Notes on the Biology of Cissites auriculata (Champion) (Coleoptera: Meloidae)*

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The genus *Cissites* Latreille is represented in the New World by two species, *C. maculata* (Swederus) and *C. auriculata* (Champion) (Betrem 1932, Cros 1928, Champion 1893). Their distribution is somewhat ambiguously recorded in the literature, but the latest studies (MacSwain 1961, Selander and Bauseman 1960) indicate that *C. maculata* is found from north Mexico to Argentina, including the West Indies and the Galapagos Islands, while *C. auriculata* extends from approximately the same northern latitude to Honduras in the south. In Guatemala the two ranges overlap, but it appears that *C. auriculata* is the more abundant. At least, it is the only species I have seen in that country in the course of several explorations conducted since 1932. Champion (1893) records the species from the Atlantic slope (San Geronimo) as well as from the Pacific side of the country; but I have seen it only at three localities, all on the Pacific coast and under 2,000 feet elevation. The three finds occurred during 1933–1935, when the Experiment Station, HSPA attempted the establishment of *C. auriculata* in Hawaii to combat the local carpenter bee, *Xylocopa* (*Neoxylocopa*) *brasilianorum sonorina* F. Smith. The notes and illustrations upon which the present paper is based were made in the course of the unsuccessful introduction.

As *C. auriculata* has been found undergoing development in the tunnels of two species of *Xylocopa*, *X. fimbriata* Fab. and *X. brazilianorum* (Linn.), Champion's surmisal that *C. auriculata* parasitizes some other wasp is proven wrong. It is curious to note, therefore that Champion's observations on the situations favored by the adult beetles agree with mine. The beetles were found only in the verandas of houses, or on roof timbers of sheds open to light and fresh air but well protected from rain. These are the situations preferred by *Xylocopa* also; but the preference is evidently exclusive on the part of *C. auriculata*, whereas it is distinctly not so on the part of carpenter bees, the nests of which are often found in dead trees, fallen trunks, and other exposed situations.

Numerous inquiries brought out the fact that *Cissites* beetles are known to the people of Guatemala, who hold mistaken beliefs in regard to their habits. The only one deserving mention is that the beetles often "spit" in the eyes of children and blind them. The idea probably originated from the fact that the beetles,

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when taken in the hand, simulate death and usually exude drops of a thick yellow liquid from the leg joints. This exudation has a strong and disagreeable odor, and it is not improbable that in the long course of their association with *Cissites* the children of the peasantry have sometimes gotten the liquid in their eyes and found it unpleasant.

Xylocopa bees resent the presence of the beetles. I witnessed determined efforts on the part of a bee to dislodge or scare away an adult *Cissites* from its perch on a rafter. Buzzing in a loud and unusual key the bee in this case hovered near the beetle for several minutes and made repeated sallies towards it, never quite touching it but coming very near and attempting, or threatening to bite it at each sally. The beetle seemed disturbed at first with the bee's truculence and turned to face each sally with its head raised and its powerful mandibles open in a posture of defense; but eventually it gave up the contest, crawling slowly, and rather casually into a nearby crevice. The bee thereupon also left the scene.

In the sugar cane plantation near the town of Escuintla, Guatemala, where most of these observations were made, the recurrence of *Cissites* adults was definitely cyclical. In 1933 the first individuals appeared in the early part of October, and in 1934 two individuals, a male and a female, were first seen on September 5. During the latter year the peak of abundance was reached about two weeks from the time the first beetles were seen, and before the end of October no beetles were left. At the peak of abundance the main focus of population, which was located on the roof timbers of the "El Salto" sugar mill sheds, consisted of about 30 beetles of both sexes and over a dozen egg masses. The inaccessibility of many timbers prevented an accurate count.

In their native habitat *Cissites* beetles are sluggish. Excepting the single individual observed fleeing from the attack of a *Xylocopa* bee, no beetles were found more than a foot away from the holes of their emergence, nor were any seen moving rapidly or more than an inch or two at a time. That both sexes can fly and that they pursue one another agilely on foot was shown by the behavior of individuals in captivity, but no such activity was seen in the field.

Emergence of the adults from the tunnels where they develop takes place exclusively at night. Mating and oviposition may be both diurnal and nocturnal for they have been observed in the laboratory several times during the day, though never actually observed in the field.

The Egg and Oviposition

As shown in Figure 1, the eggs of *Cissites auriculata* are oval and elongate, bluntly rounded at one end and tapering rather sharply to the other. They measure about ¾ mm. in length and about ¼ mm. across the thicker end. They are pale white and shiny when newly laid. A rather heavy coating of a transparent,

viscid material covers them and often accumulates around the smaller end to form a droplet which in a short time dries and appears like an integral part of the egg. They are always laid with the smaller end down in masses three or four layers deep, with the bottom layer firmly glued to the substratum by means of the viscid covering of the eggs and the top layers more loosely piled on each other. Even after the eggs hatch the empty shells remain glued to each other in the mass and may continue for many weeks to indicate the presence of *Cissites* colonies.

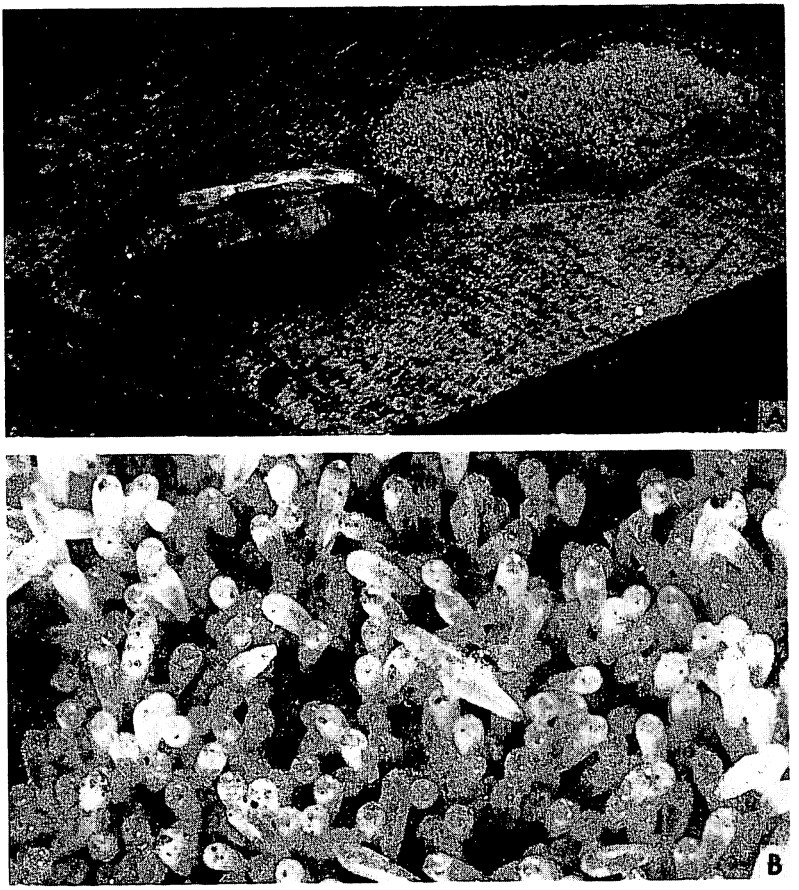

FIG. 1. A, Freshly laid egg mass of *C. auriculata*, with female in characteristic pose. B, A small portion of the egg mass greatly enlarged.

Under laboratory conditions, the total output of each female was often divided into two or more small masses; but in the field each female usually deposited all her eggs in one single mass, adding to it from day to day. The largest mass seen at "El Salto" measured 1½ by ¾ inches. It was of irregular shape, of smooth

outline and tapered from the center, where it consisted of four or five layers, to the edges, where it flattened out to one or two layers. It was estimated to contain no fewer than 22,800 eggs. Another mass, more or less oval in shape, and not as high as the first, measured 25 by 12 mm. and contained, about 30 eggs to the square millimeter, a minimum of some 9,000 eggs.

In the laboratory females normally voided the meconium, mated several times with one or more males, and deposited the first batch of eggs within 48 hours of emerging from their tunnels. Additions to the first batch, which invariably comprised the majority of the eggs, might then continue at irregular intervals for several days. One female added eggs to her original mass every day for seven days; another for nine days. Two other females, on the other hand, made no additions to the first mass. Both of these were undersized individuals, and one of them may have been abnormal, for it lived a relatively short life.

In the field no egg masses were found more than a foot from the entrance of a *Xylocopa* tunnel, and the majority of them were on the under surface or the sides of timbers. Only a few were found on the upper surface.

The relative scarcity of egg masses wherever *Cissites* were found, the large size of some of the masses, and other more direct observations lead me to suspect that in some cases more than one female added eggs to a mass.

Figure 1A illustrates the characteristic pose assumed by females during oviposition. This is the pose in which most of their life is spent, for females invariably die within a day or two after the last of their eggs are laid.

Incubation and Hatching of Eggs

Eggs in the laboratory showed a change of appearance about twelve hours after being laid. At this time the contents, easily visible through the transparent chorion, had become dense and opaque in the middle portion of the egg and almost transparent at both ends. Forty-eight hours later some eggs showed a slight yellowing of the opaque portion and further concentration of it along one side, leaving most of the egg now filled with clear liquid. Seventy-eight hours later no great change was apparent apart from some intensification of the color. Seventy-eight hours later, or approximately 216 hours from the time of oviposition, the complete outline of the embryo was visible through the chorion; it occupied the entire egg cavity and its two eyes appeared as black dots near the larger end of the egg. Segmentation of the body was already discernible at this time, although the embryo was nearly colorless except for a small amount of yellow along the midline of the body. Two hundred eighty-eight hours from oviposition the first egg had hatched and in others the fully formed triungulin was visible in the position as illustrated in figure 2A; The eye spots at this time were black; the basal segments of the antennae, the mandibles, and the tarsi reddish brown: the rest of the body transparent, except for a yellow portion of the gut which showed through the body wall. The abdominal segments, which

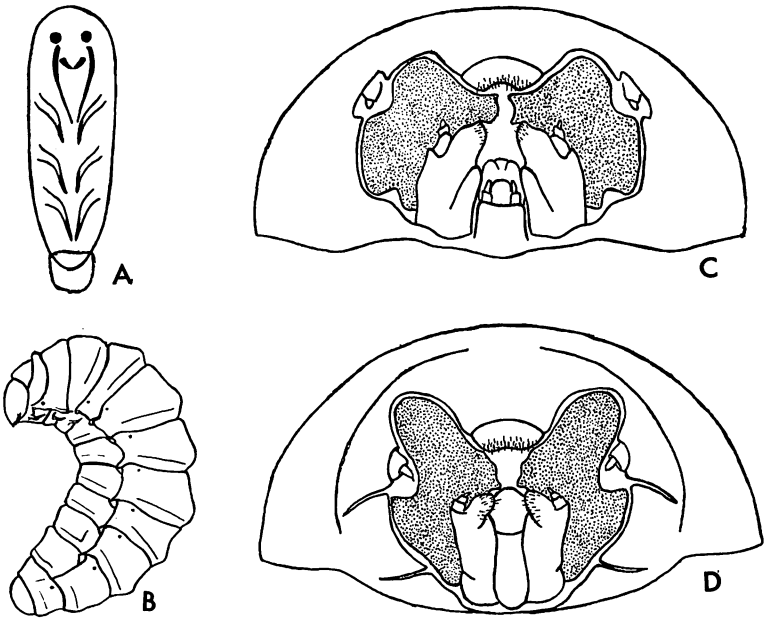

FIG. 2. A, Egg of *C. auriculata* showing hardened drop of viscid material at the smaller end, and the position of the eye spots, mandibles, antennae and legs of the fully formed triungulin within the egg; B, General appearance of the presumed second active larval phase of *C. auriculata;* C, Mouthparts at one stage of development of the presumed second active larval phase of *C. auriculata;* D, Mouthparts of a more advanced stage of the presumed active larval phase of *C. auriculata.*

in hatched triungulins comprise about half the length of the insect, were evidently compressed in the egg and to some extent telescoped into each other, permitting the head and the thorax, with the legs closely pressed against it, to fill most of the egg cavity.

The first exterior indication of the hatching process is the collapse of the chorion along the mid-ventral line of the embryo. A shallow depression results which is bound on the sides by the legs of the embryo and which reaches from near the small end of the egg to a transverse ridge formed by the mandibles. Either shortly before or after the formation of this depression the mandibles can be seen moving slowly and rhythmically, and soon a short transverse opening appears above them and at right angles to the longitudinal depression. The triungulin bends its body forward and gradually pushes its head through the transverse opening. The chorion meanwhile splits in a straight line backwards from the head along the middle of the longitudinal depression, and soon the body of the triungulin is pushed forward through the split. In eggs which had been placed horizontally under a microscope, the body at this stage protruded from the egg case like a person standing in a canoe in a stooped position, the only contact with the egg being at the dorsal part of the end of the abdomen,

which curved forward slightly. The antennae, mandibles, and legs were still held closely pressed to the body; but in a very few minutes the triungulin began to "thaw out" and slowly stretching all the body parts into their normal position was soon able to crawl off the egg shell and away.

The whole process of hatching, from the appearance of the longitudinal depression in the egg shell to the time the triungulin crawls away, takes from three to four hours.

The Triungulin and its Behavior

The triungulin of *C. auriculata* has been described by Cros (1928) and later re-described and illustrated by MacSwain (1956). Like the primary larvae of all Meloidae, this one is minute and does not resemble in any way the later stages of the species, measuring only 1.5 mm. in length and .35 mm. in width. It is at first almost colorless, except for black eye spots, brown mandibles and antennal bases, and reddish tarsi, but in about two hours from hatching all individuals develop a rich golden brown coloring which is characteristic.

Although they are active from the first and crawl continuously over and around each other in their mass, the ceaseless activity of the triungulins does not disperse them quickly and as only a few can be found venturing farther than an inch or two from the mass at any one time, it is not certain that their dispersal is entirely due to their own efforts. That they do disperse from the mass is certain, however, for normally nothing is left in any mass a week after hatching but the empty egg shells.

Since the triungulins invariably hatch in the immediate vicinity of *Xylocopa* tunnels, some of them probably reach the cells in which they are destined to develop on their own propulsion; but this is certainly not always the case, for in at least one instance a *Xylocopa* was netted on the wing at "El Salto" with a triungulin attached to its body. The triungulin was attached to one of the thicker hairs on a propleuron of the bee and had clamped its mandibles close to the base. It very strongly resisted efforts to dislodge it even quite a while after the bee had been killed by decapitation. Other triungulins would attach themselves in the same tenacious manner to dead *Xylocopa* and even to camel hair brushes brought near them.

It seems probable that in the field triungulins live longer, but when kept in small glass containers in Honolulu they died within two or three days. Food was offered to them in the form of fresh bee-bread obtained from nests of the local *Xylocopa*, but though they crawled over the bread they took small interest in it and were never observed feeding on it.

Larval Metamorphoses and History

Unable to take possession of infested timbers until the last days of my stay in Guatemala, I missed the opportunity to study in detail the life history of

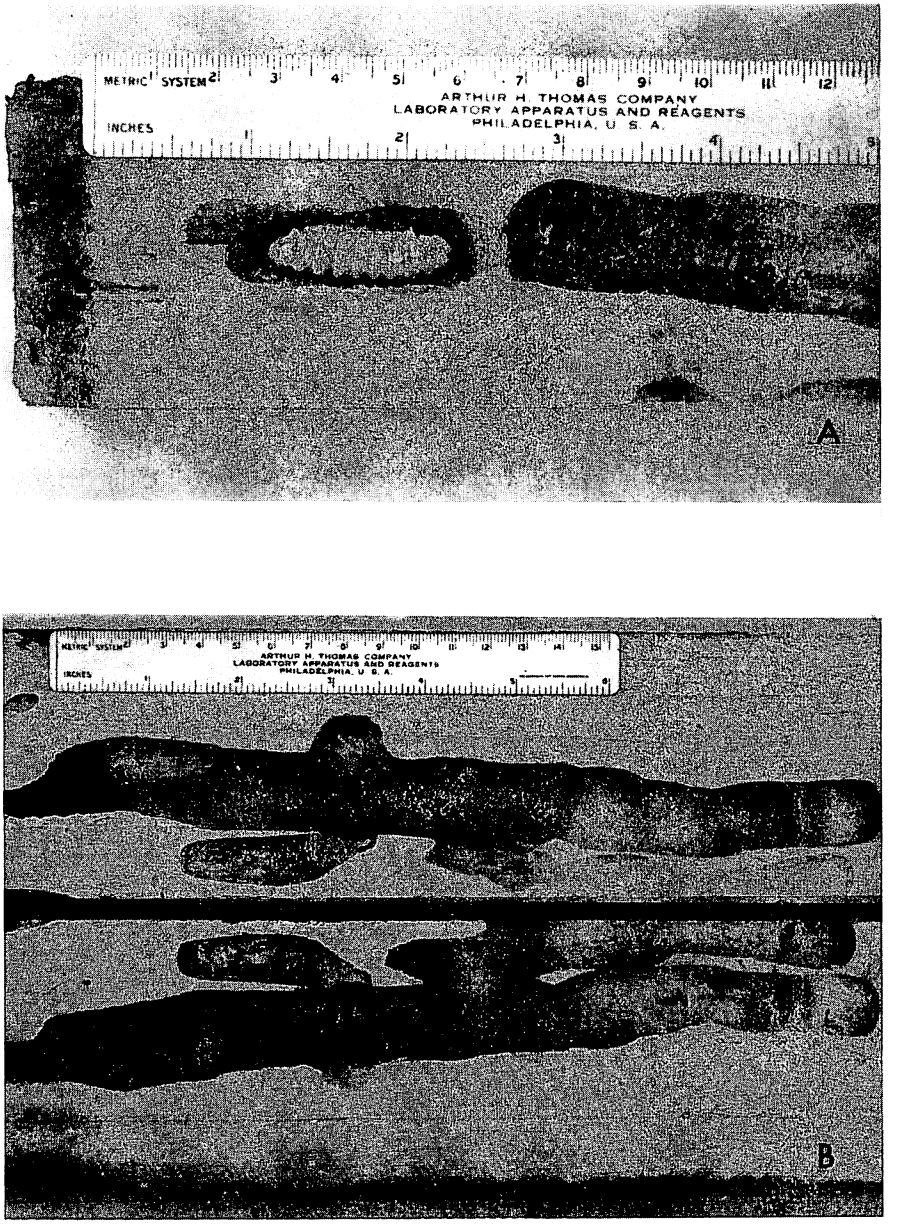

FIG. 3. A, Longitudinal section of a *Xylocopa* tunnel with a pre-pupa of *C. auriculata* resting in a terminal cell; B, *Xylocopa* tunnel cut in longitudinal sections and showing, left of center, two halves of a typical lateral cell of *C. auriculata*, with the insect removed.

auriculata beyond the triungulin stage. To my knowledge, such a study has not been made, but Guilding (1824) did illustrate some aspects of the biology of *Cissites maculata* in Barbados, and Bugnion (1909) partly elucidated the biology of *Cissites testaceous* Fab. in India, finding six phases in its development.

Of the six phases, I have seen in *auriculata* only the egg, the triungulin, a larval phase which I presume corresponds to the second active larval phase found by Bugnion in *testaceous*, the pre-pupa, and the adult. None of the timbers examined by us contained true pupae, or anything but adults and pre-pupa.

The three individuals of the second larval phase appeared one morning on the ground at "El Salto", under the opening of a *Xylocopa* tunnel in a roof beam. They had been apparently evacuated overnight either by bees or by members of their own species, and although they were alive they were badly attacked by some fungus or bacterial disease which formed small black pustules on various parts of their bodies. They were larvae of *scarabaeoid* type, with pronouncedly curved bodies, short, almost vestigial legs, and strong mouth parts. They measured respectively 20, 25 and 35 mm. in length and evidently represented at least two stages of development. It could be judged so from the fact that without other structural differences of apparent significance the largest larva showed mouth parts of considerably greater development than was found in the two smaller individuals. The general appearance of the three larvae and the two types of mouth parts are shown in figure 2, b, c, d.

Of the pre-pupal phase I have seen only one representative. This was transported from "El Salto" in a beam and was found in Honolulu resting snugly in the sealed cell in which it had developed (fig. 3a). It was accidentally destroyed before it could be studied.

Like those of *maculata* and *testaceous*, the larvae of *auriculata* excavate offshoots from the tunnels of their hosts and complete metamorphoses therein. The most important question which remains is whether the ambulant stages move any distance from the *Xylocopa* cell of their origin and whether in so doing they destroy more than one *Xylocopa*. Bugnion's and Guilding's evidence on this point may have been conclusive, but ours left ample room for doubt.

The offshoots are cells of characteristic appearance. They may be either lateral or terminal extensions of the *Xylocopa* tunnel, but they have nearly the same shape in either case. Laterally they never join the tunnel at a great angle, being in some cases parallel to it. Though the shape of the excavation may vary according to the angle, the space actually occupied by the *Cissites* larva is always an elongate oval with the broader end towards the tunnel. This shape is obtained by modifying the shape of a plug which separated the *Cissites* cell from the *Xylocopa* tunnel. The plug consists of particles of wood so compactly and smoothly glued together that it is often difficult to distinguish the plug from the walls of the tunnel or the *Cissites* cell. The size of the cells appears to vary with the size of the occupant, which fits snugly and has been found by me with the head oriented towards the

plug and the accumulated exuviae tightly pressed into a concave plate at the distal end of the cell. One cell measured 39 mm. from the face of the plug to the bottom of the cell. Its greatest diameter measured 12 mm. Its plug, slightly concave on both faces, measured 7 mm. of thickness along the edges and 5 mm. in the center. It closed an opening somewhat smaller than one cm. in diameter.

Not knowing what part of their lives the beetles may spend within the tunnels, we were forced to measure adult life from the time of their emergence from the tunnels. Thus, a series of 12 males lived approximately 3, 12, 12, 17, 18, 21, 21, 23, 24, 28, 30, and 46 days, respectively, and a series of five males lived 20, 15, 10, 8, and 5 days.

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