KENTUCKY

AGRICULTURAL EXPERIMENT STATION

OF THE

STATE COLLEGE OF KENTUCKY.

BULLETIN No. 49.

I. DESTRUCTIVE LOCUSTS IN KENTUCKY.

II. THE BUD-WORM OF TOBACCO.

LEXINGTON, KENTUCKY,

MARCH, 1894.

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AGRICULTURAL EXPERIMENT STATION

The Bulletins of the Station will be mailed free to any citizen of Kentucky who sends his name and address to the Station for that purpose. Correspondents will please notify the Director of changes in their post office address, or of any failure to receive the Bulletins.

Address:

KENTUCKY AGRICULTURAL EXPERIMENT STATION,

Lexington, Kentucky.

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BY H. GARMAN, Entomologist and Botanist.

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Our locusts are known as grasshoppers here, but are all members of the same family as the locusts of the Scriptures, and one, the bird grasshopper, agrees very closely in size, shape and markings with its eastern relative. We have thirty species of the family in Kentucky, but only the five treated below are liable to prove troublesome on the farm. The rest live scattered in various situations, and hence are not so much to be feared.

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The habits of the different species agree, as far as known, in their main features. The eggs are placed in

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packets in the earth or in wood, generally in the fall of the year, and remain here to hatch the next spring. Young resemble the adults in shape, but at first lack wings. These soon begin to appear, but remain short and functionless until the last moult of the skin, when the functional wings unfold. Most of our species produce but one brood during a season. A few are known to produce two; probably none have more than this. The young of some species hatch in the fall and pass the winter hidden away among dead vegetation, to mature the following spring. Our largest species, the bird grasshopper, matures late in the season and passes the winter as a winged adult.

REMEDIAL TREATMENT.

A costly experience with the destructive locust (the Kansas grasshopper) of western states has furnished us with some methods of fighting such insects that compensate in a measure for the injuries suffered. During a recent outbreak of this species in Minnesota active work in the way of destroying the insects was done under the supervision of State officials.

Three methods of combating the insects were there tried and found useful. (1) The farmers of the invaded regions turned out and with various contrivances collected large quantities of the insects. In 1888 about 35,000 bushels of the locusts were collected and destroyed in a single county in Minnesota. (2) Deep plowing in fall and spring before the locusts hatched was found to be effective by burying the egg-masses so that the young hatching from them did not succeed in reaching the surface. (3) The use of arsenites (London purple and Paris green) was found to be effective, but was avoided by most farmers for fear of injuring stock.

The locusts were collected in greatest quantities by the use of long sheet-iron pans with an upright back,

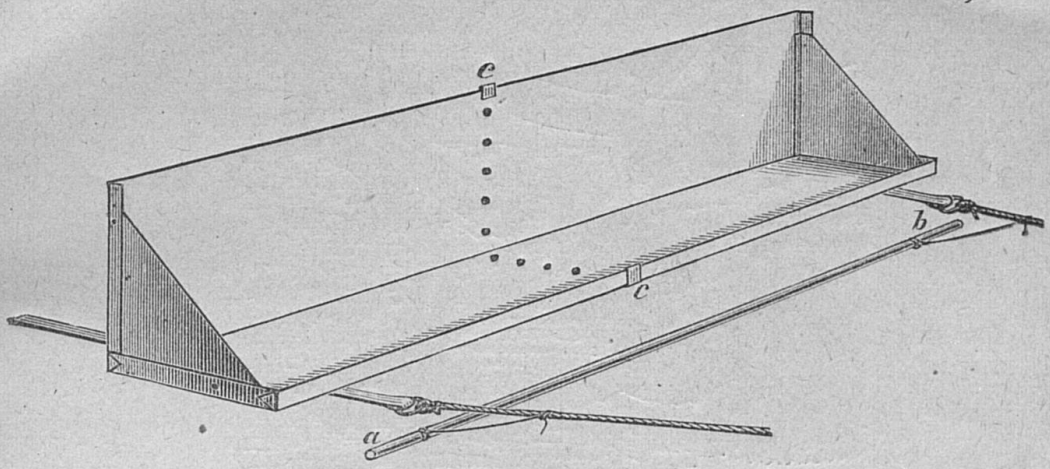

Figure 1. Showing a form of hopper-dozer used for collecting locusts.

and filled with coal oil, or of coal oil and coal tar mixed. The contrivance is known among western farmers as a "hopper-dozer." Writing of the use of this apparatus in Minnesota, Prof. Otto Lugger, in a valuable bulletin published in 1889, says:

"A careful use of this practical contrivance will destroy a very great majority of such insects. To catch as many locusts as possible with the least expense for labor, four hopper-dozers were joined together by means of short ropes, thus forming a continuous pan some forty feet long. The pulling ropes from the corners of each pan were left rather long, and fastened to a single tree; the combined weight of these dozers could be easily drawn by one horse, which moving in front of the center, scared the locusts and made them jump. To stir them up still more a rope was dragged some few inches in front of the dozers, and the locusts in jumping all landed in the pan, which had also a canvas stretched behind it to deflect too active hoppers, and throw them in the oil. As the farmers like a mixture of coal tar and kerosene oil, better than the latter alone, because they could actually see their enemy perish before their eyes, these materials were furnished them."

The egg-masses of the locusts are usually placed just below the surface, so that the young when hatched have no difficulty in getting out of the ground. With a view to learning what the effect of turning the egg-masses under with a plow would be, Prof. Lugger secured a dozen lots of locusts eggs and "planted" them in flower pots at different depths. Half of these were kept in dry soil, the rest in soil that was moistened from time to time.

In the dry soil eggs placed one inch below the surface yielded 93 per cent. of young locusts, Those placed four inches in the ground yielded 13 per cent. of young. Those placed five inches under ground yielded 2 per cent.

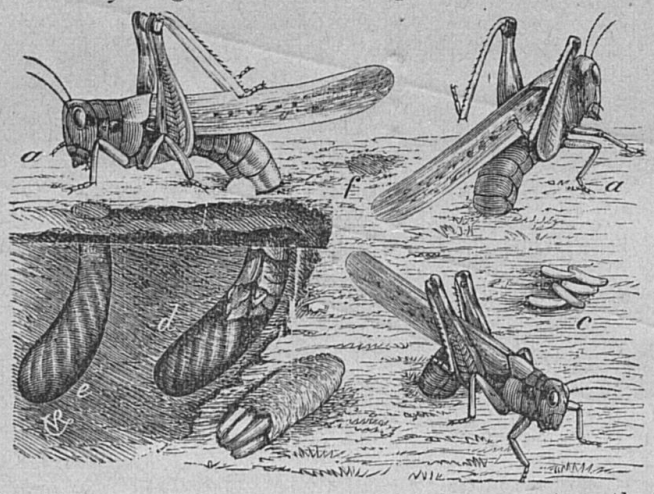

Figure 2. Showing the manner in which locusts place their eggs

While eggs with six inches of soil above them yielded no young.

In the moistened soil the result was similar, but the young did not succeed so well in emerging. Thus from eggs one inch beneath the surface 87 per cent. of young emerged. Eggs four inches down yielded only 1 per cent. of young. While those five and six inches deep yielded no locusts.

It was thus evident that plowing the fields in which the locusts were observed to place their eggs would result in the destruction of the young. It was found to be a practicable remedy, and Prof. Lugger reported that no young locusts appeared in the plowed fields. Plowing, he says, breaks the egg-masses, but this does not destroy their vitality. The good accomplished is the result of burying the eggs so deep that the young are not able to push their way to the surface.

Plowing should be done in the fall if possible, but is effective when done very early in spring.

These remedies have the sanction of those who have had extended practical experience with locusts, and are commended to the attention of farmers in Kentucky, whose crops may be endangered during the coming two or three seasons.

THE BIRD GRASSHOPPER.

(*Schistocerca americana*).

Numerous complaints from farmers appeared in the papers issued during the summer and fall of 1893, concerning the injuries done to corn and meadow by a large grasshopper. It was especially abundant and injurious in southwestern Kentucky, where the young sometimes collected in such large numbers that meadows were described as "brown with grasshoppers." The insect which occasioned these complaints is known all over the South because of its conspicuous size and great power of flight. In some localities it is known as the "bird grasshopper," a name given it possibly because of its habit of flying up and alighting in trees. Grown examples in some cases measure two inches in length of body, and including the wings reach a length of 2.56 inches. The general color is ocher-yellow, the ground color of the fore wings approaching straw-yellow. The markings are mostly blackish (fuliginous), consisting of lines and spots, those on the front wings being especially noticeable. A yellow stripe extends along the back from the front of the head well towards the tips of the folded front wings.

The young may be recognized by their general resemblance to the adults in shape. They have only rudimentary wings. In color they vary more than the winged adults, being sometimes pale green with minute black spots, and again decidedly brown with conspicuous black markings, among which a stripe along the middle of the back and an acutely triangular spot below each eye are characteristic, the latter mark being present also in the adult.

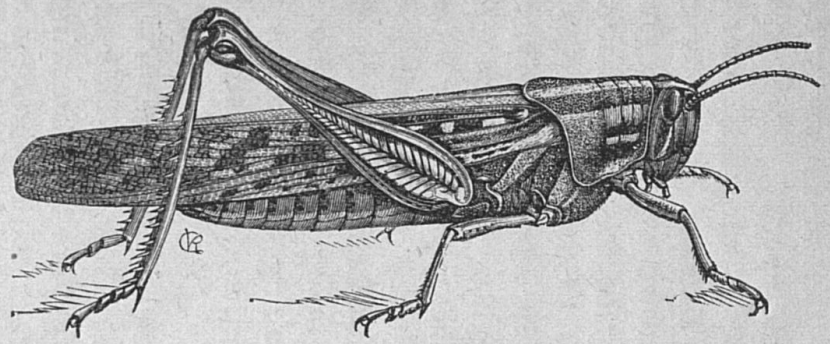

Figure 3. The Bird Grasshopper.

	May 9	June 3	June 23	July 13	July 19	July 21	July 31	Aug. 5	Aug. 9	Aug. 12	Aug. 21	Aug. 24	Aug. 26	Sep. 7	Sep. 12	Sep. 16	Sep. 23	Sep. 28	Oct. 11	Oct. 17	Nov. 1
Adults	+	+	+	+		+	+			+						+	+	+	+	+	+
Young					+		+	+	+		+	+	+	+	+						
	Adults									Young						Adults					

Figure 4. Showing the dates (marked by a cross) at which the bird grasshopper has been observed in Kentucky.

An interesting fact concerning this grasshopper is that it is so much like the "locust" of the Bible that good authorities on the group of insects to which it belongs, are disposed to regard the two insects as varieties of one species. They are certainly much alike in appearance, but after having had an opportunity to compare them, I am satisfied that they are distinct. We have, however, on the west coast of South America and in the Argentine Republic a locust which seems to be identical with that of Syria and Palestine. Through the kindness of Samuel Garman, of the Museum of Comparative Zoology at Harvard University, I have recently had an opportunity to examine examples of this destructive species from Chili. It resembles our bird grasshopper in a general way, both in shape and markings, but has a larger head, larger, broader wings, and shorter hind legs. Some of the specimens I received were submitted to Mons. A. Giard, of Paris, France, for comparison with the locusts which recently devastated Algeria. M. Giard has had unusual opportunities to study the latter, and after examining my specimens wrote as follows:

"I have carefully examined the specimens of Chili grasshoppers and find them almost identically similar to the *Schistocerca peregrina*, of Algeria. They belong to the reddish variety, as do all the examples of this species coming from America that I have had an opportunity to examine. The only difference that I can perceive is that the anterior border of the elytra [first wings] has no spots in the three specimens sent from Chili, while it is largely spotted in those from Africa; perhaps however this is merely a difference of individuals and in any case cannot be said to constitute a specific character"

From this statement it is apparent that the locust of the Scriptures, occurs in both hemispheres.

Our species is southern in its distribution, occurring in the Central American States, in Mexico, and all the southern United States. It extends as far north as New

Jersey and central Illinois but is not common north of the Ohio River except in a small portion of Indiana and Illinois. At times it shows a tendency to assume the habits of the locust of North Africa and South America, collecting at such times in swarms which mount into the air and migrate from place, sometimes appearing suddenly in localities where it is not ordinarily found, to the great wonder of the inhabitants. Swarms are said to have appeared in southern Ohio, Indiana and Illinois in 1875–1877. During the same years they were observed in large numbers also in eastern Tennessee and in Georgia.

The following clipping from a Warren County newspaper issued last fall, will give a conception of their abundance and injuries last season in western Kentucky.

"There is a plague of grasshoppers north of the river. In the Phalan and Oakland countries they are chewing up everything that a grasshopper can masticate. They are also appearing in other parts of the county and are thicker and bigger than ever before. They are stripping the corn of its blades and in many places only the stalk and ears of corn are left. The are also cleaning up the grass as they go."

In some sections they were so abundant that they invaded dwellings and public buildings, as many as 30 or 40 appearing in a room, gnawing their way through the netting of windows, and even, it is said, gnawing holes through the mosquito-bar covering of beds.

Their capacity for mischief is certainly very great, and it is fortunate that they are abundant only at long intervals, otherwise agriculture in the southern United States would be seriously handicapped by them.

DISTRIBUTION IN THE STATE.

The species is found everywhere in Kentucky, but becomes less abundant eastward toward the mountains. In western Kentucky it is a characteristic insect, and it is here that its numbers attract attention and give rise to

newspaper comment. In the Blue Grass Region it was last season very common, but ordinarily is rather scarce, or only moderately abundant.

LIFE-HISTORY.

Adult grasshoppers appear very early in the season, the first of which I have record being seen May 9. From about this time until the last of June they increase in numbers, and then gradually disappear, the last being observed about the first of August, though some continue as late as August 12. These individuals have passed the winter as adults, and have come out of their winter hiding places to place their eggs. This act accomplished their life cycle is completed, and such as are not captured and eaten by birds die of "old age."

The eggs are placed in the earth, in grass land commonly, the female boring into the ground with tip of her abdomen and then depositing her eggs in a packet. I have no record of the occurrence of young grasshoppers before July 19. At this date in 1889 they were observed in a large flock at the edge of a wheat field near Lexington, and from the fact that they become scattered after hatching it is probable that those seen had not been long out of the ground. By the first of August they are rather common, and before the middle of the month probably all the eggs are hatched. Many of those which hatch never reach maturity, since with increase in size goes diminution of numbers due to the onslaughts of birds and other enemies. They mature during the first half of September. The young ready for their last moult are provided with wing-pads in the place of fully expanded wings and lacking the reddish markings of the winged adult. With the last moult of the skin the wings and characteristic adult markings appear. The adults continue common until cold weather, but with gradually diminishing numbers, many serving as food to the migrating birds which reach us from the North about this time of year.

Just where they pass the winter is not known. It is a little strange that they are not found in the situations usually frequented by hibernating insects. I have never encountered them under logs or bark, and have no evidence that they enter the soil. So large and conspicuous an insect would be very likely to attract attention if it occurred in ordinary situations, and I am at a loss to say where they conceal themselves, unless it be in hollow stumps and trees. Like other species of the genus, they show a strong disposition to resort to trees at all times, and it is not improbable that they should select these when cold weather approaches as a refuge from frost and their enemies. That they hibernate admits of no question. The early appearance of adults in spring precludes the possibility of an early spring brood from eggs laid in the fall. Furthermore, I have kept pretty close watch of the grasshoppers which appear in the State, and among records and collections made throughout the season from July, 1889, to November, 1893, there is no indication of the occurrence of young in early spring. The accompanying table and diagram, showing the dates of collecting or observing the young and adults of this species, illustrates very well the life-history of the species for Kentucky.

INJURIES.

The grasshoppers are all provided with powerful jaws with which they can gnaw away substances of considerable hardness. They have been known to devour even the bark of twigs when they were abundant and other food became scarce. Ordinarily the food consists of grasses, but they range widely, and probably get a meal here and another there, so that the sum of their injuries becomes apparent and calculable only when from their abundance they are driven to the cultivated fields for a living. The corn at the edges of fields, under these circumstances, is sometimes completely deprived of

blades, while the injury gradually extends towards the centre of the field, so that much of the corn is finally more or less injured. This mischief is done by the winged grasshoppers alone, and, fortunately, is much of it done so late in the season that it does not affect the yield of grain as it otherwise would. The earlier injury done by this species is the work of the young, and is often very considerable in meadows, where timothy and other grasses suffer chiefly. The Johnson grass in one of our experimental plots seems to be especially relished by the young.

THE RED-LEGGED GRASSHOPPER.

(*Pezotettix femur-rubrum*).

While the bird grasshopper oftener attracts attention than this, because of its great size and striking colors, it is not to be considered more injurious. The species under consideration is very much smaller than the bird grasshopper and is more plainly colored. In length of body it varies from 0.87 to 1.00 inch. The front wings when drawn straight out at the sides measure about 1.75 inch from tip to tip. The general color is rather dull brown. On the side of the division of the body following the head is a shining black band which extends from the front margin to a cross groove marking the beginning of the hind third of the division. Below the base of the folded wing is an oblique yellow stripe which reaches nearly to the base of the hind leg. The thickened basal portion (femur) of the hind leg is generally of a coral-red color, this giving origin to the common name. The front wings are brown, with a few minute dark specks near the base. The hind wings are transparent and uncolored.

This grasshopper is always present in Kentucky fields as young or adult during much of the summer season. It occurs also in other sections of the Union,

ranging from British America to the Central American States, and from the Atlantic to the Pacific Oceans. Three-fourths of the small grasshoppers which fly up as one walks in meadows and stubble fields in August and September, pertain to this species. It is a near relative of the notorious Kansas grasshopper, but does not migrate extensively, and while injurious at times, is never so destructive as is its western cousin.

Last season it was exceptionally common, and in conjunction with the bird grasshopper did a good deal of injury to corn. It was also locally destructive to hemp and even tobacco. In our forage plant plots it was especially destructive to alfalfa.

LIFE-HISTORY.

Unlike the larger species, it passes the winter in the egg state. The adults may be observed in the latter part of September placing their eggs in the earth along little used roads and paths. When the eggs are laid the adults disappear, though often common as late as November 1. The young of this species appear in pastures and meadows about the middle of July, and may be seen until the 23d of August or thereabouts. The adults appear about August 13 at Lexington, but probably earlier in the south part of the State. They were observed at Fulton, in Southwest Kentucky, August 11, 1892. Since the young appear in the latter part of June, the whole development after leaving the egg takes place in about ten weeks.*

FOOD PLANTS.

It cannot be said that this grasshopper has any very decided preferences as to food. Its wide distribution

*In a list of Illinois Orthoptera, printed in Psyche, Vol. 6, p. 74, McNeill states that this species has been taken at Moline, Ill., as early as June 23. I assume he means the examples taken were adult, and if so, the observation seems quite out of accord with the observations of others. It may be that some belated individuals hibernate as adults, and place their eggs in the spring, but it seems a little remarkable that a species which requires ten weeks for its development during the heat of summer, should complete its growth before June 23 at so high a latitude as Moline.

and abundance almost everywhere on this continent is due in a large part doubtless to the fact that it can subsist on almost any sort of vegetation. It is to be found everywhere among grasses and weeds in open fields. It is not a woodland species, though individuals may be encountered anywhere. The great bulk of the individuals is to be seen in meadows, pastures, stubble fields and along roadsides. The variety in its regimen while giving it a decided advantage over its competitors ordinarily makes it less to be feared by the farmer as long as an abundance of miscellaneous vegetation flourishes in the neighborhood of his cultivated fields. When vegetation becomes scant owing to drought its advantage becomes more apparent and the farmer becomes the sufferer, for it concentrates in the edges of cornfields and in meadows. If there are any of the low-growing cultivated plants upon which it will not feed at such times, I do not know what they can be. Even tobacco, which is with the exception of the work of three caterpillars but little injured by gnawing insects, is very badly damaged at times by the red-legged grasshopper. I saw fields in the latter part of the season of 1893, in which large numbers of plants were so badly riddled with holes gnawed by these insects that they were of little value for any purpose. Clover, alfalfa, bluegrass, millet, wheat, corn, hemp, cabbage, beans, beets, in short, everything worth cultivating seemed to be, to a greater or less extent, laid under contribution.

THE LESSER MIGRATORY LOCUST.

(*Pezotettix atlanis*).

We have in Kentucky another very widely distributed locust which is so much like the red-legged species as to be with difficulty distinguished. It is not recognized as distinct by the average observer, and for practical purposes this is not important. It may be said

in passing that its general colors are like those of the other species, but the red of the hind thighs is not apparent and the black mark on the side of the body back of the head is not so decided, It averages a trifle smaller, the body measuring from about 0.80 to 0.92 inch in length, while the wing expanse is in the neighborhood of 1.46 inch.

This species is very closely related to the Kansas grasshopper, and like that species sometimes assumes the migratory habit, though its movements are not so extended nor its injuries so great. In New England it has at times proved a severe scourge. While always rather common in all parts of Kentucky, it is ordinarily not as abundant as the red-legged locust. In 1889, however, it proved the more common of the two, and showed itself capable of doing quite as much mischief.

LIFE-HISTORY.

The species is two-brooded, in which respect it differs from most of our other grasshoppers. The eggs laid during summer and fall hatch early in spring, so that young appear in meadows in April and May, from which winged adults are developed as early as June 15. From the latter date until cold weather the adults may be observed, but part pertain to the spring brood and others to the fall brood. The adults of the first brood are common in July; those of the second brood during September and October. Specimens of the adult have been collected by me in Kentucky on the following dates:

June 15; July 10, 16, 21, 26, 30; August 3, 6, 15; September 7, 11, 23, 26; October 3, 11, 17, 30; November 1.

I can say nothing as to differences in the food habits of the two species. They frequent similar localities, and occur together in cultivated fields. I think, however, that this species is the better adapted to rather high and dry land, while the other finds its most favorable sur-

roundings among the more luxuriant vegetation of low lands, especially of the rich alluvial soils of river valleys. It is my impression that *P. femur-rubrum* becomes more abundant, on the whole, towards the Mississippi River, though *P. atlanis* is very common locally at Bowling Green and elsewhere well toward the western end of Kentucky.

THE DIFFERENTIAL LOCUST.

(*Pezotettix differentialis*).

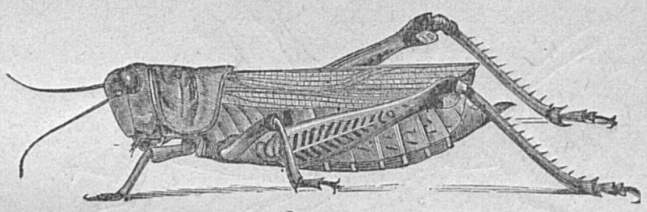

Figure 5. The Differential Locust.

A large, olive-brown locust without decided markings of any sort, is common in places in Western Kentucky, and from its known destructiveness in the northwest can be expected to prove mischievous occasionally in this State. In Illinois and other States north and west of us, it is one of the most common and injurious locusts. Notwithstanding its clumsiness, it flies pretty well, and has at times been known to join the two preceding species in local flights, when hundreds circle about in the air at great heights and give rise to stories about the Kansas grasshopper having appeared east of the Mississippi river.

I have had no opportunity to follow the development of this species in Kentucky, as it does not occur in the eastern part of the State. My specimens were all taken in western Kentucky in August. The species is known to pass the winter in the egg state. The young hatch very early in spring and undergo their last moult and become mature in late June and during July. A single

brood appears each year. The food consists of various grasses and weeds. The species sometimes shows a disposition to attack the leaves of small trees, but is on the whole a freqenter of open lands. It measures 1.46–1.56 inch in length of body, and has a wing expanse of 2.56 inches.

THE YELLOW-STRIPED LOCUST.

(*Pezotettix bivittatus*).

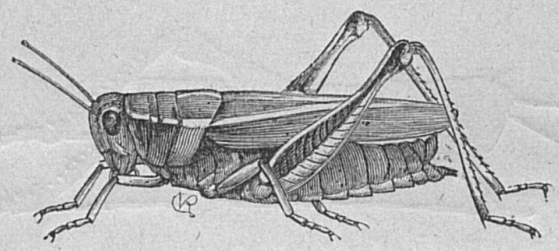

Figure 6 The Yellow striped Locust.

This species resembles the preceding in general form of body, but may be distinguished from any other Kentucky species by the presence of a yellow stripe on each side of the head and body and along the upper part of the folded wings. The body is stout and measures about 1.50 inches long. The wing expanse is about two inches, their appendages being much shorter relatively than in the other species.

While this grasshopper is widely distributed in Kentucky, it is not common enough to do much injury to crops. I have never witnessed any damage of consequence done by it to any vegetation; yet it is ranked among the destructive locusts of this country because of mischief it is known to have done in other States, and it is with the idea that it may sometime show its destructive propensity with us that it is mentioned in this connection.

II. THE BUD-WORM OF TOBACCO.

BY H. GARMAN.

It is commonly stated that the bud-worm of tobacco and the corn-worm are one and the same insect. It is possible that the corn-worm has been observed at times on tobacco, since it is found at Lexington to desert ripening corn towards fall and resort to the young growth of leaves on the severed stalks of tobacco plants left in the field; but there is a probability that in some cases another insect has been mistaken for the corn-worm.

Several bud-worms were brought to the Station, July 29, 1893, and confined in a breeding cage until they matured. They proved to be *Heliothis rhexia*, the adult of which is a small sea-green moth. This species has been observed on weeds belonging to the same family as the tobacco, but has not hitherto been accounted a tobacco insect.

Our specimens left the tobacco and went into the ground August 10, and the adult moths came out, one on August 24, the other the following day. A third, when about ready to emerge, was placed in alcohol for preservation as a pupa. This worm and the corn-worm are so much alike that it is difficult to give characters by which they may always be distinguished readily. The corn-worm is rather stouter, more glossy, and has less red on the body. When grown it will average larger than the species bred by me. So great is the resemblance, however, in pattern of coloration and in structure that I can not consider the two insects members of different genera.

The injury done by the insects studied at the Station consists in gnawing holes in the young rolled up leaves at the center of the plant, the worms, a single one to a plant, remaining concealed among the leaves.

No doubt an application of Paris green would reach

them if thoroughly applied. Where not very common, probably removal by hand is the safest and cheapest method of ridding plants of them. Since their original food plant was probably some one of the weeds known as ground-cherry and horse-nettle, it would be well always to destroy such plants when growing about tobacco. It is probable that in some cases the insects make their way among the tobacco from weeds of this sort growing at the edges of fields.

The worm measures 1.44 inch in length, and has a diameter of 0.16 inch. General color olive-green, with fine yellowish green longitudinal lines above, uniform below, but showing on close examination minute white dots. Skin opaque. Head shining, rust-colored. Body with fine scattered whitish hairs, arising from black-tipped prominences; a distinct but poorly outlined spot of brick-red on each side of the body divisions from the third to the 11th inclusive; breathing-pores brown rimmed, the hindmost several times larger than the preceding.

When ready for its next stage the worm leaves the plant and enters the ground for a few inches, changing to a tawny pupa measuring 0.72 inch in length and having a diameter of 0.21 inch. It is smooth and shining everywhere, and has two slender, closely placed spines at the tip of the abdomen.

The moth which emerges in August* measures 1.34 inch from tip to tip of the outstretched front wings. The general color of the front half of the body and of the front wings is sea-green, the wings crossed obliquely by three nearly straight bands of white; hind wings whitish at base above, slightly iridescent, outer third black in the male, obscurely blackish in the female; abdomen pale ocher-yellow above; largely yellowish white everywhere beneath, with some evident black markings in the male, among which are two black dots on each front wing.

* A second brood comes forth in spring in states south of us, and I am disposed to think a second brood develops here also.