched are females, and reach maturity in ten or twelve days. Without any intercourse of the sexes, these females that are produced from eggs, now commence giving birth to living young, bringing forth about two daily, for a period of two or three weeks, when having become decrepid with age, they perish. The young mostly locate immediately around the parent, as closely as they can stow themselves. Upon a young leaf, in a space less than half an inch long and the tenth of an inch

<sup>49</sup> First and Second Reports on the Noxious and Beneficial Insects of N. Y., by Dr. Asa Fitch, pp. 50-2, 1855.

wide, I counted thirty-six young lice and four winged females, which had recently alighted there to begin a new colony. The young reaching maturity after a similar length of time in their turn become parents. Thus these vermin continue to breed, and as fast as new leaves expand they are in readiness to occupy them. When favorable circumstances attend them, their multiplication surpasses all power of computation. In the warmth of summer they attain maturity in less than half the time they do early in the spring. And like most of the species of the Aphides they at this period of the year produce winged as well as wingless females, the former dispersing themselves to found new colonies upon other trees. It is reported of the insects of this family, that there are from sixteen to twenty generations in the course of the season, from twenty to forty young being produced from each parent. Thus, from one egg, as stated by Mr. Curtis, in seven generations, 729 millions of lice will be bred. And if they all lived their allotted length of time, by autumn everything on the surface of the earth would be covered with them. When cold weather begins to approach, males as well as females are produced, and their operations for the season close with a deposit of a stock of eggs for continuing their species another year. On the last day of last October, it being a warm sunny day after many nights of frost, I observed myriads of winged and apterous lice wandering about upon the trunks, the limbs and fading leaves of all my apple trees, many of them occupied in laying their eggs. These were scattered along in every crevice of the bark, in many places piled up and filling the cracks, and others were irregularly dropped among the lichens and moss growing upon the bark—every unevenness of the surface, or wherever a roughness afforded a support for them, being stocked with as many as could be made to cling to it. The eggs were then of a light yellow or green color, and were so slightly glued in their places that it was evident by far the largest part of them would be washed away by rains or brushed off by the driving snows of winter. But I by no means anticipated such a great diminution in their numbers as actually occurred. I should judge that in the spring several hundreds had disappeared for every one that then remained."

Of the three principal species of Aphides infesting our smaller cereals, this species occupies an anomalous and at the same time important position. In point of numbers it is very greatly in advance of *Toxoptera graminum*, and, usually, of *Siphonophora avenæ*, and its effects on young wheat during the fall is, if anything more serious than either of the others, especially if the land be poor and the weather be dry. So far as my own observations go, it is more detrimental to the wheat than to the apple. The occurrence of the eggs on the twigs of apple, during winter, and the appearance of the young on the first tender buds and leaves in the spring, are familiar to all horticulturists. I have several times made the attempt to colonize the species on wheat plants, with individuals taken from the apple, but was never able to thoroughly succeed in this until this year, when a series of experiments was begun in the insectary which swept away any previous doubts on the subject of migrations.

Several years ago, on April 17th, all stages of *A. mali* were found on the young buds of quince—a new food plant so far as published record goes—and being unrecognizable without the winged adults, the attempt was made to carry them on artificially until these would appear. In doing this a number escaped from the breeding cage where they were kept, and

took up their abode on some young wheat, growing in a box on the same table. Not knowing with what generation I began investigating it on the quince, it is of course impossible to say whether, as with the Hop Aphis, it is not until the third brood is reached that adults attempt to escape to other plants, and if it was to this third brood to which the escaped individuals belonged. It will be only safe to say that they were winged and migrated. A wingless female from the quince also strayed from the cage and stationed herself on some of these wheat plants, and produced a number of young, but these all died and fell from the plants. At the same time, in a large cage out of doors, others of this species were being reared from the eggs on twigs of apple. Wheat was sown within this cage, and some of the winged adults, after leaving the young buds and leaves, went first to the muslin sides of the cage and afterwards to the wheat plants. One of these remained for two weeks alive, on one of the plants, but I could not see that she produced young. While these transitions were certainly made between the tree and grain plants, nature apparently chose to accomplish it only by her own methods, and would brook no interference or human assistance.

Early in March of the present year (1893) I placed in the insectary a couple of small seedling apple trees and to these bound twigs from the orchard, thickly stuck with eggs of this *Aphis mali*. In the same bench, about twenty feet away, wheat was sown, while some corn was planted in the intervening space. A pot containing a strawberry plant infested by another species of Aphis, and which were attended by ants, *Lasius flavus*, had previously been placed on this bench. With the hatching of the *mali* a large portion of the ants abandoned their wards on the strawberry and gave their attention to the new ones on the apple. The strawberry was then removed, but they still clung to their new found friends. As the population on the apple increased the ants distributed the apterous females to plants of *Poa*, *Setaria*, and *Ambrosia artemisiæfolia*, but especially to the wheat, carrying them by the corn to the wheat beyond, which soon became overrun with aphis. Later, they began to colonize their wards on the corn, but this seemed to be less desirable than either the wheat or grass. Winged *mali* left the apple unaided, and after taking up their position on the wheat began their labor of reproduction. On this wheat being uprooted the indefatigable ants removed them to a few wheat plants still farther away from the apple.

The species also lives over winter in the wheat fields, at least during mild winters, and I have found females reproducing every month of the year. Here, in the west, when the young wheat comes up in September and October, the winged females appear on the plants and give birth to their young, and these crawling downward attach themselves to the stems just below the surface of the ground, or often on the roots themselves. Here they go on reproducing when the temperature is favorable, the adults being apterous, so far as observed by me, until spring,



when they ascend to the foliage, the adults being after this both winged and wingless. On the stems and roots below the surface of the ground, they are of a greenish color tinged with reddish brown, especially posteriorly, the full grown individuals often being wholly of a dark brown. It is during autumn that they do their greatest injury to wheat by sucking the juices from the young plants, often, if on poor land and during dry weather, checking their growth and causing the foliage to turn yellow.

My previous experiments in rearing the species were in some respects unfortunate, in being interrupted, although there was some profit attached to the failures. The results, as well as the whole series of experiments, as they were carried out, are here given.

Infested wheat plants were taken from the field and placed in breeding cages, out of doors, April 5th. May 6th, from what appeared to be the second generation from the individuals from the fields, two pupae were selected and isolated on wheat plants. On the 8th both began reproducing, but only one of them was retained, the other being destroyed. The retained female produced five young between 7:30 A. M. and 5:30 P. M. of the 8th, and eleven more up to 7:30 of the 9th. Six young were found on the morning of the 10th, five on the morning of the 11th, three on the morning of the 12th and three on the morning of the 13th, but the mother was nowhere to be found, she evidently having escaped from under the glass with which the plant was covered. Her progeny of the 8th, five in number, had been kept on a separate plant under another cover, and these, except one which was killed by accident, reached the adult stage on the 15th. Two of these were winged and two were wingless, and one of each produced young as follows:

May 15,	winged female had produced	0	and wingless	8	young.
" 16,	"	"	0	"	11 "
" 17,	"	"	7	"	7 "
" 18,	"	"	3	"	8 "
" 19,	"	"	2	"	7 "
" 20,	"	"	3	"	5 "
" 21,	"	"	2	"	10 "
" 22,	"	"	3	"	9 "
" 23,	"	"	1	"	1 "
" 24,	"	"	3		
" 25,	"	"	0		
" 26,	"	"	0		

The winged female died on the 26th, after producing 24 young in twelve days. The wingless female escaped on the 23rd, after producing 65 young in nine days.

Females were again secured and produced young on June 2nd, after which the parent was destroyed, the progeny themselves giving birth to young on the 8th. A wingless female was selected and reproduced as follows:

3. Ex. STA. 51.

June 8, produced 7 young.			June 18, produced 1 young.		
" 9,	" 3	" "	" 19,	" 1	" "
" 10,	" 3	" "	" 20,	" 1	" "
" 11,	" 6	" "	" 21,	" 2	" "
" 12,	" 6	" "	" 22,	" 4	" "
" 13,	" 5	" "	" 23,	" 1	" "
" 14,	" 4	" "	" 24,	" 1	" "
" 15,	" 5	" "	" 25,	" 1	" "
" 16,	" 3	" "	" 26,	" 1	" "
" 17,	" 4	" "			

The female continued to live a few days longer but died without further issue, she having produced 59 young in nineteen days.

The results of the rearing of this species show that, as with the others, the winged female is the least prolific. It is also probable that some individuals are more productive of young than others, and that the species as a whole may be more prolific early in the season than later on towards midsummer.

As a comparison of the rapidity with which the species multiplies I append the following record of similar experiments with the grain aphid, *Siphonophora avenæ*:

A female was isolated on a wheat plant May 5th, and on the next day, having in the meantime given birth to four young, she was destroyed. On the 14th two of these were also destroyed, the remainder reaching maturity, one being winged and the other apterous. These were both kept on plants under glass, and carefully watched, with the following results, the young being destroyed as fast as produced:

May 15, winged female had produced 1 and wingless 6 young.					
" 16,	" "	" "	3	"	4
" 17,	" "	" "	4	"	4
" 18,	" "	" "	5	"	6
" 19,	" "	" "	4	"	8
" 20,	" "	" "	2	"	5
" 21,	" "	" "	4	"	7
" 22,	" "	" "	3	"	4
" 23,	" "	" "	1	"	6
" 24,	" "	" "	1	"	4
" 25,	" "	" "	2	"	3
" 26,	" "	" "	1	"	3
" 27,	" "	" "	2	"	6
" 28,	" "	" "	0	"	2
" 29,	" "	" "	2	"	3
" 30,	" "	" "	3	"	8
" 31,	" "	" "	1	"	2
June 1,	" "	" "	0	"	2
" 2,	" "	" "	0	"	0
" 3,	" "	" "	1	"	1
" 4,	" "	" "	0	"	3
" 5,	" "	" "	0	"	2

The wingless female died on the 6th, but the winged female lived on, without issue, until the 11th of June. The period of reproduction being 19 days with the winged female and 21 days with the wingless, the former producing 40 and the latter 89 young.

I found that the young moulted on the second, and began reproducing either late on the seventh or early on the eighth day after birth. The insects and plants were inspected, and the young removed each morning, usually about eight o'clock, so that the young were the reproduction of the preceding 24 hours.

#### REMEDIES.

There is some uncertainty in regard to the efficiency of kerosene emulsion in destroying the eggs of this pest, on the apple trees, without also injuring the tree itself. It seems quite probable that comparatively few of the eggs hatch, and, if taken in time, the young can be killed on the buds and very young leaves by the use of this insecticide. It is, however, doubtful if this would materially affect the numbers on the wheat several months later. I know of no way of reaching them in the wheat fields with topical applications. A rich soil, with that management that will best facilitate a vigorous growth of the young wheat plants, will come as near solving the problem of protection against the effect of these insects as anything now known.

#### NATURAL ENEMIES.

This pest has its full share of these. Some rather indefinite observations of mine lead me to suspect that at least two very minute insects destroy the eggs. These are *Gonotocerus brunneus* Ashmead, MS. and *Cosmocema citripes*. From the lice themselves I have reared similar but larger parasites as follows: *Pachyneuron micans* Howard, and *Lysiphlebus tritici* Ashmead, the former attacking its host while on grass and the latter while on young wheat, and there are probably others.

Lady beetles destroy these lice in great numbers, as also do the larvæ of Lace-wing flies. In many cases when the lice are swarming on the trees, small flat worms or maggots appear among them. These maggots are blunt at one extremity and pointed at the other, of a greenish white color with brown backs. They move about among the lice, feeding on such as they can reach, and finally transform to pretty yellow and brown flies, known as Syrphus flies.

## SOME INSECT IMMIGRANTS IN OHIO.

In the following paper the term immigrant is to be understood as given in our lexicons, viz: a species that has come to this State from elsewhere and taken up its permanent abode in our midst, and is not migratory in the sense that that term is used when applied to migratory birds, whose movements are, to a large degree, influenced by the seasons. While the insects mentioned in the following account are largely of transatlantic origin, yet this is not true in all cases, and the term foreign is hereafter intended to apply to territory outside of the State of Ohio. Nor do I intend to enumerate all of the foreign species that have gained a residence within the boundaries of the State, but to give some facts relative to the time, place and method of introduction of a number of them.

Not every farmer or horticulturist is aware of the influence of rapid transportation facilities and close commercial relations on the diffusion of insect pests, not only between states, but nations as well. And the economic entomologist, who, twenty-five years ago, could work very satisfactorily within the boundaries of a very limited territory must now keep in touch not only with his immediate neighbors, but must know also what is transpiring in other countries, not knowing what year some foreign species may appear along our shores. At the present time it is not long after an undesirable immigrant of this sort gains a footing in this country before it is discovered, and its evil habits while at home are published far and wide and its progress inland heralded in advance of its coming. This is especially true with respect to the injurious or beneficial, from the fact of their being more closely watched and their movements better understood; but among the earlier known species we find that even these are often difficult to follow in their advance across the country. There are, seemingly, two of what we may term gateways through which the majority of species that have come to us from the east have made entrance into the State, and, later, spread out over the northwest. The first, and apparently the most important one of these, being at the extreme northeastern part, adjoining Lake Erie and which we might term the north gate, and, second, the valley of the Ohio river, from a point where it begins to form the eastern boundary of the State, southward—perhaps to Wheeling, W. Va. Now, there also appear to be two great national avenues or highways which insect migrations follow; progressing more rapidly along either one or the other, but not equally so along both, and often following only one; the more sub-tropical species, whether American or introduced, taking the southern or what I would call the Great Southwestern route, while the sub-arctic, including, besides American, such species as have come to us from England or Europe north of latitude 45° north, take what I would term the Great Northwestern route. There are, however, occasionally some very striking exceptions to this rule, as pointed out by Mr. E. A. Schwarz, in a paper read before the Entomological Society, of Washington, a year or

two ago. In this paper (Proc. Ent. Soc. Wash., vol. 1, pp. 182-94) several examples are given, among which is our common willow beetle (*Lina lapponica*), which in the Old World occurs only in the north and on high mountain ranges, whereas in North America it extends to the extreme southern portion of the country. A carrion beetle (*Silpha lapponica*) occurs all over North America, except the southeast, and is common as far south as San Diego, California, while in Europe it is strictly arctic, and does not occur even in the alpine regions. Notwithstanding these exceptions, however, the rule is as stated above, and the dividing line between these two great thoroughfares may be indicated approximately, as shown in Fig. 17, by a line drawn from New York City, latitude  $40^{\circ} 43'$  north, to St. Louis, Missouri, latitude  $38^{\circ} 38'$  north, thence to Pueblo, Colorado, latitude  $38^{\circ} 17'$  north (about), the line of separation trending northward, east of St. Louis, under the influence of the gulf stream and the great lakes, chiefly the former. Of course it is not to be understood that this line is direct, as it is doubtless more or less irregular, and from its very nature, to some extent unstable, nor is it to be supposed to form a radical boundary, as some northern forms gradually work their way south of it, and *vice versa*. Yet it will, I think, be found approximately correct.

One of the first species to push its way across our country was the Angoumoise Grain Moth, *Gelechia cerealella* Oliver. From the best information we can obtain, it seems to have been introduced into this country from southern France, as early as 1728, occurring at that time in

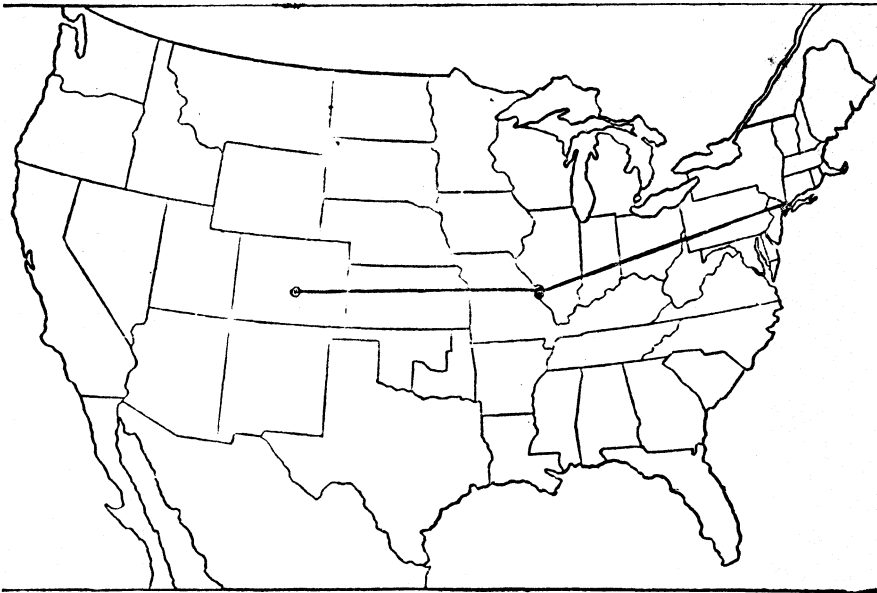


FIG. 17. Indicating, approximately, the natural divide between the northern and southern insect faunas, east of the Rocky Mountains.

North Carolina. This is a southern species, and it is no way likely that it entered from the north, but found its way into Ohio, where it appeared, probably about 1840, from Kentucky. It has not, so far as I am aware, been observed in any considerable numbers north of the line indicated, but has pushed its way to the southern part of Texas. The wheat midge, *Diplosis tritici* Kirby, which probably came to us from England, via Quebec, Canada, entered the United States through northern Vermont in 1828-29, pushing southward and westward, but seemingly making more rapid progress to the west. This certainly entered Ohio through the northern gateway, over-running the State, as also Indiana. Though reported, first in 1843, and again in 1847, in central Ohio, it was in 1849 reported in destructive numbers along the northern part of the State, while the eastern and southern portions seemed exempt. Therefore, I conclude that it came to the State through the north gate. It is one of the species that has followed both the northwestern and southwestern routes, but has probably made more rapid progress and advanced further along the former. Of the early movements of the Hessian Fly, *Cecidomyia destructor* Say, in Ohio, I have no exact data. It might have come up from the South, or entered by either of the two eastern gateways. Like the wheat midge, however, it appears to have made more rapid progress north of the line than south of it. The Imported Cabbage butterfly, *Pieris rapæ* Linn., a native of England, but first appearing in this country in the vicinity of Quebec, Canada, in 1860, pushed its way southward, and in ten years had reached southern New York. From here it gradually moved to the west and south, being first observed in Ohio, about Cleveland, in 1873, a year earlier than elsewhere in the State. From this we infer another entrance through the north gate. Though spreading southward, so that the line given does not at present mark the boundaries of its habitat, yet it flourishes best near or to the north of it, and is not nearly so abundant in the Gulf States, though reintroduced into South Carolina in 1873 and in Florida in 1874. It has mainly followed the northwestern route, but, like the wheat midge, its southern boundary lies far south of the line. The three clover insects, *Cecidomyia leguminicola* Lint., *Hylesinus trifolii* Muel., *Phytonomus punctatus* Fab., without exception, I believe, first came to us from the northeast; though the last two are now known to occur in extreme southwestern Ohio and southeastern Indiana. They probably entered the State from the southeast by way of the Ohio river, at a later date, there being no continuation of the northern colonies to the southward so far as I have been able to observe or learn. *P. punctatus*, which was found about Cincinnati by Mr. Charles Dury, in 1892, was very likely carried down the Ohio river, having been washed into some of its upper tributaries, one of which, Beaver river, takes its rise in northeastern Ohio, by the very high waters of the last two years, and deposited by the receding waters along the banks. There is, however, another element that promises to figure in the diffusion of

this species, and that is the wind. Mr. Ottomar Reinecke, of Buffalo, N. Y., writes me that the insect is especially abundant there just after a heavy east wind has been blowing. This phenomenon was also observed by Mr. A. H. Killman, Ridgeway, Ontario, in 1884. It would also seem that a lack of clover will not prove a barrier to its progress, as I find it even shows a preference for white clover over the red, and besides, have taken the beetles under circumstances that strongly indicate that they feed on the leaves of burdock, while Mr. J. S. Hine has sent me specimens from near Toledo that he found feeding in numbers on the bloom of solidago, with which I found their stomachs literally packed. What the final distribution of this species in this country will be no one can foresee, as in Europe it is found from Sweden south to Italy, where it was known to depredate on clover as long ago as 1867, with a probability that similar injuries were caused as early as 1834.

Hylesinus may have been introduced into southwestern Ohio in the same manner as the Clover-leaf Weevil, but at an earlier date, as it has already become abundant enough to prove destructive in the counties of Dearborn and Franklin in Indiana. It has come to us from Southern Europe and will likely gradually spread over the country, first directly west and then gradually southward. The Grave-yard beetle, *Otiorhynchus ovatus* Linn., another insect that has come to us from the Old World, its native country being Arctic Siberia on the Jenisei, and the southern portion of western Siberia, breeds freely here in Ohio among the roots of bluegrass, and is known to injure the roots of the strawberry, while the adults not infrequently enter houses in great numbers. At present it has swept across Ohio and Indiana, and is on its way through Illinois. I do not know how far it extends to the southward. The Asparagus Beetle, *Crioceris asparagi* Linn., whose native home is Europe and Siberia, was introduced into Long Island, N. Y., about 1859, and reached Ohio probably about six or seven years ago, being first observed in Columbiana county to which it doubtless came via the Ohio river. It is also found in Cleveland, and has formerly occurred about Chicago, Illinois, where it may have been introduced by infested stalks, shipped into those cities for consumption in spring, from the east. Its congener the 12-spotted Asparagus Beetle, *C. 12 punctatus* Linn., which also inhabits Europe and Western Siberia, was first observed about Baltimore, Md., by Prof. O. Luggler in 1881, is likewise spreading out to the westward, but also moves very slowly.

The Horn Fly, *Hamatobia serrata* Rob-Desv., probably came first from the northeast, followed almost immediately by an independent introduction by way of the southeast gateway. Coming originally from France, this species, in spreading over our country, does so entirely regardless of the lines we have drawn. Still, its more rapid progress along the southern route, where the facilities for its diffusion are much inferior to those along the northern route shows that it is swayed by the same in-

fluence that have directed the course of other species. So far, we have been dealing largely with species of trans-Atlantic origin. Now we will take an American species—the Locust Borer, *Cyllene robinæ* Forst. This species has for upwards of a century been known in New York, as an enemy of the Black Locust, *Robinia pseudacacia* L. Some time about the year 1850 it began its invasion westward across northern Ohio, Indiana and Illinois, reaching the Mississippi river about 1865, carrying death and destruction to the Black Locust along its path, but not at once extending its ravages, to a serious degree, in the southern portion of these States. Again, reversing the order of migration that we have been following, we will take another American species, *Doryphora 10-lineata* Say. Starting in Colorado, it pushed its way rapidly eastward to the Atlantic coast, and, though not confined to our northwestern route, as we have termed it, nevertheless, its most rapid progress and greatest destruction was executed north of our imaginary line. Even yet it has not spread southward to the Gulf of Mexico.

Another species of whose advance I am not certain, is *Diabrotia longicornis* Say, described many years ago from examples collected near the foot of the Rocky Mountains, but which I know to now occur in Arizona and Central America. This has become a terrible pest in fields of Indian corn all over the west; and Professor Forbes, of Illinois, some years since, expressed the opinion that it was moving eastward. While mentally differing from this opinion myself, yet the fact that it was, last year, reported for the first time in Ohio, along the western border, for a time led me to feel that Professor Forbes' opinion might yet prove to be a correct one, but more recent information has shown that such was not the case, the insect having been observed in considerable numbers in western New York prior to 1880, and if there was an advance from west to east it must have been long ago.

Last year, it was reported in Ohio for the first time, and was not noticeable in two or three localities along the western border of the State. This year I have found it in the second tier of counties almost throughout the entire length of the State and know that in some localities the larvæ worked some injury to the growing corn. Its congener, *Diabrotica 12-punctata* Oliv., though we do not know it to be of southern origin, yet it is very destructive to the same cereal in the south, but this injury, so far as known, is confined largely, at least, to the territory south of the dividing line, unless it be in Ohio, where, I strongly suspect, it is more destructive than we are aware. Of the southwest route, we have already observed much in relation to such species as have pushed their way over it from the east toward the southwest. Therefore, I shall speak only of such species, with two exceptions, American, I believe, as have passed over the ground from southwest to northeast. One of these exceptions is the larger cornstalk-borer, *Diatræa saccharalis* F. According to Mr. L. O. Howard, who has studied the species quite thoroughly, it may be a



native of the West Indies, or it may have originated in South America and made its way to the United States by way of these islands. Be this as it may, it occurs along the Gulf and Atlantic coasts, and, in the light of recent observations, it seems to be pushing its way northward along the Atlantic, having now reached the vicinity of Washington, D. C. Though for years known to infest both sugar-cane and maize, in Louisiana, yet we have no information of a corresponding advance northward. This, in some respects, appears to be the case with another insect, *Cylas formicarius* Fab., which breeds in the sweet potato, a native of Cochin, China, India and Madagascar, but introduced into the United States, probably, by way of Cuba. This may have been introduced either in Florida or Louisiana, as it occurs in both States, and is now pushing its way west across Texas. Whether it will follow in the path of the *Diatræa*, along the Atlantic, remains yet to be seen. They are both slowly making their way along our great southwestern highway, and if either reach Ohio it will most likely be the *Diatræa* and along our southern border. The Harlequin Cabbage Bug, *Murgantia histrionica* Hanan, is known to occur as far south as Gautemala, through Mexico, and first came to notice in destructive numbers in Texas about 1866. Four years later, it had pushed north to Missouri, and in 1875 it had made its way to Delaware, and on the west occupied wholly or in part Arizona, Nevada, California, Indian Territory and Colorado. It is now found in extreme southern Illinois-Indiana and Ohio, in all cases, I believe, near the dividing line between the two routes, also in New Jersey, thus covering almost exactly the southwestern highway, but, excepting, perhaps, in the far west and near the Atlantic, not extending far beyond it. Although an older established species, *Dynastes tityus* Linn., occupies almost exactly the same area except in the extreme east, where Dr. Lintner has recorded it at Kingston, some seventy miles north of New York City. To my personal knowledge it breeds in southern Illinois, and also at Bloomington, Indiana. I have found it at Columbus, Indiana, and have good evidence of its occurrence in the vicinity of Columbus, Ohio. It has been reported from southern Pennsylvania, and, later, from New York. Of the Bag or Basket worm, *Thyridopteryx ephemeraformis* Haw., also a southern species-I only know that it breeds in southern Illinois, Indiana, and in Ohio, a short distance north of Hamilton, Butler county, while under Atlantic influences, it is sometimes abundant as far north as New York and found also in Massachusetts. The Praying Mantis, *Stagmomantis carolina* Linn., breeds in extreme southern Illinois, and also in extreme southern Indiana, but is said not to do so in Ohio. I have a male, given me some years since by Professor S. S. Gorby, State Geologist of Indiana, that was captured in a railway coach, running between Cincinnati, Ohio, and Indianapolis, and was captured between the latter city and Dayton, Ohio. I also learned that a female had been captured in Indianapolis, by which I judge that these two southern species are hovering in the vicinity of our boundary line.

We have in the country another group of destructive insects whose original habitation we are unable to determine, from the fact that their present distribution is so extended that they are liable to appear in almost any country, and even now may be present but unnoticed; in other words we know not from whence they came or whither they are going. The Corn or Boll Worm *Heliothis armiger* Hubn., is a good example of this group, as it occurs all over the United States south of lat. 44, north, in Mexico, Venezuela, Brazil, Buenos Ayres, Patagonia, Jamaica, Barbadoes, Cuba, England, Isle of Wight, France, South Africa, Cape of Good Hope, Congo River, Madagascar, Cape de Verde Islands, Azores, Bengal, North India, Mauritius, Ceylon, Java, Japan, Australia, New Zealand, and the Navigator Islands. When, or from what direction it came to us in Ohio, it is obviously useless to attempt to determine. The Clover-Hay worm, *Asopia costalis*, Fabr., is a native of Europe, but generally distributed over North America from Canada to the Gulf of Mexico. In Ohio, it seems to limit its destructiveness to the northern portion of the State, for reasons that I am unable to explain. The American Plum-borer, *Euzophera semifuneralis* Walk, was first described from Columbia, South America, but is now known to infest the country from Canada to Florida westward to Texas and Washington. In Ohio, I find it about Cincinnati, and reared it from black knot from Wayne county. It is injurious to the plum, and its depredations were first observed in Illinois, by Prof. Forbes.

Again, it is very difficult in many cases to determine just when a species first enters a given territory, as, in some cases they will remain for a long time without attracting any attention whatever by their injuries, while in others they will begin to devastate as soon as they appear. A very good illustration may be found in the Mediterranean Flour Moth, *Ephestia kuehniella* Zell, which sometimes over runs flouring mills, its larvæ becoming so abundant as to ruin the contents of the mills. Now we find it difficult to determine just whereabouts in the world it primarily belonged. In this country, it first appeared in a mill in Canada, the next we hear of it is in California. It may at present be in Ohio, yet I have no knowledge of it. It seems to have appeared in Paris, France, in 1840, and in a steam flour mill in Constantinople in 1872, and at Halle, Germany, in 1877, and it also occurs in England. Two years ago, a very interesting little parasite, *Encyrtus flavus* Howard, was reared by myself from the Broad Scale, *Lecanium hesperidum* Linn.

This scale is not only generally distributed throughout the United States, but is found also in England, Europe, Asia, Africa, and Australia. It was described by Linnaeus in 1735 in his Fauna Suecica and in his System of Nature he states that it "infests evergreen and greenhouse plants." In Europe it is more especially abundant on the orange and ivy. In South Africa, according to Miss Ormerod, it is known as the "Broad Scale," and is said by Prof. P. MacOwan, of Cape Town, to seriously affect the orange trees. In Australia, it is said by Mr. Tryon, of Bris-

bane, to be very common on garden shrubs. Its injury in Asia is recorded by the late E. T. Atkinson in the Journal of the Asiatic Society of Bengal. In New Zealand, Mr. W. M. Maskell says it is the commonest species of the genus in that country, being found everywhere on ivy, holly, camelia, orange, laurel, myrtle, box and many other plants, both out of doors and in greenhouses.

The scale has, in this country, several minute parasites, *Coccophagus cognatus*, How., *C. vividus*, How., *C. flavoscutellum*, Ashm., *C. lecanii*, Fitch and *Trichogramma flavum*, Ashm. *Encyrtus flavus*, Howard, was described twelve years ago, from specimens received from California, and had not prior to my rearing it, been observed outside of the State.

The Army worm, *Lucania unipuncta* Haworth, occurring periodically over the whole length and breadth of Ohio, is also a resident of Venezuela, United States of Colombia and Brazil in South America, Isle of Wight, England, North India, Java, Australia where the writer heard much of its ravages when in that country in 1888-9, and in New Zealand.

A careful study of the geographical distribution of other species would, doubtless, throw more light upon the problem. Our dividing line is supposed to be correct only in a general way, as, of course, there can be no such thing as an exact or continuous line of demarkation. This will of necessity be more or less irregular. Again, a species spreads over an area particularly adapted for its occupancy. But no sooner is this done, than the individuals along the frontier begin to adapt themselves to an environment but slightly unfavorable, and, as their adaption changes, so do they slowly advance outward from the territory originally occupied. A series of favorable seasons might occasion the occupation of a wide margin of adjoining country, while a series of unfavorable seasons might sweep this tide of advance back to the place of its origin. But as the receding tide of the ocean leaves many pools of water in the depressions of rock, so will there be left in especially favorable nooks a few of the insects which will retain their hold and form small, local colonies, of perhaps not more than a few individuals, and the offspring of these will meet the investigator long distances from the real habitat of the species. There is scarcely a collector who does not know of one or more small, secluded areas, in his neighborhood, that are rich in varieties, and which he seldom visits without satisfaction, and frequently he is astonished at his success. How long this ebb and flow has been going on, and how many species have been brought to us in this way, are problems we are yet unable to solve.

It will be observed that by far the greater number of these immigrants have come to us from the east or south, very few from the north or west, even in the case of those from North Europe and Siberia. There is, however, an intimate relation between the insect fauna of Siberia and Alaska, as has been pointed out by Dr. Hamilton, who thinks, and with reason, that the area now occupied by the Behring sea was once

dry land, and possessed a more temperate climate than at present. These Siberia-Alaskan species do extend their way southward along the mountain regions as far as New Mexico, but they do not come eastward, but, in many cases meet there the westward bound tide from the east. It was not far to the south of this that the wily Spaniard, coming too from the east, in his greedy search for gold, came in contact with a civilization, strange to him, though little inferior to his own. In the canons and caverns of New Mexico and Arizona, the Anglo-Saxon meets with the abandoned habitations of an extinct race. These may be only so many coincidences, but one can hardly help wondering at their similarity. Quite apropos to this subject comes the interesting statement of Dr. Henry Skinner, of Philadelphia, who in a recent note in the *Canadian Entomologist* for October, 1893, speaking of the distribution of Lepidopterous insects says; "In the species that fly from the Atlantic to the Pacific, and also exist in Europe, it will be found that the Pacific Coast examples far more closely resemble the European ones than those individuals found on the Atlantic slope.

While close commercial relations and transportation facilities have much to do with the diffusion of insects over the face of the globe, there are yet other influences at work that are little noticed by the ordinary man or woman. Rev. Dr. Henry C. McCook, in his most admirable work on *American Spiders and their Spinningwork*, a careful, conscientious production in commendation of which scarcely too much can be said, has clearly shown that the winds may have much to do with the distribution of insects, as I have later indicated in the case of the Cloverleaf weevil. In volume II, the author has shown that the general distribution of the Huntsman Spider, *Heterapoda venatorius*, covers with remarkable exactitude the belt over which the north and south trade winds blow. Through the courtesy of the Author, I am able to reproduce here the illustration used by him on page 271, Vol. II, of his work.<sup>50</sup>

Strictly speaking, spiders are not insects and the Huntsman spider has the advantage in that it spins a large mass of web which is so exceedingly light that the maker is readily wafted about in the air, supported by its balloon-like production. While this of course gives it an advantage, in the matter of transportation, yet the fact that many insects are blown about and even transported long distances, is witnessed by the occasional swarms of butterflies observed at sea, and the showers of grasshoppers and other insects that sometimes occur on land.

It is not the intent of this paper to enter into details of the distribution of species, but the questions so often asked by farmers, where do the insect pests of their crops come from, and are not new ones appearing each year? seem to warrant the explanations given in the foregoing. With our present laws, it is impossible to prevent the spread of these

<sup>50</sup>*American Spiders and their Spinningwork*. Vols. I-III, Philadelphia, Pa., Rev. Henry C. McCook, author and publisher.

and other species over our country. For the present, we can only watch for them and be prepared to meet them with measures for destruction and prevention when they appear. Therefore it is the very best of practices to report to the proper authorities the appearance of any strange or unfamiliar insect that appears in any community, especially if it exhibits any destructive propensities. Any Entomologist will be glad to give all the information in his power, free of charge.

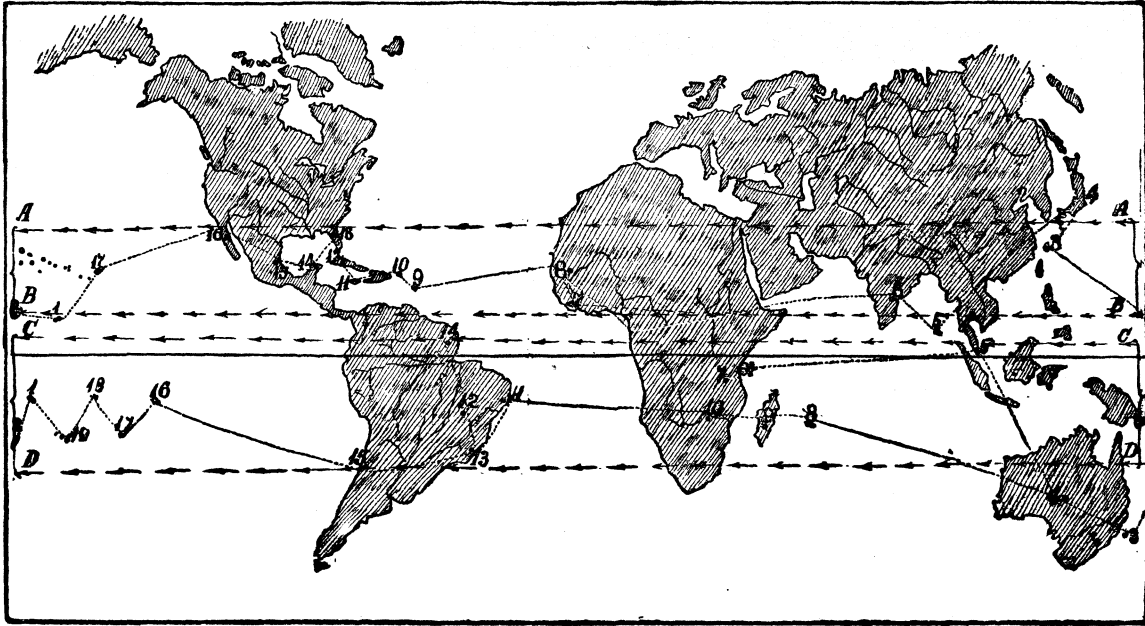


FIG. 18. Chart to show the circumnavigation of the globe by the Huntsman spider, in the course of the Trade Winds.

The heavy line in the center represents the equator, while the arrows indicate in a general way the area covered by these Trade Winds. The numbers indicate localities where the spider has been observed, and are explained as follows:

## ABOVE THE LINE.

1. Palmyra Island.
2. Pelew Islands.
3. Loo-Choo Islands.
4. Japan.
5. Nicobar Islands.
6. Tranquebar, India.
7. Liberia, Africa.
8. Senegal, Africa.
9. Martinique, North America.
10. Santa Cruz.
11. Jamaica.
12. Cuba.
13. Florida.
14. Yucatan.
15. Mexico, Jalapa.
16. California.
17. Oahu, Sandwich Islands.

## BELOW THE LINE.

1. Viti Levu, Fejee Islands.
2. New Caledonia.
3. Sydney, Australia.
4. Australia.
5. Singapore.
6. Zanzibar, Africa.
7. Southeast Equatorial Africa.
8. Mauritius.
9. Madagascar.
10. Zululand.
11. Pernambuco.
12. Brazil.
13. Rio Janeiro.
14. Surinam.
15. Valparaiso, Chili.
16. Tahiti, Huaheine, Society Islands.
17. Rarotonga, Cook's Island.
18. Upolu, Navigator Island.
19. Tongatabu, Friendly Islands.

## INSECT FOES OF AMERICAN CEREALS, WITH MEASURES FOR THEIR PREVENTION OR DESTRUCTION.\*

The three principal cereals grown in America north of Mexico, viz: maize, wheat, and oats, cover an approximate area of from 140,000,000 to 150,000,000 acres. In other words, the natural flora over this vast territory, comprising a great variety of species, has been largely exterminated, and, instead, but three have been substituted, all of which are annuals with a capacity for reproducing each year from twenty to two thousand fold. As nature is said to abhor a vacuum, so does she resent a monopoly, except it be in cases where but few species can exist, and the increase of the individuals of these is ultimately restricted by other influences, such as a rigorous climate or a barren soil. Our grain fields include neither the barren desert, the frozen mountain tops, nor the ice-clad regions of the far North, but the fertile prairies and valleys over which vegetation naturally grows in great luxuriance and profusion, each species if left to itself being kept in its proper numerical sphere by natural laws. The agriculturist, however, comes upon the scene and incites an insurrection, causing the three species before mentioned to not only rebel, but overrun and take possession of these broad acres, putting the original inhabitants to death and establishing themselves in nearly or quite full power. If the contest were wholly a natural one, the interlopers would soon be forced into their proper places, and would exist only in proportion as they could resist the returning encroachments of the natural flora. But the plow and the hoe again interpose, and the victors still hold the field. Nature then does what is naught but good generalship, brings up her reserves in the animal and vegetable enemies of the three usurping species and precipitates them upon the foe. It is here that the hand of the husbandman seems to lose its cunning. He can fight the forests, the weeds, and the grasses, but when it comes to warring upon the insect and fungoid enemies of his grains he seems to lose heart. His reserve force is, or at least should be, in his superior knowledge; but too often this virtue seems to be either sadly aborted or entirely wanting. He does not study ways to destroy or circumvent these enemies of his crops, but, on the whole, allows them to go their way, patiently taking what they leave and hoping for better luck another year.

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\* Read before the Association of Economic Entomologists, at Madison, Wis., August 15, 1893, and published with the Proceedings in *Insect Life*, Vol. VI, No. 2, pp. 146-57, 1893.



It is here that I wish to take up my subject and show how many of the insect foes may be either destroyed or prevented from inflicting serious injury. The field of applied entomology is not the science of killing insects, alone, but includes also the warding off of their attacks. For my own part I would reverse these terms, as it seems to me that the evasion of an attack is ordinarily the most important. I would put it in this way: Warding off the attacks of injurious species by preventing their breeding, and, in case this is not practical, destroying them either before or after the attack had begun. And I may be allowed to here make use of an oft-quoted adage, "An ounce of prevention is better than a pound of cure."

There are upwards of 140 species of insects affecting these three grain crops, and maize alone has over 100 insect foes, a number of course depredating alike upon all three. Of these, such as infest the stored grain excepted, there are very few whose attacks can not be far more easily warded off than remedied after they have begun. I know of no better insecticide than good farming.

THE HESSIAN FLY.

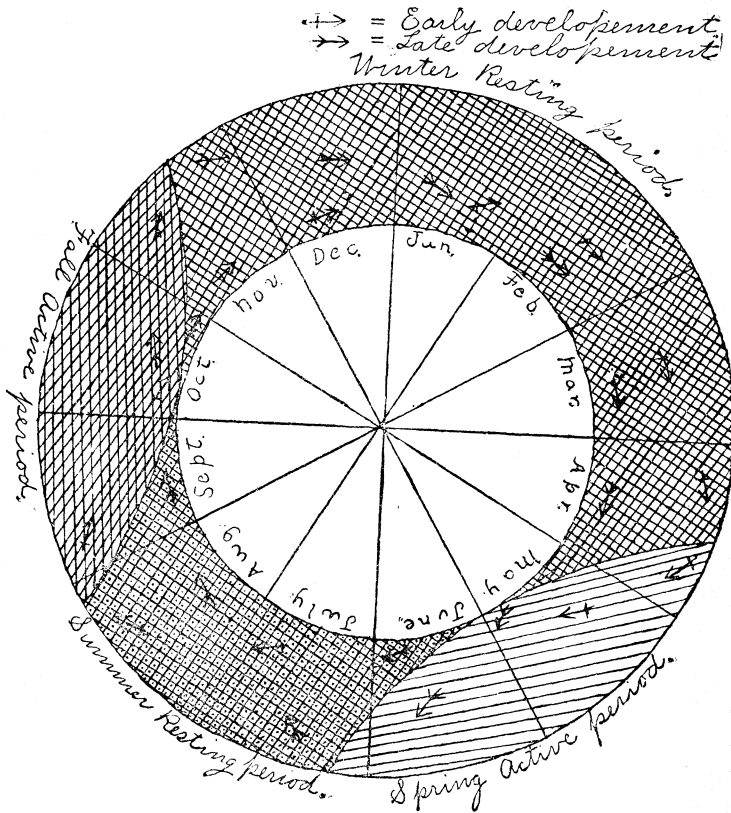


FIG. 18. Illustrating the annual cycle of the Hessian Fly.

It will be noticed that the arrows alternate from the outer to the inner edges of the circle thus: The arrow indicating the late development of larvæ in November, crosses to the inner edge at May, indicating that the adults from these will appear late the following spring; while larvæ entering flaxseed stage in October develop adults early the following spring—the arrows in this case crossing from the inner to the outer edge of the circle.

After eight years of study of the Hessian Fly (*Cecidomyia destructor*), I am satisfied that four-fifths of its injuries may be prevented by a better system of agriculture. For years I have seen wheat grown on one side of a division fence without the loss of a bushel by attack of this pest, while on the other side the crop was almost invariably more or less injured. No effect of climate, meteorological conditions, or natural enemies could have brought about such a contrast of results. The whole secret was in the management of the soil and the seeding. In fact, the question of success in evading the pest, in the one case, did not appear to be an entomological one at all; and I am fully convinced that the Hessian fly problem, so far as it relates to agriculture, throughout that portion of the country lying between the Allegheny Mountains and the Mississippi River, and between the Ohio River and the Great Lakes, may be considered practically solved.\* As applicable to this area, I have attempted to illustrate in Fig. 19, and also in Fig. 20, ideographically, the annual cycle of this insect, which can of course be only approximately correct for any single locality, there being a variation of nearly if not quite one month in the season of development between the northern and southern boundaries. It will be observed that there are four seasons in this cycle, two of activity and two of inactivity, or, we might term the latter resting seasons. Over this area the winter resting season is by far the longer, while the two active seasons are about equal. Toward the south I believe the winter season will be found to be shorter and the summer season lengthened until they become equal, while to the north I confidently look for the autumn season of activity to wholly disappear and the species found to be single brooded. (See Fig. 20.)

Heretofore we have told people that the fly could not exist except where fall wheat was grown. But this can be said no longer, as the pest occurs in North Dakota and in a locality where fall wheat is never sown. Since the fall brood of flies emerges continually earlier as we go northward, it seems to me that we must eventually reach a point where it will cease to appear in autumn at all, and will go over until spring, a state of affairs that will easily account for the breeding in spring wheat in North Dakota. In other words, I expect to find that nature has protected the species alike from the protracted northern winter, and the equally prolonged southern summer, by varying its resting season with the latitude, and, possibly, also with its proximity to the sea coast. That is, we shall

\* See bulletin of this Station for November, 1891.

find the insect passing both the hot and cold seasons largely in the flax-seed stage, that being the stage of development during which it is best protected from the elements and lack of food.

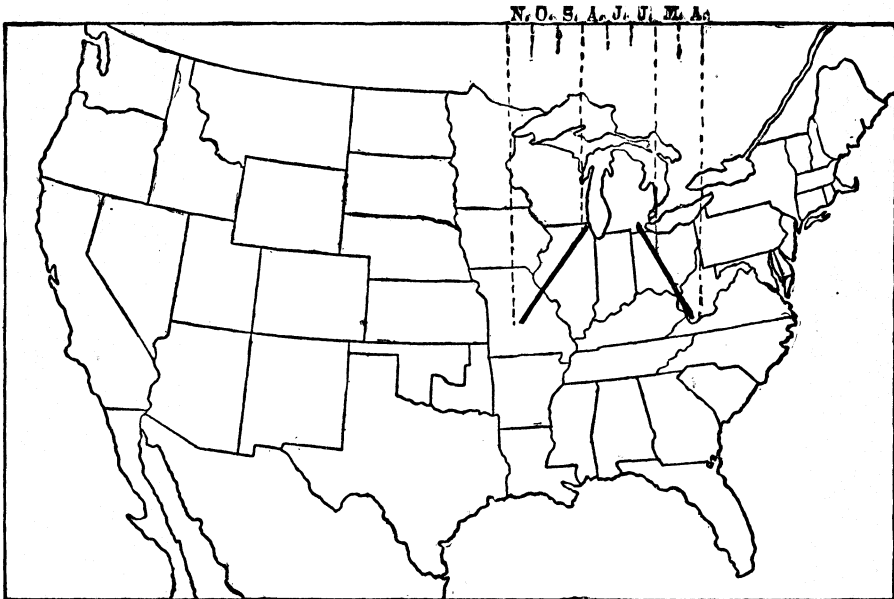


FIG. 20.—Illustrating the divergence of the two annual broods of the Hessian Fly with reference to date and latitude; the letters at upper margin, N, O, S, J, J, M, A, indicate the months from April to November while the heavy, oblique lines represent the diverging of the two broods to the southward and their approach to each other northward.

There are several good reasons why we might expect the fall brood to become extinct to the north, while the spring brood continues, the principal one being that there is not sufficient time for the former to develop before the cold season begins. Besides, in the continuity of the species it can best be spared, and I understand it is not present in England. In nearly all cases where a species is two-brooded, the spring-appearing brood of adults is the producing, while the fall is the diffusing brood. The spring-appearing flies are loth to leave the field in which they originated, and prefer to oviposit on the tillers of the wheat plant, while the autumn-appearing adults will spread out everywhere over the country, and will seemingly, scent out a field of wheat at long distances. They can even be drawn to very small plots in the midst of large cities. With the Aphides the winged female produces fewer young, but spreads them over a larger area. In the Wheat Straw Worm, *Isosoma tritici*, the spring brood of females has so far followed this rule in the past that their wings are either entirely absent or aborted, while the summer brood, *grande*, has invariably fully developed wings, and is the diffusing brood. The Army Worm, *Lucania unipuncta*, is destructive through one brood only,

the fall brood being far less gregarious. This is also true of the Chinch Bug, *Blissus leucopterus*, though in northern Indiana and northern Ohio I find the larger part of the adults with aborted wings. The spring brood of Hessian Fly, coming as it does from plants that will continue through a sufficient season for their progeny to develop, has no need to migrate, while those that summer in the stubble must necessarily change, as the plants can furnish no further nourishment; besides, diffusion and differentiation serve, in a measure, to protect from natural enemies. But notwithstanding this, it will be easily observed that the later brood can be best dispensed with without material and permanent injury to the species. This appears to me to be a state of affairs that we may look for. I do not wish to be understood as making the unqualified statement that these conditions do exist, and only hope that readers of this bulletin, located to the north and to the south of the area indicated, will be able to prove either the truth or fallacy of my position. We have much yet to learn in regard to this Hessian Fly, and a study of it in any locality would probably develop some new features, or at least new parasites.

#### THE STRAW AND JOINT WORM.

There are some facts connected with the two species of *Isosoma*, *I. tritici* (the Straw Worm), and *I. hordei* (the Joint Worm), that, to me at least are rather puzzling. Unless an undetermined species, found in New York by Dr. Lintner, proves to be *tritici*, I am not aware of its occurring east of the Allegheny Mountains, though it reaches west to the Pacific coast. On the other hand I never saw *hordei* in Illinois or Indiana, nor did I find them in central Ohio, yet I had not been a week in the northern part of the latter State before I found them in abundance. They occur, generally, over the north portion of the State and into Michigan. Is it not possible that *hordei* is of northern origin, where the season is too short for two broods, while *tritici* has pushed up from the south, where the protracted vernal season is favorable for the development of two broods? I find that *hordei* almost invariably selects small wheat plants in which to oviposit, while the summer brood of *tritici* as invariably selects large, thrifty stalks, usually where the plants are thin on the ground but rank growing. In northern Ohio I never find *hordei* far below the upper joint, an exceptional feature I believe, though it seem to me we might look for such a state of affairs, as it oviposits during a season intervening between the spring and summer broods of *tritici*. Then, too, I notice the parasites of *hordei*, at least *Eupelmus allynii*, French, *Semiotellus chalcidiphagus* Walsh, and *Websterellus tritici* Ashmead, emerge in August and oviposit in the same straws from which they themselves emerged, the adults from these emerging in spring. I have also noted the same thing in the two former species where their host was a Hessian Fly. In both instances, however, I got fewer parasites in spring than in August.

So far as measures for their control are concerned, *tritici* can be largely overcome by a rotation of crop, while both this and *hordei* will be destroyed by burning the stubble, a measure equally applicable to the Hessian Fly and Wheat Stem-maggot, *Meromyza americana*.\* In some portions of the country, however, clover is sown among the young wheat in early spring, and a burning over in summer under such conditions is impracticable.

#### THE CHINCH BUG.

I wish to call attention to a few points in reference to the Chinch Bug, *Blissus leucopterus*. The area of extreme continued injury by this pest covers southern Minnesota, southeast South Dakota, much of Nebraska and Kansas, all of Iowa, and much of Missouri, Illinois, all of Indiana except northeastern portion, extreme southwest Ohio, and northern Kentucky (Fig. 4), though in the wheat region of the Mississippi Valley the pest is by no means limited to this area, nor does it confine itself to the wheat region at all.

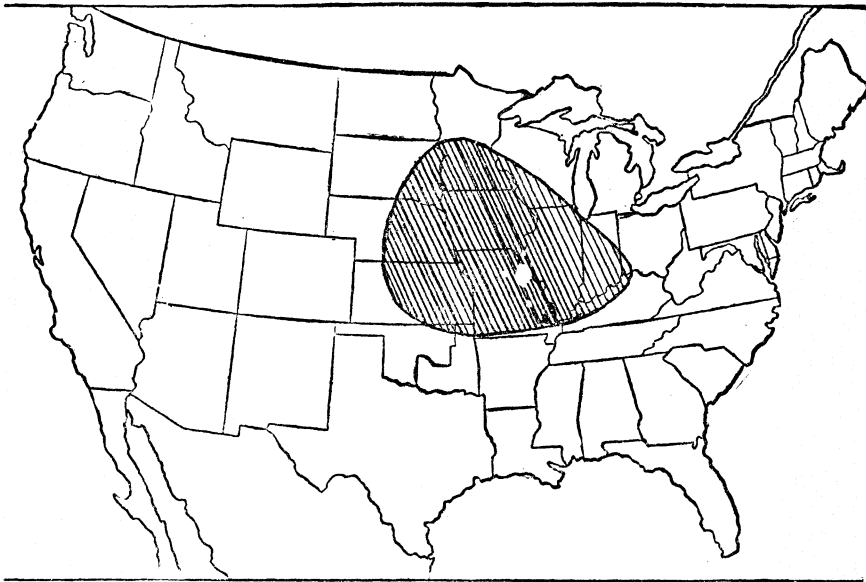


FIG. 21. Showing area of continued serious ravages by Chinch Bugs. (Webster del.)

It is more abundant in Louisiana, where wheat is never cultivated, than in northern Ohio, where this cereal is one-half of the grain crop. When it was working its greatest havoc in southern and central Illinois and southwest Indiana, I looked in vain for it in northern Indiana. I do

\* For full description of insects affecting the wheat plant the reader is referred to Bulletins of this Station for November, 1891, April, 1892, and No. 46, 1892.

not understand why it is that a very large per cent. of the adults found in Ohio, along Lake Erie, and in Northern Indiana possess only aborted wings; yet I have found this to be the case. The insect parasites of this species are very few and of little account in holding it in check. For aid in this direction we must look to meteorological conditions unfavorable to its increase and the fungoid and bacterial parasites. These last will be found available during some seasons and within a certain limit, but nature is not likely to use one of her servants to annihilate another. We may be able to emphasize their work in this direction by continual artificial cultivation and distribution; further than this we cannot expect to go, and the relief will at best be but local and temporary, though not by any means without value in limited areas. The only difficulty is in that we cannot foretell a year of destructive abundance with certainty, and a few false alarms will so discourage the ordinary farmer that he will do nothing to protect himself. For my own part I feel quite sure that if the bugs can be induced to oviposit in spring in small plots of millet or Hungarian grass they can be controlled by the use of the bacterial and fungoid diseases to far better purpose than to attempt to do so in the fields of ordinary cultivation. But there must be, somewhere, a central source of supply where requests for material can be promptly filled, as has been done by Prof. Snow, before the plan will prove a success. Next in value to such plats is, I think, the cornfields where the bugs must of necessity congregate in compact masses and thus facilitate contagion.

#### PLANT LICE.

It would appear almost visionary to advocate spraying apple orchards in midwinter to protect the wheat crop, but nevertheless one of the most serious enemies of young fall wheat passes its egg stage on the twigs of the Apple during the winter season. I refer to the Apple Leaf-louse, *Aphis mali* Fab. Soon after the young wheat plants appear in the fall the winged viviparous females of this species flock to the fields and on these give birth to their young, which at once make their way to the roots, where they continue reproduction, sapping the life from the young plants. On very fertile soils this extraction of the sap from the roots has no very serious effect, but where the soil is not rich, and especially if the weather is dry, this constant drain of vitality soon begins to tell on the plants. Though they are seldom killed outright, these infested plants cease to grow, and later take on a sickly look, and not until the *Aphis* abandons them in autumn to return to the Apple, do they show any amount of vigor. It is very seldom that the affected plants fully recover, at least in autumn, and the result must be to reduce their productiveness the following year.

## CORN INSECTS.

The greater number of serious pests of our fields of Indian corn are such as work their injury below the surface of the ground. Wire worms devastate our lowlands and the White Grub ravage the higher lands, while Cutworms, Web Worms, and Corn Root-worms are found generally diffused over both. The Corn Root-worm, *Diabrotica longicornis*, excepted, all of these seem more destructive to a crop of grain following a grass crop or pasture. Yet this is not always true. I have known of fields of corn being seriously affected by white grubs when such fields had not been devoted to grass for a single season in twenty years.

In the case of Wire Worms some good results may be secured by fall\* plowing, though as the adults emerge in August or September and winter over, also in this stage, we can hope to do little with these. There are, however, during the winter two younger generations in the soil, and against these a fall plowing may and evidently does have an ill effect. What a summer fallow would do I have had no opportunity of learning. There is no end of reported successes and failures among farmers, but there is so much obscurity shrouding these that one cannot judge of their authenticity. Once, and only once, have I felt quite sure of having beaten these pests. This was in the case of a field of grass land, plowed in spring and planted with potatoes. The worms nearly ruined the crop, and in the fall the ground was still well populated with them. The following spring, potatoes that had escaped notice when the crop was harvested seemed to attract the worms, and the latter were found burrowing in the tubers in great numbers. On my suggestion, hogs were turned into the field, and these rooted out and promptly disposed of both potatoes and worms, no injury occurring to the following crop, which was of corn. There may be some virtue in the application of kainit, although this has not as yet been thoroughly and clearly demonstrated, and, besides, over the vast corn belt of the Northwest, its application is impracticable. For myself, I am willing to confess ignorance of any unailing, practical measure, either of prevention or destruction. Fall plowing and a rapid rotation of crops are as yet the best measures we can recommend.

White Grubs, the larvæ of several of our species of *Lachnosterna*, appear to give preference to the higher lands. Where the soil of such lands is of such a nature as to wash easily during winter and spring, fall

\*NOTE: This statement is based on the fact of adults being found above ground in the fall and under boards and similar objects in early spring, before the ground has thawed to any depth. Mr. M. V. Slingerland, of Cornell University, has kindly called my attention to a statement appearing in Bulletin 33, of the University experiment station, to the effect that the adults develop in the summer but do not appear above ground until the following spring. I think that my own statement may, perhaps, be modified slightly, as it is very possible that some individuals emerge in the fall while others do not. However, they are altogether too numerous above ground in the fall and winter to warrant the statement that they do not emerge in summer and autumn.

plowing results in the washing out of great gullies, thus constituting a grave objection to the measure. Outbreaks of this pest seem to be usually of triennial occurrence, different localities being affected during different years, and I have thought we might accomplish something by mapping out these areas, and so warn the agriculturist of their probable appearance. Here, however, the same trouble awaits us. A single mistaken prediction discourages the few who will follow our direction, and we get only derision from the remainder. In my own correspondence I have advocated the same measures against these as in case of the Wire Worms, viz., a rapid rotation of crops, especially of grass or clover, and fall plowing, whenever it can be done without detriment to the fields. What has, or is likely to be accomplished by the use of fungoid parasites, I do not know. As in the case of the Corn Root-louse, *Aphis maidis* Fitch, or *Aphis maidi-radidis* Forbes, less injury is done in fields that have been fertilized with barnyard manure.

The Corn Root-worm, *Diabrotica longicornis* Say, has by its ravages cost the farmers of the Mississippi Valley millions of dollars during the last fifteen years, every penny of which might have been saved by a judicious system of husbandry. In Ohio it is unknown, except along the western border of the State. Its occurrence here, where it was reported last year for the first time, raises the question of its eastward diffusion—a problem which I hope to be able to solve. The congener of this species, the Southern Corn Root-worm, *Diabrotica 12-punctata* Oliv., will certainly not be managed so easily. There is yet some investigation to be done on this species, before we can confidently advise in regard to its destruction. It appears, in the adult stage, to be well-nigh omnivorous, and the larvæ travel freely.

The corn or Boll Worm *Heliothis armiger* Hbn., is more especially a Southern species, though as far north as Chicago there are, during some seasons, two broods, as, in that portion of Illinois, I have found half grown larvæ in the ears of ripe corn, in November. In the North the damage done is trivial, often being due to the rain and dew running into the affected ears, causing them to decay. Among the market gardeners, where it works in the sweet corn, the measure suggested by Prof. French, several years ago, which was late plowing in the fall, will do much to hold the species in check. In the South the most sensible and practical suggestion that I have seen mentioned is to plant corn early amongst the cotton in order to attract the early brood of worms, and then destroy the corn in a way to kill the depredators.

For the major portion of the cutworms, I have much faith in laying down of poisoned grass or clover baits, but the larvæ of *Hadena devastatrix* Brace and *H. stipata* Morris, cannot be reached in this manner, as they do not come to the surface to feed. The first eats the plants directly off a short distance above the roots, while the last eats into the stem at about the same place, then tunnels its way upward, eating out the heart after the manner of the Stalk Borer, *Hydræcia nitela* Gn.



## A NEW CORN INSECT.

I have here to introduce a third species of *Hadena*, *H. fractilinea* Grt., an entirely new depredator in our cornfields, at least so far as published records are concerned. In fact we rarely find the species mentioned at all in our entomological literature. The imago was described in the *Canadian Entomologist* (Vol. VI, p. 15, January, 1874), the habitat there being given as Canada (Petit), Albany, N. Y., (Lintner). Prof. G. H. French, who first determined the species for me, has it from Maine and New York, and Prof. John B. Smith has it from Maine to Ohio, Minnesota to Colorado. How far south it extends I do not know. The adults are so exceedingly quick in movement and secluded in habit that it is not surprising that it should be overlooked. Several specimens of both sexes that were transferred from the cage in which they were reared to another in which grass was growing were not observed afterwards.



FIG. 22. Adult of *Hadena fractilinea*. Life size. From photograph by F. J. Falkenbach, Ohio Ex. Station.

The habits of the larvæ are in strange contrast with those of *stipata*, at least in the cornfields, where that species work entirely below the ground, entering the stem just above the roots and eating its way upward, while in this species they climb up the plant and eat downward, devouring the whole interior of the stem down to a point where the *stipata* would begin. If the plant be a young one—that is only two or three inches in height—these larvæ will enter the cylinder formed by the youngest leaf, but if the plant be older and tougher they will eat downward along the edges, as shown in Fig. 5, until the tissue is more tender, when they will enter the stem and work downward. The time of oviposition I am unable to give. Larvæ, from two-thirds to quite full grown, were taken the last of June, when they were said by the farmers to be disappearing. From these larvæ imagoes appeared in the insectary, the last days of July and up to the 10th of August. I did not observe them, nor can I learn of their occurrence elsewhere than on spring-plowed grass land, and \*this either



FIG. 23. *Hadena fractilinea*; a, larva; b, pupa—nat. size.

wholly or in part timothy sward. There appeared to be no difference in point of injury between early and late spring plowing. There did not appear to be any disposition on the part of the larvæ to wander about, but if the corn was planted in hills, after finishing one stalk they would abandon it and attack another, and so on until all were destroyed.

*Description of the Larva.* (Fig. 23, a).—Length 26<sup>mm</sup>; color, yellowish white, two dark, broad, dorsal stripes separated by a narrower light stripe of the general color of the body, the dark stripes extending from the anal segment forward, unbroken, to the first thoracle where there are one or two narrow, sharply defined interruptions, also of the general color of the body and near the anterior margins of each of the thoratic segments, thereby dividing the dark stripes unequally, the anterior portion being little wider than the interruption. Cervical shield honey yellow, uniform in color with the head, but rather lighter than the anal shield. A rather narrower and darker lateral stripe extends from the head to the anal segment, its lower margin being on a line with the spiracles. At the posterior extremity of this lateral stripe, just above and slightly forward of the anal proleg is a round, dark-brown dot from which originates a short, hooked bristle; just beyond this dot and extending around the posterior margin of the anal segment to a corresponding point on the opposite side and just under the slightly projecting anal extremity is a continuous row of four connected dots of the same dark-brown color and each producing a short, curved bristle, all slightly curving upward. The head is small, rather less than the anal segment with the mouth parts well developed and very dark brown in color, being smaller than the first segment in about the same proportions as the anal segment decreases in size from the one that precedes it and the coloration and markings being so nearly alike, it is not an easy matter to distinguish the two at a glance. From the second to the ninth segment there is little variation in the size of the body, it being rather slender until near the time of pupation, when it increases somewhat in size anteriorly.

*Description of the Pupa.* (Fig. 23, b). Length 14<sup>mm</sup>, greatest diameter 4.5<sup>mm</sup>. There are no teeth or spines except at tip, where, extending from near the dorsal tip of the last segment are two horizontal, short, robust, blunt appendages, parallel, but flanked on each side by a very slender, hooked appendage, exceeding in length the former but of a lighter color. Just beneath these on the ventral surface, is a short deep slit, the edges and vicinity of which are very dark brown. The general color does not differ from that of other allied species.

The larvæ from which all my adults were reared, were taken from corn plants either in the field, or from plants sent me by my correspondence, and I saw every one of them in transferring them to the breeding cages. All were working in corn in precisely the same manner and there was certainly no noticeable difference in the larvæ. The imagoes, however, were those of two species, as they are now understood, the larger number being the one under consideration, while the remainder were *Hadena misera* Grt. If, therefore, the two species are distinct, then this also must be added to the list of corn destroying insects, and a further study will be necessary to separate the larvæ, whose depredations appear not to differ. Prof. Smith writes me that he has this last species from Colorado, taken by Bruce, and also from Minnesota, bred by Prof. Luggen. All this, of course, does not disprove the validity of the species, as, if I

remember rightly, there is a strong resemblance between the larvæ of *H. fractilinea* and *H. stipata*, as I observed them in corn in Indiana some years ago.<sup>61</sup>

My attention was first called to the depredations of these cutworms in Ohio, by Mr. C. H. Coon, of New Lyme, Ashtabula county, and it was while I was spending a day with him in response to his letter of inquiry that I found the pest and was enabled to study its habits, to a limited extent. Later, I received specimens from Mr. D. H. Blake, of Chapel, in the same county, with the statement that they were common and destructive in his neighborhood, working on land that had been in timothy the preceding year, clover sod being less or not at all affected. In my own observations this appeared to be the rule, as was also their non-appearance on fall plowed ground except where such ground bordered on a field of timothy, in which case a few worms might be found ravaging the first two or three rows of corn along this border. A very similar case of preference for timothy in a closely allied species, *Hadena devastatrix*, came under my observation in Indiana some years ago, where the larvæ destroyed whole acres of the grass leaving the clover growing among it untouched<sup>62</sup>.

The various species of web worms, larvæ of several species of *Crambus*, are, of late, working nearly as much damage in our cornfields as are the cutworms, and are even less accessible. The larvæ of at least three species have this season devastated the cornfields of eastern Ohio, one of which appears to feed below ground exclusively. For my part, I am puzzled to know how to deal with these. Can it be done by breaking the sod in early summer, and allowing the wind and sun to dry out and kill the grass roots, thus starving the very young worms? The plan of breaking the ground very late in spring and planting the crop immediately I find often fails of protection.

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#### ACKNOWLEDGMENTS.

FIGS. 2, 3, 10, 16 were secured through the aid of Dr. J. A. Lintner.

FIG. 9 was secured through the kindness of Prof. Bruner.

FIG. 13 was purchased from Prof. C. V. Riley.

FIG. 18, loaned by Rev. Henry C. McCook.

FIGS. 19, 20, 21, 23 were secured from the U. S. Department of Agriculture, the drawings having been furnished by this Station, and were made by Miss Vinnie Cunningham, under supervision.

FIGS. 14, 22 were photographs from life by F. J. Falkenbach, of this Station.

<sup>61</sup> *Insect Life*, Vol. II, p. 333.

<sup>62</sup> *Rept. Comm. Agr.*, 1836, p. 578.

## SUMMARY.

*The Asparagus Beetle* is an imported insect feeding in both the larval and adult stages on asparagus. It appears to be slowly extending its area of attack to the west and south, and is establishing itself in Ohio. There are several generations each year, the pest wintering in the adult or beetle state. Sowing lime over the asparagus beds in the morning, while the dew is on, and the application of pyrethrum to the plants while the insect is in the larval stage, are the best remedial measures.

*The Western Corn Root-worm* is the larva of a small green beetle, a near relative of the striped squash and cucumber vine beetle. The eggs are laid about the roots of corn in late summer and fall and hatch the following spring or early summer. If corn follows corn on the same ground year after year these worms will continue to increase and feed on the roots of the corn plants. The effect of these worms on the roots is to destroy them and thus wholly or in part destroy the crop. A rotation of crops from corn to any of the small grains or grasses is a perfect protection.

*The Broad-striped Flea-beetle* is a small jumping insect, striped somewhat like the squash and cucumber vine beetle, but is very much smaller, and more active. The pest is supposed to breed in the ground, and is not usually abundant enough to cause serious injury. Dusting the plants being attacked with Paris green mixed with flour, and applying kerosene emulsion are the remedies.

*Blister Beetles:* There are five species of these common to Ohio, four of which are more or less destructive. They all breed in the ground and while in the larval stage are carnivorous, feeding to some extent on the eggs of grasshoppers, and are to this extent to be considered beneficial. It is difficult to find a remedy against their attacks, as, while poison doubtless kills some of them when it is thoroughly applied to the vines of potatoes being attacked by them, the effect is so slow and there being a continual influx from outside it is well nigh impossible to thus cope with them to advantage. Driving them on to patches of straw laid down along the edges of the fields and burning this is the most effective. It is possible that spraying with Bordeaux mixture may be a protective measure.

*The Bag or Basket-worm* occurs only in the southern part of the state, not extending northward to Columbus. It belongs to the same order of insects as the butterflies, but the male only possesses wings, and the eggs are not deposited on vegetation by the female, but within the bag or basket and the young make their way out. The bags or baskets from which these caterpillars take their name are begun as soon as the young emerge from that occupied by the mother, and are enlarged to conform to the growth of the occupant, as the season advances. There is but a single annual brood, the males emerging in the fall and the young hatching from the eggs in the following June. The pest can

be destroyed either by collecting the bags or baskets during the fall, winter or early spring, or by spraying the trees late in June with Paris green or London purple, as for the codlin moth.

*The Cabbage Aphis:* This, too, is an imported species that has become naturalized in this country, affecting cabbage, turnips and others of this group of vegetables. The insect winters over, largely at least in this latitude, in the egg state. In the spring these eggs hatch fertilized females which reproduce by giving birth to their young after the manner of animals, the young themselves developing and reproducing within a few days after being born, all young produced being females. Late in the fall, there is a generation produced in which there are both sexes, and of these, after pairing, the males die and the females deposit eggs, after which they also die. The remedies for these are tobacco dust and kerosene emulsion.

*The Apple Plant-louse:* This belongs in the same group of insects as the preceding, and reproduces in the same manner. In this case, however, the eggs are deposited in the fall on the twigs and limbs of the apple, hatching in spring into the small green lice so noticeable on the young buds in early spring when these are being first put forth. Later, they desert the tree and go to the weeds and grasses. After the young wheat is well up in the fall the lice congregate on the young plants and reproduce, and the young, descending to the lower part of the stem, continue reproduction and, when abundant, do some injury to the plants. The only place to fight these insects is on the apple trees and with kerosene emulsion.

*Lines of Insect Immigration:* There appear to be two great highways which insects imported from Europe have followed in entering Ohio. Those coming from north of latitude 45° north, have generally entered the State at its northeastern corner and their spread southward has, as a rule, been less marked than to the westward, while those coming from southern Europe have generally entered by way of the Ohio valley and have a comparatively restricted northern distribution.

*Measures for the Control of Insects Affecting Cereals:* For the Hessian Fly, late plowing is the most effective preventive yet discovered. Burning the stubble is useful in preventing the ravages of this insect, as well as of the Straw and Joint worms. For destroying the Chinch Bug, Prof. Snow seems to have used a fungoid, *Sporotrichum globuliferum* to considerable advantage. Fall plowing and rapid rotation of crops are the best measures yet discovered for preventing the increase of Wire worms and White grubs. Rotation alone will overcome the Western Corn Root Worm, and most cutworms may be destroyed by laying down baits of poisoned grass or clover.