U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ENTOMOLOGY—BULLETIN No. 57.

L. O. HOWARD, Entomologist

REPORT

ON

MISCELLANEOUS COTTON INSECTS IN TEXAS.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST

BY

E. DWIGHT SANDERSON,

Special Agent, Bureau of Entomology, in Cooperation with the Entomological Department, Agricultural and Mechanical College of Texas.

WASHINGTON:

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, D. C., December 5, 1905.

SIR: I have the honor to transmit herewith the manuscript of a report on miscellaneous cotton insects in Texas, prepared by Prof. E. Dwight Sanderson, entomologist of the New Hampshire College Agricultural Experiment Station, formerly State entomologist of Texas and a special agent of this Bureau cooperating in the work on insects injurious to cotton in Texas. This report gives the detailed results of a year's work on the minor insect enemies of cotton by Professor Sanderson and assistants, and is supplementary to investigations which have been conducted by other field agents of the Bureau on the more important subjects of the cotton boll weevil and bollworm. It contains definite records of observations on the life histories of numbers of species, as also data on their natural enemies. It has been prepared with the valuable assistance of Mr. A. C. Lewis at Terrell, and Mr. C. E. Sanborn at College Station, Texas, many of the records of life histories having been made by the gentlemen named. I recommend the publication of this matter as Bulletin No. 57 of the Bureau of Entomology.

Respectfully,

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

Hon. JAMES WILSON,
Secretary of Agriculture.

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INTRODUCTION.

Economic entomology has heretofore been concerned with but a few of the many species of insects affecting the cotton plant. The leaf caterpillar and bollworm, and recently the boll weevil, have been exhaustively studied as being the most important insect enemies of the cotton crop, but very little attention has been given to numerous others which frequently cause more or less injury.

The reason for this is found in the manner of the growth of cotton, the methods of its culture, and the nature of the injury done by these miscellaneous insects. Cotton is one of the most rank growing of all our staple crops, is cultivated over large areas, and matures its fruit normally for over a month. Consequently, any insect which does only local injury, which does not entirely destroy the young plant, and which does not defoliate the older plants nor destroy the most of their fruit, has been hardly worth combating; for the planter could better afford to stand the loss than to attempt fighting these pests by artificial means.

But with the advent of the boll weevil, and the consequent necessity for early cotton and intensive culture with reduced acreage, conditions have somewhat changed, and injuries which before were unheeded are now decried as further reducing the small margin of profit in the weevil district. Any insect which destroys the young plants, necessitating replanting, or which checks their growth while young, prevents an early maturity and consequently exposes the crop more to the attacks of the weevil; and later in the season when the weevil has levied its heavy tax upon the crop, any additional injury by insect pests seems a most onerous loss to the planter.

These considerations led to the investigation of the cotton insects of Texas reported below. A single season is far too short a time in which to thoroughly cover so large a subject over a State with such varied conditions, and the writer fully appreciates the incompleteness of this report. However, he has endeavored to collect or refer to all the available information concerning the economic aspect of the species treated, so that these notes may form the basis for a further and more exhaustive treatise upon cotton insects in the future.

It may not be out of place here to briefly refer to previous articles on cotton insects. Having briefly mentioned a few species during the preceding year, in 1855 Townend Glover included an article on cotton insects in his report to the Commissioner of Patents for that year, illustrated with numerous figures of the more common species.[a] Later he engraved better figures of many of these species, with which he published a few notes.[b]

In 1892 F. W. Mally, at that time an assistant in the Division of Entomology, in his report on the bollworm,[c] mentioned several cotton insects whose injuries might be mistaken for those of the bollworm. Some portions of this report were republished in Insect Life. As a result of an investigation of the insects frequenting cotton fields in Mississippi, Dr. William H. Ashmead published several papers[d] in which he gives brief notes on the habits of the insects found. In 1896 Dr. L. O. Howard gave the first general account of cotton insects published since that of Glover.[e] Since the publication of this paper no general study has been made of cotton insects other than the boll weevil and bollworm, except that excellent work of Prof. H. A. Morgan upon the differential locust, which is noted in the account of that insect in the following pages.

From his study of the life histories of the minor cotton insects and the methods of cotton culture, the writer believes that for but few of them will artificial remedies, such as poisoning, be found generally practicable. Like most of the insects affecting our staple crops, they must be largely controlled by general methods of culture and farm management, such as the destruction of their native food plants, rotation of crops, and winter or early spring plowing. More intensive cultivation of cotton will undoubtedly result in a material lessening of the injury by many of these pests, and, under such conditions, those which may be profitably combated by remedial treatments will be more successfully and generally treated.

Most of the work upon the life histories described below was done by Mr. A. C. Lewis, who was in charge of a temporary laboratory upon the demonstration farm of Mr. E. H. R. Green, at Terrell, Tex., and by Mr. C. E. Sanborn at the laboratory at College Station. Mr. A. F. Conradi, at that time assistant entomologist of Texas, also helped in the work. The writer is indebted to Doctor Ashmead, of

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[a] Report of U. S. Comm. Patents f. 1855, Agriculture, 1856, pp. 64–115, pls. 6–10.

[b] Manuscript notes from my journal.—Cotton and the principal insects, etc., frequenting or injuring the plant in the United States. Washington, D. C., 1878, 2 pp., 22 plates.

[c] 1893: Bul. 29, o. s., Div. of Ent., U. S. Dept. Agric., pp. 29–33.

[d] 1894–95: Insect Life, Vol. VII, pp. 25–29, 240–247, 320–326.

[e] 1896: "The Cotton Plant." Bul. 33, Off. Exp. Sta., U. S. Dept. Agric., pp. 316–350, figs. 9–29, Pl. IV; and 1897: Farmers' Bul. 47, U. S. Dept. Agric., pp. 31, 18 figs., 1 pl.

the U. S. National Museum, for the determination of the parasitic Hymenoptera, to Prof. E. D. Ball, Logan, Utah, for the descriptions, and to Mrs. Ball for the drawings, of the Jassid nymphs.

INSECTS AFFECTING THE YOUNG PLANTS.

CUTWORMS.

Observations were made upon three of the most common species of cutworms, and although the facts ascertained are not complete in any instance, so little has been written concerning the life histories of cutworms in the South that it seems well to record the facts observed.

Reports from numerous voluntary observers in different sections of Texas indicate that injury by cutworms to garden crops commences during the first half of March and ceases from the middle of April until early May, the exact dates depending upon the latitude. Thus in 1904 Mr. G. E. Miles reported that at Friendswood, Galveston County, cutworms commenced work on corn and potato about February 20, were still at work March 30, and ceased injury about April 13. In Cherokee County injury commenced about March 1. In Anderson County the injury was most serious about March 15, subsiding about April 16, and cutworms were reported as being found in gardens during the entire winter. Little injury was reported to cotton in 1904, but correspondents state that in many previous seasons they were obliged to replant very largely, on account of cutworms. Planters state that the injury is much more serious if during the previous fall there has been an abundant rainfall, so that there is a rank growth of grass and weeds about October 1, and that in the spring the worms are found in greatest numbers at the sides and along the ends of the fields, where there has been more vegetation.

After studying the following rearing records in Texas and other available data concerning these and other species in the South, the conclusion has been reached that the three species discussed below probably have much the same life history. It is probable that the insects may pass the winter in either the adult, pupal, or larval state; but the latter is by far the most common method, and wintering larvæ of all stages of growth have been found. The moths of this brood are seen about May 1. A second generation of moths appears during the first half of July, the larvæ being found about the middle of June. During September considerable injury was observed in 1904 in fall gardens, the larvæ, doubtless, being the progeny of the July moths. The adults of this third brood probably deposit eggs during early October, the larvæ from which pass the winter. It is very evident, however, that there is great variation in the life history, in Texas even greater than elsewhere, for, with the open winters and with but little if any frost in the southern half of the State, there is, doubtless, very

little true hibernation, and the different broods must overlap one another at all seasons.

Doctor Riley states that the granulated cutworm, *Feltia annexa* Treitschke, probably has three generations in Georgia, and that it is the most common cotton cutworm in the South. From the writings of Doctor Riley and others, we believe that *Agrotis ypsilon* Rott. has one generation in the most northern States and two in the latitude of St. Louis, Mo.

THE GREASY CUTWORM.

(*Agrotis ypsilon* Rott. Fig. 1.)

Our records concerning this species are as follows:

TABLE I.—*Transformation records of the greasy cutworm, 1904.*

Place.	Larva taken.	Pupated.	Days pupa.	Moth emerged.
Terrell, Tex	May 2	May 21		
	March 28	April 26		
	June 15	June 18	15	July 3
College Station, Tex	March 15	April 28		
	March 16	March 26–29		
	March 28	April 28	20	May 18
	April 4	April 22[a]		

[a] Two specimens.

The average date of pupation of the hibernated larvæ was, therefore, about April 25, and thus the moths would emerge about the middle of May. Very evidently the moth emerging July 3 is of a second brood.

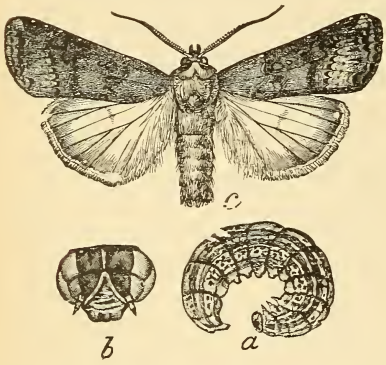

FIG. 1.—*Agrotis ypsilon:* *a*, larva; *b*, head of same, *c*, adult—natural size (after Riley & Howard).

The worms were observed feeding upon onions, cabbage, potatoes, and cotton. A moth was taken at College Station, May 11, 1903.

Several pupæ were parasitized by the tachinid fly (*Gonia capitata* DeG.), the first specimens of which emerged May 7.

Previous records.—This species first received careful consideration in this country by Riley,[a] who summarizes the knowledge of the species at the time of his writing, and describes the larvæ and eggs. He states that there is either a dual method of hibernation or it is double brooded. He records pupæ received from a cotton field at Americus, Ga., April 22, from which moths emerged April 24, 1879, and a pupa from Virginia Point, Tex., received December 3, from

[a] 1869: First Rept. St. Ent. Mo., pp. 80–81, fig. 28; and 1885: Ann. Rept. U. S. Comm. Agr. f. 1884, pp. 294–295.

which the moth emerged December 6. In Missouri full-grown larvæ were found as early as May 1, but in no case did the moths from them emerge until July. In his eighth report Lintner has discussed this species as an onion pest.[a] The first larva pupated June 16 and the moth emerged July 12, while other larvæ pupated July 2 and 6. Concerning the time of appearance of the moths he states:

> I have taken it as early as May 30, and in collections made by me "at sugar," have observed it every night through the months of June, July, and August, on over half the nights of September, and until the last week in October.

The species was reported as injurious to cotton in Mississippi in 1888.[b] Garman[c] states that the larvæ are injurious from May to June 21; that adults have been taken from June 25 to September 23, and that newly emerged moths occur from June 29 to July 12. Quaintance, in his account of the tobacco insects of Florida,[d] states that the larvæ may be found in all stages of growth throughout the winter. In Maryland Johnson observed the species as a tobacco pest in late May and June, the first moths emerging July 19.[e] In his Twenty-first Report of the Insects of Illinois,[f] reporting the species as an enemy of sugar beets, Dr. S. A. Forbes writes as follows:

> There is apparently but one brood each year, with many occasional irregularities in the stage of hibernation and periods of development. It seems usually to hibernate as a larva, pupating about June 1, and yielding the moth late in June and in July. The hibernating larvæ are seldom found after July 15. Pupæ have, however, been found in winter, and adults, probably emerging from these, early in spring.

It would seem, therefore, that not infrequently they winter as pupæ, the moths from which lay eggs in early spring, and from these develop caterpillars, which do not transform until midsummer or August. Normally, however, the insect winters as a larva, and the moths emerge early in July. In Texas, at least in the southern part of the State, where this species is most injurious, there are probably three generations. It must be remembered that the difference in latitude between St. Louis, Mo., and south-central Texas is equal to or greater than that between the former point and the northern boundary of the United States. Taking the length of seasons into account, it is only reasonable to suppose that the number of generations annually would increase in arithmetical progression as we go south.

An exhaustive study of this and other species of cutworms, both in the South and North, would clear up many uncertain points relative to their life history.

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[a] 1893: Eighth Report N. Y. State Ent. f. 1891, pp. 188–191.
[b] 1889: Insect Life, Vol. 1, p. 217.
[c] 1895: Bul. 58, Kentucky Agric. Exp. Sta., p. 97.
[d] 1898: Bul. 48, Fla. Agric. Exp. Sta., pp. 181–183.
[e] 1898: Bul. 55, Md. Agric. Exp. Sta., p. 143.
[f] 1900, p. 104, 2 figs.

THE SHAGREENED CUTWORM.

(*Feltia malefida* Guen. Fig. 2.)

The summary of our observations on the life history of this species is as follows:

TABLE II.—*Transformation records of the shagreened cutworm, 1904.*

Place.	Larva taken.	Pupated.	Days pupa.	Moth emerged.
Terrell, Tex	March 29	May 6		
	April 23	May 4	27	May 31
	June 14	June 18	15	July 3
College Station, Tex	March 30			May 19
	do	April 29	23	May 22
	do	April 10		
	April 4	April 30	20	May 20

Larvæ were taken feeding on potato, cotton, and cabbage. Moths were captured at College Station September 15, 1902, and August 23, 1903.

Previous records.—The larva was first described by Riley,[a] who states that it "appears to be confined to the South Atlantic States, from the District of Columbia to Alabama." Since then the only published record occurs in Insect Life,[b] where the larva is reported as feeding on young cotton plants in Mississippi in 1889. The records of the Bureau of Entomology show that larvæ were received from Warrentown, Ga., where they had damaged cabbage, on May 3, 1879, and from Alabama, where they were injuring cotton, on June 23 of the same year. No other records of the species have been found. It is very common in Texas and evidently is a southern species.

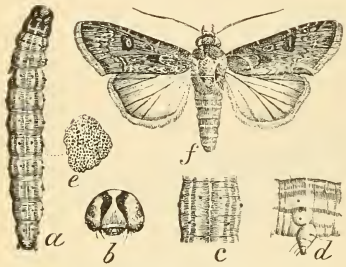

FIG. 2.—*Feltia malefida*: *a*, larva; *f*, moth—natural size (after Riley).

The caterpillars of this species are parasitized by *Glyptapanteles militaris* Walsh and *Meteorus vulgaris* Cress.

THE VARIEGATED CUTWORM.

(*Peridroma saucia* Hbn. Fig. 3.)

This species prefers garden vegetables for food, but it has been taken upon corn and doubtless occasionally attacks cotton. It has been fully discussed by Doctor Chittenden,[c] and the following brief sum-

[a] 1884: Rept. Comm. of Agric. f. 1884, pp. 292–293.

[b] 1890: Insect Life, Vol. II, p. 283.

[c] 1901: Bul. 29, n. s., Div. Ent., U. S. Dept. Agric., pp. 46–64, figs. 9–11.

mary of our observations on the life history in Texas merely supplements his account.

TABLE III.—*Transformation records of the variegated cutworm, 1904.*

Place.	Larva taken.	Pupated.	Days pupa.	Moth emerged.
Terrell, Tex.	March 31	April 5		
	April 18	April 25		
College Station, Tex.	March 16	March 24	18	April 11
	March 29, on corn.			

Judging from the above records, the life histories of the three species of cutworms discussed are evidently much the same.

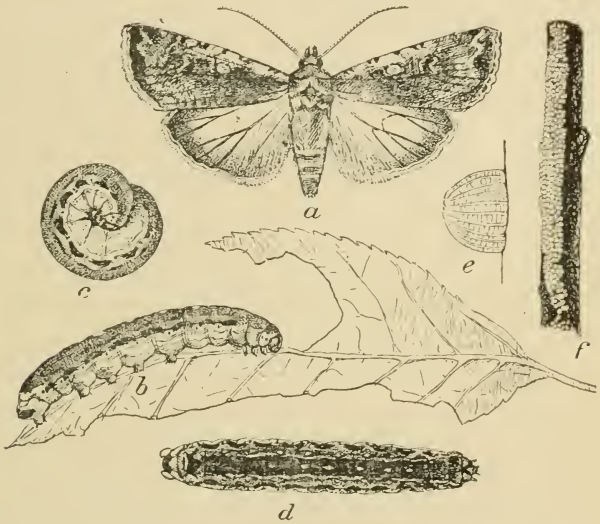

FIG. 3.—*Peridroma saucia: a*, moth; *b*, normal form of larva, lateral view; *c*, same in curved position; *d*, dark form, dorsal view; *e*, egg from side; *f*, egg mass on twig (after Howard).

THE GARDEN WEBWORM.

(*Loxostege similalis* Guen. Fig. 4.)

In Texas and the Southwest, the common name which has been given this insect seems hardly suitable, for there it is primarily a pest of corn and cotton and only incidentally a garden insect. In 1903 very serious and widespread damage in north Texas and Oklahoma, as well as in other parts of Texas, to young cotton and corn, necessitated replanting after the plants were well started. This injury occurred most generally during the first two weeks of June.

In 1904 the first moths were taken at trap light at College Station, April 10, 21, and 24. At Terrell the first was taken at light on May 24, and during the season there were more specimens of this moth

caught at light than of any other affecting cotton; not a sufficient number, however, to warrant the use of light as a remedy at any time.

April 20, 1904, we received a report from Mr. S. J. Berryman, Montalba, Anderson County, that there was "some complaint of budworm (*Heliothis obsoleta* Fab.) and webworm in corn." No specimens of the webworm were received, but as we know of no similar insect commonly attacking corn in Texas, and as this pest is commonly known as the webworm and would injure corn about the time that injury by the "budworm" would commence, there seems no good reason for doubting the identity of the insect.

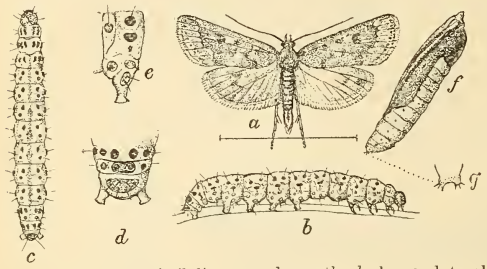

FIG. 4.—*Loxostege similalis*: *a*, male moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, anal segment; *e*, abdominal segment, lateral view; *f*, pupa; *g*, cremaster—*a*, *b*, *c*, *f*, somewhat enlarged; *d*, *e*, *g*, more enlarged (reengraved after Riley, except *c*, from Chittenden).

A nearly full-grown larva was taken at Terrell about May 17, 1904. Moths taken May 24 oviposited on the 26th. The eggs are deposited on either surface of the leaves in bunches of from 8 to 20 and hatch in three days. One female laid 48 and another 54 eggs. From these eggs three generations were reared up to September 29, as shown in the following table:

TABLE IV.—*Transformation records of the garden webworm.*

Egg laid.	Days egg.	Hatched.	Days larva.	Pupated.	Days pupa.	Moth.	Days before oviposition.	Total days.
May 26	3	May 29	17	June 14	9	June 23	3	31
June 26	3	June 29	25	July 24	7–8	August 1	6	42
August 8	4	August 11	22	September 1	8	September 9	6	38
September 15	.....	.....	.....	.....	.....	.....	.....	.....
Average	3.3	.....	21.3	.....	8	.....	5	37

In the case of the second generation, one larva which had hatched June 29 was observed to molt July 7, 19, and 24, at which latter date it pupated.

The eggs laid September 15 had not hatched on October 1 and were probably infertile. It has not been observed in what stage the winter is passed, but from the observations of Professor Gillette[a] on the nearly related species *Loxostege sticticalis* Linn. it seems probable that the larvæ hibernate in the ground in a silken tube. It is entirely possible, however, that in Texas the pupa or adult moth may pass the winter. In any event the hibernating brood first becomes mature by

[a] Bul. 98, Colo. Agric. Exp. Sta., p. 6.

the middle of April in central Texas and larvæ of the first brood are found nearly full grown by the middle of May. The moths of this brood oviposit late in May, of the second in late June or early July, of the third about August 8, and of the fourth about September 15. There would still be ample time for a fifth brood in the fall, especially in the southern part of the State. Without rearing one series through an entire season it would doubtless be impossible to determine the probable number of generations, for the moths appear almost continuously in July, as is seen by the following record, which shows the number of moths taken at trap light at Terrell on the dates given—July 3, 3; 7, 4; 8, 5; 9, 4; 10, 5; 14, 6; 26, 4.

Young cotton and corn are usually affected when about 8 inches high, so that replanting makes a very late crop. Alfalfa is also often seriously damaged, the injury occurring somewhat earlier in the spring than that to corn and cotton, and again in August or September. Undoubtedly the larvæ working on the alfalfa in the fall remain in the fields over winter. In the spring they work upon the alfalfa, and, when that is cut, they move out into the cotton and corn adjoining in such numbers that this migration has often been observed and reported to us. About the middle of July, 1903, alfalfa was thus injured in Oklahoma. On August 24, 1904, Mr. Lewis found that the alfalfa near Scurry, Kaufman County, Tex., had been somewhat injured, and learned that the insect had done similar damage about the same time in 1903. On September 1 the same injury was found at Wolfe City. The larvæ had migrated to the adjoining rows of cotton, which had been partly defoliated, and had then disappeared, evidently being in the pupal stage, as were those being reared in the laboratory at that time. September 12, 1899, Mr. W. D. Hunter sent to the Division of Entomology two moths of this species, stating that it had been exceedingly destructive to alfalfa in southeastern Nebraska during that year.

As has been previously recorded, the favorite food of the insect is the common pigweed or "careless weed" (Amaranthus), from which the insect received its local name of "careless worm." It is common throughout the arable portion of the State, as is evidenced by reports of its occurrence from near San Antonio, from Victoria, and from east Texas (Anderson County), but it seems particularly injurious in the northern part of the State. Many of the larvæ captured were parasitized by *Apanteles laphygmæ* Ashm. and *Cardiochiles explorator* Say. One specimen was parasitized by a larva which emerged and formed its cocoon July 29, the adult, which proves to be *Mesochorus electilis* Cress, emerging August 4.

The species has also been found to be parasitized by *Exorista hyponsæ* Coq. and *Phorocera parva* Bigot, specimens of which have been bred by Mr. Pergande.

Past history.—The first account of this insect was published by Doctor Riley,[a] who gives its past history, an account of its depredations, its food plants, and life history, and a partial description of the larva. Doctor Chittenden has published notes upon the species,[b] and Dr. S. A. Forbes has also given an excellent account of the insect.[c]

Remedial measures.—Dusting or spraying the affected crops with an arsenical will, of course, quickly check the depredations of the pest; but as some delay is usually involved in such an operation over a large area, considerable injury will have been done before it is completed. Preventive measures are more important. Of these the destruction of those native weeds upon which the larva feeds is of great importance, especially where land is left uncultivated. The thorough cultivation of the land in fall or winter will also probably be of great benefit, if the larva passes the winter in the soil, as seems probable. On this point, Mr. S. J. Berryman, of Montalba, a careful observer, writes:

> I think the reason that I am not bothered by them is because I have had all of my land broken in the winter and harrowed it several times. The blackbirds followed my plow all the time, and I think they got most of them. At least, I am not bothered with the insects, and I hear no complaints from those who did the same way.

In the case of alfalfa a thorough cultivation in late fall or early spring would doubtless be of value for the same reason.

THE WHITE-LINED SPHINX.

(*Deilephila lineata* Fab. Fig. 5.)

The well-known and exceedingly variable larvæ of this sphinx moth are common inhabitants of the cotton field about the time the young plants are being chopped. Usually their injury to the foliage of the young plants is noticed by the hands, who can destroy most of the caterpillars at this time. Occasionally, however, they become overabundant and swarm over all the vegetation much as does the army worm, destroying every low-growing plant in their path. Such was the case near San Antonio in 1903, when garden crops and cotton were seriously injured by immense numbers of these caterpillars.

On May 30, 1903, caterpillars in almost all stages of growth were common on cotton at College Station, and several were kept under observation. The first was ready to pupate June 1, and three entered the earth to pupate June 11. June 25 about twenty flies of *Winthemia quadripustulata* Fab. emerged from these. Three moths emerged on July 3, 4, and 14, respectively. The caterpillars were not subse-

[a] 1885: Rept. Comm. Agric. f. 1885, pp. 265–270.

[b] 1902: Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 46, 47; and 1903: Bul. 43, l. c., pp. 39–40, figs. 36 and 37.

[c] 1900: 21st Rept. State Ent. Ill., pp. 108–109, fig. 33.

quently observed that season, and only rarely in 1904, so that it seems probable that the insect was checked by the parasitic fly mentioned.

May 18, 1904, a number of larvæ were taken at Terrell, Tex. The first pupated June 3, another June 7, and a third June 14. The moths from the two last mentioned emerged June 24 and July 2, respectively. On June 14 a pair of moths were taken *in coitu*. On the 16th, 96 nearly globular green eggs were laid by the female on the leaves, from one to eight eggs being deposited in a place. These

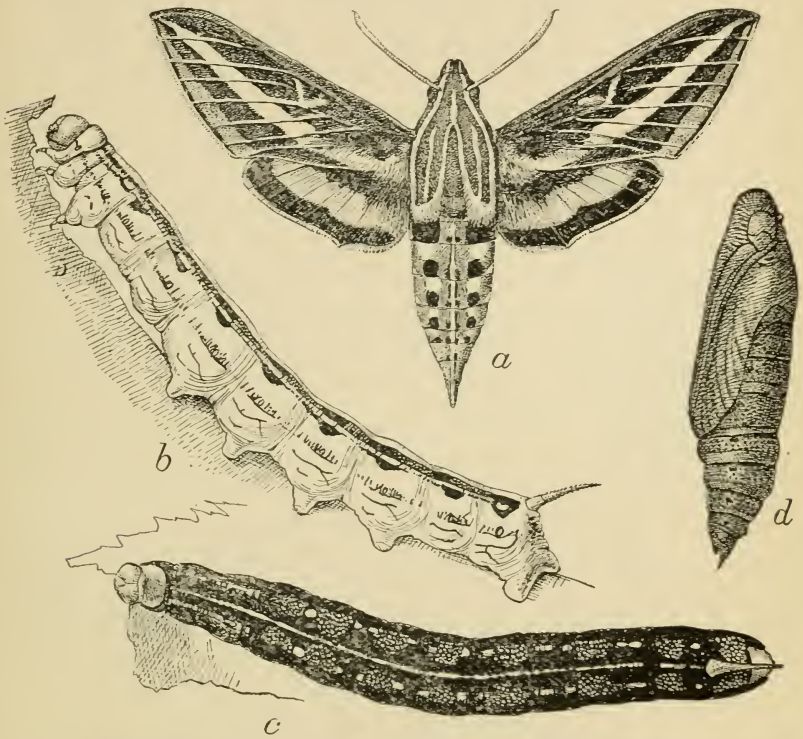

FIG. 5.—*Deilephila lineata*: *a*, moth; *b*, pale larva; *c*, dark form of larva; *d*, pupa—all natural size (from Chittenden).

hatched June 20, but, unluckily for the continuation of the experiment, the young larvæ died.

It would seem evident that there is another and possibly a third generation during the season in Texas, although no observations were made later in the year than those above reported. Riley states that there is but one generation in a year[a], but Forbes[b] records two broods, the larvæ of the first appearing in July and August, and those of the

[a] 1871: 3d Rept. State Ent. Mo., pp. 140–142, figs. 60–62; and 1884: Rept. Comm. Agr. f. 1884, p. 412.

[b] 1900: 21st Rept. State Ent. Ill., p. 155.

second from the middle of September through October. The winter is undoubtedly passed in the pupal stage, as has been observed farther north. Although so common, no thorough study of the life history of the species seems to be recorded in entomological literature.

Food plants.—A long list of food plants has been attributed to this species. Of these, purslane and chickweed are undoubtedly the favorites. Chittenden[a] states that they feed on sugar beets, tomatoes, and apple and prune trees. Dr. Herman Behr[b] states that the species is nowhere as common as on the Pacific slope, and that in California the larvæ prefer plants of the family Onagraceæ, including Epilobium, Boisduvalia, Clarkia, Eucharidium, Godetia, Œnothera, and the introduced Fuchsia. He says also that there the insect rarely suffers from parasites, and that it easily adapts itself to other food plants, such as Rumex and Portulaca, but is not common on grape. Walsh and Riley give as food plants purslane, turnip, buckwheat, watermelons, and apple,[c] and state that the species is commonly attacked by tachina flies.[d] Saunders[e] mentions the larva as occurring also on plantain. There is no previous mention of the species as a cotton pest, though planters state that they have frequently noticed the larvæ. It is commonly found on grapevines and may be considered as feeding on almost all low-growing vegetation.

Of the methods of control, the most important is that of preventing the growth of the weeds upon which the larvæ normally feed. Only where these have been abundant does the species become injurious. When serious injury is threatened, the caterpillars may be readily controlled by dusting or spraying with arsenicals. To destroy the pupæ, land grown up in weeds on which the caterpillars were known to have been feeding in the fall should be plowed and harrowed thoroughly in winter.

MAY BEETLES.

LACHNOSTERNA CRIBROSA Lec. (Fig. 6.)

Injury by this species to cotton was first reported by Mr. J. H. Burton, of Valleyview, Cooke County, about the middle of March, 1904. On March 25 the work of the beetles on Mr. Burton's plantation was observed by the writer. The beetles, which are about an inch long and shining black in color, remain in the soil during the day, emerging about an hour before sundown, or on a cloudy day at about 4 p. m. They feed for an hour or two and then reenter the soil.

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[a] 1903: Bul. 43, n. s., Div. Ent., U. S. Dept. Agric., p. 41.
[b] 1882: Papilio, Vol. II, p. 2.
[c] 1869: Am. Entomologist, Vol. I, p. 206.
[d] 1870: l. c., Vol. II, p. 257.
[e] 1877: Can. Ent., Vol. IX, p. 66.

If near the old hole, a beetle will use it again; otherwise a new one is quickly made, and in a few minutes the beetle will have disappeared. The beetles were usually found about 3 inches deep in the soil, but Mr. Burton stated that he had found them in burrows running horizontally to a vertical burrow some 4 or 5 inches deep. A hundred of the beetles were picked up around the edge of a cotton field in a few minutes. Some of them emerged from ground which had been covered with water, but seemed none the worse for it. They are exceedingly awkward, and when disturbed feign death, remaining in any conceivable position for several minutes. For the past two years they had destroyed peanuts and had injured strawberries, grape cuttings, and cowpeas in this locality. Young cotton was attacked in preference to anything but ragweed, which is the favorite food plant. When observed they were feeding on the ragweed along the fences around cotton. This is the usual place for them to appear. Subsequently they spread into the cotton, doing injury along the edges. One beetle is said to destroy a cotton plant 6 or 8 inches high during its evening meal. A number of beetles were observed to emerge in young corn. They did not feed, however, and many of those found were dead. They were not found in meadow land. During the previous year cotton had been planted on land where grain had been grown the year before. After the grain was cut the land had been left for the remainder of the season to grow up to weeds, and it was not plowed until late the next spring, just before planting cotton. In this field the extent of injury to cotton was unprecedented. The cotton planted in 1904 was on land which had been well plowed and kept free from weeds during the previous fall and winter, and in this case the injury was not serious. The beetles do not seem to be injurious on land following corn. It seems probable that the females oviposit in cotton land and that if this is well cultivated and winter plowed the larvæ are killed. Larvæ feeding on the roots of weeds along the fences where plowing is impossible will, of course, survive this treatment, but the number of adults emerging in the spring will be comparatively very small.

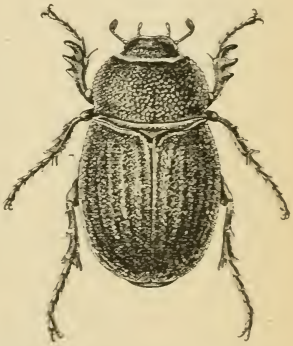

FIG. 6.—*Lachnosterna cribrosa:* female—enlarged (author's illustration).

On July 14, 1904, injury by this insect was observed along one end of a small piece of cotton at Wichita Falls, the land having been in wheat during the previous season. At this time the beetles had practically all disappeared, although they were present in great numbers a few days previously.

The species was also reported from Fife, McCulloch County, where damage to garden crops commenced about March 15; from Wawaka, Ochiltree County, where they were injurious in gardens May 10, and from Canyon, Randall County, in the central part of the Panhandle, where some damage was done to cotton about July 20. In the last case the beetles had almost disappeared on August 25.

Beetles confined under a cage over cotton in the field laid a few eggs July 1, but unfortunately the eggs were destroyed by ants and no larvæ were secured.

It was found that when Paris green was dusted upon the foliage the beetles readily succumbed to the treatment, so that there should be no difficulty in controlling them by dusting the weeds around the edges of fields.

FIG. 7.—*Lachnosterna lanceolata:* female—somewhat enlarged (author's illustration).

This species was originally described from the Rio Grande Valley, and no other type locality was given. The only previously published record of injury is that in Insect Life, Volume VII, page 360, where the insect is reported to have destroyed several crops of wheat in Baylor County, Tex., the beetles having increased in numbers for several years previous to 1895. It is evidently most abundant in northwest Texas, and has not been observed east of Cooke County.

LACHNOSTERNA LANCEOLATA Say. (Fig. 7.)

This species, somewhat smaller than the preceding, is of a brown color and is well clothed with gray hairs. Specimens were received July 5, 1903, from D'Hanis, Tex., where, occurring in large numbers, they had done considerable damage to cotton. Beetles were found common, though not abundant, on cotton and sunflower leaves at Terrell. From specimens confined June 4 eggs were secured June 18. The white, globular eggs, about 2 mm. in diameter, were laid singly about 2 inches beneath the surface. They hatched June 25, and the larvæ fed on cotton and grass roots during the summer and fall.

July 15, 1902, the Division of Entomology received specimens from S. E. Russell, Duncan, Ind. T., stating that they were damaging young cotton. The species has also been reported from China Spring, McLennan County, Tex.,[a] where it was injuring collards. It had been noticed commonly since 1890, and its favorite food plants were stated to be several species of Amaranthus common around corn fields.

[a] 1900: Bul. 22, n. s., Div. Ent., U. S. Dept. Agric., p. 107.

LACHNOSTERNA FARCTA Lec.

This species has been reported as injuring cotton in southwest Texas by planters in Uvalde County, where it is occasionally quite abundant on young plants. According to previous accounts,[a] the feeding habits of the beetles seem to be much the same as those of *Lachnosterna cribrosa* Lec. November 3, 1895, Mr. E. A. Schwarz sent from Beeville, Tex., a larva of this species taken in a cotton field. Another larva, received from him from San Diego on December 14, was placed upon grass roots and was still active the following April. It was then given fresh sod and remained alive until September. In the Report of the Commissioner of Agriculture for 1879 Professor Comstock mentions an outbreak of this species on beans in Bexar County, Tex. The feeding habits of the beetles as described by him are similar to those of *L. cribrosa*.

It should be noted that the larvæ of none of these species of "May beetles" have been observed in injurious numbers and that very little is known of their habits.

THE DIFFERENTIAL LOCUST.

(*Melanoplus differentialis* Thos. Figs. 8, 9, 10, and 11.)

More or less injury is done by this locust every year in some locality in Texas. In the spring of 1904 an exceptional outbreak occurred in

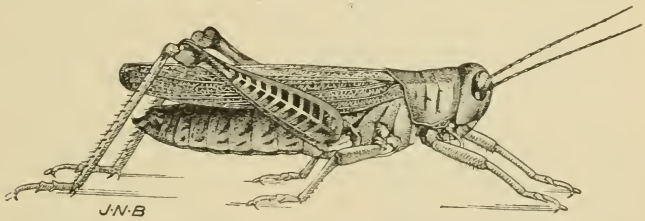

FIG. 8.—*Melanoplus differentialis:* adult—enlarged (author's illustration).

the south-central part of the State, along the Brazos River and its tributaries, being especially injurious in Grimes, Waller, Washington, Lee, Brazos, and Burleson counties.

Owing to the very careful studies of the habits of this species made by Prof. H. A. Morgan in Mississippi in 1899 and 1900,[b] it did not seem necessary to devote much attention to that subject. Therefore, although a few observations on the life history are noted below, we were chiefly concerned in finding the most feasible means of combating the young hoppers over large areas.

The eggs commenced hatching about the middle of March, 1904, and young nymphs continued to appear for about three weeks, the majority

[a] L. c., p. 107; and 1880: Rept. Comm. Agric. f. 1879, p. 247.

[b] 1901: Bul. 30, n. s., Div. Ent., U. S. Dept. Agric., pp. 7–27, 12 figs.

before April 1, the season being an exceptionally early one. The eggs had been laid in the hard ground on the edges of fields and in fields uncultivated during the present season. Young of the first instar taken to the laboratory on April 23 molted April 25, May 10, May 23, and May 30 and became adult on June 8. The habit of ascending a stalk of corn or weed during the last molts is illustrated in figure 9. It was found exceedingly difficult to distinguish the different instars by any markings or by the general size of individuals, for in both these respects different individuals vary very greatly. It was found by measuring reared specimens, however, that the length of the hind tibiæ was fairly constant for a given instar, and this proved true of a series subsequently measured. The length of the metatibia is as follows: First instar, 3–4 mm.; second instar, 5–6 mm.; third instar, 8–9 mm.; fourth instar, 11–12 mm.; fifth instar, 15–16 mm. These are the measurements of the cast skins, the measurements in the case of live or mounted specimens being slightly less in each instar. The time of molting varied for different individuals and was governed by the amount of food available, so that no fixed dates can be given. In 1903, in a local outbreak, the first three stages, mostly the second and third, were found to occur on June 1. The development during these two seasons probably illustrates the extreme dates of early and late development for this latitude.

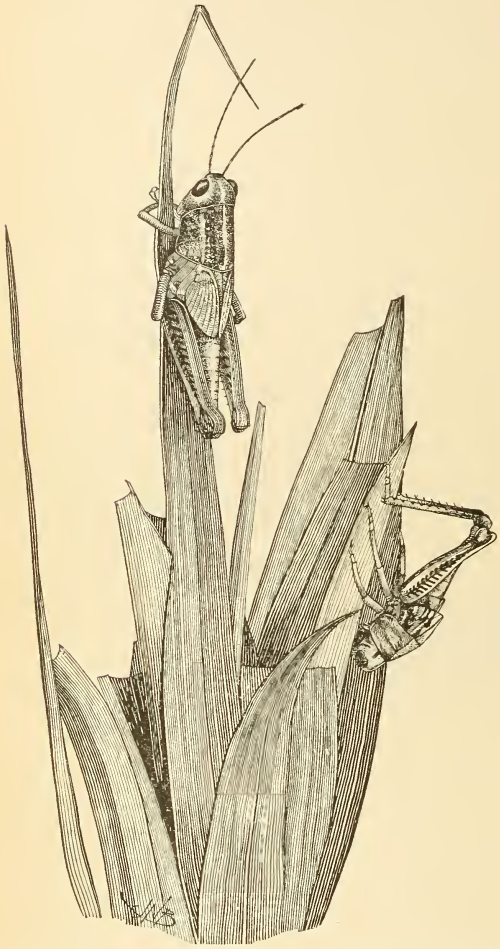

FIG. 9.—*Melanoplus differentialis* on corn leaves: adult in natural position, upper figure; pupa skin below on right—natural size (author's illustration).

Attention was first called to the 1904 outbreak by Mr. W. H. Brown, of Navasota, whose plantation lying along the Brazos River was visited by the writer April 1. At this time the young hoppers had been at work for about ten days, and were still hatching. They occurred in countless numbers around the edges of cultivated fields and on uncultivated ground among the weeds, from which they were migrating to the young crops as the food supply became scarce. In

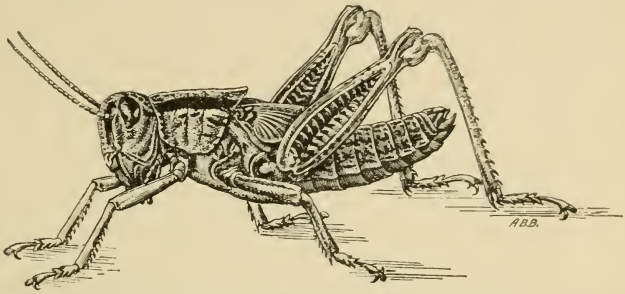

FIG. 10.—*Melanoplus differentialis:* young nymph—enlarged (author's illustration).

such situations old logs were so covered with the young as to be completely blackened by them. The "stand" of young corn and cotton had already been destroyed over several acres. In one field, where they first appeared, Mr. Brown had used dry Paris green and had largely checked the injury. It was found that by plowing fields where the stand had been badly injured or was poor, large numbers of the young hoppers were destroyed by burying, and the remainder migrated to the weeds at the edges of the fields. While still young they can not be readily driven as is possible when they are half or more nearly grown. All of the vegetation around the edges of the fields was therefore poisoned with Paris green or green arsenoid. In some cases the poison was mixed with flour, which made it more adhesive. Over the fields, both those which had been plowed and those wherein the hoppers were feeding, poisoned bran mash was distributed, 1 pound of Paris green being mixed with 25 pounds of bran. This treatment proved exceedingly effective. Five days later, when again visited, the great majority of the hoppers were found dead among the weeds which had been thoroughly poisoned. The effect of bran mash is not so apparent, as the hoppers after eating it crawl beneath small clods of earth and there die, but by examining the ground around a small pile of the mash from 12 to 20 dead hoppers were found, and many more had doubtless died farther away. To moisten the mash, water is found as effective as molasses. Around the edges of the fields, and in patches of weeds on uncultivated land, a spray of pure kerosene or of strong

FIG. 11.—Egg mass of *Melanoplus differentialis*—enlarged (author's illustration).

kerosene emulsion was used with marked success. The planters preferred using the pure oil, its effect being more quickly apparent. Paris green was used both as a dust and as a spray. The dust seemed to be much the better form of application and more effective, although more material is required. Several types of portable powder guns were used by various planters under our direction, and were found to apply the poison much more effectively and economically than is done by the use of a sack. Where these methods were thoroughly practiced, the young hoppers were much reduced in numbers by the third week in April and their injury checked. An unfortunate feature of these methods of treatment lay in the fact that, after a field had been almost entirely rid of the pest, migration would take place from adjoining uncultivated land, possibly owned by a nonresident, or on a part of a neighboring plantation where no harm could be done the crops of the owner and where, therefore, nothing had been done toward checking it. This necessitated continued work by certain individuals, much later than would have been necessary had the whole community pursued the same methods; and in several instances caused vexatious losses after it was thought that a field had been entirely freed from the hoppers.

Natural enemies.—Just after the young had hatched large numbers of a small conopid fly, *Stylogaster biannulata* Say, were observed darting about and hovering over the young hoppers. It was impossible to observe their oviposition or to rear them from the hoppers subsequently, but, owing to the previously observed habits of this species, there is little doubt that it was parasitic upon the young.

During the last week of April large flocks of blackbirds and reedbirds or bobolinks appeared in the fields for a few days, and undoubtedly did more than any other natural agency to check the pest. They consumed immense numbers of the hoppers, so that, with the methods previously employed, but little damage was done later in the season.

Trapping in holes.—June 1, 1903, a small outbreak occurred a few miles from College station. At that time the locusts were slightly less than half grown. The eggs had been deposited in a small strip of grass and weeds along a ditch running through the center of the field, and from there the young hoppers had migrated for some little distance on all sides and had destroyed considerable cotton, then about six inches high. In this case it was essential to prevent further injury as soon as possible, and although poisoning would undoubtedly have killed them in a few days much damage would have been done before they succumbed. A number of post holes were therefore dug in a double row, the holes alternating, near the center of the affected area, and several men and boys drove the hoppers toward them. Very large numbers were thus caught in the holes and were then easily

destroyed. It was demonstrated that for such conditions this is one of the most satisfactory methods for quickly checking the injury over a small area.

Cause of 1904 outbreak.—In the summer of 1902 the Brazos River overflowed in a most unusual manner, and again in February, 1903, a smaller overflow occurred. This resulted in large areas throughout the lower Brazos valley remaining uncultivated in 1903. This hard-packed soil gave ideal conditions for oviposition, and the weeds which came in furnished the favorite food of the hoppers, thus making their rapid multiplication certain. That an unusual outbreak should occur in the spring of 1904 was therefore to be expected. Throughout the bottom lands of central Texas this species is always common, and does more or less damage along the edges of the corn and cotton fields; but ordinarily the planters disregard the injury and allow the pest to multiply. Then, when such conditions as those above outlined occur, the pest increases very rapidly and serious injury is widespread. Were the weeds around the edges of the fields dusted with an arsenical whenever grasshoppers are observed to be common, and were uncultivated areas plowed during the winter when possible, the numbers would be so reduced that such outbreaks would not frequently occur. These conditions were exactly similar to those mentioned by Professor Morgan[a] concerning the outbreak of this species along the Mississippi, after a crevasse had been formed in the levee and a consequent overflowing of the adjacent land had resulted.

Use of fungous diseases.—Cultures of the fungous diseases with which experiments have been made in recent years as a means of combating locusts were secured from several sources. The tubes received from Prof. Lawrence Bruner, of Nebraska, mentioned below, were stated to contain what was probably a species of Mucor. Those received from Prof. C. P. Gillette, of Colorado, had been sent him by Doctor Edington, of the Bacteriological Institute, Grahamstown, Cape of Good Hope. Those from the Bureau of Entomology were marked "Culture C," and were also of South African origin, although prepared by the Department of Agriculture. These cultures were handled according to the directions sent with them,[b] and locusts dipped in the prepared solution were freed where they were most abundant in the field. Corn meal moistened with the solution was also scattered in these localities. These distributions were made on April 19, at four points, several miles apart. Examinations on April 29 and May 9 failed to reveal any grasshoppers dead from disease, nor did the planters see any later in the season. After May 1 the locusts had been so depleted

[a] 1901: Bul. 30, n. s., Div. Ent., U. S. Dept. Agric., p. 31.

[b] See Howard, Yearbook U. S. Dept. Agric. f. 1901, p. 464; and Bruner, Bul. 38, Div. Ent., U. S. Dept. Agric., p. 50.

in numbers by the remedial measures taken and by birds that they were not excessively abundant; but had the cultures been effective some diseased individuals would surely have been found three weeks after the first distribution, when the insects were still plentiful. Furthermore, at College Station, on April 4, a dozen locusts were dipped in the culture received from Professor Bruner and introduced into a field cage where several dozen live hoppers were given favorable conditions. These were supplied with food and the cage kept in good condition until June 4, during which time much rain fell, but no diseased specimens were observed.

Early in June cultures of the South African fungus were received direct, through the courtesy of Dr. Alexander Edington. Upon learning of an outbreak of *M. differentialis* in north Texas, and upon the request of planters there, several of these tubes were sent them and were prepared and disseminated by them as directed. They were, however, unable to notice any diseased locusts as a result.

These accounts of failures to secure any benefit from grasshopper cultures can not be regarded as at all conclusive concerning their lack of efficacy, but they at least add to the weighty evidence already reported against the value of such cultures for the control of grasshoppers.

THE CLUMSY LOCUST.

(*Brachystola magna* Gir. Fig. 12.)

Throughout the counties of west-central Texas, as far east as Bexar and Comal, this species replaces the common southern lubber grasshopper (*Dictyophorus reticulatus* Thunb.), shown in figure 13. Unlike

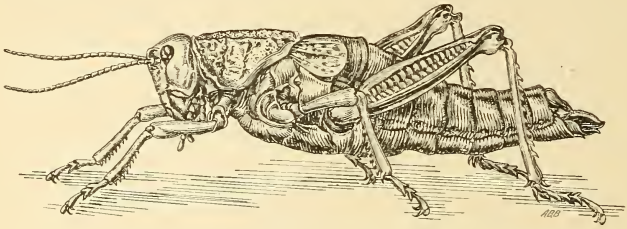

FIG. 12.—*Brachystola magna*, adult—natural size (author's illustration).

the latter species, however, the "clumsy locust" occurs in large numbers and often does serious damage. In 1904 it was much less injurious than usual, and no observations upon it in the field were possible. Our information concerning its habits is, therefore, derived mostly from correspondence with Mr. L. B. Smith, of Rescue, Lampasas County, a prominent bee keeper and careful observer, whose accounts have been largely confirmed by others in neighboring counties. May 22, 1903, Mr. Smith wrote as follows:

We are being bothered again by the wingless locusts. They are destroying the cotton crops by the wholesale, and, unlike most other insects, these come early and

remain until frost comes in fall, and do not seem to have any natural enemy or disease. This insect has destroyed cotton in isolated districts of this section for several years past, but has appeared earlier and in greater numbers this year than ever. They are usually worse in June and July than at any other time. Some of us saved the larger part of our crops last year by unceasing fight against them with sticks, but we had to keep that up for about six or eight weeks, and it is very tedious work. They ate thousands of dollars' worth of cotton last year. We think the principal cause of their increase is the destruction of the wild birds and the hog law. In neighborhoods near here where there is no hog law and hogs run at large the grasshoppers do not get numerous. We have seen hogs eating them.

Mr. Smith requested that if possible some more efficient remedy be suggested, and in our reply the use of poisoned bran mash and the

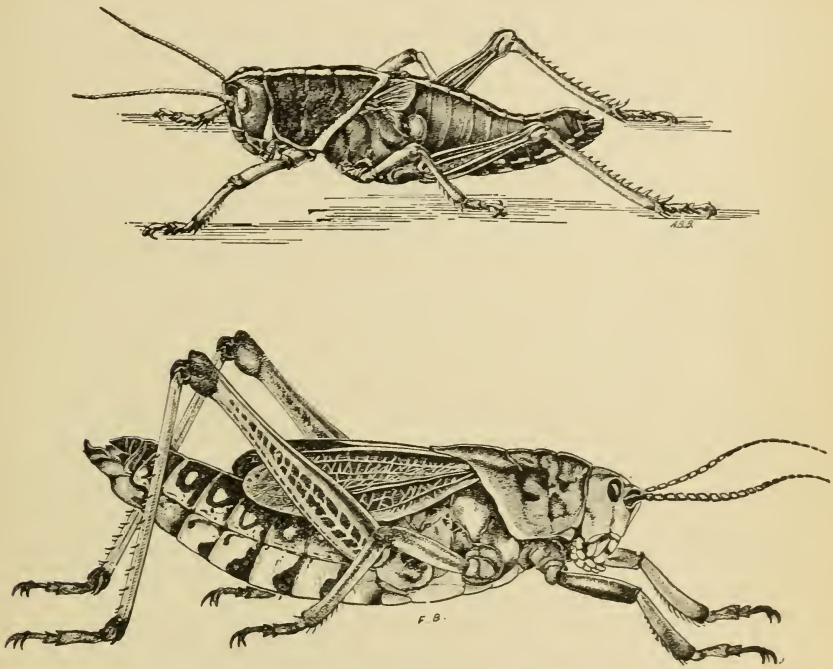

FIG. 13.—*Dictyophorus reticulatus:* nymph above, adult below—somewhat enlarged (original).

thorough poisoning of all weeds and grass was advised. In reply to questions concerning the habits of the locusts, Mr. Smith wrote on June 9, 1903:

I shall answer your questions in regard to the cotton-eating grasshoppers as best I can. First, "When do they appear first in the spring?" They usually appear in the latter part of May and first of June, but usually not in sufficient numbers to seriously affect cotton until about June 15. This year they were numerous by May 1 and have now become very destructive to cotton. Second, "How late do they work in the fall?" They remain until freezing weather comes on, though they do not seem so vigorous in August and September and do not eat cotton so much then. Third, "At what time do they become full grown in summer?" Usually in July

they begin mating and depositing eggs, though many of them are grown [now], as the large pair I am mailing to-day. Fourth, "In what places are they most numerous and destructive?" In cotton fields. They have never seriously injured any other crop than cotton, though they are found in pasture far from any farm. They are destructive in Coleman, Runnells, Burnet, and Llano counties and as far west as Concho County, and I know not how much farther west.

These grasshoppers are numerous in nearly all districts in these western counties in which the hog law has been enforced for the past few years. We can not use the poisoned bran mash here on account of the great honey dearth, as it would poison my neighbors' bees as well as my own.

However, the mash was tried, as Mr. Smith's next letter, dated July 6, indicates.

The hoppers are still giving me trouble, but we have them somewhat checked now by using the poison on them as suggested by you. I am using the wheat bran sweetened with a cheap grade of molasses and arsenic mixed with it, and I believe it would have been a perfect success if I had commenced in time. I saw the first pair mating June 10. They get their full growth by the last of May. As to when and where they deposit their eggs, I have never been able to ascertain.

Mr. Smith sent numerous specimens, which were kept in cages in the laboratory for some time, but all failed to oviposit.

Undoubtedly the poisoned bran mash will prove perfectly effective for the control of these insects if employed plentifully early in the season. It is possible that the eggs are laid in grass land, and that they or the young hoppers may be eaten to a considerable extent by hogs where the latter are not restricted. Probably with larger areas of land under cultivation in these western counties the species will become less abundant, for, although it occurs as far north as Kansas and western Missouri, it is reported by Doctor Riley to be not very injurious there.

The species has been well named the clumsy locust, for it is exceedingly awkward. The wings are shorter than those of the other lubber grasshoppers, and, unlike those of Dictyophorus, are not raised from the back when disturbed. The coloration is somewhat variable, being mostly a tawny brown, with markings of greenish or yellowish, the latter often being quite pinkish.

THE BUR CLOVER APHIS.

(*Aphis medicaginis* Koch.)

Associated with the common cotton or melon aphis, *Aphis gossypii* Glover (fig. 14), there was found another species concerning which no previous economic mention has come to our notice, although the *Aphis* sp. mentioned by Mally[a] may be the same thing.

The two species occur together on the young cotton plants just as the first leaves are forming. *A. medicaginis* may be found abundantly at this time, and for a week or two earlier, on the common bur

[a] 1891: Bul. 24, o. s., Div. Ent., U. S. Dept. Agric., p. 30.

clover and a species of Oxalis. Mr. Sanborn has also noted it as occurring on clover (*Trifolium bajariensis*), cowpea, alfalfa, and coffee bean (*Cassia occidentalis*). Late in April it often becomes so abundant on bur clover as to cause the plant to wither, large swarms of flies buzzing around the infested plants attracting attention to them. Like the cotton aphis, the species is often so severely parasitized by *Lysiphlebus testaceipes* Cress. that it is killed out in a very few days.

The young stages and the apterous females are not at first easy to distinguish from *A. gossypii*, but the apterous females are darker and have a shining reddish or brownish-black appearance, while those of *gossypii* are deep greenish in color and have the cauda very much

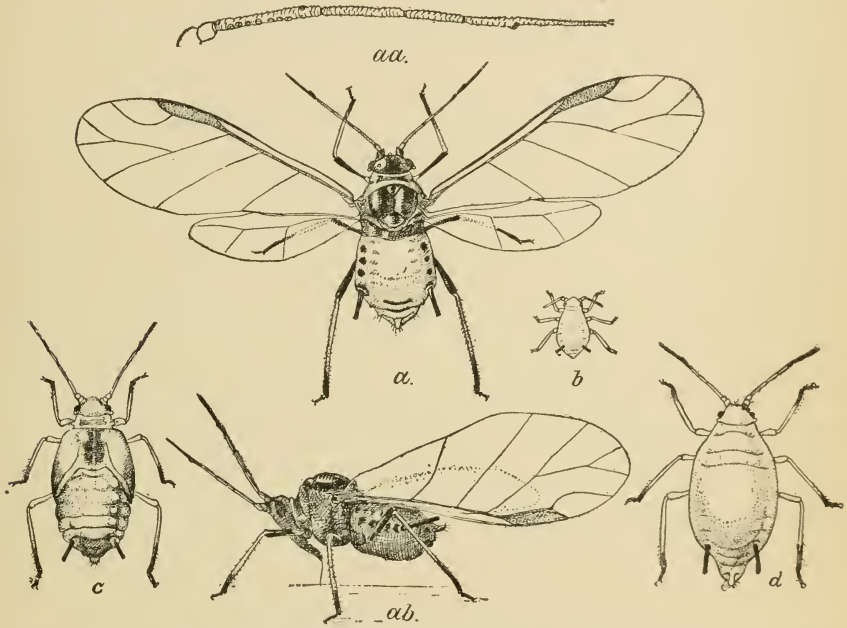

FIG. 14.—*Aphis gossypii: a*, winged female; *aa*, enlarged antenna of same; *ab*, dark female, side view; *b*, young nymph or larva; *c*, last stage of nymph; *d*, wingless female—all greatly enlarged (after Chittenden).

longer. The winged forms are readily distinguished by the dark markings on the abdominal segments of *medicaginis* which are lacking on *gossypii*. These markings, however, are only noticeable when the specimens are mounted in balsam.

Specimens were determined as probably *medicaginis* Koch by Mr. Th. Pergande, who, however, seemed to share our own doubt as to their identity with that species. After a careful examination of Koch's description and figures, though there are some noticeable discrepancies, it nevertheless seems probable that our species is that described by him, especially as some of its host plants have come from Europe. Koch states that the species is hardly distinguishable from

"*Aphis cichorii*" (*Aphis intybi* Koch), and his descriptions hardly distinguish the two species, the main differences being the smaller size of *medicaginis* and the coloration of the antennæ and legs. In coloration of the legs the apterous females of our specimens resemble *medicaginis*, but the coloration of the antennæ is like that of *cichorii*. The size is difficult to determine from Koch's figure. It appears probable that *Aphis medicaginis* Koch is synonymous with *A. cichorii* Koch (*A. intybi*), but as it is practically impossible to determine this without the types, and as the name *medicaginis* has heretofore been used in American literature, it seems best to retain it.

For those who are unable to refer to Koch's description it is here given:

Head, neck, and body black, legs yellowish white, the points of the femora, tibiæ, and tarsi, black. Honey tubes somewhat long and black. The middle joints of the antennæ yellowish. This form is very closely related to and hardly distinguishable from *A. cichorii*. It is smaller, and is the smallest of the species which have yet come to my notice. The winged insect has the same colorings as *A. cichorii*, except that the two middle segments, namely the fourth and fifth [*evidently of the antennæ*—E. D. S.], are yellowish, and the stigma of the front wing is smoky brown, darker on the margin, approaching yellow toward the base.

The wingless mother is hardly larger than the winged, though a little broader, not as broad, however, as the same form of *A. cichorii*. She is dark brown above and below, on the back somewhat blackened. Honey tubes and style black. Antennæ and legs yellowish white. The two end joints and the three shorter basal joints of the antennæ, as well as the points of the femora of the third pair of legs, and the points of the tibiæ and tarsi of all the legs, black. The points of the femora of the second pair grade into brown at the tips. The coxæ grade into smoky brown. The whole insect has very little glossy appearance. Only the back part of the abdomen shows itself somewhat flattened, and with a short brilliant gloss.

The host plant is *Medicago fulcata;* the aphis appears on this in very large numbers, congregating in millions. They colonize on the twigs, and more seldom down on the leaves. The winged forms readily make their escape when they notice danger.—(Translation of C. E. Sanborn.)

The species was first noticed in this country at St. Louis, Mo., in July by Monell,[a] who gives its food plants as *Caragana arborescens*, *Robinia viscosa*, and *Melilotus italica*. Monell notes the shining black dorsum, which agrees better with our description than that made by Koch, who states that it is glossy only for a short distance on the abdomen. This character is noted also by Thomas.[b] The species is also mentioned by Œstlund in his Aphididæ of Minnesota (p. 69), and by Osborn in his Catalogue of the Hemiptera of Iowa.[c] In a paper on the Hemiptera of Colorado[d] Cohen notes it on *Astragalus bisulcatus*, principally in the racemes of the flowers, and on *Glycyrrhiza lepidota*.

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[a] 1879: Bul. U. S. Geol. Survey, Vol. V, No. 1, p. 24.
[b] 1895: 8th Rep. State Ent. Ill., pp. 100–192.
[c] 1892: Proc. Iowa Acad. Sci., Vol. 1, p. 129.
[d] 1895: Bul. 31, Colo. Agric. Exp. Sta., p. 120.

DESCRIPTION.

Winged viviparous female.—Length, 1.99 mm.; width, 0.58 mm.; antennæ, 1.33 mm.; segment III, 0.33 mm.; IV, 0.27 mm.; V, 0.22 mm.; VI, 0.10 mm.; VII, 0.27 mm.; wing expanse, 6.64 mm.; cauda, 0.11 mm.; cornicles, 0.34 mm.; metatibiæ, 0.91 mm.

Head, thorax, antennæ, cornicles, and cauda black; abdomen slightly lighter or more grayish-black; legs yellowish, except distal half of femora and distal fifth of tibia and tarsus, which are dark; stigma and insertion of wings yellowish; three lateral blackish spots on margin of abdominal segments in front of cornicles, and fainter dark-brown markings forming broken bands on abdominal segments. Cornicles straight, tapering. Antennæ with a row of about five sensoria on segment III.

Apterous viviparous female.—Length, 1.66 mm.; antennæ, 1.19 mm.; segment III, 0.25 mm.; IV, 0.15 mm.; V, 0.17 mm.; VI, 0.11 mm.; VII, 0.22 mm.; cauda, 0.13 mm.; cornicles, 0.33 mm.; metatibiæ, 0.86 mm.

Reddish or brownish black when seen under lens, but otherwise apparently shining black; cornicles and cauda black; sutures of caudal segments whitish, pulverulent; antennæ yellowish, except black distal segments; legs yellowish, except tarsi, tips of tibiæ, and tips of metafemora; cornicles slightly constricted at base, extending to or beyond tip of cauda.

First and second instars.—Light yellowish brown, a light stripe bounded on either side by a darker brownish stripe along the dorsomeson; cornicles black and connected by a dark rusty band; head darker, rather greenish; legs and antennæ similar to adult.

Third instar (which will form pupa).—Deep pinkish, dorsal lines on abdomen as in previous instar; shoulders whitish, otherwise same as before.

Pupa.—Deep pinkish.

Fourth instar, apterous.—Deep reddish or maroon covered with whitish pulverulence; head rather greenish; at first the body is greenish or brownish, but gradually becomes uniform dark reddish as seen under lens, and finally blackish.

In either this last or the adult stage the insects commence to turn blackish on the caudal portion, the change in color gradually extending forward. At the same time the pruinosity is lost, and finally the adults become shining blackish. The color of the immature stages is exceedingly variable.

THE FALSE CHINCH BUG.

(*Nysius angustatus* Uhl. Fig. 15.)

During the spring of 1904 the false chinch bug occurred in unusual numbers over widely separated localities in Texas and Louisiana, damaging all sorts of crops, many of them not heretofore known to be injured by it, and among them cotton.

Attention was first called to its occurrence by the citizens of Sabinal, Uvalde County, Tex., late in April; and on May 2 Mr. Sanborn visited the locality. The insect had been known there for several years, but until that spring had never done serious damage. The young bugs occurred at that time in countless numbers, having caused the mesquite trees to turn yellow, and destroyed the young cotton so as to necessitate replanting over large areas, more or less injury occurring over the

territory within a radius of 10 miles from Sabinal. The migration of the bugs was much like that of the true chinch bug (*Blissus leucopterus* Say); they would remain in one place until the vegetation there was destroyed and then move on. At this time hardly any adult bugs were seen. Late in May the writer visited the same fields, and hardly a specimen could be secured, although a few adults were found in corn. In this case the damage was done entirely by the nymphs; and the swarms disappeared after their devastation of the cotton as suddenly as they had appeared. Of the nymphs taken to the laboratory all died before maturing, so that their identity can not be definitely established; but there seems to be no doubt, from a comparison with determined specimens, that they are *Nysius angustatus*.

Early in May the same species appeared in immense numbers in wheat fields in one or two localities in north Texas, greatly to the alarm of the owners, but no material injury was done. Later in the month specimens were received from several points in central Texas, where, occurring in immense numbers, they were doing serious damage to various garden crops. In Brazos County they appeared sporadically in April, May, and early June, seriously injuring gardens. They were also observed in the field working on prickly lettuce and other weeds. In most cases they appear suddenly, practically destroy the vegetation within a certain area, then move on, and nothing more is seen of them in that locality. In habits they are much like the true chinch bugs, many of them remaining in the soil at the base of the plant and quickly running into it when disturbed, so that it is exceedingly difficult to combat them successfully. This was observed at Sabinal, where the nymphs attacked the young cotton before it was fairly out of the ground.

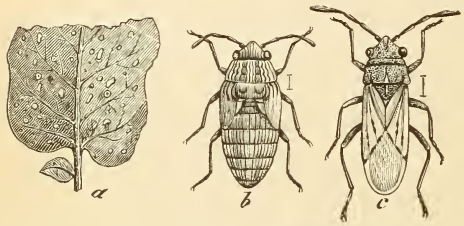

FIG. 15.—*Nysius angustatus*: *b*, last stage of nymph; *c*, adult—much enlarged (after Riley).

Late in May Prof. H. A. Morgan, State entomologist of Louisiana, forwarded specimens of this species collected by Mr. E. W. Dayton, who reported them as seriously injuring cotton at Jonesville, La. On June 15 Mr. Dayton wrote further:

> Just after receiving your first letter we had a hard rain, and that with the hot sun caused most of the insects to disappear, but there are spots of about one-fourth an acre scattered over the fields yet, and they are doing some damage. They damaged about 75 acres, reducing the stand to about one-half on this. I noticed a spot of about one-fourth an acre yesterday covered with them, and they seemed to be doing the usual damage.

It would seem, therefore, that this pest feeds on nearly all low-growing vegetation. Its favorite food seems to be plants of the

family Cruciferæ, such as shepherd's purse and pepper grass, under which the nymphs are frequently found in large numbers.

All efforts to rear the insect or to determine its life history proved futile, as appears to have been the case in the past, for no definite observations seem to have been made concerning its life history. Professor Forbes[a] states that Professor Osborn has taken the eggs in Amaranthus blossoms, but this would not necessarily indicate that to be the usual place of oviposition. Undoubtedly the winter is passed in the adult stage, and there is probably more than one brood in a season. The species is a difficult one for the entomologist to study, either from the economic or from the systematic standpoint. After the examination of a large series taken in various localities in Texas and on various plants, Mr. Heidemann considers all the specimens to be of this species, but he states that the genus is so poorly known that it is impossible to satisfactorily separate the species at present.

The nymphs may be readily combated by spraying with kerosene emulsion, but the adults are difficult to handle. On garden crops we have found that by beating along the infested plants with a small screen covered with a sticky substance, such as is used for "fly paper," large numbers may be caught. Tobacco water applied copiously on the soil around the plants is also of value in the garden. A better knowledge of the life history would undoubtedly aid in devising means for controlling the insect on field crops, which fortunately, however, are not often attacked.

THE COWPEA-POD WEEVIL.

(*Chalcodermus æneus* Boh. Figs. 16 and 17.)

This weevil was frequently sent to us, being mistaken for the boll weevil. In several instances, however, it was stated that it was doing noticeable damage to young cotton, as has already been reported by Doctor Chittenden.[b] Subsequent to his report, in May, 1904, serious injury was done by the species in Georgia. As it was impossible to investigate the cases in Texas, the following account of the injury in Georgia and the habits of the weevils has been kindly furnished by Prof. Wilmon Newell, recently State entomologist of Georgia:

FIG. 16.—*Chalcodermus æneus:* lateral view, much enlarged (from Chittenden).

Injury by this species was personally investigated at Herod, near Dawson, Ga., May 27, 1904. Beetles were found upon about 15 acres of cotton, from 4 to 10 beetles on each plant. The plants were about 4 inches high. The beetles feed for the most

[a] 1900: 21st Rept. State Ent. Ill., p. 95.

[b] 1904: Bul. 44, Div. Ent., U. S. Dept. Agric., p. 39.

part in the afternoon or early morning, and upon cloudy days, although a few may be found on the plants at noon on bright days. The beetle punctures the tender

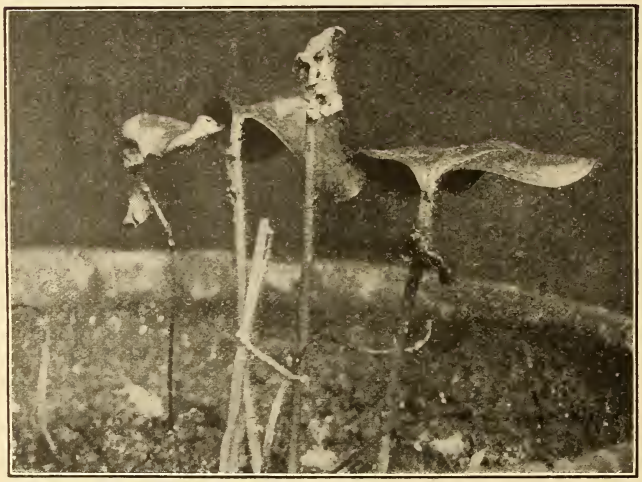

FIG. 17.—Work of *Chalcodermus æneus:* above, on young cowpeas; below, on young cotton. (Photograph by Wilmon Newell.)

stem, often just below a leaf, and this puncture reaches to the very center of the stem or occasionally to the epidermis of the opposite side. Punctures occur upon

leaf stems and the upper tender part of the main stem, often just below a leaf, but rarely upon the base of the stem near the ground. The punctures upon leaf stems are so close as to practically sever the stem; the leaf soon withers and dies and drops. In some cases the beetles seem to stay over the puncture after it is made and suck up the sap which accumulates. In several cases we found a beetle upon the shady side of a stem, remaining over or close to several punctures, indicating that a single individual may make several punctures and take the sap that accumulates in all of them. Punctures in a case of this kind are not over one-sixteenth to one-eighth of an inch apart, and from two to four are found in each group. We are inclined to think that the punctures are made purposely for securing the sap and not for devouring the tissue. Eight punctures were counted on a plant not over 2 inches high, and in this field were found an average of from 5 to as many as 16 beetles on and about each plant. In this 15-acre field fully 25 per cent of the cotton stalks had been killed by the attacks of this beetle, and in some small areas as much as half had been killed.

During the day the weevils hide for the most part in the loose dirt about the plants at a depth of from one-half an inch to 2 inches. They occurred also on neighboring farms, but in no other case in such injurious numbers. In all cases the owners of infested fields reported that the first appearance of these insects in the cotton was in those portions of the fields that had been in cowpeas the year previous. About three weeks later—May 27—the injury became less, owing to the more rapid growth of the plants, and perhaps also to the greater dissemination of the beetles.

The use of arsenicals is not likely to result satisfactorily unless the treatment is exceptionally thorough. If cotton is not planted after cowpeas the pest will be disposed of, but the latter crop is very necessary in the rotation plans of the Georgia farmer. Where these beetles appear in the cotton fields in early spring we suggest merely that chopping be as long delayed as possible or until the amount of damage can be accurately forecasted. The injury will probably not result in more than a severe thinning, and if care is exercised in chopping a good stand may be secured in nearly all parts of the infested fields. In the laboratory adult beetles placed upon young cotton plants readily left them and migrated to young cowpea plants near at hand. A decided preference for cowpeas is indicated, and trap rows of cowpeas through the cotton fields might be efficient.

LEAF-EATING CATERPILLARS.

SALT-MARSH CATERPILLAR.

(*Estigmene acræa* Dru. Fig. 18.)

This caterpillar is a common pest in cotton fields and often does considerable damage locally. A very satisfactory description of the different stages of the insect has been given by Doctor Hinds[a] in his account of an outbreak in cotton at Victoria, Tex., so that the following notes will merely furnish further data toward a more complete knowledge of the life history.

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[a] 1904: Bul. 44, Div. Ent., U. S. Dept. Agric., p. 80.

TABLE V.—*Transformation records of the salt-marsh caterpillar.*

Place.	Larva taken.	Pupated.	Days pupa.	Moth emerged.
Terrell, Tex	June 18	June 20, 27	25	August 22, unhealthy.
Do	June 29	July 2	14	July 16, 1904.
Do	August 20	August 29	14	September 12, 1904.
Do	October 8	October 18		——, 1904.
Do	June 27	July 11	14	July 26, 1904.
College Station, Tex	September 5, 1902.	October 14–22	24	November 8 to January.
Paris, Tex.[a]		Cocoons, May 29, 1885.		
Ercildoun, Pa.[a]	July 17, 1893			July 29.
Hartford, Conn.[a]	Eggs laid August 3, 1893.			
San Jose, Cal.[a]		Cocoons, March 9, 1883.		

[a] From the records of the Bureau of Entomology.

The notes concerning the cocoons from Paris, Tex., state that they were found by the million on cotton, and that the caterpillars were destroying it and other green plants. As hibernated caterpillars of

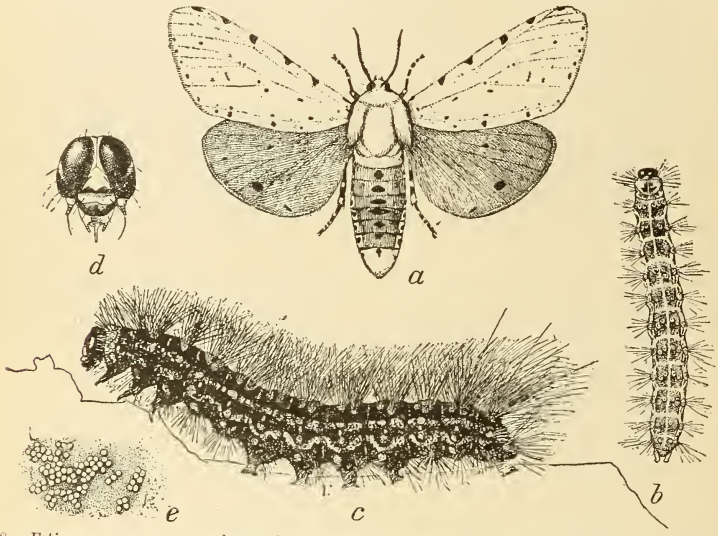

FIG. 18.—*Estigmene acræa: a*, male moth; *b*, half-grown larva; *c*, mature larva, lateral view; *d*, head of same, front view; *e*, egg mass—all slightly enlarged, except *d*, more enlarged (from Chittenden).

this family do not usually feed before pupating, these cocoons must have been those of the first spring generation. In this case there would probably be four generations in a season. The life history is exceedingly variable, as may be seen from the above records and by comparing them with those in Doctor Hinds' account.

Mr. Newell observed in 1902 that *Podisus spinosus* Dall., which hatched from eggs taken in the field with the larvæ of *acræa*, attacked the young larvæ vigorously and would soon have destroyed all of them.

The caterpillars of *Estigmene acræa* are parasitized by *Apanteles rileyanus* Ashm.

THE ARGE TIGER MOTH.

(*Apantesis arge* Dru.)

The caterpillar of this species is quite similar to the one last mentioned and is common on cotton, but has never been noted as very injurious. Our records concerning its life history are as follows:

TABLE VI.—*Transformation records of the arge tiger moth.*

Larva taken at Terrell.	Pupated.	Moth emerged.
May 27	June 15	June 26.
.....	July 9	July 23.
October 11	October 18	.....

Apparently the life history is very much like that of the salt-marsh caterpillar, probably three generations occurring in a year.

The Division of Entomology received eggs of this species on a peach twig from J. W. Porter, Charlottesville, Va., April 22, 1887, which hatched May 4. The larvæ commenced to pupate June 23, and moths issued June 28 and July 2, although even on the latter date a number of larvæ were still feeding. Doctor Chittenden states that a moth attracted to light April 15 laid eggs April 16, which hatched by the end of that month. Another lot of larvæ transformed to pupæ June 4, and moths emerged June 16, while others pupated and emerged just three days later.

THE BEET ARMY WORM.

(*Caradrina exigua* Hbn. Fig. 19.)

Larvæ of this species were found eating cotton foliage at Terrell June 20, 1904. These pupated June 23, and a moth emerged July 1. July 3 at least 75 eggs were laid in several masses on both sides of the leaf. These hatched July 6, the larvæ pupated July 29, and moths emerged August 4. More larvæ were taken in the field July 2, eating leaves and into the squares. These pupated July 10, and moths emerged July 18.

A very complete account of this species has been given by Doctor Chittenden.[a] Recently Prof. C. P. Gillette[b] has published considerable data concerning the life history. His observations show that in Colorado injury by larvæ has been observed in June, the egg hatching about June 1; again in July, all of this brood having pupated by July 29, and again in August. His observations, as well as those recorded

[a] 1902: Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 37–46, figs. 8 and 9; and 1903: l. c., pp. 36–37.

[b] 1905: Bul. 98, Colo. Agric. Exp. Sta., pp. 13–15, Pl. III.

by Doctor Chittenden, would seem to indicate that the moth hibernates over winter. Professor Gillette states that the eggs require four or five days to hatch, and that the first eggs are laid about five and the last about sixteen days after emergence. No record of the length of the larval stage has been given. In Texas the eggs hatched in three days as against five, and the pupal stage was six to eight days as against ten to fourteen—approximately—in Colorado. The length of the larval stage in Texas was twenty-three days. Thus the complete life cycle from the time of oviposition until the moth lays most of her eggs would require in that section about forty days.

Comparing the above data with the life history of the garden webworm, as given on pages 12–13, many points of resemblance will be seen. From this analogy the hibernating moths of the beet army worm probably oviposit early in April, the moths maturing from them—those of the first generation—being abundant about the middle of May. The second generation of moths emerges during the first or second week in July, and the third a little over a month later—early in August. A fourth generation of moths undoubtedly matures by the third week of September, as larvæ have been taken in southern California October 24 and November 5, in about the same latitude as southern Texas. The hibernating moths would thus probably form the fifth generation. Previous writers are doubtless correct in stating that in Colorado there are but three generations.

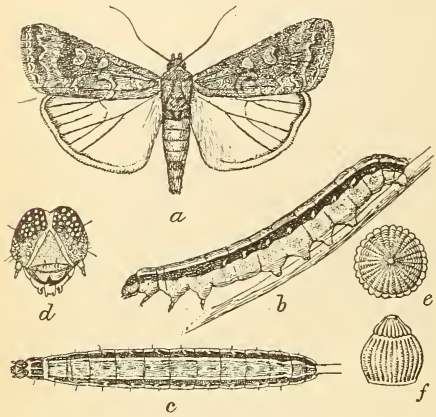

FIG. 19.—*Caradrina exigua: a*, moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, head of larva; *e*, egg, viewed from above; *f*, egg, from side—all enlarged (*e*, *f*, after Hofmann; *a-d*, after Chittenden).

Owing to the destructive habits which this insect has shown in the Colorado beet fields, its course in the cotton fields as it moves eastward will warrant attention.

Parasites.—The July brood of larvæ which matured early in August were badly parasitized by *Pristomerus texanus* Ashm., *Chelonus texanus* Cress., and *Apanteles algonquinus* Ashm.

PLATYNOTA LABIOSANA Zell.

Small green larvæ of this species were found rolling up cotton leaves at Terrell July 2, 1904. They pupated July 11, and moths emerged July 20. Mally has mentioned *Platynota rostrana* Walk. as sometimes working on cotton.[a]

[a] 1893: Bul. 29, o. s., Div. Ent., U. S. Dept. Agric., p. 30.

THE IO MOTH.

(*Automeris io* Fab.)

Larvæ of the io moth were found working on cotton at Paris, Tex., in August, 1904. September 8, about a dozen were found on a single stalk of cotton at Cooper, Tex.: one of them had pupated by October 1. This is a not uncommon species on cotton, but the injury is only local.

INSECTS AFFECTING THE STALKS.

THE SNOWY TREE CRICKET.

(*Œcanthus niveus* DeG. Fig. 20.)

This insect is of little economic importance in the cotton field, being beneficial, if anything; but the fact that the eggs found in the stalks in winter have been generally mistaken for those of the boll weevil by persons unacquainted with the habits of the latter insect makes it of interest. The eggs are laid in the fall in the stalks of cotton and various large weeds. They are arranged in a longitudinal row, and form a scar with numerous punctures, like the scars upon raspberry canes and fruit trees (fig. 21). These eggs hatch in early spring and the young feed upon plant lice. The habits of the nymphs have been well described by Prof. C. O. Houghton,[a] and our observations confirm his statements regarding the food habits, except that we have observed the adults to feed somewhat upon the tender portions of the foliage. The young become full grown by the middle or latter part of June in Texas, whereas in Delaware they did not mature until July 25. In the North there is but one generation a year, but there seems to be good evidence that two generations occur in Texas.

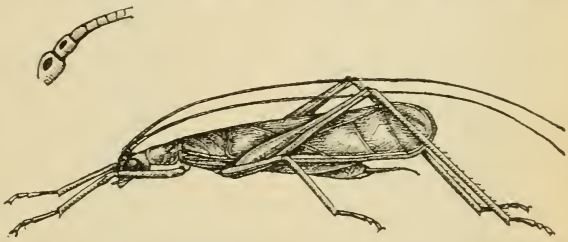

FIG. 20.—*Œcanthus niveus:* adult—three times natural size (original).

Two females were placed in a cage June 12, 1904, at which time the adults were common. A week later it was observed that the leaf petiole had been eaten until almost severed and the lobes of the leaves had also been attacked for food. July 1 it was found that the underside of the petiole toward the leaf was the favorite feeding point. July 8 eggs were found deposited in a leaf petiole, sometimes the egg-puncture extending through it. The eggs are about 1 by 4 mm.

[a] 1904: Entomological News, Vol. XV, pp. 57–61.

These eggs hatched July 23, but the nymphs subsequently died. This observation clearly indicates that oviposition sometimes, if not always, takes place in July.[a] During July and August nymphs are commonly captured by sweeping, though the first generation matured in June. The fall eggs are not laid until October or November, and during September fresh adults are found.

FIG. 21.—*Œcanthus niveus:* egg punctures on stalk (original).

The oviposition on cotton is of no practical importance, and the crickets doubtless do much unnoticed good in consuming the plant lice always abundant.

STALK-BORERS.

AMPHICERUS sp.

Early in March, 1904, Mr. J. W. Howell, of Corsicana, Tex., sent cotton stalks containing specimens of a species of Amphicerus. Upon visiting this field as many as a dozen of these beetles were often found in a stalk. No injury could be attributed to them, and it seems probable that they work merely in the mature stalk and hibernate in it. The species may be the same as that observed at San Diego, Tex., by Mr. E. A. Schwarz, who took specimens of *Amphicerus fortis* Lec. in old cotton stalks April 25, 1895.

ATAXIA CRYPTA Say.

This species has been styled the cotton stalk-borer. It can hardly be considered a cotton insect, however, as it attacks only diseased or injured stalks, and normally breeds in cockle. It has not been recorded as injuring cotton except individual stalks here and there. The records of the Bureau of Entomology state that a larva of this species which had been boring into the root of *Xanthium strumarium* was forwarded by Mr. Schwarz from Beeville, Tex., October 26, 1895. One beetle issued June 24, another July 3, two July 27, and one July 29, 1896. May 1, 1897, a beetle was reared from a stem of cockle from Tucson, Ariz., three more emerging June 8.

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[a] June 23, 1905. Mr. Sanborn states that the species has been full grown for at least five weeks and has been ovipositing. He thinks that there are undoubtedly two broods.

WORK OF ONCIDERES CINGULATA ON COTTON STALKS.

[These illustrations, running from left to right, show earlier and later stages in the girdling process.]

ORTHOSOMA BRUNNEUM Forst.

A larva, probably of this species, was sent to the Bureau of Entomology by Prof. Wilmon Newell, from Villa Rica, Ga., where it was stated to be boring into the bases of growing cotton stalks. It is probable that this injury is more or less accidental. The larva usually works in dead wood; and possibly where dead wood occurred in the cotton field and was plowed up, the larvæ might have attacked the cotton.

ONCIDERES CINGULATA Say.

In October, 1904, numerous specimens of cotton stalks cut off about 1 foot above the ground were received from Waco, Tex., the work being undoubtedly that of this species. Subsequently the fields were

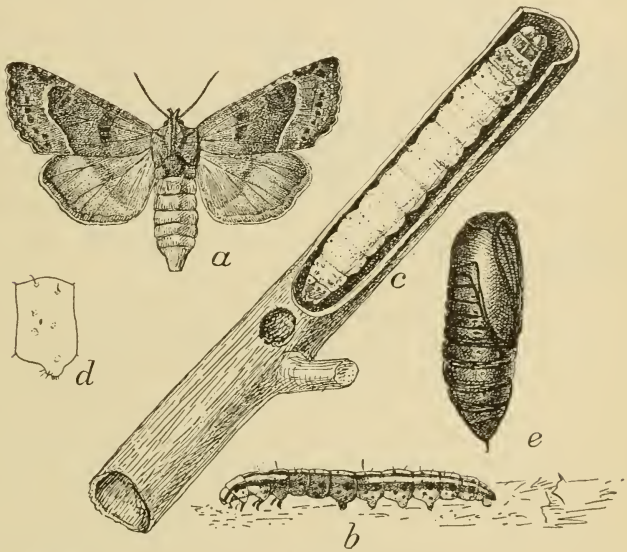

FIG. 22.—*Papaipema nitela:* *a*, female moth; *b*, half-grown larva; *c*, mature larva in injured stalk; *d*, lateral view of abdominal segment of same; *e*, pupa—all somewhat enlarged (from Chittenden).

visited, but none of the beetles could be found, though similar work was noticed on neighboring hackberry trees. Injury by this insect is very common to shade and fruit trees, especially to pear, in west-central Texas.

PAPAIPEMA NITELA Guen.

In July, caterpillars presumably of this species (fig. 22) were found not uncommon, boring in the cotton stalks at Terrell, especially along a small creek. The larvæ enter the stalk 3 or 4 inches above the ground, boring upward and causing it to wilt and die. The larvæ were very common in the stalks of "bloodweed" (*Ambrosia trifida*) in Brazos County, but none were found on cotton. June 24, 1904,

specimens were received by the Bureau of Entomology from L. Goldman, Lagrange, Ark., who reported them boring into cotton stalks. Injury by this species seems to be rather accidental, and probably occurs more commonly where fields are weedy, or where they adjoin uncultivated fields.

INSECTS AFFECTING THE FRUIT.

THE COTTON-SQUARE BORER.

(*Uranotes melinus* Hbn. Fig. 23.)

History.—In the two brief economic accounts of this species already published[a] it has been considered as an enemy of beans and hops, but no reference to it as a pest of cotton has been found. Mally has recorded the similar habits of *Calycopis cecrops* Fab. (*Thecla pœas* Hbn.),[b] and since then much of the injury due to *melinus* has been referred to the latter species. In Texas, although *cecrops* is common, by far the largest amount of damage is done by *melinus*.

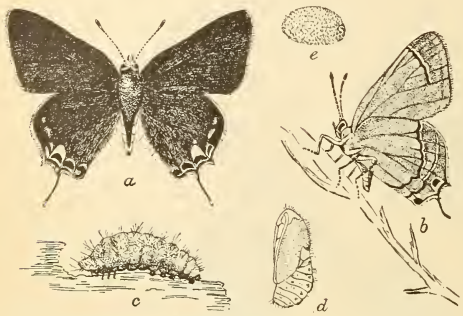

FIG. 23.—*Uranotes melinus: a*, dorsal view of butterfly; *b*, butterfly, with wings closed; *c*, larva from side; *d*, pupa; *e*, egg—all somewhat enlarged, except *e*, greatly enlarged (all except *e* redrawn from Howard).

The records of the Bureau of Entomology give the following data concerning this species: A larva sent by C. V. Riley, September 16, 1878, taken feeding on cotton at Augusta, Ga., was found to be parasitized by a species of Apanteles. September 4, 1880, a larva on cotton was received from Selma, Ala., likewise parasitized. July 6, 1880, a larva was received from R. F. Cooke, Marion, Ala., and parasites emerged the next day, seemingly *Apanteles theclæ* Riley. June 27, 1892, larvæ taken on cotton were sent by L. T. Sanders, from Plain Dealing, La. Under date of June 18, 1895, Mr. E. A. Schwarz, investigating the boll weevil, wrote from San Diego, Tex.:

> My friends here have brought me during the last two days plenty of squares said to be infested by the weevil, and I myself find others, but in every instance the author of the mischief is the cotton Thecla, which at present is the only injurious insect on cotton here.

Mr. Schwarz sent larvæ of this species from various points in south Texas in May and June. One larva was sent by him from Beeville, Tex., October 22, 1895, and another one from Bergs Mill, Tex.,

[a] 1895: Riley and Howard, Insect Life, Vol. VII, pp. 354–355; and 1902: Chittenden, Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 101–102.

[b] 1893: Bul. 29, o. s., Div. Ent., U. S. Dept. Agric., pp. 29–30.

December 9. He also sent a pupa from Beeville November 29, the butterfly from which emerged December 20.

Butterflies of this species are always common about the cotton field, and may be seen laying their eggs upon the foliage. Injury is more prevalent, however, where cotton adjoins or succeeds cowpeas, upon which plant the larvæ feed readily, according to the testimony of planters preferring it to cotton. Injury to cotton squares is exactly like that done by young bollworms later in the season, but occurs when the first squares appear. Often when the squares have been destroyed a larva will bore into the young stalk. Local injury to young cotton is often quite serious.

Life history.—The butterflies appear about the middle of April and eggs are laid in May. The larvæ of this generation are most injurious to cotton, and butterflies from them emerge late in June and early in July. A third brood of butterflies emerges in August. Larvæ are taken during September and October, and pupæ later in the fall, so that it seems probable that the winter is usually passed in the pupal stage, in old leaves, under rubbish or bark, etc., though sometimes a butterfly emerges in December and may hibernate. Mr. Sanborn observed the butterflies October 15, 1904, more abundant than at any time during the summer. At that time they were feeding on castor bean blossoms. The different generations are by no means distinct, and quite possibly four may occur in a season. After the first brood the larvæ are so parasitized that injury to cotton is not usually apparent, though considerable damage was noticed October 8, 1904, at Clay, Tex.

In addition to the food plants noted in the previous accounts—cotton and cowpeas—eggs and larvæ have been taken on "goatweed" (*Croton capitatus*), and a single larva, apparently of this species but not reared, was found boring into a half-grown peach in May, other fruit bearing marks of similar injury.

The small yellowish or almost transparent egg is laid on the leaf stem just at or upon the base of the leaf. The female, in ovipositing, bends the ovipositor downward and forward, so that she may deposit her egg upon the under side of the leaf though resting upon the upper surface. No eggs have been observed upon the squares. The eggs hatch in from two to five days. The larva becomes full grown in fifteen or sixteen days in midsummer, though twenty-nine days are required in May. The length of the pupal stage averages about ten days. Thus the complete life cycle occupies about a month. The records of rearings are summarized as follows:

TABLE VII.—*Transformation records of the cotton-square borer.*

Place.	Egg laid.	Egg hatched.	Larva taken.	Days larva.	Pupated.	Days pupa.	Adult emerged.	Adults collected.
College Station, Tex.	.....	.....	June 11, full grown.	Died.	.....	.....	.....	
	.....	.....	June 21	.....	June 23	Died.	.....	
	.....	.....	June 25, 29	.....	July 11	8–11	July 17, 22	
	July 2	July 6	.....	15	July 21	10	August 1	April 27.
	.....	.....	.....	.....	July 25	13	August 7	May 11.
	July 26	July 28	.....	16	August 14.	Died.	.....	June 15.
	.....	.....	Aug. 2	.....	do	7	August 21	July 14, 21.
	.....	.....	Oct. 8, nearly full grown.	Died.	.....	.....	.....	August 7.
Terrell, Tex.	April 28	May 3	.....	Died.	.....	.....	.....	
	May 6	May 11	.....	29	June 9	11	June 20	April 20.
	.....	.....	.....	.....	June 30	9	July 8	August 5, 26.
	.....	.....	July 5	.....	July 19	9	July 28	July 30
	.....	.....	October 22	Died.	.....	.....	.....	September 6.

The pupal stage is passed in a folded leaf, which is drawn together with a few strands of silk and which is attached to the stalk or under some shelter.

As yet injury by this species has been local, and rarely has any considerable amount occurred year after year in the same fields. This is undoubtedly due to the exceedingly effective work of the parasites. Should remedial measures be desired, thoroughly dusting or spraying the foliage of the young plants with Paris green or other arsenical will doubtless result in killing many of the young larvæ, as they feed somewhat upon the foliage in the same manner as the true bollworm.

Parasites.—As noted above, the June caterpillars are so thoroughly parasitized that it is difficult to rear adults from larvæ taken from the fields. Were it not for this good work of the parasites the insect would be a most serious enemy of the planter. Practically all of the parasites bred were *Apanteles cardnicola* Pack., but one lot of caterpillars was parasitized by *Metadontia amæna* Say, which Doctor Ashmead states is "a rare species long lost to science."

THE COTTON-BOLL CUTWORM.

(*Prodenia ornithogalli* Guen. Figs. 24 and 25.)

The larva of this species was commonly observed in north Texas feeding upon the foliage of the young cotton plants, and later boring into the bolls in the same manner as does the bollworm. The species was under study throughout the season at Terrell, and the data concerning its life history are given in the following table:

TABLE VIII.—*Transformation records of the cotton boll cutworm.*

Eggs laid.	Eggs hatched.	Larva taken.	Days larva.	Pupated.	Days pupa.	Moth emerged.
.....	.....	March 30	.....	April 5	36	May 11.
.....	.....	May 14	.....	May 21	19	June 9.
.....	.....	.....	.....	May 28	15	June 12.
.....	.....	June 28	.....	July 4	12	July 15.
.....	.....	July 10	.....	July 15	10	July 25.
.....	August 9	.....	18	August 27	16	September 12.
.....	August 27	.....	21	September 17	11	September 28.
October 11	October 17	.....	60	December 17	19	January 5.[a]

[a] One moth emerged.

The first larva taken on March 30 was full grown, and was feeding upon amb's quarter (*Chenopodium album*). All the others were taken on cotton. No eggs were secured from reared moths, but two lots were found in the field. The brown, globular eggs were deposited upon the under side of a cotton leaf, in a pile of about 200 or more. They are laid in rows in a nearly square mass, fifteen to twenty eggs in a row and about fifteen rows. The mass is covered with light-brown down from the female, which hides the eggs from view.

Of several larvæ pupating December 17, one adult emerged January 5, the remainder dying in the pupal stage.

Owing to the very complete description and account of this species given by Doctor Chittenden[a] it is unnecessary to enter into further discussion concerning it except to indicate its life history.

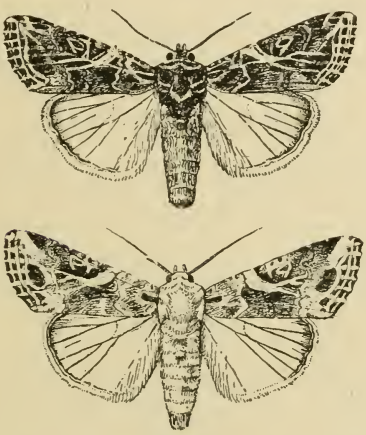

FIG. 24.—*Prodenia ornithogalli:* dark form, male, above; pale form, female, below—somewhat enlarged (from Chittenden).

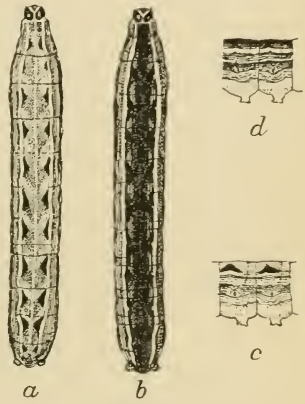

FIG. 25.—*Prodenia ornithogalli: a*, pale form of larva; *b*, dark form; *c*, lateral view of abdominal segments of pale form; *d*, of dark form—all enlarged (from Chittenden).

In addition to the records published by Doctor Chittenden, the following notes in the records of the Bureau of Entomology upon *Prodenia flavimedia*, which is now considered synonymous with this species, are of interest. September 13, 1878, a larva sent by C. V. Riley was received from Albany, Ga. October 5, 1878, another larva was received from Professor Riley, probably from the same locality. This specimen commenced to pupate October 8 and the moth emerged December 27. May 1, 1882, a larva was received from E. H. Anderson, who stated that he had observed the species feeding on cotton at Kirkwood, Miss., for several weeks. This larva pupated May 8 and the moth emerged June 5.

[a] 1901: Bul. 27, n. s., Div. Ent., U. S. Dept. Agric., p. 64.

These records, with those published by Doctor Chittenden, would indicate the following as the probable life history of the species in the Gulf States. The winter is usually passed in the pupal stage in the soil, though possibly a few moths, emerging late, hibernate. The first brood of moths appears from the middle of May until the middle of June, mostly early in June. A second brood appears during the latter half of July, and a third late in August and during September. A few of the fourth brood may emerge in December, but most of them do not do so until the very early spring, when they lay eggs upon various weeds on which the larvæ feed until cotton appears. The length of time occupied in the different stages is seen to be quite variable, but is approximately 6 days for the egg, 20 days for the larva, and 13 days (usually 10 to 15 days) for the pupa—making a total of about 40 days for the complete life cycle.

A larva of *Prodenia eridania* Cress. taken on cotton at Terrell October 22, 1904, pupated November 1 and the moth emerged November 22.

The caterpillars are parasitized by *Ophion bilineatum* Say.

THE COTTON LEAF-BUG.

(*Calocoris rapidus* Say. Fig. 26.)

These capsids were noticed commonly upon cotton at College Station and elsewhere late in the summer of 1903, and a few were received for

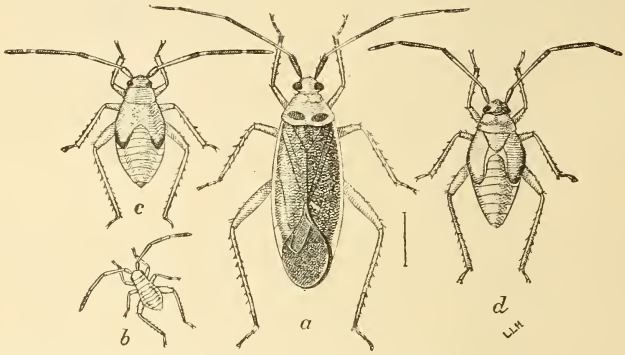

FIG. 26.—Cotton leaf-bug, *Calocoris rapidus*: *a*, mature bug; *b*, young nymph; *c*, fourth stage of nymph; *d*, fifth stage of young (author's illustration).

identification, but little importance was then attached to them. Late in August, 1904, reports of serious injury to cotton were received from Kaufman, Hunt, Ellis, and adjoining counties, and Mr. Lewis was directed to investigate the injury. He reported as follows:

On September 1 the insect was found abundant in all fields examined at Wolfe City, both nymphs and adults feeding upon the squares, young and half-grown bolls, and in the blossoms. The nymphs were most numerous on the squares, the adults

on the blossoms and bolls, especially just after the blossom has fallen. Planters stated that this injury prevents squares from blossoming and that they drop. At this time but few squares were being injured, but planters stated that the bugs had been very much more abundant and injurious a fortnight previous. In the flower they feed at the base of the petals, causing it to wilt and drop. The small bolls fed upon dry up and drop off, while if the larger ones are much injured they become soft and mushy; some of them continue to grow on one side, the punctured side being found dead and discolored. The insect appeared about the middle of July at Wolfe City, and is stated to have done some damage in 1903. During the next ten days fields were visited at Commerce, Ennis, Crisp, Cooper, and Enloe, and at all of these places conditions were found much the same as those described above. Most of the damage seemed to have been done to late cotton and to the young bolls just after the blossoms had dropped.

FIG. 27.—Cotton boll showing punctures of *Calocoris rapidus* (author's illustration).

The adult bug is a quick flyer and is difficult to capture when disturbed, though it flies but a short distance, usually to the next row or for a few yards only. The nymphs are swift runners and are most common on the young squares. No eggs were secured, but a very small nymph not over 2 or 3 days old, which had probably molted but once, was taken September 8. It molted September 16, 19, and 24, when it became adult. Another young nymph was taken September 24, molted September 28, October 3 and 8, when it became adult. The complete life cycle probably does not occupy over thirty days.

Practically nothing is known of the habits of this species earlier in the season. Two specimens were taken at trap light at College Station April 18, and one was received from Wise, Tex., June 1, 1903. At Terrell, the first specimen was taken at trap light June 17, 1904. Later, on July 3, three were taken; on the 7th, 4; 8th, 5; 9th, 4; 10th, 5; 14th, 6; and 26th, 4.

Where the bugs fed upon the bolls there appeared around each puncture a black spot, much like the early stages of anthracnose (fig. 27). To determine definitely whether or not this was produced by the punctures of the bugs, six of these were placed on a young cotton plant about 8 inches high October 1. Five days later the plant was dead from the injury. October 7 six bugs were placed in a bag over a fair-sized boll, perfectly green; by the 10th it was well covered with the black marks made by the bugs. To make certain of the nature of the injury, bolls were submitted to Dr. A. F. Woods, Pathologist and Physiologist of this Department, who reported: "These resemble somewhat the early stages of anthracnose, but we have been unable to find any fungus present, and the spots have not enlarged or developed any fungus even after several days in a moist chamber." There is no

doubt, therefore, as to the cause of this injury, which was quite considerable in the counties mentioned and noticeable elsewhere.

That this is no new enemy of cotton is shown by the fact that Glover in his report on cotton insects in 1855[a] mentions and figures it. Again, in his manuscript notes and plates, he states that it injures the plant by piercing the leaves and young shoots.[b] It was next mentioned by Prof. F. M. Webster[c] as injuring wheat in Indiana by attacking the heads and causing them to wither. In 1893 Mally gave a brief description of the injury done to cotton, similar to that recently observed.[d]

Calocoris chenopodii, an allied species, has been observed to feed on larvæ of the asparagus beetle in Europe, and Doctor Chittenden states[e] that the present species is not uncommon in asparagus beds.

There seems to be no feasible means of combating the adult bugs; but the nymphs would undoubtedly succumb to a spray of kerosene emulsion or similar contact insecticide, which should be applied as soon as they are observed to be numerous. By such an application during July, when there are but a few here and there, serious injury by the increased numbers late in the summer might be prevented.

CORIZUS PICTIPES Stål.

September 5, 1904, this species, which somewhat resembles the preceding, was found very abundant in all stages at Sherman, Tex., on a species of Althæa, affecting it much as the leaf-bug affected cotton. From eggs which hatched September 5 adult bugs matured October 7. Later in October the species was found on cotton at Terrell, and specimens taken on cotton were received from Cameron, La., October 10.

OTHER PLANT-BUGS.

The black spots upon the bolls and the consequent shrinking and softening are not always due to *Calocoris rapidus* Say, as several other species have been noticed as producing the same injury, although they do not occur in such large numbers and the injury is not so general.

LARGUS SUCCINCTUS Linn.

This species is frequently found on the bolls in late summer, causing some injury. Adults were found common late in July, and on the 28th a pair were confined on cowpeas. On August 6 two egg

[a] 1856: Rept. U. S. Comm. Patents f. 1855, Agriculture, p. 87, Pl. VII, fig. 6.

[b] 1878: Manuscript notes from my journal—Cotton and the principal insects, etc.—Washington, pl. 11.

[c] 1885: Rept. Comm. Agric. f. 1885, p. 317.

[d] 1893: Bul. 29, o. s., Div. Ent., U. S. Dept. Agric., p. 31.

[e] 1898: Bul. 10, n. s., Div. Ent., U. S. Dept. Agric., p. 57.

masses were deposited under trash in the soil, one mass containing 215 eggs. The species has been previously recorded as injurious to cotton by Glover and Mally (*l. c.*), and to nearly ripe peaches near San Antonio, Tex., by Lintner, who has given the only complete discussion of the insect.[a] It has been similarly mentioned by Doctor Howard.[b]

JADERA HÆMATOLOMA H.-Schf.

This dark-bluish bug often occurs on cotton, though no injury by it has been observed. It normally feeds on weeds and low growing vegetation. The young, in all stages of growth, were seen feeding on various weeds at Navasota, Tex., about the middle of May. The nymphs have the interesting habit of keeping together, so that a considerable number are found feeding in one spot; but as they grow older they drift apart, and the adults are usually found in pairs. Eggs laid July 20 hatched on the 29th. On August 4, adults which were found common on the china-berry tree were confined on cotton, and were observed to oviposit in crevices of the soil. In oviposition the female turns the abdomen upward at a decided angle and expels the egg, which falls to the ground. After laying about a dozen eggs in this manner she makes use of her forefeet to cover them with loose particles of soil. Copulation takes place after each laying. Eggs were also found in the hull of a china berry, in which they seemed to have been hidden. Probably they are laid under any sort of rubbish on the soil.

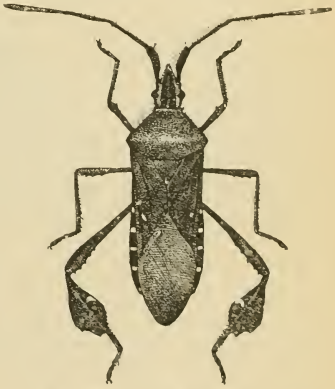

FIG. 28.—*Leptoglossus oppositus:* adult—twice natural size (from Chittenden).

LEAF-FOOTED PLANT-BUGS.

(*Leptoglossus oppositus* Say, fig. 28, and *Metapodius femoratus* Fab.)

These insects have been frequently observed by Messrs. Lewis and Bishopp in north Texas puncturing cotton bolls and causing more or less injury. Both were mentioned by Glover as cotton insects.

THE GREEN SOLDIER BUG.

(*Nezara hilaris* Say. Fig. 29.)

A letter dated March 7, 1903, from Mr. R. L. Taylor, of Help, Tex., first called attention to this insect as a cotton pest. Mr. Taylor sent

[a] 1885: Second Rept. N. Y. State Ent., p. 164, fig. 41.
[b] 1901: The Insect Book, p. 307, fig. 200.

a specimen he had that day found in the woods and stated that in 1902 this insect had ruined his cotton crop. As many as three of the bugs were found on one boll, and by shaking the stalks as many as five bolls would sometimes drop, presumably as a result of their injury. The statement that the injury was done by this insect may be questioned, but its identity could hardly be confused; and, judging from later observations, if it occurred in the numbers stated, the injury would undoubtedly be serious.

In September and October, 1904, Mr. Lewis frequently found these bugs puncturing bolls at Terrell, causing black spots and injuring the lint. September 1 a mass of fifty eggs was taken at Wolfe City, and several masses were previously taken at Terrell. These eggs hatched September 2, the young nymphs being almost black. The nymphs molted September 5, 19, 26, and October 1, the wing-pads appearing on the latter date. The last molt occurred on October 11.

The adult bugs hibernate over winter, as is shown by the fact that specimens have been taken at Wellborn, Tex., March 7, 1903, and at Manor, Tex., March 29, 1904.

The insect has been known as a resident of cotton fields before, but its exact status has never been determined. In the Fourth Report of the United States Entomological Commission, page 79, it was reported as feeding upon the cotton caterpillar. Riley and Howard record injury by it to cotton and also to garden plants at Tallahassee, Fla., November 14, 1890.[a] Nymphs were also recorded by them as seriously injuring beans in Stafford County, Va., September 30, 1889.[b]

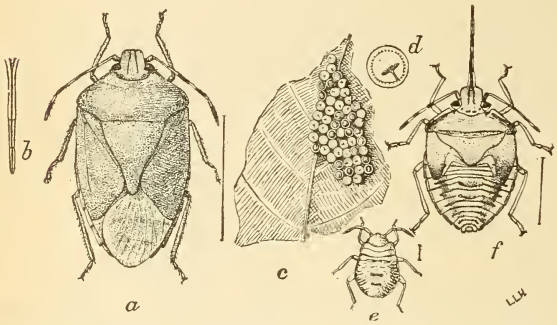

FIG. 29.—*Nezara hilaris:* *a*, mature bug; *b*, beak of same; *c*, egg mass; *d*, single egg; *e*, young nymph; *f*, last stage of nymph—all enlarged; *b*, *d*, more enlarged (from Chittenden).

The records of the Bureau of Entomology show the insect to be undoubtedly an enemy of the orange tree and to have a wide range of food plants. March 19, 1883, eggs, nymphs, and adults were received from Mr. T. Franklin, West Apopka, Fla., who stated that they were injuring orange trees. More eggs and nymphs were received April 7. October 3, 1898, specimens were received from W. L. Thomas, Valdosta, Ga., who reported great numbers injuring leaves and fruit in

[a] 1891: Insect Life, Vol. III, p. 403.
[b] 1889: Insect Life, Vol. II, p. 148.

his orange grove, in Orange County, Fla. January 5, 1899, Mr. J. P. Donnelly, of Mount Dora, Fla., sent an adult of the species and stated that they were sucking the juices of his oranges. The specimen sent had been attacked and killed by *Euthyrhynchus floridanus* Linn., which accompanied it. Injury to cabbage, corn, cotton, and peas was reported by Mr. J. P. Cooksey, Pin Hock, Fla., January 6, 1892, and injury to peaches from the adult bugs by Mr. J. P. Lorenson, Salt Lake City, Utah, September 12, 1898. September 26, 1904, Doctor Chittenden observed the adults puncturing okra pods at Washington, D. C.

THYANTA CUSTATOR Fab. AND PROXYS PUNCTULATUS Beauv.

These insects were also frequently observed on cotton bolls, though no injury could be directly attributed to them. The former species was exceedingly destructive to various field crops—corn, sorghum, cowpeas, etc.—in north Texas in 1903.

SHARPSHOOTERS.

Although the first species to be discussed below is the one commonly known as the "sharpshooter" of cotton, we may well consider three others, nearly related and with very similar habits. All four species are found more or less on cotton, and would not be readily distinguished by the average planter.

THE GLASSY-WINGED SHARPSHOOTER.

(*Homalodisca triquetra* Fab. Fig. 30.)

Life history.—The adults pass the winter in rubbish, leaves, etc., near the food plants. On January 11, 1905, they were found feeding on yaupon (*Ilex decidua*), reported by Mr. Sanborn as one of their favorite food plants. On cold days they crawl down among the trash and leaves. They begin to leave their hibernating quarters late in March, our first record at College Station being March 24, 1904, but are not common until two weeks later. On April 6, 1904, adults were common along a small tributary near the Brazos River on hackberry (*Celtis mississippiensis*) and cottonwood, and still more numerous on elm and willow. On April 14 they were exceedingly numerous on elm and hackberry, the dropping of their exudation being very noticeable; but none were found copulating. At this time numerous jassid nymphs were found upon these trees, but, as we were then unfamiliar with the nymph of *triquetra* and were unable to rear any of them, the species is uncertain. The occurrence at this time of these nymphs, which if not the species under discussion, must certainly have been nearly related to it, indicates, in any event, the possibility of oviposition in early April, although this is certainly not common. Numerous observations were made each week, yet none were found mating until

May 13, when a single pair was observed. On May 20 several pairs were observed *en copula* and other females were found to be full of mature eggs. At this time they had left the elms and some had migrated to sorghum, cotton, corn, and sunflowers, but they were still common on hackberry. On June 10 the adults were numerous on sunflower and pigweed; and nymphs, undoubtedly of this species, were found on hackberry. On the 17th as many as fifty to the stalk were observed on sunflowers; but although common on weeds at the edges of the fields, none were found on cotton. During the weeks previous to this date none were seen on elm or hackberry, but they were quite common on cottonwood. During June and July numerous unsuccessful attempts were made to secure eggs from adults in confinement. Until about July 20 the adults were common upon sunflower and cottonwood, but at about that date they became more scarce, and were found only on young bushes. During the early summer a few nymphs in various stages of development were usually found with the adults.

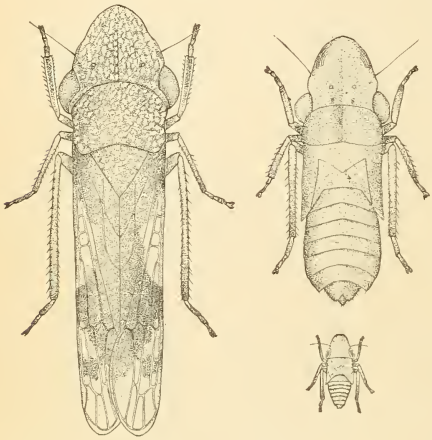

FIG. 30.—*Homalodisca triquetra:* adult at left, last stage of nymph at right, young nymph below—all enlarged (author's illustration).

At Terrell several adults were confined on cotton June 17. The next day one lot of ten eggs was laid in a row just under the epidermis. These hatched June 24, and the nymphs molted on July 11 and 25 and August 15. All died on August 26. After the third molt the wing pads were just appearing. Judging from this fact and comparing further observations on nymphs taken in the field August 8, which molted once before becoming adult, it seems probable that had these nymphs lived they would have molted twice more and become full grown early in September. During the latter half of July the adults were decidedly less abundant near College Station. About the 1st of August the cowpea was found to be a favorite plant for food and for oviposition. Young were observed hatching on August 3 and 5, and at about the same time nymphs were observed to make the last molt and become adult. During the first two weeks of August numerous egg masses were laid in cowpea leaves in field cages at the college, often two or three masses in a leaf. The eggs are usually laid in rows on the ventral side of the leaf, averaging about twenty in a row. The surface of the leaf above the eggs is covered with a whitish powder

from the body of the female, which gives them a very striking appearance and at first sight seems to be a decided disadvantage, but which possibly is of some value in protecting them from parasites. This wears off in a few days, often leaving a margin of white around the eggs. Eggs known to have been laid August 17 hatched about 7 a. m. on the 25th almost simultaneously. About twenty minutes later the nymphs changed from a bright green to a metallic lead color and had increased very rapidly to about twice the size at which they emerged. On August 12 more adults were found on okra than on any other plant. Eggs were common on the bloodweed, and were also found at College Station on catalpa. Only a few sporadic adults were found on cotton. Nymphs were most common along the Brazos River on young elm, box elder, mulberry, and bloodweed. About the middle of August a very large percentage of the eggs became parasitized by *Ooctonus homalodiscæ* Ashm. n. sp., so that it was exceedingly difficult to rear nymphs. The larva of a chrysopid was also observed feeding on the young nymphs. This larva, which was colored like the petiole at the base of the leaf, awaited its prey upon the red spot at that point. On August 20 an egg mass was found deposited in the bract of the involucre in a field cage in which adults had been placed on cotton in the Brazos bottom. These were parasitized, but six eggs were found in one small boll. This is the only instance in which any injury to cotton was observed under field conditions. On August 28 the adults were quite abundant on fig trees and on cotton near the Brazos, but no eggs were found on fig. On August 24 eggs were taken on okra and catalpa. By September 1 the adults were much less common on cowpeas, but one lot of eggs deposited September 15 hatched the 22d. On October 8 adults and nymphs in the last stage were taken on the fig trees, but no eggs could be found.

At Terrell a nymph with wing pads just showing was taken August 8, and became mature upon molting August 15. On August 24, adults were found in the field, which from their bright color and texture were evidently newly transformed. Eggs laid September 6 hatched September 12.

These observations may be briefly summarized as follows:

TABLE IX.—*Transformation records of the glassy-winged sharpshooter, 1904.*

Place.	Mating.	Eggs laid.	Hatched.	Nymphs.	Grown nymphs.	New adults.
Terrell, Tex.	.....	June 18	June 24	August 15	.....	.....
	.....	.....	.....	3d stage, August 8.	.....	August 15
	.....	.....	.....	.....	.....	August 24
	.....	September 6	September 12	.....	.....	.....
	.....	.....	.....	October 22	.....	October 22
College Station, Tex.	May 13–20	Soon after May 20.	.....	.....	August 3	.....
	.....	August 5	August 11, 13	.....	.....	.....
	.....	August 17	August 22	.....	.....	.....
	.....	September 15	September 22	.....	October 8	.....

It will be seen that the eggs hatch in six or seven days; but that the period of oviposition lasts for a number of weeks, so that the two broods overlap more or less. There seems abundant evidence that there are two and more probably three full broods. Concerning this matter Prof. E. D. Ball, one of the best authorities on the Jassidæ, writes as follows:

> If adults go over winter they would surely not have second stage larvæ by April 14, as overwintering species usually have to feed long enough in the spring to develop their eggs, and usually larvæ are later in appearing than from overwintering eggs by about a month. The record of "sexes copulating May 20" would be about the record I should expect for an overwinter adult.

However, as previously noted, the adults frequently come out and feed on warm days during the winter months, and as the season was early and the previous winter very open in 1904, it is entirely possible that there may sometimes be an additional spring brood; but this is undoubtedly not true in the large majority of cases.

These insects seem to be much more active in the spring than in the fall, but are decidedly more hardy in the fall. On October 11 it was observed that they did not move around much and were not easily disturbed. Early in the morning, in early summer, they will jump like a grasshopper when disturbed; but if the plant is slightly jarred in the middle of the day they fly with a distinct buzz.

Frequently a large white spot of lime-like matter is found toward the tip of the wing of this species, often more or less rubbed off. Mr. Sanborn has observed the formation of this spot:

> It is transferred to the wing from the anus with the distal end of the metatibia. When exuded it is globular and resembles an egg, but is not pure white. With an adroit motion of the hind leg the insect secures the drop as it is drawn past the anus, and with a forward movement it is brought against the side of the wing to which it adheres. A similar spot is then placed in the same manner on the other wing. These spots occur on both sexes.

Food plants.—In addition to those mentioned above, the following food plants have been observed: Wild grape (*Vitis cinerea*), Osage orange, Johnson grass, thorny amaranth (*Amaranthus spinosus*), cocklebur (*Xanthium canadense*), grape, banana, and apple. Riley and Chittenden record it as attacking asparagus in South Carolina.

Supposed injury.—During August there is always considerable complaint that "sharpshooters" are injuring cotton by causing the squares and small bolls to flare and drop. Many of these complaints have been investigated. The writer has solicited reports of injury, with the offer to personally investigate them, and has had extensive correspondence upon the matter with many planters, but no evidence of such injury being due to this insect has been secured. On the other hand, all manner of insects were sent us, many even considering the bollworm

as "the sharpshooter." Moreover, when the insect was described to planters, many recognized it as "the dodger," which name they had given it from its characteristic habit of dodging around the stalk when slightly disturbed, and stated that though they had seen it commonly on cotton for years they had never thought it injurious. In our own field observations we have sometimes seen this species quite abundant on cotton, but have never noted any injurious effect from its presence, and it is never so abundant on cotton as on other preferred food plants. It is exceedingly fond of young sorghum, sunflowers, and bananas. Prof. H. A. Morgan informs us that he has seen sunflowers considerably injured by the large numbers of these insects upon them. To further test the matter, numerous observations were made upon individuals confined in cages upon cotton, both in the laboratory and field. In only one instance was anything like injury to the squares observed. In this instance two specimens were confined on a twig of cotton bearing three squares. Five days later two of the squares were flaring, and by very close examination a very small puncture, but slightly larger than the black markings on the square, was found on the side of each. Observations a few days later in a field where the adults were very abundant on cotton showed no such injury, however, so that it is doubtful whether or not the supposed punctures were made by these insects. Indeed, it is safe to assert that the insect does not feed or oviposit upon the squares or bolls, except by the merest accident in very exceptional cases. It is always seen feeding upon the stems, and the eggs are laid in the leaves or possibly in the bracts, but preferably on other plants than cotton.

The occurrence of this species on cotton has been noted by Riley and Howard in Insect Life.[a] The only other previous observations recorded are those of Mally and Banks,[b] who give a very excellent and detailed account of the process of oviposition and state that "they feed by puncturing the epidermis at the base of the flowerbud or the very young boll * * * . Soon after the form or small boll will 'flare' and drop off. If examined when about to drop off a small roundish black spot will be found upon the peduncle, the base of the form, or boll." This is stated to refer to the feeding habits of the young. It is the popular impression, however, that it is due to the feeding of the adults. As previously stated, neither the writer and assistants nor, as we are informed, any of the other field agents of this Bureau, working in the cotton fields of Texas and Louisiana have been able to recognize any injury caused by this insect. We therefore wrote Professor Mally concerning the above account of the injury and received

[a] 1892: Vol. V, pp. 150–154, fig. 10.

[b] 1893: Bul. 29, o. s., Div. Ent., U. S. Dept. Agric., pp. 31–33.

the following reply, which it will be noticed much more closely agrees with our observations and practically explains the seeming differences:

Replying to your favor of August 11 (1904), making inquiry concerning my observations upon *Homalodisca coagulata* (*triquetra*), I beg to state as follows: The observations on the laying of the two eggs were the first in which I actually saw the deposition made. Later on, however, I found the egg-laying in greater quantities and in a row, as you indicate you have observed. So far as I have ever observed, they always lay just underneath the epidermis of the leaves or stems, and I have often found them on the outer surface or at the base of the involucre of the squares and forms. I certainly ought not to be quoted as observing them laying their eggs within the young form and squares, because it is not correct [in reply to my query concerning the statement in Insect Life to this effect]. The small black speck which you speak of on the squares is certainly not due to the egg deposition of this sharpshooter; neither is it due to the feeding habits of these leaf-hoppers, especially if they are more than half grown. The newly hatched sharpshooters feed more or less under shelter; that is, they may be more or less hidden; for this reason the very young are often found in the bud, so called, of the tender growing tips of the branches on cotton. It is here, while the leaf buds and fruit buds are bunched together and in a formative condition, that the most serious damage is done. The feeding punctures are often not serious enough to shed the squares until they grow out and attain some size. Just where the square has been punctured can not be readily determined when the injury has been done while the square was very young, as it simply yellows a little and sheds. However, there is no question but that much of the shedding charged to the sharpshooter is due to natural causes or lack of proper nutrition in the plant.

You will not find the second brood very clearly indicated by anything you will find in the cotton crop or, in fact, any of the cultivated crops which it is known to attack. It seems to prefer the indigenous plants of various kinds, where the later brood and egg laying has a better chance of escaping destruction.

Summing up all our information, we are forced to conclude that the possible injury to the cotton plant from this insect and those to be discussed below which might easily be confused with it, is inconsiderable; and that the shedding usually attributed to injury by the vague and unknown "sharpshooter" is due to purely natural causes involved in the physiology of the plant.

DESCRIPTION OF NYMPH, BY E. D. BALL.

Head long, flat, shovel-like as in the adult, but not as much inclined. Vertex flat or slightly concave on the disc, with the margins rounding. Jugæ distinct, shorter than in the adult; front very similar to the adult in the pupæ, somewhat flatter in the younger stages. Clypeus rounded. Color pale olivaceous-brown; front pale; arcs on front, a continuation of them on vertex, and a pair of depressions at base of vertex, slightly fuscous. The ocelli appear as pale-reddish spots in the pupæ. Front with median fuscous stripe widest above and fading out on clypeus. There is sometimes a faint median light stripe on abdomen and usually a row of white dots on either side midway to the margin. Legs pale, the anterior tibiæ flattened in the later stages; claws dark.

ONCOMETOPIA LATERALIS Fab.

(Fig. 31.)

This species has been fully as common in cotton fields investigated by us as the last, but being smaller is not so readily seen. We have never observed the species in large numbers on any of its food plants,

Our notes upon it are meager, but indicate that the life history is probably the same as for the last species. The adults emerge from hibernation about the last week in March, though specimens were sent us from Ondee, Tex., January 25, 1903. The adults are most abundant during June and July. Mr. Lewis observed the oviposition at Terrell several times. The eggs are laid just beneath the epidermis, ten or twelve in a row, in practically the same manner as by *H. triquetra*.

TABLE X.—*Transformation records of Oncometopia lateralis.*

Eggs laid.	Eggs hatched.	Nymphs died.
May 30	June 6	June 10.
June 18	June 25	July 11.
August 10	August 18	August 20.

During the preceding summer we endeavored to rear the nymphs in a field cage, but all died. It would seem that there are two distinct generations, the larger number occurring in July being the new adults, which oviposit in August. Professor Ball, however, finds but one generation in Colorado. He writes us as follows:

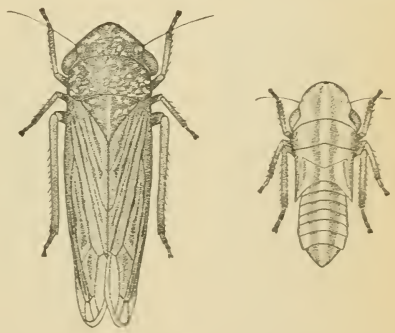

FIG. 31.—*Oncometopia lateralis:* adult and nymph—greatly enlarged (author's illustration).

The species (*O. lateralis*) is but single brooded in all parts of Colorado from the coldest to the warmest. The adults hibernate over winter, as do all of the tettigonids here, and are common from the middle of March into June, most of them disappearing by the middle of that month; but a few scattering ones run on into July. They lay eggs in May and June. The first larvæ appear about May 24 and continue to come out through June, the last ones disappearing in August, about the 15th. Fresh males appeared July 6—the females not until later—and ran on through the season, without mating or developing eggs. Thus there is a wide variation in the time of appearance of all stages; one could find nearly full grown larvæ in June and again in August, two months later. From almost daily observations on a single area where they were common, I am very positive that there is but one brood.

The difference in latitude between Colorado and Texas—equal to that between Washington, D. C., and Jacksonville, Fla.—however, will easily account for another brood occurring in Texas.

DESCRIPTION OF NYMPH, BY E. D. BALL.

Head much longer and more inflated than adult, with about the same anterior slope. Front longer and narrower, proportionately, giving the larva a much more pointed head as viewed from the side, and a long sloping face. Color: pale, creamy yellow, a round black spot at apex of head; from this two fairly definite dark stripes

extend the entire length of the body; these stripes are often narrowly interrupted on a line with the antennæ. Another pair of dark stripes originate behind the eyes, and extend along the margin to the wing pads, where they divide and continue slightly obliquely to the margin of the latter, appearing again as single stripes on the abdomen. A transverse band runs in from the antennal sockets on each side. Front with five brown stripes, the median and lateral ones narrow and definite, the intermediate ones which arise on the vertex are broad and interrupted by light arcs. Legs pale.

The species is entirely harmless to cotton, and, so far as we have observed, and as may be judged from the fact that no records of injury by it have been published, it does not damage any cultivated crops.

ONCOMETOPIA UNDATA Fab.

(Fig. 32.)

The life history of this sharpshooter also seems to closely resemble those of the preceding species. The adults emerge from hibernation late in March, our first record being on the 22d. At this season and throughout the summer they are particularly fond of redbud (*Cercis canadensis*) and are also common on elm. The first eggs were laid in confinement on cotton at Terrell May 5, and the first observation on adults mating in the field was made on May 9. Three more lots of eggs were laid May 11, the deposition being much like that of *O. lateralis*. These eggs hatched in eight and ten days. Those which hatched the 13th molted on the 26th and again on June 10. On June 30 all were dead, the wing pads just appearing on the larger ones. On July 2 Mr. Lewis observed in the cotton field numbers of this species, which, judging from their fresh, bright colors, had evidently just become mature. A few were copulating. Eggs were laid July 4 by females confined on cotton. The eggs were laid, as a rule, on the under side of the leaves, the single exception being laid on the outside of the involucre, but not on the square. In the cage they were observed feeding on the leaves and stems of cotton, but never were seen resting on the squares. These eggs hatched July 10 and all the nymphs were dead by the 15th. By August 15 nymphs were found in the field with wing pads forming. On September 5 three adults were inclosed over a cotton limb, and on the 12th young nymphs were

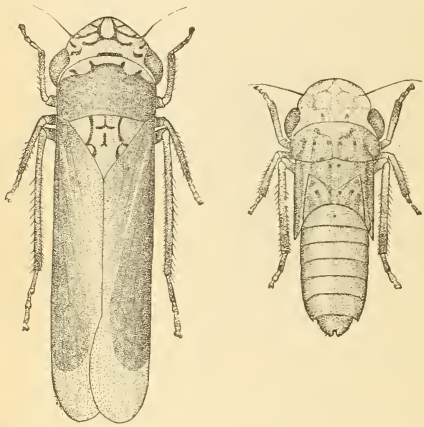

FIG. 32.—*Oncometopia undata:* adult at left, nymph at right—greatly enlarged (author's illustration).

found, though the eggs were not observed. Our latest record for the adults in the field is October 10, 1902, at Courtney, Tex., but it is quite possible that they may occur later. It seems clear that there are two generations of this species, and there is a decided probability of at least a partial third generation.

The species is entirely harmless to cotton and is much more common on trees. It was reported as quite injurious to grapes at San Marcos, Tex., May 10, 1886,[a] and at Greensboro, Ala., June 25, 1890,[b] and we have recently had similar reports. Lugger has also given a short description of the species and its work on grape.[c] It was responsible for the so-called "weeping willow," which attracted public attention in north Texas in 1889,[d] the "weeping" being due to the remarkable excretion of this species, which very frequently is ejected to a considerable distance. This has been observed and reported to us by Mr. J. C. Melcher, of O'Quinn, Tex. It has also been recorded in Insect Life as occurring on orange trees in Florida and on cabbage and okra in Mississippi. On August 8, 1896, the records of the Bureau of Entomology state that specimens were received from Joseph Husband, Leanderville, Ill. He wrote that they infested apple, pear, and plum trees, and he had counted 14 specimens on a young shoot 18 inches long.

Dr. F. H. Chittenden states that the species is abundant in the District of Columbia, and prefers for food the half-woody stems of volunteer parsnips growing in shade. The nymphs and adults are found particularly on elder. The species has been previously noted on cotton by Riley, Mally, and others, but no injury was reported. We must therefore conclude that, although occasionally injurious to grapes, the species is practically harmless to cotton.

DESCRIPTION OF NYMPH, BY E. D. BALL.

Head of general form of adult, less inclined and slightly more inflated, almost semicircular before the eyes and evenly rounding on to front. Body stout, about as wide as head, with abdomen tapering to a blunt apex. Color pale straw, marked with irregular pale fuscous lines and spots. Vertex with a fairly definite band connecting the antennæ, and another between the eyes, usually interrupted in the middle and connected by longitudinal stripes, dividing the disk of the vertex into irregular oval compartments. A median basal pair of compartments contain two very definite dark spots. Anterior margin of vertex and front with three longitudinal stripes, the median one narrow and definite, the lateral ones broad and irregular above and narrowing down to a line below, where they curve in and unite with the median one. All three stripes interrupted by a narrow light line apparently separating vertex and front. Pronotal and abdominal segments very irregularly marked with stripes and dots. Legs pale.

[a] 1890: Riley and Howard, Insect Life, Vol. II, p. 321.

[b] 1890: Riley and Howard, Insect Life, Vol. III, p. 123.

[c] 1900: Bul. 69, Minn. Agric. Exp. Sta., p. 136.

[d] 1889: Riley and Howard, Insect Life, Vol. II, p. 161, and 1891: loc. cit., Vol. III, p. 415.

AULACIZES IRRORATA Fab.

(Fig. 33.)

This species is also not uncommon on cotton. Mr. Lewis found it feeding on cotton at Terrell, July 2, 1904. Eggs were laid in a cotton stalk in the laboratory on July 6, one bunch of twelve and another of sixteen. The eggs hatched July 14, the young nymphs being nearly white. On July 15 eggs taken on cotton in the field had also been deposited in the stem. The eggs are laid in a row up and down the stalk just below the epidermis. In ovipositing, the female inserts her ovipositor just beneath the epidermis and deposits an egg, then backs a little and deposits another until a slit about half an inch long, in which the eggs are laid, is formed.

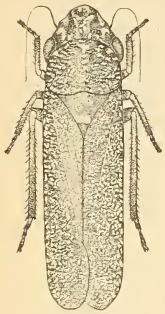

FIG. 33.—*Aulacizes irrorata:* adult—much enlarged (author's illustration).

Adults were taken at trap light at College Station, May 27, 1904, and at Courtney, Tex., October 10, 1902.

GYPONA OCTOLINEATA Say.

This is a common inhabitant of cotton fields and was specially noticed at Wellborn, May 29, 1904.

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