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"THE BOLL WORM"

AND

"THE COTTON WORM."

BULLETIN NO. 8,

OF THE

State Department of Agriculture.

E. C. BETTS, COMMISSIONER.

AUBURN, ALABAMA—1885.

In the preparation of this bulletin, free use has been made of following publications:

1st., "Report upon Cotton Insects" by Prof. J. H. Comstock, Entomologist, published by Department of Agriculture, Washington D. C., 1879.

2nd., Bulletin No. 3, "The Cotton Worm", by Prof. C. V. Riley, chief U. S. Entomological Commission, published by Department of Interior, Washington D. C., 1880.

3rd., An additional account of the cotton and boll worms by Prof. C. V. Riley, Entomologist, in the annual report of Department of Agriculture for 1882.

4th., Bulletin No. 3, "Division of Entomology" U. S. Department of Agriculture, Washington D. C., 1883.

From the "Report upon Cotton Insects" have been taken the illustrations of the eggs; and the colored plates of the boll and cotton worms in all their stages. No claim is made for originality in this bulletin, but an earnest effort to get before the public the latest facts upon these subjects.

AUBURN, ALA.,
March, 1885.

EXPLANATION TO PLATE VIII.

Heliothis armigera. (Original.)

FIG. 1.—Verticle section of a fully-expanded cotton flower, at end of the first day of blooming, showing a young boll-worm at work.

FIG. 2.—Boll-worm moth seen from below.

FIG. 3.—The same seen from above.

FIG. 4.—Dorsal view of a partly grown larva.

FIG. 5.—Side view of a nearly full grown larva.

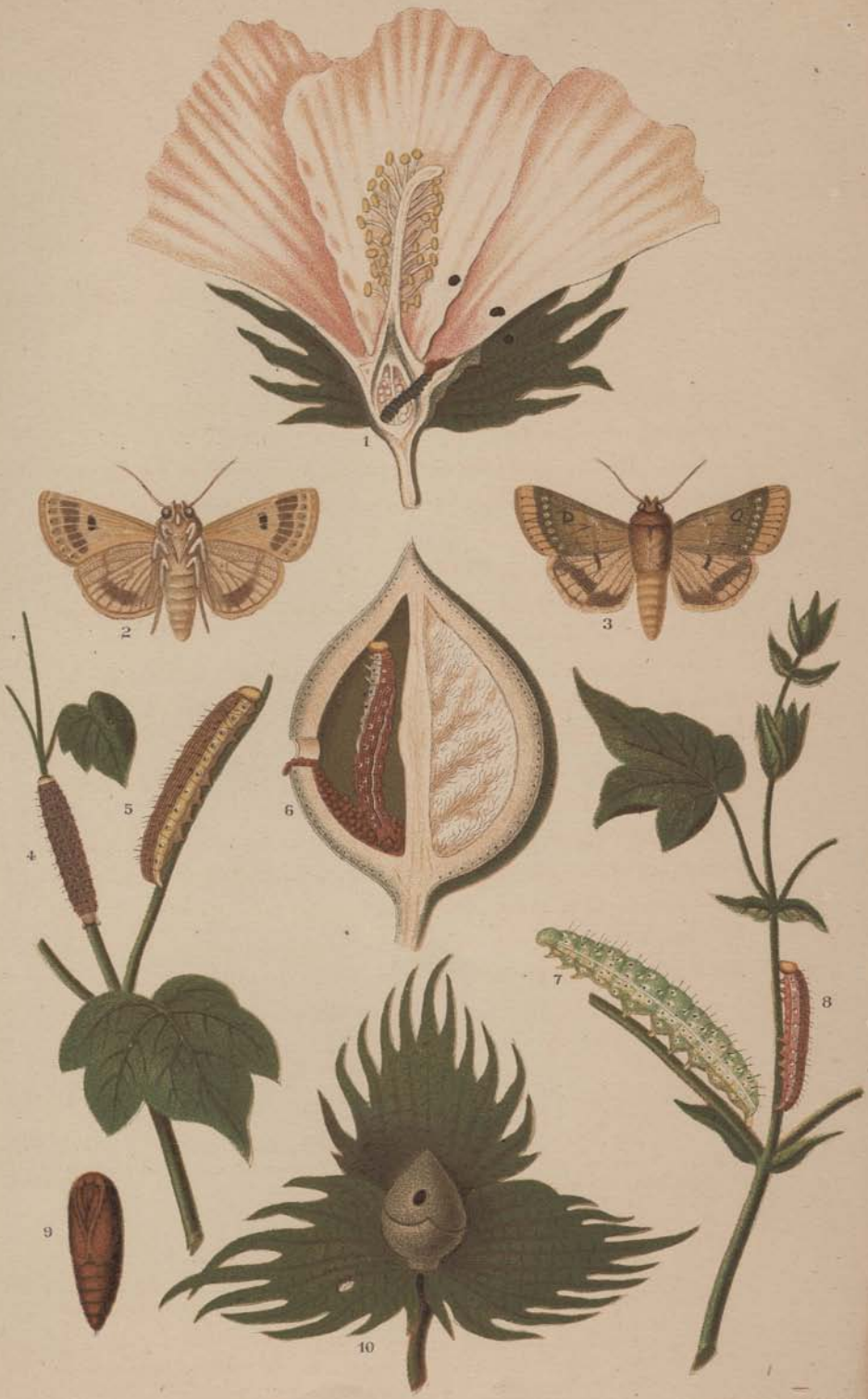
FIG. 6—Verticle section of a large green boll, one compartment of which contains a boll-worm that has eaten the contents of the cell, the bottom of which is occupied by its frass.

FIG. 7.—Full-grown green boll-worm.

FIG. 8.—Young rose-colored boll-worm, often seen in cotton flowers and on corn silk.

FIG. 9.—Pupa seen from below.

FIG. 10.—Young boll pierced by a small boll-worm. The injury has caused the involucre or "ruffle" to flare open.



From Report of Department of Agriculture 1879.

A. Hoen & Co. Lithocaustic Baltimore.

THE BOLL WORM

Heliothis armigera (Huebner.)

THE BOLL WORM.

(*Heliothis Arm'gera*—Huebner)

Last summer the excessive injury to the cotton plant in the "black belt" of Central Alabama by the "boll worm," caused general and loud complaint. This pest appears, more or less, upon every cotton plantation each year, and the pierced shrunken boll, with wide spread involucre, lying dead here and there upon the ground beneath the plant, informs the planter of its presence. The aggregate of injuries to the cotton plant by this worm is but slightly, if any, below that of the cotton caterpillar, (Aletia Xylina), which is, and has been, the terror of so many planters in the lower part of the cotton belt. The following will show this: The caterpillar appears periodically in large armies, but over limited areas, and if unchecked in its ravages, carries destruction in its pathway. Its visits are confined, however, to the lower cotton belt, and if by reason of the lateness of the season, or other causes, it reaches the upper or northern portion, it benefits rather than injuries, by removing the excessive foliage and hastening maturity of the bolls. The caterpillar lives only on cotton, and when the supply of this plant is exhausted must perish for the want of food. It hibernates only in the Southern belt and is sustained in the early spring by the "rattooned" cotton which has survived the winter's cold. It has many natural enemies which assist in its destruction, several mammals, many birds, spiders, beetles, flies, wasps, ants, and above all its own numerons parasites. The caterpillar can also easily be destroyed by the judicious application of poisons, and many farmers now dread its approach, only as an item of cost in the purchase and use of Paris Green.

The boll-worm on the contrary, makes its appearance annually with far more destruction in some seasons than others. Its theatre of action is the entire cotton belt, and its operations are upon the extensive rather than intensive system. It is found here and there as a picket or scout, each worm doing its full share of damage, which in the aggregate is large, but it is generally widely distribu-

ted so that no one neighborhood or planter suffers severely therefrom. Occasionally these pickets and scouts multiply so rapidly as to constitute a very formidable skirmish line, which defies the planters' efforts at its destruction. Then it is, that indignation is excited, alarm aroused and full appreciation of its damages entertained. It hibernates everywhere and eats almost everything. It has comparatively few enemies and only one or two known parasites. It is not easily mastered by poisons, and the remedies against its ravages are few and inefficacious.

From above comparison it will be seen that over a large part (the northern portion) of the cotton belt, the boll-worm is more to be feared than the caterpillar, and that even in the southern portion, that those farmers who openly express grave apprehensions from the results of the boll-worm, have their fears well founded upon the known habits and peculiarities of this insect. It is asserted by many intelligent farmers, and not disproved by statistical information, that the aggregate damage to the cotton crop through a given series of years by the boll-worm, is greater than that inflicted by the caterpillar.

But what is this "boll-worm?" Of names it has many; a true cosmopolite, it is at home in every clime. It is almost omnivorous in its diet, with the digestion of an ostrich. It is the old well known "corn-worm" which has periodically caused so much injury to the corn crop of the West. In the South, when it occurs on the corn, it retains its common name "corn-worm"; when it attacks the cotton, it is called "boll-worm", when, in early spring, it pierces the tender bud of the very young corn plant it is called the "bud worm". Tomatoes are sometimes seriously injured by the same worm, it is then called the "tomato-worm." All of these names are applied to the same worm, but as we are mostly concerned about its attacks on cotton, we shall throughout this bulletin call it "The Boll-Worm."

The Geographical range, of this worm is very extensive, specimens have been exhibited and identified from Asia, Australia, Europe and America. Indeed so wide is its distribution that, Mr. Grote, a famous entomologist, long since predicted that future entomologists would in their description of this insect, write after its habitat, *the world*. This prediction is justified by a knowledge of the large number of plants, which furnish it with food. Beside those plants already mentioned, it is found, according to Prof.

Riley, upon many others. Nearly every family of plants furnishes a species for its voracious appetite. Palatability is ignored in its selection of food; for we find it, first on the corn, consuming its starchy constituents, then on the young cotton bolls, eating the woody fibre. It is excessively fond of our garden pea, (*Pisum Sativum*) and sometimes feeds on the string bean (*Phaseolus Vulgaris.*) In 1879 Messrs. Landreth & Sons, seedsmen near Philidelphia had their Lima Beans "damaged to the extent of from 3 to 5 per cent." It also feeds upon our Southern cow peas, (*Vigna and Dolichos,*) but its method of attack upon these is quite different from that upon the garden pea and bean. With these it bores directly into the pod and never leaves it until the contents are consumed With the cow pea it bores in opposite a pea, destroys it, comes out and enters again opposite another pea; this in preference to piercing the fleshy partitions which separate each pea. It is found in Europe upon Lucerne (*Medicago Sativa*) and on the Chick pea (*Cicer Arietinum*), both leguminous plants. A wild plant belonging to this same family of Leguminosae and known as Erythrina Herbacea commonly found near the Southern coast, is a favorite food. Even the narcotic properties of tobacco are not objectional, since in Europe it has seriously injured the crop by devouring its leaves. Our common Jamestown or Jimpson weed (*Datura Stramonium*) and the ground cherry (*Physalis*) are frequently infested by it, while the pungent and stimulating red pepper (*Capsicum Annuum*) is not always free from its attacks. Pumpkins (*Cucurbita pepo*), melons (*Cucumis Melo*) squash (*Cucurbita Verrucosa*) and Okra (*Hibiscus Esculentus*) are some of our garden plants which are occasionall injured by the boll worm. Many other plants could be given upon which this worm has been found, but these are enough to attest its diversified taste. Nor is this taste confined to vegetables only, for it has been known to eat the pupae of the cotton caterpillar, and to devour each other, especially when in confinement, the larger ones dining upon the smaller.

The identity of the destructive corn-worm with the cotton-boll worm, now known to nearly every farmer, was not discovered, or if discovered not published officially till the year 1854. In the Annual Report of the Department of Agriculture for that year, we find the following from the pen of Mr. Townsend Glover, then entomologist of the Department:

"There is a striking similarity between the boll-worm and the

corn-worm in appearance, food and habits, both in the caterpillar and perfect state, which leads to the supposition that the boll-worm may be the young of the corn-worm moth, and the eggs deposited on the young bolls as the nearest substitute for green corn, and placed on them only when the corn has become too old and hard for their food. Col B. A. Sorsby, of Columbus, Miss., has bred both insects and declares them to be the same; moreover, when, according to his advice, the corn was carefully wormed on two or three plantations the boll-worms did not make their appearance that season on the cotton, notwithstanding on neighboring plantations they commit great ravages."

This gives the credit of the discovery to Col. Sorsby, of Columbus, Miss., yet in the *American Cotton Planter*, of July 1850, Mr. J. W. Boddie, of Jackson, Miss., has the following to say:

"This insect is an anomaly in the natural history of insects, for it is much more destructive to the plant, cotton (*Gossypium*), for which it was never made, than to the one to which it naturally belongs, corn (*Zea mays*).

"If I am right in my supposition, this insect is the caterpillar we find in the end of ears of corn, eating the silk and some little of the corn. This insect is at the North as well as at the South—in fact it is wherever the corn grows, and will never depredate on the cotton plant save through necessity."

Subsequently several gentlemen independently discovered and published the same fact.

The fololwing descriptions of the Egg, Larva, Chrysalis and Moth of the boll-worm, is taken from the "Report on Cotton Insects," by Mr. J. Henry Comstock, furnished to the Department of Agriculture and published in 1879:

THE EGG.

"The egg of the boll-worm moth, (see figure 1) differs in form from that of the cotton-worm moth by its much greater diameter through from top to bottom, looking, as one author aptly expresses it, 'as though molded in a tea-cup, while the cotton worm egg was moulded in the saucer.' The two diameters of the egg are nearly equal and are about the same as the greatest diameter of the egg of *Aletia*. In color also it differs from the egg of *Aletia*, the latter being of a delicate green, scarcely distinguishable from the leaf, while the former is nearly white and easily detected upon the plant. A noticeable feature of many of these eggs is an irregular reddish brown band near their summits, which gradually disappears with the development of the embryo. The sculpturing of the egg is almost identical with that of the cotton-worm moth. The number of eggs laid by the female *Heliothis* must approximate pretty closely to that laid by the female *Aletia*. According to Mr. Glover, a single female boll-worm moth dissected by Dr John

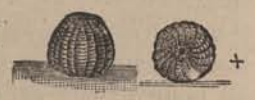


FIG. 1.—Egg of Boll Worm.

Gamble, contained upwards of 500 eggs. From their greater thickness, this number of eggs would necessarily take up more room than the same number of *Aletia* eggs, and hence we find that the female *Heliothis* is more robust than the *Aletia*.

"From all accounts, the favorite ovipositing time is at or shortly after twilight, when the moths are flying in great numbers. Concerning the place of deposit of the eggs, however, published accounts have differed. Mr. Glover says:

"'The egg is generally deposited singly on the outside of the involucel or outer calyx of the flower or young boll, where it adheres by means of a gummy substance which surrounds the egg when first laid, and which hardens by exposure to the atmosphere It has been repeatedly stated by planters that the egg was deposited on the stem, and that the young stem forms the first food of the newly hatched caterpillar; but after a careful examination of several hundred stems I found only one egg placed in this situation, and that, from the fact of its being laid on its side instead of the base, had evidently been misplaced.'"

"Professor Riley, in his Third Missouri Entomological Report follows Mr. Glover quite exactly, saying: 'It is usually deposited singly on the outside of the involucre or outer calyx or young boll.

"Observations made during the past two years would seem to disprove this statement of Mr. Glover pretty effectually. I found it to be the exception that the eggs are laid upon the involucre. Although I have found them upon all parts of the plant, the majority of them seem to be deposited upon the lower surface of the leaves, as is the case with the cotton-worm eggs I made a careful search of many plants while in the cotton fields of Alabama, and the following note will serve to indicate the usual distribution of the eggs: 'On one plant I found eleven eggs, which were distributed in the following manner: One on the involucre, two on the stalks, and eight on the leaves.' Mr, Trelease states in his report that he found them upon the petioles and both surfaces of the leaves, and upon the outer surface of the involucre.

"The duration of the egg state varies with the season of the year, much as it does with the egg of the cotton-moth. We have no data as to the actual length of time between the laying of the egg and the time of hatching, but it probably approximates to *Aletia* in this respect, although the time may be somewhat longer.

THE LARVA.

"As just stated, we have disproved the old idea that by far the majority of the eggs are laid upon calyx and involucre, and it consequently follows that the received opinions as to the newly hatched worm boring immediately into the boll or flower bud must also be thrown aside. The worm after gnawing through its egg shell makes its first meal upon the part of the plant upon which the eggs was laid, be it leaf, stem, or involucre. Should it be laid upon the leaf, as is usually the case, it may be three days before the worm reaches the boll. Should it be laid upon the involucre, the young worm bores into the boll at an earlier date. As a rule we may safely say that where the egg is laid upon the involucre the worm

pierces through within twenty four hours after hatching.

"The newly hatched boll-worm walks like a geometrid larva or looper, 'a measuring worm,' as it is often called. This is easily explained by the fact that, while in the full grown worm the abdominal legs or pro-legs are all nearly equal in length, in the newly hatched worm the second pair is slightly shorter than the the third, and the first pair is shorter and slenderer than the second, a state of things approaching that in the full grown cotton-worm, though the difference in size in the former case is not nearly so marked as in the latter. This method of walking is lost with the first or second molt. There is nothing remarkably characteristic about these young larvae. They seem to be somewhat thicker in proportion to their length than the young cotton-worms, and they have not so delicate and transparent an appearance. Their heads are black, and their bodies seem already to have begun to vary in color. The body above is furnished with sparse, stiff hairs, each arising from a tubercle. I have often watched the newly hatched boll-worm while in the cotton fields. When hatched from an egg which had been deposited upon a leaf, they invariably made their first meal on the substance of the leaf, and then wandered off for a longer or shorter space of time, evidently seeking a boll or flower bud. It was always interesting to watch this seemingly aimless search, the young worm crawling first down the leaf stem and then back, then dropping a few inches by a silken thread, and then painfully working its way back again, until at last it found the object of its search, or fell to the ground, where it was destroyed by ants.

"We may safely say then, that the young larvae feed for a longer or shorter space of time upon the part of the plant on which they are born, but usually migrate sooner or later to flower-bud or boll. That the worm may occasionally attain full growth, having fed upon the leaves alone, is suggested by the fact that Mr. Trelease, on May 30, found a partly grown boll-worm feeding upon the leaves of cotton. At this time the forms were very few and very small. Comparatively early in the season, when feeding upon buds or small bolls, a single worm often does a great amount of damage, proceeding from bud to bud or from boll to boll.

"The destruction of the essential parts of the flower before the boll proper is formed, is sometimes as great a source of loss as the destruction of the maturing bolls.

"It is quite a common sight to see large worms in the flower, as also the younger individuals, the latter, however, usually having penetrated the bud and forced the premature blossom.

"As the boll-worms increase in size, a most wonderful diversity of color and marking becomes apparent. In color, different individuals will vary from a brilliant green to a deep pink or a dark brown, exhibiting almost every conceivable intermediate stage, and from an immaculate, unstriped specimen to one with regular spots and many stripes. The green worms are more common than those

of any other color; but those of varying shades of pink or brown are so abundant as to make it impossible to fix upon a type. Early in the season (as will be hereafter shown) the prevailing color is green. A common variety is light green in color. Running from the first ring back of the head to the posterior end of the body on each side is a broad whitish line; just above is a broad dusky line; down the center of the back is another dusky line, or stripe, as it should preferably be called; this dorsal stripe has a narrow white line down its center, and it is bordered on each side by a narrow white line. Between the dusky dorsal and lateral stripes run four or five very faint, wavy, longitudinal, white lines, so faint as not to interfere with the general color of the body. Each body-ring has eight black spots, which, upon being examined with a lens, are seen to be tubercles, each with a stiff hair upon its tip. These spots are arranged in two transverse rows of four, the spots in the front row being slightly closer together than those in the back row; the outer spot of the back row is small and placed nearer the front row.

"Of these features the most constant seems to be the whitish stripe on each side. When the boll-worm is brown these stripes assume a yellowish hue. They are shown in all illustrations of the boll-worm yet published, and are present in all specimens in the department collection. Another pretty constant feature is the relative position of the tubercles just described. They are not always of a contrasting color to the rest of the back, and hence cannot always be spoken of as spots. When they are not discernible as spots, however, an examination with the lens shows them still present as tubercles, each surmounted by a hair. This point affords apparently a good and reliable means of distinguishing the young boll-worm from the young cotton-worm, which otherwise might prove a matter of difficulty during the earlier stages and in the early part of the year, before black cotton worms are to be found. In the cotton-worm the two middle spots of each of the two rows of four are of the same distance apart, so as to form the four corners of a rectangle. In the boll-worm. however, the two middle spots of the hind row are more widely separated than the corresponding spots of the front row. This distinction may be recognized at a glance when the eye has become accustomed to it. The dusky dorsal stripe is often wanting, as also are the dusky lateral stripes, and, as just stated, the spots are often indiscernible.

"We have shown elsewhere that the larva of *Heliothis* has one redeeming character in its occasional cannibalistic and predaceous turn of mind. Boll-worms, when in confinement, have the habit, in common with other lepidopterous larvae, of devouring one another. All through the past summer larvae were being sent to the Department from the South, but whenever several boll-worms were mailed in the same box, one only would reach us alive, all the others having been destroyed. This was the case even when the box was filled with cotton leaves and bolls or corn leaves. It might, however, be

said that the food dried up on the journey, and that hence they were driven to destroy one another; but, the fact is, that even when confined in breeding cages, where fresh food was always at hand, and where the conditions were made as natural as possible, they seemed as hungry as ever for their companions, and it was impossible to rear more than one in the same box or cage.

"Still more conclusive, however, and of extreme interest, is the fact that Mr. Trelease actually saw, upon several occasions, on the plant and undisturbed, large boll-worms catch smaller ones, which they devoured 'hoof and hide,' or simply pierced the skin with their mandibles, so that the juice could be sucked, the refuse being dropped.

"In addition to this we have the fact fully established during the past season that the boll-worm, in a state of nature, preys more or less frequently upon the chrysalis of the cotton-worm.

"In the specimens sent to the Department, the full-grown boll-worm was found entirely within the folded leaf and the hind end of the body of the chrysalis was eaten into.

"Judging from the data at hand, the duration of the larva state of *Heliothis*, or, in other words, the *worm* state, seems to vary from eighteen to twenty-four days in the cotton-belt, depending much upon the climate, the state of the weather, and the food plant. When full-grown it transforms to a chrysalis, with very different preliminaries from those which prepare the cotton-worm for pupation.

THE CHRYSALIS.

"Almost all of the statements regarding the pupation of the boll-worm have been to the effect that the full-grown worm descends into the ground to the depth of several inches, and there forms itself an oval cocoon of gravel and earth, cemented together by its gummy silk.

"Prof. G. H. French, of Illinois, has studied the chrysalis of *Heliothis* carefully of late, and sums up his observations as follows:

"'In digging for the chrysalis around the corn-hills, I found that instead of their occupying an oval earthen cocoon, as has usually been written of them, and as they apparently do in the breeding box, they were down in the ground from five to six inches below the surface, in a hole about a third of an inch in diameter, reaching from the chrysalis to the top of the ground, where it was covered with a thin film of dirt from an eighth to a quarter of an inch thick. This hole was larger at the bottom than at the top, apparently so as to give full motion to the chrysalis, and usually bent in its course so the lower part would have an inclination of perhaps forty-five degrees. At the bottom would be found the chrysalis, the small end downward and the head upward. In one case I found the hole so bent that the chrysalis occupied a horizontal position. The hole was smooth inside, and was, perhaps, made so by cementing the earth together, but of that I could not tell, for the whole ground was moist, though dry enough to be firm.'

"In reference to these observations of Professor French, Mr. Trelease says, in a recent letter:

"'In deep breeding-jars, with four or five inches of loose soil, I found that the larvae of *Heliothis* went several inches from the surface before forming their cocoon, but did not notice a passage leading down. As I did not notice very closely, such a tube may have been there, but I think if so I should have seen some trace of it. In all cases there was a thin film of silk. In the field I saw numbers plowed up, but did not dig for any

with care. Of course, the plowing would have destroyed such a tube, but I sometimes found the silk about the pupa, though always more or less torn.'

"The rearing of boll-worms at the Department would seem to show that in loose, friable earth the passage made by the worms in their descent becomes obliterated by the falling together of the earth behind them; but it seems probable that, in compact soil, any larva entering the ground would leave a rough passage behind it. A thin film of silk has always been noticed lining the cell in which the chrysalis is found.

"In addition to the prominent distinguishing point that the chrysalis of *Aletia* is invariably found only above ground, and is normally found in rolled leaf and slight cocoon, while the chrysalis of *Heliothis* is invariably found only below the surface of the ground, normally in a smooth shell, lined with a thin film of silk, it may be well to mention the characteristic points which distinguish the chrysalis themselves.

"The pupa of *Heliothis* is reddish or light brown, and polished, and the pupa of *Aletia* dark brown, sometimes almost black, with the lower margin of the abdominal rings, 4 to 6, of a reddish-yellow or saffron color; it is not polished, but has a greasy appearance. The pupa of the *Heliothis* is rather stout, and the last segment is rounded and furnished with two slender, straight spines. The pupa of *Aletia*, contrary to this, is quite slender, especially the abdomen, the last segment is not rounded, and its tip is prolonged into a tail like appendage, which bears at the tip 4 spines, the ends of which are curved so as to form a loop; four similar spines are placed transversely in a row, a little in front of the terminal 4 hooks; this makes eight spines for *Aletia* and only two for *Heliothis*; the stigmata or breathing holes are rather conspicuous on the pupa of *Heliothis*, and scarcely noticeable on the pupae of *Aletia*.

THE MOTH.

"It is a very variable species, and it is owing to this fact that American specimens were so long considered to form a species distinct from the European. In size the variation is not great, the smaller individuals having an expanse of wing of an inch and three-eighths, and the larger ones expanding an inch and three-quarters. The general color of the body and upper wings varies from a light gray tinged with olive green, to a rich yellow gray, almost tawny. In some specimens the markings of the fore wings are almost obliterated, and in others, they appear with great distinctness. On the hind wings there is great variation in the size of the light spot within the dark band; in some specimens it is not discernable, and in others its length equals half the breadth of the wing. The width of the black band of the posterior wings also varies greatly. The moth is so very different from *Aletia* that even a hasty glance at the plates will enable the planter to distinguish them. The most prominent distinguishing feature, and one that can be recognized at a glance, is the broad black band on the hind wings of the boll-worm moths. When at rest the latter does not

tightly close its wings roof shaped over its back, as does the cotton-worm moth, but holds them slightly open, so that the black band is plainly seen.

"The moths begin to fly shortly after sundown. During the day, when disturbed, they fly out with the quick darting motion peculiar to most noctuids under such circumstances—a flight almost precisely like that of the cotton-moth. At night, however, their flight is freer and more sustained. As has been noted in the adult *Aletia*, these moths feed at night upon the nectar secreted by the glands of the cotton plant, the cow-pea, the greater coffee weed, and probably upon others. Their methods of feeding are almost precisely like those of the cotton-moth, the antennae being kept in constant vibration. They also, upon occasion, hover before a gland, steadying themselves by their fore legs. When at rest and sucking nectar, they do not fold their wings like *Aletia*, but keep them slightly raised and partly open. We have not heard of this moth being found to feed upon fruit, as *Aletia* does, though it is probable that this may occur, as the tip of the proboscis is spined in a somewhat similar manner."

NUMBER OF BROODS.

The chrysalis of the boll worm, which has hibernated in the ground, gives forth the perfect worm early in May in the central portions of Alabama. This first brood is our

BUD WORM,

and as such, is in certain wet localities very destructive. These moths deposit their eggs *usually*, upon the tender leaves of the young corn, *occasionally* upon the cotton plant now just appearing above the surface of the ground, and *rarely* upon other food plants. In a few days the larvae are hatched and begin life by feeding upon the leaves on which the eggs were deposited. These leaves soon become riddled with small irregular holes; after which the worm makes its way to the bud, where they perform the work of destruction. Every farmer is familliar with the appearance of a corn plant which has been destroyed by the bud-worm, and an examination of the plant by slipping off its outer leaves will reveal a brown colored excrement, increasing in quantity until the pale green worm is found hid away in the closely folded bud of the plant. After the worm has destroyed the bud and attained its full size, it cuts its way out by a circularhole through the leaves, falls to theground where it undergoes transformation to a moth and these moths deposit the eggs of the second crop. The injury done by this insect in the role of the bud worm to our young corn, is difficult to estimate. It varies in different localities and seasons. It is greater in wet than in dry spots and always more destructive to late planted than early planted corn.

It has been estimated that from 2 per cent. to 5 per cent. of the young corn of the state is annually destroyed by this worm—an amount perhaps startling to many farmers who have given this subject but little attention, but we venture the assertion, that a careful examination of any field of corn in the state the coming season, will show a much larger proportion of young corn plants destroyed by this worm, than is ordinarily supposed. It will seldom be found that less than one plant out of fifty is attacked.

THE SECOND BROOD

makes its appearance in central Alabama about the first of June and again lays the majority of its eggs upon the corn leaves as before, though now an increased number is deposited on the cotton plant. This brood of larvae feed at first upon the corn leaves, then on the tassels, then on the silks and finally as they approach full growth upon the tender ear of corn. Reaching maturity, they bore through the shuck and fall to the ground, where they again transform and produce

THE THIRD BROOD.

It is this brood which inflicts the severe damage upon the corn. It is this brood which is called the corn worm and silk worm. It appears early in July and this time its eggs are laid on or near the ears of corn. As yet but few are laid upon cotton, even when growing in the same field. The young worms feed upon the silk and milky grains near the end of the ear of corn. In this way they do great damage. Besides the destruction which they themselves perform, by their work, they partially lay bare the extremity of the husk, and thus exposing it to the weather, causes more or less rot and mildew, which renders the ear unfit for use. The worms of the first two broods are mainly pale green, while these vary in color through different shades of green, pink and rose. These worms attain full growth in a shorter time than the former broods, but like the others when they attain growth they bore through the husk, fall to the ground and pass through the same preparation as before and form

THE FOUTH BROOD,

which constitutes our destructive boll-worm. This brood of moths appear early in August; at which time the ears of early corn are rapidly hardening. Instinctively, in the absence of late corn, they now lay their eggs upon the cotton which is succulent, leafy and full of bolls and squares. Soon the young worms appear, begin

their work of destroying the young forms and bolls. To the planter this is by far the most destructive brood.

A FIFTH BROOD

appears in September, and is almost exclusively confined to cotton. This brood is not so destructive as the fourth, since the cotton is now well on to maturity, the nights are colder, the season for the growth and development of this insect, very nearly over, and hence, except in the extreme southern portion of the State, this is our last brood for the year, and the *chrysalides* from this brood penetrate the ground and there in their cells pass the winter.

The above order of appearance and habits of each brood, is in the main correct, yet there may be exceptions. Favorable seasons and localities may increase the above number of broods Again, late planted corn may be more or less injured by the fourth brood, which usually attacks cotton, and there are exceptional instances where cotton is slightly injured by the second and third broods, but observation has plainly demonstrated that corn diet, when in proper condition, is the normal food of this insect. Again, when the early crops of worms are very abundant, we should expect to find them infesting the cotton, especially if corn is not grown in the vicinity. The occasional early reports of the destruction of cotton by the boll-worm may be thus explained.

We have given five broods as the total number found in one season in this latitude. Sometimes there are apparently many more. This discrepency arises from the facts that not all of the moths issue simultaneously from their winter quarters; that after issuing, some lay eggs sooner than others, according as suitable places are found, and that circumstances develop some larvae faster than others. These would cause irregularities in the start, which would multiply during the season, until finally, we could easily find in the same field the insect in every stage of development and growth. Occasionally the boll-worm hibernates as a moth, but it is an exception, the chrysalis state under ground, being the rule.

WET OR DRY SEASONS.

Is the boll-worm more numerous during wet or dry seasons? Do they do most damage in dry sunshiny weather or when wet and damp seasons prevail? The testimony of the farmer is conflicting on this subject, though the mass of it, is on the side of wet weather and damp soils. An explanation of this has been made by ascribing to the ants the faculty of destroying, in a large measure, the eggs and larvae of the boll-worm. It is well known that ants inhabit only

dry spots and multiply more rapidly under sunshine. It is also well known that many species of this little animal destroy both caterpillar and boll-worm. It is highly probable, then, that ants aid in protecting the plants by eradicating the boll-worm, but they cannot be responsible for all the facts which observation has established. We would rather suspect that a rank and succulent plant would furnish more and better food than a dry and stunted one. Again moths are supported by sucking nectar from certain glands of plants. May not healthy growing plants supply more nectar from their glands to feed moths than dwarfed and stunted ones? This *nectar gland theory* is now accepted in connection with ants, and the juicy succulent growth of cotton, as having much to do with the prevalence of both the boll-worm and cotton caterpillar. Mr. Wm. Trelease has published a special paper on "Nectar—what it is and some of its uses," which was published in "Report on Cotton Insects" Department of Agriculture, 1879. From this paper we make the following extracts:

"It has long been known that specialized organs for the elaboration of nectar glands, exist in the flowers of many plants, as well as outside of the floral envelope."

In the cotton plant he found and described three distinct sets of these glands—in the flower—around the flower—on the involucre, and on the leaves.

FLOWER GLANDS.

Mr. Trelease "found within the corolla, where the petals separate from one another, and from the staminate column, a set of small hairs, which are slightly viscid, as shown by the adhesion of pollen grains to them. What causes this viscidity? I infer this viscidity of the hairs is caused by exudation of true nectar.

INVOLUCRAL GLANDS.

"Each flower of the cotton plant is surrounded by a *whorl* of three large *laciniate* bracts, on the outside of which, near its base, is a nectariferous pit. Alternating with these bracts, and just within the circle formed by their bases, smaller than the former, but like them, active, are three other pits. The first few flowers that open possess only the rudiments of glands, but all after the first few, possess the outer set, though it is not till the cotton has been blooming about amonth that the inner set appears. Observing flowers which possess both sets fully developed, we find that a number of days before a flower bud opens, all of its involucral glands are visited more or less frequently by ants; and occasionally a wasp or hive bee may be seen about them, although to our eyes they are dry. Evidently, then, they secrete a thin sugary film. The evening before such a bud opens, its visitors increase in number, and we may

perhaps see a little nectar in the glands. But during the night preceeding its unfolding, its cups fill out with the sweet fluid which is collected by large numbers of ants, and early the next morning a large drop may be seen suspended from the lower margin of each, or in some cases running down the base, and throughout this which may be called *the* day of blooming, bees, wasps and ants of many species may be found in constant attendance on the glands. Though drawn so close to the flower, these insects never enter them. * * * * During the night when this abundance of nectar is collecting, they are visited by thousands of moths of the boll worm and cotton worm whenever these moths are flying and laying their eggs. * * * The flowers of the cotton plant suffer from the attacks of the larvae of both these moths, but most of the eggs of both species are laid on other parts of the plant than the flowers or floral appendages, consequently a larva to reach the flower must ascend the peduncle and run the gauntlet of ants, wasps and bees found at its summit: though I never saw one ascending when these insects were at their post, and therefore never had an opportunity to see what would happen then. I found that when these larvae are on the leaves of the plant they are sometimes attacked and killed by the ants without any provocation. So it appears that the secretion of these glands first attracts the worst enemies of the plant and then attacts their enemies which afford it partial relief from the misfortune that it has brought on itself."

GLANDS OF COW PEA.

It may be remarked here that our common cow pea has similar glands at the top of the flower stalk, which are much frequented by ants. These glands are visited by the moths of boll worm and cotton worm, but only the former "oviposit" on it and this in but small numbers, its larvae feeding on the green seeds.

LEAF GLANDS.

"The third set of glands are to be found on the leaf. On the lower surface of the leaf of the cotton plant, not far from its base, the midrib bears a large sunken nectar gland and each of the lateral veins of the larger leaves bears a similar gland. As shown by the visits of ants, the gland of the first leaf begins to secrete when the seedling plant has about four leaves expanded, but it is not until some days later that enough nectar is produced to be noticeable and from this time on, the gland secretes abundantly until the leaf becomes old or deseased. When a gland is in vigorous secretion it may be examined at almost any time of the day and barely enough fluid will be found in it to fill the pit two thirds full, but during the night and until some time after sunrise in the morning, great crops of the sweet fluid may be found hanging from its border. This nectar is sought at night by the moths of both boll and cotton worms, the latter of which has been seen to alternate sipping the nectar with ovipositing."

A careful reflection upon the above, will perhaps suggest to every thinking man, that these glands, their supply of nectar etc. may have much to do with the prevalence of both the boll and cotton worm.

REMEDIES.

It is greatly to be regretted that as yet no specific has been found by which this pest can be successfully destroyed. Many farmers have tried the various remedies proposed, without satisfactory results.

TOPPING

cotton at a certain stage of its growth has frequeutly been done with the view of destroying the eggs of both boll and cotton-worms. By this process manv eggs are doubtless destroyed, but so many are left that it is doubtful whether the results compensate the labor involved. Several of our correspondents have tried this method. Mr. Charles L. Stickney, of Hale, says: "I have topped the stalks and main limbs on the first appearance of the fly, but with no perceptible results." Mr. W. H. Whetstone, of Lowndes, tried the same remedy in 1868, "on cotton planted on bottom land, about 1st. of August; result, complete failure."

POISONING.

No systematic efforts at poisoning the boll-worm alone, is reported by our correspondents. Still several found that in using Paris green and arsenic to destroy the cotton-caterpillar, that a "perceptible check" was also put on the boll-worm. Mr. B. J. Fort, of Dallas, gives this as his experience. Judge Lancaster, of Elmore, found that in poisoning the cotton-caterpillar with Paris green that "a large amount of boll-worms" were destroyed. Mr. C. A. Poellnitz, Jr., of Marengo, says: "I have never used any remedy for the boll-worm, but in using Paris green for the caterpillar, I notice the boll-worm generally stops." Mr. S. H. Gist, of Bibb, says: "Some have used Paris green with good results. The experience of these farmers would indicate that the poisons, when properly applied, would check materially the ravages of this pest. It is known that its eggs are generally laid on the leaves, and the young worms feed more or less on the leaves before they go to the forms or bolls. Again, the worms in going from boll to boll, often stop to eat of the leaves. Therefore poisons well distributed would

destroy some of the large worms and a great mumber of small ones. The time for poisoning must always be decided by the farmer, though generally, it will doubtless be found just as the fourth brood appears, or when the worms are leaving the

HARDENING

corn for the cotton. It is rarely ever the case that the poisons can reach the worm in the boll, still, in its transit from one boll to another, it may be killed as above suggested. We believe that poisoning is the only method of checking their destruction, unless a system of

WINTER PLOWING

is adopted. By this means the *chrysalides* will be exposed to the cold of winter, and if freezes occur, will be killed. We rarely have a winter without sufficient cold to kill these chrysalides when brought to the surface by the plow.

A ROTATION,

by which small grain, sowed in late fall or winter, could be made to follow corn and cotton, also suggests itself as a means of destroying the chrysalides. In the absence of winter plowing, it is suggested that a few small boys following the plows in the spring could find and kill a great many which would be brought up by the plow.

LIGHTS

in the fields at night, with attractive sweets, have been used by many farmers, but this practice, while destroying many moths, has not been effective. Planting a very late crop of corn in or near the cotton, upon which the worms may feed instead of the cotton, is recommended by some, but considered of little value by others.

HAND PICKING

of the early worms on corn, and on cotton, too, when they occur thereon, would materially reduce the numbers thereafter; but only the early crops could be so manage l, since it would be the height of folly to attempt such a thing after they have infested the cotton.

THE NATURAL ENEMIES

of this worm, insectivorous birds, ants, wasps, flies, ground beetles, etc., should be as far as possible protected. The assistance given by these in checking the ravages of this worm, is truly marvelous.

CAUTION.

Not all of the squares or young bolls which are found beneath the cotton plant have been destroyed by the boll-worm. Some perish from the want of proper fertilization, others from excessive drouths or moisture, and still others from injuries received by other insects. These insects have been noticed and described by several scientific observers, and some of our most observant farmers have long since learned to distinguish between the bolls destroyed by the boll-worm and those destroyed by other insects. These insects belong to the hemipterous order, and are usually very small.

REMARKS OF CORRESPONDENTS.

Before preparing this Bulletin questions were sent out to our correspondents throughout Middle and Southern Alabama. I give them in their order with the replies of each correspondent.

Question 1st. Has the boll-worm troubled you in cotton, if so at what time did it appear, and when its principal damages?

REPLIES.

We havn't had the boll-worn to do much damage in eight years. Eight years ago—or nine—they were pretty thick about the middle of Sept. From then until the 10th Oct. they do their worst.
J. A. McLennan, Barbour.

—

No boll-worms have ever injured cotton in this community in my knowledge.
W. H. Mahan, Bibb.

—

About the last of July.
C. W. Kumpe, Bullock.

—

Yes. they usually appear with the fruiting of the cotton plant, in what is called the squares or forms, punture them, which causes them to drop off and as the worm grows he attacks larger bolls. By the middle of September he is grown and does the most damage.
Jas. Orum, Bullock.

—

The boll-worm is usually more numerous in the latter part of July and first of August, sometimes doing great damage.
G. S. Lazenby, Bullock.

—

It has not.
R. A. Taylor, Chambers.

It has: I have known them to appear as early as the forms began, and continue on until Seplember.
E. A. Bryant, Clarke.

—

The boll-worm rarely troubles the cotton in this county. I have not seen, or heard of its appearance for a number of years.
S. Forward, Clarke.

—

The boll-worm has done but little damage for five or six years. It generally makes its appearance in July and continues until September. J. E. P. Flournoy, Coffee.

Yes!—First appearance usually about July 1st. Principal damage in July and August.
Robt. A. Lee, Conecuh.

It has troubled me from last July until the 1st. of September. B. J. Fort, Dallas.

The boll-worm rarely ever does any material damage on my lands, which are table oak and hickory lands, but in the lands along the creeks are sometimes very injurious.
J. F. Calhoun, Dallas

It does considerable damage sometimes. They attack the bolls when over half grown. August or last of July.
T. J. Craig, Dallas.

Yes! They appear about the 20th of July, and are in the greatest abundance about the middle of August.
P. R. King, Dallas,

Appearance so as to be noticeable about the 15th of July.
Judge J. A, Lancaster, Elmore,

The boll-worm has not troubled this county as far as my knowledge extends.
Rev. A. Vaughn, Geneva.

We have had no boll-worm.
J. W. Hall, Geneva.

It has—early in July—from 1st. of August to 1st. September. J. T. Smith, Greene.

We experience but little damage from the boll-worm now. July and August is the time of principal damage to fresh lands, no damage to old sandy lands,
L. A. Lavender, Greene.

Yes, last week in July. In August. It appeared two weeks earlier two miles south of this.
Chas. L. Stickney, Hale.

Occasionally it appears in August, and damages mostly in September.
D. C. Blackwell, Henry.

I have been raising cotton about thirty years, and don't think I have been damaged to any extent by the boll-worm.
Jno. T. Harris, Lee.

It has never done any damage in this part of the country. B. H. McCullough, Lee.

The boll-worm rarely ever troubles our cotton, and I cannot make any statement about them.
Wm. Lo ther, Lee.

Yes; about August 1st. It does its principal damage from the 5th. to 15th. of August.
W. H. Whetstone, Lowndes.

I have cultivated cotton on this plantation since 1843 up to date, in Montgomery county Ala., in Red river bottoms and Bossier parish La. In all that time there has never been a season that the boll-worm did not make its appearance in numbers sufficient to destroy all the forms and soft bolls, between the 1st. and 10th. of August, except in Red river bottoms, where it never is. Geo. N. Gilmer, Lowndes.

The boll-worm made its appearance in my cotton the past season in the latter part of June, and did its principal damage during July. Wm. M. Garrett, Lowndes.

The boll-worm has troubled my cotton more or less every year. Does not fail one year in six. They generally make their appearance about the middle of July. They attack the young boll as soon as it is formed, and you can tell it, for the young boll spreads open, and in a few days falls off. They often attack the boll when it is half grown, but generally before.
C. A. Poellnitz, Jr., Marengo.

Very bad. About the 15th of August.
F. E. Blount, Marengo.

It has been very destructive. Appears about 15th to 20th of July. Principal damage during August.
W. F. Strudwick, Marengo.

Yes. Appeared about the first of July, and last of July and August.
S. D. Nash, Monroe.

Yes. In July. It destroyed squares as well as grown bolls.
J. A. Calloway, Montgomery.

Yes. Middle to last of July. In August and September they do most damage.
Dr. J. C. Nicholson, Montgomery.

It appears at all times after the forms appear on the cotton, but are most destructive in August, especially if the weather is wet and hot. The boll-worm was more destructive in 1884 than I ever knew them, although the fall was exceedingly dry, but the cotton had an immense growth, owing to wet weather in early part of summer.
Hon. A. C. Davidson, Perry.

Last year very disastrous. Appeared about the 15th of July. Principal damage in August.
H. A. Stollenwerck, Perry.

It has troubled the farmers. It appeared in 1884 about the 20th of July. It did its principal damage in July and August. D. C. Hodo, Pickens.

The boll-worm has given farmers considerable trouble: more than the caterpillar, Appears about 1st of July. Principal damage between 10th of July to 1st. of August. Worse in wet weather.
Wm. C. Anderson, Pike.

Not to any extent.
J. C. Cheney, Russell.

It has. Apperas about 15th of July. Principal damage in August.
S. M. Cathcart, Wilcox.

Question 2nd. Do you plant corn in cotton, near cotton, or do you follow corn with cotton?

In prairie section of county corn is planted quite extensively in cotton, but in poorer sections but little of this is done. C. W. Kumpe, Bullock.

Yes, our cotton fields are often crossed with corn, the same fields remain in cotton for years.
Jas. Orum, Bullock.

Yes. Yes. Yes.
G. S. Lazenby, Butler.

Yes. Yes. Yes.

E. A. Bryant, Clarke

The crossing of cotton with corn is practiced a good deal where the land is good, and with good results. The distance being from 15 to 20 feet a cross the rows.

S. Forward, Clarke.

I follow corn with oats, and oats with cotton, or cotton with corn.

Robt. A. Lee, Conecuh.

I do not. Yes. I do not.

B. J. Fort, Dallas.

Follow corn with cotton.

J. F. Calhoun, Dallas.

Yes. Cross the cotton. Following cotton with corn I consider the best plan.

T. J. Craig, Dallas.

Yes, we plant corn in cotton, near cotton and follow corn with cotton. and any other way you could mention. I find them in cotton regardless of relation to corn. When once bountifully propagated the moth flies to suit its instinct.

P. K. King Dallas.

I plant corn in cotton, corn near cotton, and sometimes. follow corn with cotton.

Judge J. A. Lancaster, Elmore

Mostly follow corn; to some extent both ways.

J. T. Smith, Greene.

As a general thing, no. The majority claim that the damage to the cotton is greater than the value of the corn produced by such combination. We follow corn with cotton.

L. A. Lavender, Greene.

I plant corn in cotton and near cotton, and follow corn with cotton every few years. which produces a more marked effect on the corn than the cotton.

C. L. Stickney, Greene.

No. Yes. Sometimes follow corn with cotton.

D. C. Blackwell, Henry.

I check bottom lands with corn—say 20 feet distance between corn rows—nearly at right angles with cotton rows. Plant cotton also near corn—follow corn with cotton in a small way.

W. H. Whetstone Lowndes.

Have tried it in all ways, without seeing any effect.

G. N. Gilmer, Lowndes.

I do not plant corn in cotton, but I plant near it. I follow corn with cotton.

W. M. Garrett, Lowndes.

I sometimes cross my cotton with corn, but can't say it makes any diference about the boll-worm. I have never yet made it a rule to follow corn with cotton, but often have made the change and cannot say that I have noticed any difference.

C. A. Poellnitz, Marengo.

Yes. Solid corn. Cross the cotton in the best land.

F. E. Blount, Marengo.

We plant corn in cotton, also follow cotton with corn.

W. F. Strudwick, Marengo.

Do not. Yes, and often follow corn with cotton.

S. D. Nash, Monroe.

No.

J. A. Calloway, Montgomery.

Frequently cross off cotton with corn. Generally plant the same land in cotton and the same in corn year after year, because the cotton land won't make corn and the corn land won't make cotton much.

Dr. J. C. Nicholson, Montgomery.

I planted what we term cross-corn in the cotton last year. Also planted late corn all through the cotton and after oats, near the cotton, and I never knew the boll-worm as bad.

Hon. A. C. Davidson, Perry.

Yes. Yes. Yes. The boll-worm did damage in all the fields alike.

H. A. Stollenwerck, Perry.

Do not plant corn in cotton. Corn is planted the year after cotton, and corn is followed by planting oats the next year, and oats is followed with cotton.

D. C. Hodo, Pickens.

Follow corn with cotton.

Wm. Anderson, Pike.

Corn is generally planted in cotton, and is that we call dotted or dodged corn. There is very little rotation of crops, as most of our lands are cultivated by negro tenants, which is a curse to the country.

S. M. Cathcart, Wilcox.

Question 3rd. Have you tried any remedies, if so, what, with what effects, and how applied?

Some. Before the war a secret remedy was sold and tried, consisting of cutting off the buds near the top and destroying them, about the first of August. It was thought that the worm deposited the eggs then about that time, and the practice would destroy them. It never succeeded. Deep plowing during winter would seem to promise some success.

Dr. C. M. Howard, Autauga.

Some have used Paris green with good results.

S. H. Gist, Bibb.

Late corn is the only remedy we know of.

J. A McLennan, Barbour.

Yes. Paris green and arsenic have been largely used. Paris green has been effectually used in solution. and dry, mixed with a cheap flour, applied with a sieve. Arsenic is also effectually applied in the same way. The above is used to destroy cotton-worms or catterpillars. Some doubt its efficiency with the boll-worm.

Jas. Orum, Bullock.

None, but have found the application of Paris green puts a perceptible check upon the cotton-worm

B. J. Fort, Dallas.

The only remedies yet attempted are to destroy the moth by attracting them to lights in the fields. This has never proved entirely effective.

Jas. W. A. Wright, Greene,

No. I have discovered the fewer birds we have, that there are a greater abundance of insects of every kind. Thousands of birds are slain annually by hunters, and different other appliances. A law to protect birds, thereby increasing their number, doubtless would curtail the ravages of insects.

P. R. King, Selma, Ala.

We have; by building fires promiscuously in the field; also bates of honey and molasses. Can't say great results were received. J. T. Smith, Greene.

—

have topped the stalks and main limbs on the first appearance of the fly here, with no perceptible good result. Chas. L. Stickney, Hale.

—

Tried one remedy in 1868. Cut the tops off some cotton planted on bottom land about August 1st. Result, complete failure. W. H. Whetstone, Lowndes.

—

I have tried Paris green in poisoning the caterpillar, and at the same time it destroyed a large amount of boll-worm, when the plants were infected with them. Roasting-ear corn planted late in cotton so as to be in at the time the worm is most destructive, I find to partially prevent their ravages. I find no benefit from planting cotton after corn. Judge J. A. Lancaster, Elmore.

—

I have never tried any remedies for the boll-worm, but in using Paris green for the caterpillar I notice the boll-worm generally stops. Perhaps from the fact that the boll-worm is not much looked for after the 25th of August.

C. A. Poellnitz, Jr., Marengo.

—

Have tried lights without good effects. Hon. A. C. Davidson, Perry.

EXPLINATION TO PLATE VII.

Aletia Xylina. (Original.)

FIG. 1.—Eggs on the lower surface of the leaf.
FIG. 2.—Very young larvæ feeding.
FIG. 3.—Older larvæ that have moved to the tender foliage at end of branch.
FIGS. 4, 5, 6.—Nearly full-grown larvæ, showing some of the color variations.
FIG. 7.—Margin of leaf as webbed about a pupa.
FIG. 8.—Pupa inclosed in fragment of leaf.
FIG. 9.—Pupa from which the leafy covering has been partly eaten by caterpillars.
FIG. 10.—Pupa entirely deprived of its case by larvæ, but prevented from falling by the catching of its anal hooks in remnants of the cocoon.
FIG. 11.—Moth at rest, seen obliquely from above.
FIG. 12.—Moth seen from below, with wings expanded.
FIG. 13.—The same from above.
FIG. 14.—Nectar gland on midrib of cotton leaf.
FIG. 15.—Nectar gland at base of involucre.

Report of Department of Agriculture 1879.

A. Boen & Co Lithocaustic Baltim

THE COTTON WORM

Aletia Xylina.

THE COTTON WORM.

(*Aletia Argillacea*—Heubner.)

(*Aletia Xylina*—Say.)

In the South this little insect has many names. It is called the "cotton-worm," "cotton-caterpillar," "the caterpillar," "the cotton army-worm," and "the army-worm." In Louisiana it is called "chenille"—a French word meaning caterpillar. Prof. Riley strongly recommends that its generic name, "aletia," be generally adopted by everybody in speaking of this insect. This worm lives exclusively upon cotton, and since the latter is not indigenous to the Southern States, but an exotic, imported from Central and South Americas, it is natural to suppose that this insect came along with it. The first recorded appearance of this insect was in 1793, followed by a disastrous invasion in 1804. Since that time it has appeared every year at some point in the South. However, only periodically, has its visits been destructive.

The aggregate of losses to the Southern planter by this little insect is simply *enormous*. A calculation based upon the losses for the fifteen years since the war, made by Mr. C. R. Dodge, and verified by Mr. J. R. Dodge, the ablest statistician in this country, places the aggregate annual loss for the entire South at $15,000,000 to $20,000,000. Alabama looses on an average nearly 18 per cent. of its crop every year from this little pest.

The literature upon this insect is very abundant. Since the beginning of the present century it has been discussed in newspapers, scientific and agricultural periodicals. A subject of such economic importance we should expect to find the National government investigating it. Accordingly as far back as 1855 we find Mr. Townsend Glover giving a description of this insect in all its stages, in the report of the Commissioner of Patents, (agriculture), 1855.

Since that time nearly every annual report from the Department of Agriculture at Washington has contained something about

this insect. In 1879 a "Report upon the Cotton Insects," prepared under the direction of the Commissioner of Agriculture in pursuance of an act of Congress, was issued by J. Henry Comstock, entomologist of the Department of Agriculture. In 1880 Prof. C. V. Riley, chief of United States Entomological Commission, issued through the Department of Interior a large bulletin on the "cotton-worm." These two publications embraced the results of the patient investigations of many scientific observers, and have added greatly to the knowledge of this insect, its habits, and means of destroying it. To Prof. Riley, particularly, are we indebted for so much that is reliable, practicable and valuable, that every farmer throughout the South accepts his assertions upon entomological subjects with absolute faith in their accuracy. We shall, therefore, in this paper, extract largely, from his bulletin, and make only such statements as have been fully verified by him—our object being simply to get the latest facts before the people. The following description of the various stages of this insect is taken from his report:

CHARACTERS AND STAGES OF THE INSECT.

"The cotton-worm, like most other insects, and all belonging to its order and family, exists in four distinct states, which differ much from each other. They are, 1st, the *egg*; 2nd, the *larva* or worm; 3d, the *chrysalis*; 4th, the *imago* or moth.

"The worm must hatch from an egg deposited by the female moth. All theories to the contrary, such as its supposed spontaneous development from the plant, or its origin from the cotton-seed, are therefore utterly without foundation. They need emphatic denial here, because of their prevalence not only among the negroes and the more ignorant, but among intelligent men unfamiliar with the principles of biology. Such theories always have been, and doubtless always will be, entertained in explanation of the apparently sudden appearance and rapid multiplication of any insect or other organism in which the preliminary phases of the phenomena are easily overlooked or with difficulty traced. Reserving minute descriptive details for future report, I will briefly indicate the characteristics of these four states, so as to enable the reader unacquainted with any or all of them to recognize the species in any phase of its growth and to distinguish it from all other insects.

THE EGG.

"The egg is 0.6mm * wide, circular, much flattened and ribbed, as at Fig. 2. Of a bright bluish-green or sea-green when first laid, it contrasts sufficiently with the warmer green of the leaf to be easily detected, even by the naked eye when practiced. It is laid singly, and fastened with such firmness as not to be easily removed without injury. It is laid by preference during early summer on the under side of the larger and lower leave, and seldom more than three or four are found on one leaf. In confinement and exceptionally in nature it will be laid on the upper surface of the leaf, or on any other exposed part of the plant. In autumn, more particularly, the upper leaves receive a due share of the eggs, and I have counted as many as 49 eggs and egg-shell on a single leaf. With development the color becomes more dingy, or pale yellowish, frequently with brownish borders or a green curve, due to the coiled embryo, which may be seen through the transparent shell. The young worm or larva eats its way out through an irregular hole on one side, usually during the morning, ere the dew is dissipated, and from three to four days after oviposition. This is the average time elapsing between the laying of the egg and the hatching of the worm therefrom in ordinary midsummer weather, but the time varies with the temperature, and a much longer period is required in spring and late autumn.

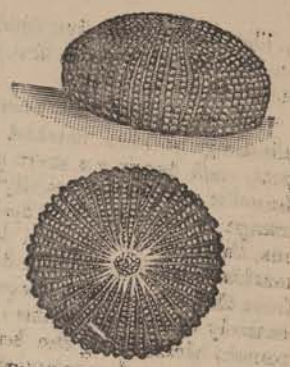


FIG. 2.—Egg of Alettia.

All eggs perish that are unhatched when overtaken by frost, as is not infrequently the case. The vacated and glistening shell is more readily noticed upon the green background than the unhatched egg.

"Humidity seems to favor hatching. Aphides or plant-lice are quite often mistaken for the eggs of this insect, while the 'Mealy-bug' (*Dactylopius adonidum*), a species of *Aleurodes*, the eggs of the lady-birds (*Coccinellidæ*), those of the Lace-wings (*Chrysopa*), and even a minute snail, not uncommon on the cotton plant, are likewise so mistaken.

THE WORM OR LARVA.

"This, as it appears in its different stages of growth on the colored plate, (see Plate 2) is familiar to every planter. Varying greatly in ground color, it is characterized by the particular position of the black piliferous spots upon the head and upon the body; by the white ring which surrounds each of the latter; by its pure white subdorsal lines and by its elongate and slender form. It is a semi-looper, the first pair of prolegs being very much reduced in size and seldom used, and the second pair, though longer, only about half as long as the succeeding pair.

*Equal to about 1-40 of an inch.

,,The worm molts five times during growth and changes appearance but little after the first molt. Exceptionally only four molts are suffered.

"The newly-hatched worm measures 1.6mm, * is of a uniform pale dingy yellow, marked with polished black, slightly elevated spots, each bearing a short pale hair. Before the first skin is shed the color often becomes slightly greenish and sometimes inclines to orange. After the first molt the piliferous spots are more conspicuous, the hairs from them longer and black, and the characteristic markings appear, though less distinctly than after the second; but from this time on the prevailing color is very variable, being either entirely of various shades of pale or pea green, or more or less intensely black along the back.

"The normal number of larval molts is five. This is the number which I have observed during the autumn months, while in midsummer, when the development is more rapid, I have, on several occasions, traced but four. The term of larval existence varies from one to three weeks.

"There is a very general belief among planters that the first worms of the season are pale and the late ones dark, and while both light and dark worms may always be found together in spring, summer, or fall, it is true that the green ones predominate early in the season and the dark ones later.

"Immediately after molting, the body is pale and without marking—a rule with all molting animals. After the earlier molts, the cast-off skin, which remains more or less fully stretched, is sometimes eaten.

"Some of the peculiarities in the habits of the worm deserve mention here of their practical bearing.

"Until after the second molt it always remains on the under side of the leaf, feeding upon the parenchyma, and leaving untouched the coarser veins, stomata, and upper skin or epidermis. The leaves where they are thus feeding present a blotched appearance, the semi-transparent epidermis becoming pale yellowish, and these blotches are, as a rule, at once distinguishable from other somewhat similar ones made by a few other insects.

"After the worm begins to eat entirely through the leaf, which is usually before the third molt, but sometimes later, it instinctively ascends toward the top of the plant and feeds on the more tender foliage, 'ragging' it, to use the expressive language of the planter.

"It can let itself down by a web from the moment of its birth, but can also fling itself from one part of the plant to another in a manner quite characteristic. The fling or jump is made by bending the fore and raised part of the body to one side and then suddenly jerking it to the opposite side, relaxing, meanwhile, the three hind pairs of legs by which it held to the plant. This is a quite common mode of motion when disturbed, and the normal way of getting from one plant to another The maximum distance which

*Equal to about 1-15 of an inch.

a worm can thus jump in a horizontal direction is about two feet, and it almost invariably alights on its legs. During chilly weather in autumn this motion is feeble and can be easily watched. When not feeding, the worm either rests stretched straight on some part of the plant or may be seen swaying its fore body from side to side, holding the while by the hind prolegs.

"Though preferring the foliage, it will, when hard pushed, eat every exposed part of the plant, even barking and girdling the stems. In feeding on the bolls, however, it does not bore like the boll-worm (*Heliothis armigera*), but eats the external parts as well as their contents. It cannot thrive on any other plant than cotton, and is evidently confined in its diet to the different species of the particular genus *Gossypium*. At all events there is yet no satisfactory evidence to the contrary, all experiments made confirming the belief.

"As one correspondent naively puts it, 'the worms feed only on cotton and one another,' the cannibalistic propensity being freely indulged when the occasion presents. It is a common remark that the presence of the worm is easier detected by smell than by sight. The planter says that he can 'smell the worm.' There is a peculiar odor arising from the excrement, but particularly from the gnawed and mutilated leaves that gives rise to this saying; but where the worms are numerous and large enough to render it obvious, there they have already existed several days, perhaps weeks, in smaller numbers.

"When numerous enough to utterly defoliate a field before they have attained full growth, the worms will travel in all directions on the ground, and they have been exceptionally known to collect together and travel in vast bodies in their search for fresh food.

THE CHRYSALIS.

"Having obtained full growth, the worm, in the language of the planter, 'webs up,' forming for protection a more or less perfect cocoon, usually within the fold or roll of a leaf, separately lined with silken meshes. Here it contracts and thickens, the distinctive marks are nearly obliterated, and the green color acquires a verdigris hue. Within twenty-four hours, in midsummer, the skin splits just back of the head, and is gradually worked to the end of the forming chrysalis, now soft and green, but acquiring in the course of an hour or more a brown color and firmer consistence. This chrysalis state lasts, on an average, about a week in hot weather, but may extend to thrice that time with lower temperature. Where necessity obliges, the worm will spin up on any other plant or in any situation that offers shelter. In confinement it will make a cocoon on the surface of the ground, covering and disguising the same with particles of earth, or it will even transform on the ground without silk or shelter. Such cases rarely if ever occur in a state of nature, but when the worms are very numerous in a field the chrysalides frequently have their leafy protection eaten away, so that

many of them either hang by the few hooks at the extremity, or fall to the ground. In no case, however, does the worm burrow in the ground as does the boll-worm, or could the moth issue from the chrysalis were the latter accidentally buried even an inch beneath the surface.

"The color varies from light mahogany-brown to deep purplish-brown, while the general form is that belonging to many other chrysalides. Neither form nor color can serve then as distinguishing traits, and the same is true of size. The peculiar form of the cremaster, or anal tubercle bearing the hooklets, will prove the best and safest criterion, and any chrysalis found in a cotton field that has a dif ferent tip may be safely determined as not that of the cotton-worm. The duration of the chrysalis state also averages about fifteen days. I have known it to last but seven days, and Mr. Glover record its lasting thirty days.

THE MOTH, OR IMAGO.

"The moth measures from one and one-eighth to one and a half inches from tip to tip of wing when these are expanded. In general color, above, is olivaceous, more or less effectually subdued by lilaceous or purple hues, and often having a clay-yellow, or faintly golden cast. The under side is more gray, with nacreous reflections.

"The markings that more particularly characterize and distinguish it from all other North American moths are certain undulating vinous or carmine lines across the front wings, a dark oval spot near their disc containing pale scales, which usually contain a double pupil (the basal or inner one the smallest and whitest), *and three white specks dividing the space between this dark spot and the shoulder in about three equal parts.*

"The sexes are not readily distinguishable, as the relative stoutness of the male antennæ compared with those of the female is so slight as to be no safe guide. An examination of the tip of the abdomen, especially from the side, will always show the difference, however, the last joint in the male being the longer and more full, and the pale tufts of hair that belong to the withdrawn genitalia showing within or beyond the squarely docked tip; while in the female this joint is shorter, more pointed, and obliquely truncate beneath.

"The habits of this moth can only be studied at night, as, like almost all the rest of its family, it is nocturnal. During the day it simply starts up when disturbed, and darts by swift and low flight to some other sheltered spot a few yards, perhaps rods, away. After sunset, however, it may be seen leisurely hovering about, either bent on the perpetuation of its kind or feeding upon whatever sweets it can get, whether from the cotton or other sources. It is very strong and swift of wing, and capable, when the necessity arises, of flying long distances. In alighting upon the plant it generally turns its head downward, and when it rests, the wings

are but shallowly roofed, the front ones closed along the back and fully hiding the hind ones. In this respect it may always be distinguished from the parent of the boll worm, which rests with the front wings partly open and not entirely covering the hind ones.

"The female begins to lay her eggs in from two to four days after issuing from the chrysalis, the time varying with the different generations and according to temperature.

"The experiments which I have made with moths confined in vivaria, eggs have sometimes been laid thirty six hours after issuing, and the moths have continued laying for twenty-one nights, the number laid each night ranging from 4 to 45.

"Examination of the ovaries of females at different seasons shows a much greater prolificacy than belongs to most moths, as the number of well-developed ova may reach 500, and of potential ova half as many more. In confinement it is difficult to obtain from one female more than 300 eggs, but that fully double this number are produced in the field during the height of the season there can be little doubt, while the average number may be estimated at about 400.

"The natural food of the moth, as first shown by me in the fall of 1878, is the sweet exudation from the glands upon the mid-rib of the leaf and at the base of each lobe of the involucres of the cotton plant. Nevertheless it is attracted to all kinds of sweets, and in most parts of the South it finds a bountiful supply in the exudation from the spikes of *Paspalum læve*, a tolerably common grass, but particularly in that copiously secreted by glands at the apex of the peduncle, just above the pods of the cow-pea (*Dolichos*). In the spring of the year, as Judge Bailey, of Marion, Ala., has observed, it may often be seen in the evening feeding in numbers first from the blossoms of the Chicasaw plum, and subsequently from those of the peach, Chinese quince, mock orange (*Cerasus Carolinensis*), the early apples, and blackthorn. Later in the season, when the glands above mentioned begin to exude and the tree blossoms are no more, the moths do not seem to be attracted by other nectar-storing flowers, since observations during the past two years by myself and assistants have resulted in finding but one species of verbena (*Verbena aubletia* L.) frequented, even where both moths and all sorts of flowers were abundant. But fruits of all kinds as they ripen are resorted to, and figs, apples, peaches, plums, apricots, grapes, persimmons, and even melons are often injured.

"Carefully examined, the tongue is seen to be armed along its terminal half with stout and sharp spines projecting forward from the upper surface and increasing in density toward the tip, which is beset with them on all sides. It is by means of this spinous tip of the tongue that the moth works a hole in these fruits; and it is thus enabled to absorb the more liquid portions. Apple pomace is especially attractive to them.

TIME ELAPSING FROM ONE GENERATION TO ANOTHER.

This varies according to temperature, and therefore according to season. There is increasing activity and acceleration in development from the first appearance until July, and thenceforth decreasing activity and retardation till frost. Thus, in midsummer the whole cycle of individual life, from the hatching to procreation, may occupy less than three weeks; while in spring and late autumn it may occupy twice that time. Taking the whole season through, however, the time from the egg of one generation to that of another will average about one month."

ERRONEOUS OPINIONS CORRECTED.

As to the time of appearance of the earliest worms, farmers themselves differ. To the question of "date of earliest appearance of this worm," sent out to one hundred prominent farmers throughout the southern portion of the State, a few reply "early in May," some in "June," while the majority puts its appearance in "July and August." Perhaps the majority of these replies mean the date of appearance in destructive numbers, since very few farmers ever notice the appearance of this worm until it is in force, and begins to "rag the cotton." It is, however, generally believed by farmers, that this worm never appears until June or July, in Southern Alabama. Entomologists of high repute have also given weight to this opinion, by asserting that this insect was yearly destroyed, and was introduced annually by immigration from more southern climes. But the entomological commission, of which Prof. Riley was chief, conclusively demonstrated that the worms appear in April and May, in many parts of South Alabama. They appear first in "isolated spots," and "are always comparatively few in number. They are therefore easily overlooked by all who do not take particular pains to search for them."

"From such spots as centers the worm multiply and spread in subsequent generations with greater or less rapidity according as the conditions are favorable or otherwise. Such increase and spread may be confined to some parts of a given county until the cotton is nearly ruined before the cotton in the rest of the county is affected. The worms will then first appear in the remainder much more suddenly and numerously than they did in the former, the parent moth migrating thereto in bevies. As a rule, however, the spread in the southern portion of the belt is gradual, and the worm in destructive numbers is preceded by one or more scattering generations in the same field."

From above we see that what is termed by our farmers as the first "crop" of worms has been preceded by one or more generations. This first crop is rarely noticed until the plant is in bloom. When the worms are very abundant in the southern portion of the State, it is very difficult to determine the time of their appearance in the other parts, since the latter is due entirely to the migration of the moths; the time and direction of their flight being controlled by circumstances. Hence some of our correspondents north of the Black Belt put the appearance of the worm as late as September. This Commission has further investigated the various theories of hibernation, and Prof. Riley closes his remarks on hibernation with the following:

"To sum up the evidence from present knowledge: The Aletia never hibernates in either of the three states of egg, larva, or chrysalis and it survives the winter in the moth or imago state only in the southern portion of the cotton belt. My own investigations during the past two years in every cotton-growing State in the Union, except South Carolina and Florida, (which have been visited by Mr. Schwarz), together with the experience and testimony of both correspondents and special agents employed in the investigation, confirm me in these conclusions, and I will close the discussion with two other suggestions that grow out of this experience.

"1. It is quite certain that by far the larger portion of the moths from the last brood of worms perish in various ways without perpetuating the species. All those which fly north of the cotton belt must needs thus perish, as doubtless do all those that attempt to hibernate in the northern portion of said belt. The evidence is strong that even in the hibernating portion of the belt only the exceptionally few, more favored than the rest, and remaining steadily torpid till early spring, survive to beget progeny. Those which are roused to activity during the mild winter weather spend their force without finding compensating nourishment, as there are neither fruits, flowers, nor sweet secreting glands at that season wherewith to break their long fast and sustain vitality. It is for these reasons that the worms are generally less injurious after mild and changeable winters and most to be dreaded after severe and steady ones, and it may very justly be argued, that did the larger proportion of the moths survive, there would be no chance to grow cotton. Like perishing of the bulk of most insects that hibernate above ground is, in fact, an acknowledged rule in entomology.

"2. The localities where aletia doubtless hibernates, and where, consequently, the earliest worms appear, seem to be more common in the western part of the cotton belt than in the Atlantic States. Since the civil war the almost complete abandonment of cotton cultivation on the sea islands of the coast Georgia and Florida

has evidently reduced the number of favorable hibernating localities there, and in so far protected the more northern and western portion of the Atlantic States from the immigration of the moth from those quarters. In Texas, on the contrary, the cultivation of cotton has been constantly increasing since that time, and consectaneously the number of hibernating points and the risk of serious harm there over extended areas have also increased."

ON WHAT SOILS DO THE WORMS FIRST APPEAR, AND WHY?

It has long been known that our "Black Belt" is peculiarly subject to the attack of the worms. It is further known that when the moths in quantities are carried beyond this belt that they seek, first, the cotton growing upon the rich lands. These facts are set forth by Prof. Riley in the following order: First, "The earliest worms are confined to fields on low lands, where the plants are naturally more thrifty and more advanced than on any other soil." Secondly, "The early appearance of the worms must be upon plants in a well advanced and luxuriant condition." Thirdly, "In counties where the soil is rich and low, there is almost always a gin-house or other building, a hay-stack or some other shelter near by where the moths have to all appearances hibernated." Fourthly, "That they recur year after year, not only in the same counties, but also in exactly the same spots."

Wherever the first worms have appeared, the plants were in every case "luxuriant, advanced, and vigorous." Is this due to a greater attraction for the moths to these vigorous plants, or do the eggs here hatch and produce the worms more rapidly?

"As throwing light on the subject, and as a rational explanation of the facts, it is well to remember that the more advanced and luxuriant plants most copiously exude from the secretory glands the sweet fluid upon which the moths feed, and by which it is fair to presume they are attracted. Also that the moths' fondness for shade and moisture is gratified in such low places, where cotton is rank. These places are also just those where the dews are heaviest, and it is quite certain, also, that moisture aids both the hatching and the development of the worm. Another suggestion may here be made, that also helps in the explanation: The natural enemies of the worm, especially the ants, are less

abundant in low, wet lands, than in that which is higher and drier. They will therefore be less efficient in destroying the young worms, which for this reason will stand a better chance of developing unchecked."

It would be well here to add that Prof. Riley divides the cotton belt into two portions: "First, The southern or permanent portion, where the first worms annually appear, and the moths in all probability hibernate. Second, The northern or temporary portion, in which the insect does not hibernate, but into which it spreads, either by gradual dispersion or by more sudden migration from the permanent portion." This dividing line is not well defined, but "in Alabama it is represented by the limestone cotton belt, south of Montgomery, though probably extending further north and to the east of this point."

"Is the worm most dreaded after a cold or mild winter?" was one of the questions sent out to our correspondents. To show the diversity of opinion existing among our farmers, we will state that of the replies received twenty-seven per cent. were decidedly of the opinion that a cold winter favored successful hibernation: forty-three per cent. were inclined to a mild winter, and thirty per cent. believed the winter had nothing whatever to do with their appearance or destructiveness the next season. Dr. Howard, of Autauga, in reply to this question, says: "Opinions conflict, and my own observation inclines to the opinion that the length of the winter rather than its temperature has more influence. The longer the winter the less the worm." Dr. Nicholson, of Montgomery county, says: "Can't see that it makes any difference, but think that spells of very warm weather after 1st. of January to 1st. of April, followed by cold, are favorable for the destruction of the moth."

Dr. Riley, in his conclusions given above, coincides with the minority of our replies, and asserts positively that "the worms are generally less injurious after mild and changeable winters, and most to be dreaded after severe and steady ones."

"Are the worms more destructive in a wet or dry summer?" is a question which can easily be answered, if we accept the generally received opinion that well advanced and luxuriant plants are the most attractive to the moths, both on account of excess of sweet fluids secreted, and of greater facility with which the eggs are hatched. We know further that a wet summer produces an excess of stalks and foliage, and renders the condition of ordinary up-

lands similar to lowlands in an ordinary season. The dews are heavier, and the natural enemies, especially ants, are largely destroyed during wet weather, and their work of destroying the caterpillar checked. All these facts show conclusively that a wet summer favors multiplication of the worm, and a large majority of our correspondents so express themselves. Others don't believe that the weather has anything whatever to do with the propagation and multiplication of the worm. While a few can't reconcile the experience of the past few years, with the accepted theory that wet weather favors multiplication. Mr. Stollenwerck, of Perry, says: "The last three years are not favorable to this theory. Two years ago it was very wet, and we had few worms. Last year was dry, and we had them in greater numbers than the year previous." Mr. C. A. Poellnitz, Jr., of Marengo, says: "The last two summers have changed my opinion, for they have been both wet, and the worm did very little damage." Dr. Nicholson, of Montgomery, says: "An excess of either, retards their production, but a good growing crop season is the one for the aletia." Mr. S. Forward, of Clarke, says: "Frequent showers and sunshine are most favorable to their increase." Another discrepancy exists in the testimony of some of our correspondents. Some claim that a wet May and June followed by dry weather is conducive to rapid multiplication, while others claim that a dry May or June followed by wet weather in July and August produces the same results. It is evident from above that no accurate conclusions can be drawn from such contradictory testimony, and we see no reason for dissenting from the opinions of Prof. Riley, and a majority of our correspondents, that "wet summers favor multiplication of the aletia." Dr. Riley shows the "influence of wet weather to be two fold—viz , direct and indirect."

"Its direct influences may, perhaps, best be illustrated by citing, in contrast, the effects of dry weather, which effects I have had an excellent opportunity of watching and studying the present year. As witnessed in the field, a large portion of the eggs during dry weather actually desiccate and fail to hatch. The worms are less active, and wanting in vitality; they drop more easily to the ground, and are so affected by the dry heated surface that, in almost every instance, they fail to regain the plant While vigor and vitality are thus impaired, the development during such weather is unduly hastened. The worms, for the most part, web up prematurely and fail to affect the change to chrysalis, generally dying in the act, half-worm, half-chrysalis. The chrysalides, in case the transformation was successful, show a great tendency to rot. while the moths,

which hatch from the comparatively few that remain sound, find scarcely any food in the cotton field, as the glands already described are almost entirely wanting in honey during very dry weather. Nourishment and fecundity being correlated, it is more than probable that the moths, poorly nourished, will lay fewer eggs under such circumstances. All the effects described are intensified and become most marked during extreme drouth, so that frequently at the end of a dry spell, such as is not infrequent in July and early August, not a worm can be found. A rainy season, following such a spell, will produce a most noticeable change. Its effects are almost magical. The plants freshen up, and the worms are so voracious and active that they soon destroy the new leaves, or 'top crop', and then, of necessity, work on the older ones.

"The effects of dryness as here described, are equally noticeable when produced artificially. Experiments upon plants growing in the field, but inclosed in muslin-covered frames, have produced all the unhealthy conditions of the insect, simply because the covering prevented the normal precipitations of dew upon the plants; while in vivaria the injurious effects of a dry atmosphere have been equally noticeable. In the dry, hot air of the Bahamas the worms are reported as often dying from the heat in numbers on the plant; a fact which would indicate that our climate is more favorable to their welfare than that of those islands, for the worms seldom, if ever, die from excessive heat in this country, except as they fall upon the heated surface of the ground.

"The in lirect influence of wet weather, first pointed out by the writer last July in some remarks before the Mobile Cotton Exchange, are even more potent in favoring the development of the worms. They consist in the comparative immunity which the pest enjoys during such weather from its numerous natural enemies' presently to be mentioned, all of which are prevented during 'wet weather from working with the energy and activity they display during dry weather. This holds especially true of birds and ants, the latter of which not only hie to their nests during such weather, but are often drowned in countless numbers in open fields during heavy showers. Few who have not carefully observed the facts can appreciate the results of the non-working, even for a few short days, of these natural checks to a species so remarkably prolific and quick of growth as our aletia.

"It may also be remarked in this connection that wet weather is unfavorable to the poisoning of the worms, and prevents the working of cotton, which working, as will be shown further on, also helps to destroy them."

NUMBER OF BROODS.

Here again an erroneous opinion, according to Prof. Riley, exists among the farmers of the South. The number of broods is much greater than usually supposed. The first and second genera-

also being confined to local areas, are usually overlooked, and the third crop, which generally becomes the destructive one, is usually thought to be the first one. This generation usually appears in South Alabama in July. After this generation the moths, on account of rapid multiplication, migrate and appear in more northerly regions, or on sandy fields, or cotton which has been retarded in growth, either by late planting or injurious environments. If everything is favorable, this crop usually sweeps the fields and leaves nothing but stalks and half grown bolls.

The question may arise if this worm multiplies so rapidly, why is it we can raise cotton at all? The answer is to be sought in the

NATURAL ENEMIES

which are constantly at work checking its increase. These enemies are far more numerous than is generally supposed. To enumerate them would extend this paper beyond a reasonable length. Suffice to say they consist of hogs, dogs, coons, bats, insectivorous birds, including several of our domestic fowls, spiders, beetles, bugs, flies, wasps, ants, the boll-worm, and a large number of parasites. A favorable season for the co-operation of all or a greater part of these enemies, must furnish an explanation why in some seasons we are overrun with worms, while in others we have none, or so few as to fail to attract attention. It also explains why, in some seasons, after an early appearance of the worm in quantities to create alarm, that it suddenly disappears without inflicting much damage.

ARTIFICIAL REMEDIES

are divided into those of prevention and destruction. Under the head of prevention I shall insert the following from Prof. Riley's bulletin:

PREVENTION.

"That much can be done toward preventing the ravages of this worm there is no question. The mode of cultivation has some influence; the principal object should be to hasten maturity, so that a portion of the crop shall be beyond the reach of harm from the more disastrous July and August broods. Aside from careful and frequent cultivation, which, moreover, has a tendency to disturb and knock off the worms, early planting in this connection is to be urged, though of course it has its drawback in exceptional seasons in the risk of late frosts. The use of early maturing varieties, and of cotton seed obtained from more northern regions will also help defeat the enemy, while it has long been known that some varieties are less subject to attack than others—the long-staple being much

more injured, for instance, than short-staple when planted side by side. Topping the cotton, while it would have very little effect in the early part of the season, may be employed to good advantage later, in cases where desperate means and the loss of the top crop are warranted. The frequent exemption of small fields that are separated from the larger ones, or surrounded by some other crop is noticeable and suggestive in this connection, while it will always be well to avoid planting cotton in those spots where the worms have been known to first reappear year after year. Diversified agriculture, and the rotation of crops on the same field are most desirable in this connection.

"The protection of those natural enemies of the worm that permit of it should not be neglected, and all shooting and trapping of the smaller birds prohibited, while the killing of hawks and other birds of prey should be encouraged. Tame fowls, such as chickens, turkeys, and Guinea-hens will prove valuable, especially if brought up near those spots where the first worms occur. The leaving of an occasional tree in fields in an open country, or even old stumps, while it may be looked upon by some as thriftless agriculture, is nevertheless advisable, for the immunity of fields containing such is often noticeable. Some attribute this immunity to the shade afforded by the trees, but the real explanation is more probably to be found in the protection they offer to birds and ants. These last, more particularly, are less liable to be washed away and destroyed by heavy rains at points where trees and stumps occur. The importance of the destruction of the first moths, whether by lights or poisons, will be shown further on, while that of the killing of the first worms is too apparent to need enforcing. The fact that vast numbers of late chrysalides are carried into the gin house, and that the moths issuing therefrom are so likely to find the requisite winter protection there, points to the expediency of removing and destroying those chrysalides as soon as possible, and not allowing them to remain in the gin house until they hatch."

To the above may be added that a proper use of acid phosphate, either when manipulated with nitrogen and potash, as in commercial fertilizers, or composted with stable manure and cotton seed, tends to hasten the maturity of the cotton crop from ten to fifteen days, and thus practically protects it against loss from this insect. The use of acid phosphate is therefore strongly recommended upon all soils where it has been found beneficial, for the the double reason of increasing the crop, and so hastening maturity as to place it practically beyond the reach of the worms.

DESTRUCTION.

For a long time various methods of attracting and destroying the moths have been tried. Lights of different intensities, varying

from a small lamp to a large bonfire, have been used to attract moths. Connected with lamps are devices for trapping and killing the insects. In the early part of the season some good might be accomplished by an universal system of lights, but later on, when the moths are numerous, the beneficial effects are rather doubtful, since, beside the moths of the cotton worm entrapped, many of its natural enemies, beetles, etc., are also destroyed. The plan of attracting the moth by lights and destroying them by poisoned sweets has been almost entirely superceded by the more successful method of

POISONING

the worm by means of Paris green, London purple, arsenic, etc. These poisons are all compounds of arsenic in some form, and are all poisonous to both man and beast. When first introduced, strong objection was made to them on account of the danger incident to their improper and careless handling. This objection is soon dispelled by experience, and the replies of our correspondents, showing the very small injury done to man and beast, indicate conclusively that these objections existed more in imagination than in reality. However, it should always be impressed upon every one using th[illegible] compounds, that they are dangerously poisonous, and that great [illegible]are is absolutely necessary, in handling them.

Which of these poisons are preferable for destroying the cotton-worm? The unanimous opinion of our correspondents is in favor of Paris green. That this substance can be used successfully for destroying the worms, is now well known to every farmer who has tried it. That a judicious use of it involves harm neither to the cotton plant nor to the soil, is also well known. Wherever failures have resulted, they have been caused by the use of adulterated articles, or by mixtures too dilute or concentrated. This poison is used in two ways; first, in liquid suspension; second, dry, mixed with some diluent.

The chief objection to the former is the difficulty of keeping it suspended in the water, and whatever machine is used in putting it on plants, a proper care must always be used to keep the poison well suspended in the water, by repeated and frequent agitations.

Prof. Riley advised from one-half to one pound Paris green to forty gallons of water, and this put on one acre; the cost of same including labor, being from twenty-five to sixty cents per acre. He recommends, however, that two or three pounds of flour, first soured in a bucket of water, be mixed with above, to give it

"greater adhesion," and "to help indicate the quantity distributed." Prof Riley's suggestions above have been generally followed by our planters. A majority of our correspondents gives one pound of Paris green to forty gallons of water as the proper proportions of these two substances, and one acre as the average to be covered by the mixture. They also report remarkable success in applying it with the ordinary sprinkling pot or fountain pump.

Applied in a powder, it must be mixed with some harmless substance, to prevent injury to the plant. The cheapest substances possessing adhesiveness, are usually used as diluents. Flour, plaster and ashes are all recommended; the first in its cheapest forms being generally used. A small quantity of dextrine, gum-arabic or rosin, is sometimes added to the mixture to increase adhesiveness, and is to be recommended. One pound of Paris green to twenty or twenty-five of diluents is the proportion generally used. This mixture is applied by our farmers with tin sifters, early in the morning before the dew is off the plant.

ARSENIC.

has been used by many of our correspondents, but their objections overbalance its chief recommendation—cheapness. It scalds the leaves and young bolls, causing the latter to fall, unless used in a very dilute solution—then it may not kill the worms. Its white color permitting it to be easily taken for flour, enhances the danger to man and animals of using it. When used, however, in proper proportions with water, it is a valuable substitute for Paris green. The same remarks are applicable to arsenate of soda."

LONDON PURPLE,

a by product in the manufacture of aniline dyes, is frequently used as a substitute for Paris green. It is more easily held in suspension in water than Paris green, and experiments have demonstrated that a wider ratio between this substance and water is required than for Paris green. One-half to three-fourths of a pound to forty gallons of water was found to be quite effective in killing worms without injury to the leaves. Prof. Riley recommends the use of one half pound of this powder to fifty or fifty-five gallons of water as the proportion most likely to give general satisfaction. There are many reasons why this powder should be generally used for killing worms. It is very cheap, costing not over six to ten cents per pound in New York. It takes less of it to poison an acre. Its finely divided condition enables it to penetrate the pores of the leaves, and thus become more persistent; while its color tells

plainly of its presence. Despite these recommendations, and the fact that it is equally efficacious as Paris green, our farmers still prefer the latter, and will scarcely use anything else.

Various machines for distributing the above poisons have been patented both for use in the dry and wet states. Some of these are highly recommended, but have not been used to any extent in this State. The common watering pot and the fountain pump, for liquid poisons, and tin sifters for dry poisons, are the instruments used by our farmers in distributing the poisons over the plant. The pump, which can spray the leaves from underneath, is desirable, since a large number of small worms are thus destroyed. At present it is deemed rather premature to recommend any particular machine. Many have been invented of great excellence, but their cost and want of adaptation to cotton growing in rows of different width have prevented a more extensive use.

Other methods of poisoning have been experimented with, but as yet results have not been so satisfactory as to recommend supplanting the arsenic compounds now so generally used.

Pyrethrum powder, obtained by drying the flower heads of different species of pyrethrum, harmless to man and beast, has been used experimentally for destroying the caterpillar. The high price of this article has forbidden its extensive use.

Kerosene oil, either alone in fine spray, or emulsified with milk or some other diluent, has also been experimentally tested for destroying the aletia. So far it has killed the worms successfully, but has also damaged the foliage of the plant. Hopes are yet entertained that by heavy pressure a spray sufficiently fine may be obtained, which in proper hands, with necessary caution, will perform the work of destruction to worms without injury to the plant.

Several machines for brushing off the worms, and catching the latter in trays, where they are quickly poisoned, have been invented and patented, but they are not so effective in their destruction of the worm as a proper use of poison.

EXPERIMENTS OF OUR FARMERS.

We insert herein the replies of our correspondents, giving their experience in the use of poisons; the efficacy of each; which they prefer; cost of same, and the cheapest and most effective methods of using them? We earnestly invite the attention of the reader to these replies, as showing what has actually been done *on the farm* in eradicating this

pest. The practical testimony of such men are worth more, in deciding the question as to the propriety and efficacy of poisoning than all the theories of learned scientists. Happily, here as elsewhere, the two closely agree, the one being the outcome of the other. It is to be hoped that no one hereafter will permit his crop to be eaten literally up by worms, simply because he does not believe that poisoning will do any good.

Question 4th. Have you used "Paris Green", "London Purple", "Arsenic" or "Pyrethrum" to destroy them, and with what effects? Which do you prefer?

REPLIES.

I have used the first two with decided success. Prefer the Paris green.
Dr. C. M. Howard, Autauga.

Paris green. Jas. Orum, Bullock.

Used Paris green and arsenic with good results. I think it pays 100 per cent. in some cases. I prefer Paris green. Geo. S. Lazenby, Butler.

Paris green and arsenic, and with success. Paris green. E. A. Bryant, Clarke.

Yes. No. Yes. The Paris green kills them, of that there is no doubt. I prefer the Paris green. T. J. Craig, Dallas.

I have used Arsenic and Paris green and find that both will kill the worm if put on properly, but the Paris green is most effective and I have never observed any other than beneficial effects from the latter, hence I prefer Paris green. J. F. Calhoun, Dallas.

I have used London purple and Paris Green, and have seen the use of arsenic. London purple effects the object slowly and is totally vitiated by rainfall. Paris green does the work promptly and effectually. B. J. Fort, Dallas.

Yes. Strictly pure Paris green is the only reliable poison for the cotton worm, used dry well mixed with flour, (10 lbs. Paris green, 10 lbs. dextrine and 10 lbs. powdered rosin to 1 bbl. of flour,) sifted on the top of the cotton stalks, very lightly, and repeated as the new growth increases, and the fly makes new deposits of eggs on the new growth.
P. R. King, Dallas.

I have used all the above except pyrethrum. Paris green is far superior to all the rest, but costs more. I have effectually destroyed the worm with a barrel of water mounted on a cart or wagon, with a force pump sprinkling from four to eight rows at a time using about 1 lb. Paris green and 45 gallons of water to the acre.
Judge J. A. Lancaster, Elmore.

These poisons have all been tried by the farmers of Hale county, and Paris green has been found to be the most effective. It is greatly preferred. In fact, all the others have fallen into disuse. Jas. W. A. Wright, Hale.

I have used Paris green, London purple, and arsenic, but not as successfully as has been reported by others. Paris green is the most efficient, though London purple has given comparatively good results, and is more pleasant to handle.
Chas, L. Stickney, Hale.

Have used all. Paris green. W. H. Whetstone, Lowndes.

I have used Paris green and London purple with good effect. I prefer the former
Wm. M. Garrett, Lowndes.

Paris green is decidedly the most effective remedy I have ever used.
F. E. Blount, Marengo.

We have used all except the pyrethrum. The Paris green was the only effective remedy used. W. F. Strudwick, Marengo.

I have used Paris green and when properly applied find it does great good. If the weather is favorable when the Paris green is applied, and done at the proper time I think it a sovereign remedy. C. A. Poellnitz, Marengo.

Yes, all but the last. I prefer Paris green. Dr. J. C. Nicholson, Montgomery.

All. I prefer Paris green, think the others are worthless. Properly applied Paris green in dry weather is a complete protection, applied either in water or by being mixed with flour and put on when the dew is on the plant. A. C. Davidson, Perry.

Have used all except pyrethrum, with good success. Prefer the Paris green, and used in solution. H. A. Stollenwerck, Perry.

Have used Paris green with satisfactory effects. Have never tried any thing else, but think I would prefer Paris green. From what I can learn from my neighbors they also prefer Paris green. S. M. Cathcart, Wilcox.

Question 5th. State cost of poisoning per acre and which is the cheapest and most effective method of using above?

Paris green costs 25c. per pound which will answer for one acre of moderate size. An ordinary three gallon watering pot serves as a good method to use the poison. Mix the poison in 40 gallons of water. Dr. C. M. Howard, Autauga.

Paris green used in solution will cost 12c. or 15c. per acre and is the cheapest and most effectual. Jas. Orum, Bullock

It usually costs from 25c. to 40c. per acre for each time used. It is sometimes necessary to poison two or three times. Use 1 lb. to 40 gallons of water and apply to one to two acres. Geo. S. Lazenby, Butler.

In solution with watering pots or fountain pumps. The cost depends on the price of the Paris green. I use 1 lb. per acre. E. A. Bryant, Clarke

Don't think it will cost over 30c. to 40c. per acre, and I prefer sprinkling with water ¾ to 1 lb. to 40 gallons of water well mixed and stirred. T. J. Craig, Dallas.

It cost me about 55c. per acre to poison, but most of the poisoning done by me has been in the nature of experiments, hence I have never done any in a thoroughly, organized way. I find the most satisfactory way for applying poison is to put it on dry by sifting a mixture of Paris green, flour and ashes, do not like using liquid poisons on small cotton. J. F. Calhoun, Dallas.

I prefer using the Paris green mixed in water, kept in constant agitation and applied with a sprinkler. The cost of application is dependent upon size of cotton, and convenience of water. I suppose the cost would ordinarily be from 10c. to 15c. per acre.
B. J. Fort, Dallas.

This depends on the size of the cotton and the manner of applying, say from one to $3 per acre being the total. P. R. King, Dallas.

Paris green is the most expensive, arsenic is the cheapest, it kills worms but when it kills them it will also kill the cotton. Judge J. A. Lancaster, Elmore.

About 75c. per acre, not counting the cost of labor which would have to be employed in other ways during the same time. Jas. W. A. Wright, Hale.

40c. will cover the cost of the best material, and the most effective way is sprinkling.
Chas. L. Stickney, Hale.

About $1 per acre. I think the most effective method is by sprinkling the poison with fountain pumps. Wm M. Garrett, Lowndes.

The cost is 15c. or 20c. per acre to use Paris green dissolved in water sprinkled on the plant, this is the most effective method. Arsenic is cheaper, applied in the same way, but not as effectual. The same of London purple. W. H. Whetstone, Lowndes.

About 35c. per acre. Three pounds flour to one pound Paris green, applied in liquid form. F. E. Blount, Marengo.

About $ 1 per acre to each application, 1 lb. Paris green to 40 gallons water applied with fountain pump. W. F. Strudwick, Marengo

I can not say exactly what the cost per acre is, as it depends upon the price of Paris green. It generally takes 1 lb. to 40 gallons of water. It must be kept well agitated. I think 60 gallons would go over one acre. C. A. Poellnitz, Marengo.

1 lb. Paris green cost 20c. to 30c. suspended in 40 gallons of water, and put three barrels in a wagon, with three good spray pumps and you can go over 50 to 75 acres per day if water is kept supplied, there is now introduced a large pump which is nearly as good as the three. Dr. J. C. Nicholson, Montgomery.

I put 10 lb. Paris green to one barrel of flour and apply with perforated tin sifters when the dew is on the plant. I also apply in solution 2 lb. to 1 barrel of water, continually stiring the solution. Hon. A. C. Davidson, Perry.

I put 1 lb. Paris green to 40 gallons of water, sufficient for one acre. Use water out of pools only. Prefer it to clean water as it leaves a paste on the leaves. I prefer it to clean water with flour or dextrine. The cost only the price of the Paris green, which is from 20c. to 30c. H. A. Stollenwerck, Perry.

The actual cost of poison without labor or implements to apply same to the plant is 25c. per acre. 1 lb. pure Paris green to 40 gallons water applied to one acre with fountain pumps is the cheapest and best method I ever tried. S. M. Cathcart, Wilcox.

Question 6th., Have any injuries resulted to plants, man or animals from the use of poisons?

The following are the only injuries reported from the use of these poisons.

If applied too strong it will kill the plant. Horses and cows have been killed in my neighborhood by getting to the poison in liquid state, and I heard of one by eating the plant after poison'ng. T. J. Craig, Dallas.

I have had men and mules blistered from using arsenic in solution and have had my cotton killed, in fact find it very difficult to use arsenic in proper quantity to destroy worms and not injure plants. J. F. Calhoun, Dallas.

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Some injury to animals where they have been allowed to go in the cotton field too soon after poisoning. Judge J. A. Lancaster, Elmore.

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Yes, sometimes by accident animals have drank water containing Paris green. Last year several mules belonging to John Minge, a farmer near Greensboro, were killed by such an accident. J. W. A. Wright, Hale.

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Yes stock have drank the water left in the fields in barrels and it has killed them. Some negroes have been nearly killed by eating the flour after being mixed with the Paris green. It will excoriate and produce troublesome sores where there is friction on man or beast. Dr. J. C. Nicholson, Montgomery.

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None to plants. I have known animals to be poisoned to death by eating the poison from barrels or buckets. Hon. A. C. Davidson, Perry.

We earnestly invite a careful consideration of the following letter, written by one of our most distinguished and intelligent farmers.

MULBERRY, ALA., Feb. 16th, 1885.

Hon. E. C. Betts, Commissioner of Agriculture,
Auburn, Ala.

Dear Sir:—I am in receipt of your questions to correspondents asking information respecting the ravages of the boll-worm and caterpillas, and in addition to the answers I have forwarded to you, I am persuaded that a letter covering more ground than can be included upon a single sheet will not be unacceptable. I have no experience with the means used to destrov the boll-worm, although I have seen their ravages fully equal to those of the caterpillar, especially before the war. I shall therefore limit what I have to say to the destruction of the caterpillar aud submit a few thoughts of a practical character based upon personal observation guided by that derived from other sources.

The inquiry you propose to institute, regarding the depredation of insects upon the cotton plant, is invested with an importance throughout the Black-Belt of Alabama, paramount to any other, relating to our Agricultural industries. On this account alone, I might be excused for obtruding a long letter upon your attention. In the past, we have treasured up but little with a view to future use. The experiences of one year fade into forgetfulness before another season calls for their application, and but little progress marks the opinions and practices of the larger number of our farmers. A reproduction therefore of the few treasured practices of the past may serve to keep in rememberance whatever has proved of practical value and make them auxiliary to a more rapid and successful advance in the future.

The main difficulty in the way to success is in the inability to satisfy our farmers that the means used in destroying the caterpillar are sufficient and practical. A few are convinced of their efficiency who have not the money at the right time, to buy the poison. Others attempt the work, but from inattention to details, fail of success. A few succeed, while the majority will not accept as true, the rusults of successful efforts and still refuse to make trial for themselves. With such diversity in opinion and practice, doubt and hesitation prevail and very few advances are made from past lines of action This state of distrust is deplorable but the hope is becoming widespread that, through your Department, more accuracy in observation will be stimulated, more confidence in each other's judgment will be engendered and a far greater diffusion of the results of experience be brought about.

Alabama produces 700,000 bales of cotton and estimating 10 per cent. only as destroyed by worms and we have a drain upon production of $3,500,000. This amount is sufficient to procure the labor during the time of making the crop and buy the poison necessary to destroy the worm.

Pardon, if you please, a reference to the observations of the Entomological commission. which made such an elaborate and accurate investigation of the habits and ravages of the caterpillar and the means to destroy them in Alabama, during the summers of 1878 and '79 and to which increased importance has been attached by the testimony of many farmers during the three succeeding summers. We will only summarize the practical points in the inquiry to illustrate the harmony between the presumptions of the commission for the guidance of the planter and the direct personal observation of those who adopted them.

The main cause of failure in the use of poison is the neglect to ascertain the presence of worms early enough to use remedies in time to have full effect. The worm is rarely found by the farmer until half grown, and the time is then too short to procure the poison, apply it and save the cotton. Owing to the fact, that the foliage near the top is first devoured, it is believed by many that the worm is hatched there and no effort is made looking to the arrest of its ravages until the cotton shows its ragged look. While the egg is found on all parts of the cotton, it is deposited in far the larger quantity upon the lower surface of the leaves of the middle third of the stalk. But one egg is laid in a place, nor more than four or five on a leaf. In warm weather, the egg is hatched in two or three days, while later in the season, the time is longer. The egg, when first deposited, is of a bluish green color, changing to a dirty white before the worm comes forth. The young worm remains where it was hatched and rarely eats through the leaves until four or five days old, when it begins the ascent of the stalk to devour the half grown leaves at the top.

This is about the time, the farmer begins to think of his danger and the means of preventing it, while his safety requires vigorous

action. He has already lost valuable time that cannot be regained. Better to have begun work two days before, for if the crop of worms be a large one, he will lose a part of his cotton before he can get to it with his poison. The worm, like time and tide, wait for no man and to dally or doubt is inevitable ruin. All the available force and appliances on the farm must be called into requisition and vigorously utilized, or else disappointment supplants the assurance that success is within reach. Observation shows that the worm lives twelve to sixteen days before it webs. It then remains chrysalitic, eight to ten days and again ushers forth in the form of a fly to renew its ravages.

We refrain from comment, upon the number of crops of the worm and the times of their approach is of minor consideration. It is of far more practical importance to know the time and place, when and where the worm will likely appear upon any particular farm. These are points that every farmer must ascertain and keep in view for himself, for upon them, must depend in large measure his entire success. It is a well known fact that the worms are apt to begin their work each year within a week of the same time and at the same place on any particular farm. This fact is in harmony with the advent of other worms which appear annually and we must recognize it as a guide to determine our action. The farmer who relies upon the observation of others, whose farms have a different elevation, soil and surroundings, will hesitate, because of conflicting statements, and his action will often be delayed too long. We would emphasize the idea, that each farmer must act upon his own judgment, based upon direct personal observation, because the opinions and actions of others, to be correct, will differ to the extent of the difference in the time of approach of the caterpillar upon their respective farms. Forty-eight hours delay will ruin a crop, and still there are many who hesitate longer, even after those to whom they look, have instituted active means of protection. Such a hesitation will always prove hurtful.

In a discussion of the means needed for protection, we will simply remark in regard to measures of prevention, that the protection of law has been thrown around the destruction of insectivorous birds, and whoever has watched the assiduity with which the bee-martin, mocking bird and blue jay reconnoitre our cotton fields in July and August, has doubtless seen enough to conclude, that in these and other birds, our farmers have friends which should prompt a vigorous inforcement of the law for their protection.

The use of poison is now recognized as the far most efficient means for the destruction of the caterpillar, and the Entomological commission have furnished ample data to guide us in the selection of the best, taking into view, its cost, its value as an insecticide, its facility of application and its effect upon the cotton plant. The commission from whose report we have extracted the main points so far, instituted as you know, an extensive series of experiments with a number of poisons and appliances, and the conclusions reached were :—that

arsenic and its compounds, the arseniates of copper, soda, potash and lime, offered by far the surest means for the destruction of the caterpillar. The experiments with them were conducted in different ways on a large scale, under differing circumstances, and results were compared one with another, and each with the condition of the crop where no poison had been used. The Paris green proved to be most effective, next to it, comes arsenic in combination with soda and potash, and then London purple.

The cheapest mode of applying the Paris green was found to be in suspension in water, the poison adhering to the cotton nearly as well as when used in emulsion in water with flour or other adhesive substances. One pound mixed in forty gallons of water, killed the worms without injury to the cotton, when applied to an acre of average size stalks, provided no rain fell upon it for three or four days. The Paris green in its dry state, mixed with flour, was found as effective when used in double the quantity, and it withstood the rain better than when in suspension in water. The cost of the material, however, and the increased time required for its application, were considerations which contracted a preference for the poison when simply mixed in water.

Now for the main point in my letter—the practical application of these conclusions of the commission by the farmers themselves. In August 1881, several farmers of this vicinity proceeded to act upon the suggestions made by the commission referred to. Upon the 10th of August they began examinations daily to find when the worms would likely occur. On the 18th of the month the moths had appeared on my farm in numbers sufficient to indicate that the worms would be sufficient to destroy the crop by the 1st. of September. Eggs were discovered, as described by the the commission, on the 18th, and by the 22nd. of August worms had developed in considerable quantities. The application of poison was at once resorted to, using one pound of London purple to forty gallons of water applied by means of an ordinary watering pot. On the following day I saw many dead worms, and the cotton leaves presented the crisped condition mentioned in the report of the commission. On the 25th the Paris green was substituted. The worm continued to increase upon the cotton to which no poison had been applied, while both the Paris green and London purple demonstrated their efficiency as indicated.

On the 28th and 29th of the month, we had a slow, steady rain, which had the effect of washing off the poison. On the 30th and 31st. the Paris green was reapplied to parts of the crop, leaving patches upon which no poison was used, in order to test the effect of the rainfall. The cotton to which no poison was applied a second time was stripped of its leaves, while that which had the second application was fully protected. Had there been no rain, the second application would have been unnecessary, the first being sufficient to kill the worms. These results were reached within my personal observation, and were in harmony with those upon adjacent

farms, where similar experiments had been instituted. Together, they demonstrated a success that no amount of negative testimony can set aside. The crops continued green, maturing a fair top crop, until the next crop of worms made their appearance and devoured the foliage.

It was supposed that the lateness of the season would prevent this last crop from doing much damage, and but a single experiment was made to determine the question. One acre of land was laid off and the poison applied to all the cotton but one row. The planter making the test informed us that from that row, he could pack all the cotton he picked in a tea cup, while the balance of the acre yielded one hundred and twenty pounds of seed cotton.

These experiments were conducted, as already intimated, in harmony with the suggestions made by the commission sent to Alabama, to investigate the ravages of the caterpillar. As far as they go, they are well nigh conclusive and serve as an admonition that farmers throughout the cotton belt should procure the report of the commission, and treasure its suggestions with a view to be ready when the destroyer comes, to meet it with firmness and persistence.

Farmers have, it seems, yet to learn that a part of the labor needed to save a crop is to use poison at the right time. Influenced by their hopes, they allow the golden opportunity to pass without procuring the poisons and implements needed, and as a result, the crop is destroyed while they are debating in their minds what means and methods should be put in force to ward off impending destruction. We plead for correct decision, persistence in the use of poison, use it when and where the worm appears, not waiting until signs of its ravages are visible. It may be needed only in circumscribed patches, but the destruction of the worm then and there may arrest incalculable injury a few weeks later. One fly lays three to four hundred eggs, and what a swarm may result from neglect to kill a few hundred worms at the right time. Once upon a time, I concluded to determine the number of worms upon an acre of cotton. After they had stripped the cotton of its foliage and younger bolls, they descended the stalk and were crawling in every direction upon the ground in search of food. By counting the number within a yard square and multiplying it by the number of square yards in an acre, I found there were 250,000 worms per acre, on the ground, exclusive of a few upon each stalk. The destruction of a few hundred worms of the preceeding crop would have prevented this grand army.

I have seen it suggested that the caterpillar has uniform seasons for its approach, like the locust, in given localities, and that is likely to remain about three years, when it disappears again, and that all deviations from this rule are from influences extraneous to their regular development. It was intimated that the time of absence was three years. Prof. Riley, I think, encourages this idea, but the rule is not sufficiently distinct to establish its accuracy. We

have had three years of partial exemption, and if the theory is correct, we may fear their coming during the present season. At all events, we should guard every point, so that we may be prepared to act intelligently and promptly.

I fear I have imposed upon your indulgence, in reproducing the experiences known to the public. Your bulletin upon worms injurious to cotton, I trust will be a valuable contribution toward better understanding of their habits, manner of propagation, and means for their destruction. Surely no question will command more attention from intelligent planters, and I hope they will give you all the aid in their power to eluciate the whole question. We need instruction, and hope to have it through your department.

Wishing you success in the task it demands,

I am Respectfully,

CHAS. M. HOWARD.