

cotton-worm. Mr. Glover, in the Agricultural Report for 1867, p. 60, says:

The eggs of the cotton-moth are frequently destroyed by several species of small ants, which are said to bite the eggs open when first deposited, and to abstract the substance. Many caterpillars, especially if weak or somewhat disabled, fall victims to the voracity of the restless myriads of ants always abounding in the fields and feeding upon the honey-dew secreted by the cotton-louse or aphid, and the bodies of such insects as they can overcome.

Dr. Phares, however, takes a very different view of the ant question, as advanced in the following quotation in his 1869 essay: \*

Last year on a farm in Louisiana, as already mentioned, the caterpillar commenced its work as early as May, and continued until frost terminated its labor; yet one generation succeeded another so slowly and in such small numbers that the cotton was scarcely injured; while on other places where the destroyer appeared later the cotton plants were so early and completely destroyed as not to mature sufficient seed to plant another crop. Why this difference? The owner of the farm mentioned, as well as others, alleged that the *ants being very numerous, carried off and destroyed the eggs and young caterpillars*. The ants, it is true, swarmed in unwonted numbers in the cotton fields, as they did also in corn-fields, potato-patches, gardens, orchards, and forests. But on other places where there were plenty of ants constantly infesting the plant the caterpillar wholly destroyed the cotton. Again, in some fields the cotton was completely stripped, as we often see, up to a definite line on one side, while not a leaf was touched on the other side of this line. This occurs even where the same rows cross this line, one portion of the row being stripped and the other unharmed, although there were plenty of ants on both sides of this mysterious line, established by the caterpillars themselves. And again, on inquiry, *I have never found any one who has seen the ants eating or carrying off either the eggs or young caterpillars*.

Here, then, it appears, is a total want of facts, and the ant theory is so far without a shadow of foundation on observed facts.

The ants collected in the cotton fields were referred to the Rev. H. C. McCook, of Philadelphia, and he has kindly prepared the following report upon them:

### FORMICARIAE.

The specimens of ants sent are of seven species, all of which are represented as in attendance upon or actually engaged in the destruction of the cotton-worm. These species represent two of the three families of Formicariae, viz, Formicidae and Myrmicidae. Of these, two were too much broken to allow specific determination.

The relation of ants to the larvæ of Lepidopterous insects has recently attracted the attention of students. During the summer of 1877 I observed several workers of *Formica fusca* in friendly attendance upon a small green grub which proved to be the larva of *Lycaena pseudargiolus*, a butterfly.\* About the same time Mr. W. H. Edwards, widely known as a student of Lepidoptera, observed the same behavior, and during the following year pursued his investigations further. The results he has given in an interesting communication to the Canadian *Entomologist*. He showed that the ants attend the larvæ with the same purpose as that which attracts them to the *Aphides*, viz, to feed upon a sweet excretion which issues from the insect. In the *Aphis* this is probably excrementitious. In the larva the sweet exudation is a secre-

\* Rural Carolinian, 1869, p. 690.

\* Mound-making Ants of the Alleghenies, Trans Am. Ento. Soc., 1877, p. 290, and John A. Black, Philadelphia.

tion from the 11th segment of the body. Mr. Edwards saw the ants greedily licking up this secretion, and caressing the body of the grub with its antennæ. I have had the pleasure of verifying a great part of his statements by personal observations. Two of the ants thus obtained by Mr. Edwards in attendance upon caterpillars were *Formica fusca* and *Prenolepis nitens*.

Some of the ants herein described are referred to by the collector simply as in attendance upon the cotton-worm. It would be interesting, as a question in natural history, to know whether they were engaged, as in the case of the ants above noticed, in collecting a sweet secretion. In this case they would be more likely to befriend than to injure their hosts.

Several of the species, however, were actually seen by Mr. Comstock killing the worm. This was especially the case with the erratic ant, *Dorymyrmex insanus*, *Dorymyrmex flavus*, and *Solenopsis xyloni*, the "cotton-ant," as it may be termed, and *Monomorium carbonarium*. The above three species include the greater part of the specimens sent, of which fully one-half were of the cotton-ant. In one bottle the body of the worm was preserved contorted as in a death struggle, and a number of ants were clinging to it at various parts with feet and mandibles. The larva had evidently been attacked by a large number of the ants, and all were surprised by the collector in the midst of the fray.

It is the habit of nearly all known species of ants to feed upon the bodies of dead insects, worms, and upon animal fats and juices generally. They attack small insects and grubs, or disabled insects and worms, quite freely for the purpose of food.

They also attack, with great fury and in united force, any such creatures as may invade their premises or cross their path. It seems more probable that the cotton-worm was attacked in this manner by the ants here described than that they were deliberately hunted down for food. At all events, the amount of damage done to the worms even by the hordes of ants that inhabit the Southern States cannot be very large. One worm would furnish a day's rations for a whole colony of such small ants as these. The friendly offices of the emmets in preserving the cotton crop can, therefore, hardly have an appreciable commercial value. Nevertheless it is a matter for congratulation that their military services, however insignificant, are in the right direction.

The following information as to ants vs. cotton-worm, collected by the Department, bears upon this point, and may justify a more sanguine view of the beneficial services of ants than the above. The testimony has been gathered from a wide range of territory, extending from the Atlantic coast to Central Texas, embracing the States of North Carolina, Georgia, Alabama, Tennessee, Arkansas, Louisiana, and Texas. It would appear from these observations that (1) the ants do certainly feed upon the eggs of the cotton-worm, and (2) more or less freely upon the larvae. That (3) the attacks made by the ants are more likely to occur when the worms are found on the ground, and (4) are confined to bright, pleasant weather when the ants come out of their fornicaries to seek food. One writer expresses the hope that the ant will ultimately exterminate the cotton-worm, of which it is now the greatest enemy; another thinks that in dry seasons the absence of caterpillars is due to emmet hostility; while a good observer like Mr. Trelease ventures the opinion that "ants are probably among the most important of the enemies of the cotton-caterpillar."

Are any predaceous insects or parasites known to prey upon it, either in the egg, larva, or chrysalis state?

The common little red ant is the only insect known to attack it.—[H. E. Brown, Camden, Ala.]

Ants.—[Knox, Minge and Evans, Faunsdale, Ala.]

It is believed that the common black ant preys upon the egg. I know of none interfering with the worm or chrysalis.—[C. M. Howard, Mulberry, Ala.]

Ants are numerous at times and seem to feed on them.—[Andrew Jay, Jayville.]

I have seen the ants at work on the egg and larva.—[J. F. Culver, Union Springs, Ala.]

Ants on the egg and larva, but the eggs are so much more numerous than the ants that the eggs are not missed.—[J. A. Callaway, Snowdown, Ala.

The small red ant.—[Woebome Young, Magnolia, Ark.

The ant preys upon the egg and worm to a certain extent.—[William A. Harris, Isabella, Ga.

Ants of many kinds are found preying on them in good weather, but not in bad, and this is the reason given why the worm increases so much faster in rainy wet weather than in dry and fair weather. The cotton fields have many enemies of the worm out in fair weather devouring eggs and worms, but rain and rust drive these enemies back to their retreats, and the worm breeds without let or hinderance.—[Douglas M. Hamilton, Saint Francisville, La.

Of late years the ant has proved to be the greatest enemy both to the egg and larva. I entertain the belief that they will ultimately destroy the worm should it prove to be indigenous rather than of foreign origin.—[Dr. I. U. Ball, Bayou Sara, La.

The common ant maintains an equilibrium when it is not too wet. The ant will destroy the eggs unless the rainy weather keeps it in its retreat. This is the reason that a dry season is never a caterpillar one.—[James C. Brown, Barnesville County, North Carolina.

The family in its different stages are preyed upon by ants.—[A. W. Hunt, Denison's Landing, Tenn.

The little black ant will devour the eggs.—[P. S. Watts, Hardin County, Texas.

Some species of the ant will prey upon the egg.—[O. H. P. Garret, Brenham, Tex.

Ants.—[P. S. Clarke, Hempstead, Tex.

Ants.—[Samuel Davis, Greenville, Tex.

Ants prey upon the egg, larva, and chrysalis.—[S. B. Tackaberry, Moscow, Tex.

Nothing but the small ant.—[S. Harbert, Alleyton, Tex.

In dry weather the little ants that are to be found everywhere prey upon them when they get knocked off on the ground; or when the sun drives the ants up the stalk for protection they attack the chrysalis, &c.—[Natt Holman, Fayette County, Texas.

Ants.—[J. H. Krancher, Millheim, Austin County, Tex.

Ants are their common enemy.—[George W. Hazard, Rutledge, Ala.

In addition to this testimony to the efficacy of the ants, we will add that of Mr. Trellease, who says:

From their great numbers and indefatigable industry, ants are probably among the most important of the enemies of the cotton-caterpillar. Individuals of many species swarm everywhere on the cotton plants, to which they are attracted night and day by *Aphides* and nectar. On many cotton leaves there are places where some larva has eaten the parenchyma of the lower surface, but the most careful search fails to discover the larva. Though not invariably so, these places are often eaten by very young larvæ of *Aletia*, and as these are not to be found, it looks as though they had been removed by some enemy, probably ants, though I have never seen ants attack very small caterpillars. In July a number of caterpillars were collected in the bottom-land, to which they were principally confined at that time, and placed on cotton growing in dry, sandy soil, care being taken to see that there were no ants on this cotton when the larva was placed on it, for my insects in breeding-jars in the house had suffered so much from the depredations of ants that I was always afraid of their attacking larvæ that I wanted to study in the field; and these particular caterpillars had been removed to the cotton indicated because I wished to make observations on their habits, and wanted them as near the house as might be, which at that time the only larvæ to be found in numbers were about a mile from where I was living. Within two hours of the time of placing them on this cotton, each of these larvæ was found by several ants, and these soon collected numbers of their fellows, whose combined attacks so worried the larvæ that they threw themselves from the plants and were soon killed and carried off by their small but persistent enemies. On several other occasions partly grown caterpillars were killed and carried off in this way by this species and a

red ant, yet I never saw ants attack them on the plant excepting when I had thus placed them on ridge-cotton for purposes of study; but when creeping over the ground, as they do after eating up the foliage of the plant on which they were born, if not full grown, hundreds of caterpillars were attacked by these ants and killed. I have never seen more than one species of ant attacking any individual caterpillar, either on the plant or on the ground.

Mr. Trelease further remarks, in speaking of the enemies of the chrysalis:

In the latter part of July several *Aletia*, just about to pupate, were taken from the swamp where they were found, and, with leaves webbed about them, they were transferred to cotton on dry soil near the house, where they were tied by their leaves to the petioles of this cotton; my object in placing them there being to determine the length of the pupa state. The same day they shed their last larva skins and this left them in an almost defenseless condition till the pupa skin should become firm and tough. About twenty-four hours after this moult they were again visited, and were found covered with red ants, which had killed and partly eaten them all, though they were on different plants, and care was taken to see that there were no ants on the cotton when the larvae were placed there.

Concerning the destruction of eggs by ants he has made no positive observations, but states his opinion in the following words:

Similarly, ants of quite a number of species frequent the cotton plant, whither they are attracted both by the sweet excretion of *Aphides* and by the nectar copiously excreted from the foliar and involucre glands of the plant, and although I never saw them molest the eggs of *Aletia*, I believe that they do so.

#### Family FORMICIDAE.

**Ants without a sting.** A single node upon the petiole. No contraction after the first joint of the abdomen proper. The nymphs sometimes inclosed within cocoons, sometimes naked.

#### Sub-family DOLICHODERIDAE, Forel.

Zeit. für wiss. Zool., xxx, suppl., and Études Myrmecologiques, Bull. Soc. Vaudoise, Sci. Natur., 1878, p. 364.

**Pedical with a single node.** The abdomen is not narrowed after its first segment. Nymphs always naked. Nests commonly made in the ground. Antennae 12 joints.

#### Genus DORYMYRMEX, Mayr.

The maxillary palps 6-jointed, the labial palps 4-jointed. The shield a little prolonged between the insertions of the antennæ. The clypeal fosse is united to the antennal fosse. The frontal area is triangular, short but distinct. The scale of the petiole vertical, smooth. The chitinous skin elastic. All the spurs pectinated. The workers have nearly always a tuft of long hairs under the head, as in the genus *Pogonomyrmex*. The mesothorax is a little compressed. There is a cone or toothed projection between the posterior or basal face and the anterior face of the metanotum. The spurs are pectinated. Ocelli are wanting.

#### No. 1. *D. insanus*, [Buckley].

1866. *Formica insana* [Buckley], Trans. Am. Entom. Society Philadelphia, p. 165.

1866. *Erratic ant*, Lincecum, Proc. Acad. Nat. Sci. Phila., p. —.

1875. *Dorymyrmex pyramicus*, Norton, Wheeler's Rep. Geo. Expl., Zool., p. 734.

1879. *Dorymyrmex insanus* [McCook], Agricultural Ant of Texas, p. 197.

This species may prove to be *D. pyramicus*, Rog. (*Prenolepis pyramica*), as suggested by Norton, or more probably a variety of the same.

Buckley's description is sufficiently indefinite, but two examples of his types in the

collection of the American Entomological Society, Academy of Natural Sciences, Philadelphia, are identical with the specimens sent.

Worker. Length,  $\frac{1}{4}$  inch.

*Color*.—Abdomen, tip of scale and cone, femur, tibia, vertex, and flagellum, black or blackish. The face (except vertex), scape, tarsus, thorax, brown or brownish. There is no tuft of hair beneath the face. They were found by Mr. Comstock actually destroy ing the cotton-worm.

*D. insanus* was collected by me in Texas (1877), and a variety quite akin to it in Colorado, 1879. In the former State, in the neighborhood of Anstin, it was found near or

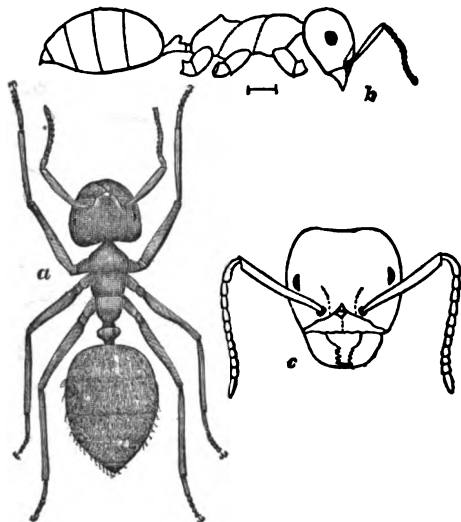


FIG. 35.—*Dorymyrmex insanus*.

to attack successfully the Occidental ant. In one case a small colony of erratics pushed up its gate in the midst of one of the principal thoroughfares of a large occidental formicary. Thereafter the little erratics flung themselves upon nearly every occidental that passed with such vigor and abandon of courage as to finally compel the latter, though greatly superior in size and armed with a formidable sting, to give up the gangway, and excavate an opening beyond the erratic boundaries. One remarkable example of this especially attracted my attention. Upon the circumjacent clearing of an occidental nest which was being opened for the study of internal architecture, there were thirteen nests or gate-ways of an erratic colony. My invasion of the formicary had, as is usual, aroused the occidentals to the highest pitch of belligerent fury. They attacked me with so many and painful stings as quite to sicken me. Yet the erratics freely assailed these irate insects as they ran hither and thither whenever they trespassed upon their borders, and invariably drove them away. If such intrepid little warriors were to devote their attention to killing cotton-worms they would doubtless do good execution.

The genus and probably this species is widely spread throughout tropical and sub-tropical America. It feeds upon the sweet exudations of plants, galls, and sweet excretions of the Aphis; but, like most ants, is fond of the juices of insects.

#### No. 2. *D. flavus*, n. var.

Worker. Length,  $\frac{1}{4}$  inch.

This variety is identical with *insanus*, except in the color, which is a uniform honey-yellow, and the contour of the thorax. The apex of the abdomen and the flagellum of the antennæ are tipped with a blackish hue. The variety appears to be quite permanent, the distinction holding in a number (25 or 30) of specimens examined. The cone is evidently higher than the thorax. There is no tuft under the face.

Habitat, United States. Southern States.

on the flat circular disks of the agricultural ant, *Pogonomyrmex barbatus*. In Colorado the nests were found in great numbers in the Garden of the gods and vicinity, upon the clear spaces surrounding the gravel-covered mounds of *Pogonomyrmex occidentalis*, Creason, which, like its Texas congener, is a harvesting species. Two, three, and four of the former nests or openings would be placed upon the latter. The external architecture of *D. insanus* is simply a moundlet of sand, two to four inches in diameter, gathered around a small opening into the ground like the familiar nests of *Lasius flavus*, the little yellow ant which burrows in such multitudes in our garden walks and lawns.

In action the erratic ant is vigorous and active. It is remarkably courageous, and was often observed by me

## Genus IRIDOMYRMEX, Mayr.

Verhdt. d. k. k. zool.-bot. Ges. in Wien, Bd. xii, 1862, Z. 702.

The workers vary very little, and only in size. The worker and the male are of the same size; the female is much larger. The maxillary palps have 6 joints, the labial palps 4 joints. The clypeus is a little prolonged between the insertions of the antennæ. The clypeal fosse is joined with the antennal fosse. The frontal area is triangular, indistinct. The scale of the petiole is vertical, unarmed. The sculpture of the body is very fine; the chitinous skin is elastic and not brittle, as is the case for the most part in other ants; all the spurs are pectinated.

No. 3. I. McCooki, FOREL, *in litt.*

This ant is a small yellow ant, about three thirty-seconds of an inch in length. Dr. Forel refers to it in his *Études Myrmecologiques* for 1878, p. 382, and reference is also made to it in my *Agricultural Ant of Texas*, pp. 202-3, 302. I found numbers of this species traveling in long lines across or near to the nest of the agricultural ant. Usually their route was established upon blades of grass growing on the nests or along low tufts of grass on the margin. They traveled in single, or "Indian" file, one behind the other. They appear to be on friendly terms with their large neighbors. The specimens sent me in alcohol were taken in the act of attacking the cotton-worm.

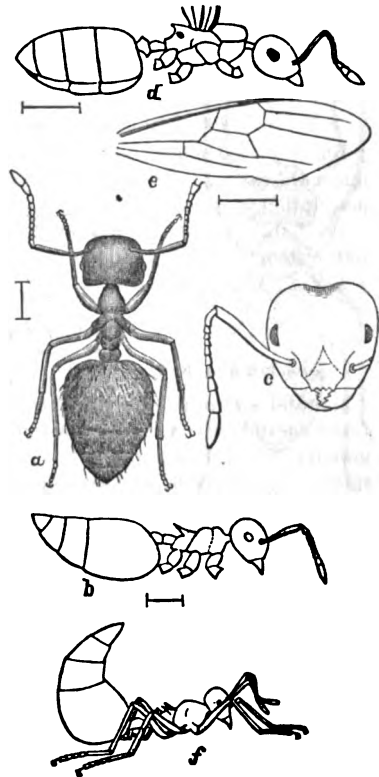
## Subfamily MYRMICIDAE, SMITH.

Ants having a sting, except with the males. Two nodes or joints upon the petiole. The nymphs always naked.

Catalogue Brit. Hymenoptera, 1851.

## Genus CREMATOGASTER, Lund.

The second joint of the petiole articulates upon the superior face of the first segment of the abdomen. Abdomen is cordiform, flattened above, rounded below, and pointed at the extremity. The maxillary palps have 5, the labial palps 3 joints. The antennæ have 11 joints. The metanotum is furnished with two spines.

No. 4. *C. lineolata*, Say.1836. *Myrmica lineolata*, Say, Boston Journal Nat. Hist., vol. i, p. 290.1866. *Oecodoma (Atta) arborea*, Buckley, Trans. Am. Ento. Soc. Phil., p. 249.1866. *Orematogaster lineolata*, Mayr, Verh. zool.-bot. Ges. in Wien, xvi, p. 901.Worker major. Length,  $\frac{3}{8}$  inch (Figs. 4, 5, 6).Worker minor. Length,  $\frac{1}{4}$  inch.FIG. 36.—*Crematogaster lineolata*.

*Color*.—The abdomen is black, shining, except at the base underneath, which is reddish brown; the petiole, thorax, flagellum, and tarsus yellowish brown; the head blackish at the vertex, as also the legs, except the tarsus. The body is lightly pubescent, the abdomen being sparsely provided with hairs. The ant when excited has the habit of turning its abdomen up, and even bending it over the thorax, as in Fig. 9. The favorite nesting place is under stones or underneath and within the decayed matter of old logs and stumps. This material is sometimes prepared by the ant as a paper-like pulp, and arranged into cells and chambers, which are attached to the surfaces of the logs. This ant is widely distributed throughout the United States; is abundant in the Middle States.

Texas. Queen, Figs. 7, 8.

#### No. 5. *Crematogaster clara*.

1870. *C. clara*, Mayr, Verhandl. der k. k. zool.-bot. Vereins, Wien, p. 900.

1866. *Oecodoma bicolor*, Buckley, Trans. Am. Ento. Soc., Phila.

Buckley's name has the priority over Mayr's, but as Smith had published a species under the same name (Proceed. Linn. Soc., 1860, p. 109) several years before Buckley's description, the name given by Mayr is that by which the insect is properly known.

The habits of the ant are probably the same as those of *C. lineolata*. It was found in the stem of the cotton plant, but was not observed destroying the worm.

Texas. E. A. Schwarz.

#### Genus SOLENOPSIS, Westwood.

Ann. and Mag. Nat. Hist., 1841.

Mandibles enlarged at the extremity, and having the terminal margin dented. Antennæ 10-jointed; the two last joints very large, and together form a club. The maxillary and labial palps have each two joints. Metanotum without teeth or spines. The clypeus has two longitudinal ridges. The sting very large.

#### No. 6. *Solenopsis xyloni*, n. sp. (♀)

Worker major. Length,  $\frac{1}{2}$  inch, Fig. 10; side view of same, Fig. 11; view of head enlarged, Fig. 12. The head, body, nodes, and abdomen are of a dark claret-brown color, glossy, covered with stout hairs. The flagellum of antennæ and the tarsi are a lighter color.

Worker minor. Length,  $\frac{1}{10}$  inch. Color as in the worker major.

Female. Length, more than  $\frac{1}{2}$  inch (9mm), Fig. 12. The body is of a uniform amber color. The single specimen is unwinged.

The largest number of specimens sent belong to this species, but no habits are noted except that the ant kills the cotton-worm. In one bottle the caterpillar is preserved, with a number of the dead ants still clinging to it by their mandibles. *Solenopsis* is a mining ant, and lives in nests made in the ground. Some species of the genus occasionally place their homes within or very near the bounds of other species of ants. *S. fugax*, for example, according to Dr. Forel (Swiss Ants, p. 233), lives, without danger, in the very center of the formicaries of *Formica fusca*, *Polyergus rufescens*, *Tetramorium caespitum*, &c. They are always enemies of their hosts.

#### Genus MONOMORIUM.

#### No. 7. *Monomorium carbonarium*, SMITH.

Catalogue Brit. Mus., Hymenoptera., Formicidae, p. 127.

Worker. Length,  $\frac{1}{16}$  inch.

This is a small, black, shining ant, and was taken in the act of killing the cotton-

worm, a specimen of which (in alcohol) was fairly black with the hordes of tiny emetets which clung to it.

NOTE.—I am indebted to Dr. Auguste Forel for valuable aid in the determination of the above species. My own studies of ants having been heretofore chiefly directed to their habits and structure, I sent examples to Dr. Forel, and received an answer barely in time for use in verifying and correcting proof-sheets. I cordially acknowledge his friendly assistance.

The specimens of *Dorymyrmex insanus*, sent Dr. Forel regards as *D. pyramicus*, Roger, Berlin Ento. Zeit., 1863, p. 1860. *Solenopsis xyloni* he believes to be *S. geminata*, Fabr. I have nevertheless allowed my name to stand provisionally, until further examination, for the following reason, among others. The specimens sent me by Mr. Comstock were quite numerous, and were all workers, major and minor. Neither these nor specimens from Texas in the American Entomological Society collection had examples of the large-headed soldier caste, which belongs to *S. geminata*, specimens of which I have from Florida.

#### ILLUSTRATIONS.

Fig. 35 (a). *Dorymyrmex insanus*. Dorsal view, enlarged.

Fig. 35 (b). *D. insanus*. Side view, enlarged. The natural length is indicated by the line beneath the figure.

Fig. 35 (c). *D. insanus*. View of head.

Fig. 36 (a). *Crematogaster lineolata*. Enlarged.

Fig. 36 (b). Side view of same.

Fig. 36 (c). Same; view of head.

Fig. 36 (d). Same; queen; side view.

Fig. 36 (e). Same; wing of queen.

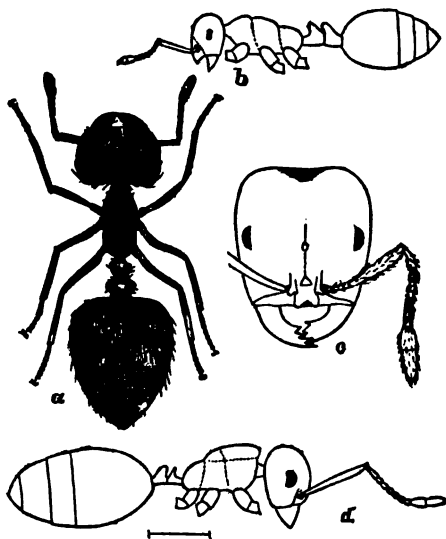
Fig. 36 (f). Same; view of insect when excited, with abdomen turned up.

Fig. 37 (a). *Solenopsis xyloni*. Dorsal view, enlarged.

Fig. 37 (b). Same; side view.

Fig. 37 (c). Same; view of head.

Fig. 38. Same of queen; side view.



FIGS. 37 and 38.—*Solenopsis xyloni*.

#### PARASITES.

The abundance of the true parasites of the cotton-worm, and the number in which they occur, renders their consideration of the highest practical importance.

Taking into consideration the number and variety of these friends of the planter, and the way in which they may make themselves obvious to every one who tries to work out the life history of the cotton-worm, it seems very strange that several recent writers should have entirely overlooked their presence. Mr. Grote, in his paper before the American Association for the Advancement of Science, stated that he had