BIOLOGICAL AND BEHAVIORAL NOTES ON *GASTERACANTHA CANCRIFORMIS* (ARACHNIDA: ARANEIDAE)[1]

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ABSTRACT

Observations and experiments on the common, citrus grove-inhabiting, spiny-bellied orb-weaver, *Gasteracantha cancriformis* (L.), have demonstrated that the spider completes a life cycle in 1 year, maturing in the late fall and early winter. The characteristic webs vary in size and position and are reconstructed daily. Prey includes whiteflies, flies, moths and beetles. The tiny males accomplish sperm induction just prior to the 1 hour courtship and copulation. The ovate green-striped egg cases are constructed and filled in 1 to 2 hours. Eggs incubate in less than 2 weeks, deutova and first instar spiderlings hatch and molt within the case. Spiderlings do not disperse for 2 to 5 weeks.

Gasteracantha cancriformis (L.) is a common, tropical-subtropical spiny-bellied, orb-weaving spider in the western hemisphere. Although the species is frequently defined and discussed in texts on spiders (Comstock 1912, revised 1940; Gertsch 1949; Kaston and Kaston 1953; and Levi and Levi 1968) little is known about its biology and behavior. Marx (1886) discussed and described the tiny male, and Comstock (1912 and 1940) and Gertsch (1949) described and discussed the web structure, position, and location. But information on web construction, prey capture and feeding, sperm induction, courtship and mating, egg case construction, egg deposition and incubation, deutova and spiderling activity, and seasonal history is not available. Therefore, the following notes, although fragmentary, should be of interest to araneologists.

Field observations and specimen collections were accumulated, mostly from citrus groves, since 1952, but laboratory observations and experiments were restricted to the past 2 years. Males were found commonly only during 1970. Most behavioral observations were conducted in the laboratory under controlled experimental conditions during 1969, 1970, and 1971.

Seasonal History.—Adult females, which measure from 5 to 7 mm long and from 10 to 13 mm wide (Fig. 2), are common in mixed-mesophytic woodlands and citrus groves in Florida from October through January. At this time, the characteristic webs (Fig. 1) attain their greatest size and may be found from less than 1 to more than 6 m above ground. The tiny, 2 to 3 mm, males (Fig. 3) are common during October and November. They hang from single strands of silk either in or adjacent to the fe-

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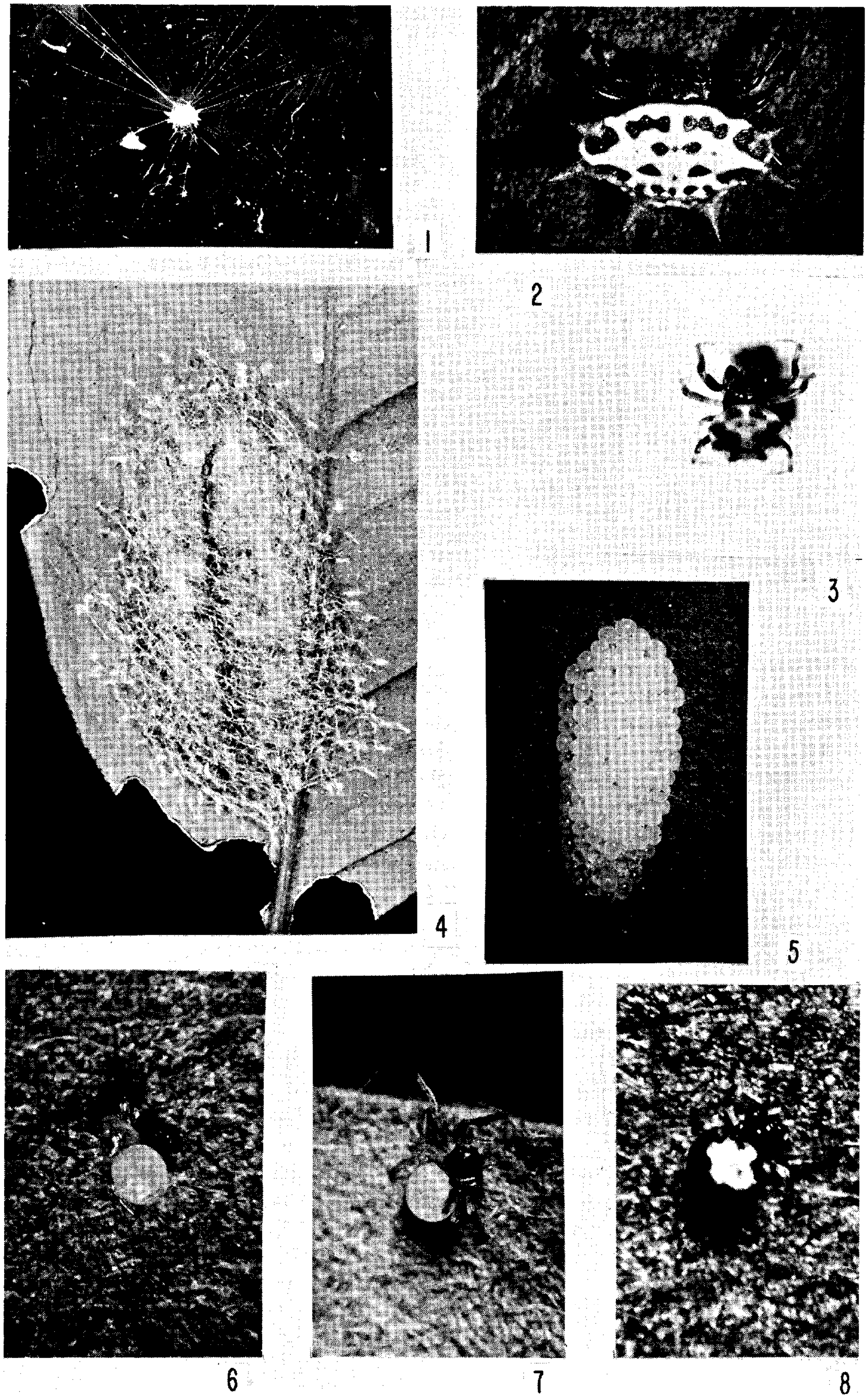

Fig. 1-8. *Gasteracantha cancriformis* (L.). 1. Web. 2. Adult female. 3. Adult male. 4. Egg case on citrus leaf. 5. Egg mass removed from case. 6. Deutovum. 7. First instar spiderling, freshly molted. 8. First instar spiderling with typical markings.

male's web, and from 1 to 3 may be found in a single web. The green-striped egg cases, which vary from 20 to 25 mm long and from 10 to 15 mm wide (Fig. 4), are deposited on the underside of leaves adjacent to the female's web from October through January. Spiderlings (Fig. 8) and immature spiders are found in places protected from the wind and sun from late winter through the succeeding fall. Spiderlings and tiny male-like immatures either hang from single strands of silk or on tiny, delicate, inconspicuous orb-webs during most of this time. Significant increases in size apparently do not occur until late summer and early fall when female-like immatures may be found in larger, stronger orb-webs. When females attain about one-third to one-half their adult size, males can be found in or adjacent to their small but typical webs.

Web Construction.—The web construction discussed here is that of the adult female. Webs of immatures are tiny and significantly different from those of sub-adult or adult females in lacking elongate reinforced guy lines, distinct tufts of silk on the radii or foundation lines, and a definitive central disc or resting plate. The males apparently spin no definite web.

The spider first spins the basic foundation of the web which consists of a single reinforced strongly tufted non-viscid line that usually extends from a high to a low elevation. This foundation may be transected by a second tufted primary line or simply connected to a primary tufted radius that pulls the basic line into an angle causing 3 convergent primary radii. Occasionally, 5 or 6 primary radii are constructed as a foundation. A strong, exterior circumferential tufted line that will mark the outer limits of the spiral thread is then laid down between these radii at a distance from the 3 or 4 line hub. The spider then spins secondary non-viscid radii and attaches them to the concurrently spun, partially spiral, partially random lined central disc, and the peripheral, circumferential thread. These secondary radii vary in number, but in large webs 20 to 30 such may be counted; the number is invariably greater in large webs and fewer in small webs. After completing the secondary radii, the spider spins the viscid spiral thread, starting at the circumferential line and working inward. The succeeding loops of the spiral thread are spaced at intervals of 2 to 4 mm. Variation also exists in the number of loops of the spiral thread. Again, the number apparently varies with web size; as many as 30 loops occur in large webs, as few as 10 in small webs. The completed web has an open area of 4 to 8 cm diameter between the central disc and the viscid spiral thread and, excluding the elongate foundation or guy lines, may vary from 30 to 60 cm in diameter. Tufted silk is most distinct on the foundation lines and circumferential line but may also occur on secondary radii or the central disc.

Under natural conditions, webs are constructed at a slight to distinct angle from perpendicular, and the female rests on the lower face facing downward to await prey. The plane of some webs is, in fact, curved downward on both sides of the hub. Guy lines, exterior portions of primary radii, frequently extend 2 to 4 m from the orb to the web supports. Webs are probably eaten and rebuilt daily. This activity has never been observed, but laboratory females have built webs one morning, have none the next morning, but have built one again the following afternoon. One isolated, field-observed female built 2 webs in 1 day.

Prey Capture and Feeding.—Prey capture and feeding of adult females were observed in both the field, primarily citrus groves, and in the laboratory. Males and immatures were not studied as extensively as females.

The female spider rests at the hub of the web on the central disc while awaiting prey. When an insect flies into the web, the female orients to the disturbed sector. She then plucks or snaps the radii on each side of the disturbance. This action is accomplished with the first or first and second pairs of legs, and is usually repeated once, sometimes twice to more securely trap the prey before the spider rushes out on the disturbed radii to capture the prey. When the prey is located, it is bitten and carried in the chelicerae back to the central disc for consumption. The female uses 2 techniques in her return with captured prey to the central disc. She may either climb back over the web or swing free and climb back up her drag line to her resting place. If the prey is tiny, much smaller than the spider, it is paralyzed, carried, and eaten without further treatment. Prey either approaching the spider's size or larger than the spider is wrapped in silk and paralyzed before it is carried to the central disc. When several prey strike the web either concurrently or within a short period of time, the spider locates and paralyzes 2 or more but leaves them in their trapped position, feeding on them consecutively. Tiny prey apparently is deliquefied rapidly, if not instantly, and discard of the remains is easily overlooked. Large, swathed prey is greatly reduced in size by the feeding activity, but the mummified carcasses are easily recognized in the chelicerae and when they are discarded.

Observed and experimental feeding have shown that the adult females readily capture and eat whiteflies and several families of flies, moths, and beetles. To date, no trapped prey have been observed to be rejected. Males have not been observed feeding under either field or laboratory conditions. Immatures have been observed to feed on tiny to small insects similar to those consumed by the females, but since they cannot be readily induced to spin webs in the laboratory, their food habits have not been tested with known foods.

Courtship, Sperm Induction, and Mating.—The behavior of males and females prior to and during copulation were observed only twice, and these were consecutive observations on the same male and female under laboratory conditions.

A caged female was fed aleurodids and drosophilids until she stopped feeding. A male was then introduced into the cage at the attachment point of one of the upper guy lines of the web. The male made a number of exploratory runs into the web on primary and secondary radii, apparently searching for the female. When he approached within 4 cm of the female on adjacent strands of silk, both spiders showed agitation by vibrating their legs and the web; the male drummed the web rhythmically. When the male finally made an approach on the radius occupied by the female, both spiders moved toward each other with the male drumming or vibrating the web repeatedly in a 4-tap rhythmical series (.... ....). On contact, the female vibrated her legs and moved backward a short distance, but the male dropped to the bottom of the cage on a drag line. The male then worked up and down the drag line 5 times, stopping every 2 to 4 cm on each passage within a period of 3 to 5 min. Although the large 3X lens used for observation did not afford clear detailed vision, it is believed that the male accomplished sperm induction during this activity. After sperm induction, the male climbed back into the web on his drag line and quickly relocated the female. On this second approach, the male again drummed the web in the rhythmical 4-tap pattern. At second contact, both became agitated, and the male dropped 10 to 15 cm before climbing back to the female's radius. On the third approach, the male, after drumming at a distance of 4 to 5 cm from the female, darted quickly to the female's venter where she strapped him in place with 3 or 4 strands of non-viscid silk. The copulation position was venter to venter with both sexes oriented in the same direction. Clear vision of palpal alternation was prevented by the dark coloration of the female venter and male carapace, legs, and palpi. The pair remained *in copula* for 35 min with the male shifting position slightly every 2 to 3 min. About halfway through the copulation, the female removed the strap-lines, apparently moved the male, and spun new strap-lines. After 35 min the female responded typically to a drosophilid that struck and stuck in the web, and the male dropped free. The entire process—search, courtship, sperm induction, and copulation—was accomplished in about 1 hr.

One-half hour later, after a second sperm induction, the search, courtship, and copulation were repeated with very little variation from that described above. Variants were sperm induction before search and only one false preliminary contact before copulation. The female captured and fed on a drosophilid during this second copulation. The male accomplished sperm induction immediately after this second mating and remained in the web vicinity for 6 days before dying.

The following statements are conjectural. It is believed that the female movement of the male during copulation probably involves palpal alternation. Males may not accomplish sperm induction prior to location of an occupied female web but probably maintain charged palpi thereafter throughout the association.

Egg Case Construction.—The following notes on egg case construction are based on observations and studies conducted in Florida citrus groves during the past 18 years (1952-1970) and in laboratory studies during the past 2 years (1969-1970).

The ovate-lenticular egg cases are constructed predominantly on the lower side of citrus leaves (Fig. 4). They are occasionally found on the upper surface of leaves, and in the laboratory have been built on the sides of tin cans and large test tubes. None have been found on the limbs and trunks of citrus trees. The number of cases produced per female is not known, but 2 and 3 cases have been collected adjacent to single webs, so the species probably lays more than 1 mass of eggs per female. Location of the cases in respect to the web seems to be variable; some have been found adjacent to the attachments of the upper radii, others adjacent to the lower radii. In the laboratory, cases have been constructed both above and below the female's resting site.

The following description of normal case construction is based on several partial and 1 complete set of observations. The female first laid down an ovate egg-sheet or platform constructed of loosely woven, fine, white to yellow-white threads firmly attached to the lower leaf surface with strong distinct attachment discs. Eggs were deposited upward onto this platform in an elongate, ovate, lenticular mass (Fig. 5). The egg mass then was covered with a loose, spongy, tangled mass of fine white to yellow-white threads that was also fastened with distinct attachment discs. Just prior to constructing the final covering or canopy, the female moved up and down the long axis of the mass laying down a ridged stripe of several to a dozen or more coarse, dark green threads. The final net-like canopy of coarse green and yellow threads was then spun over the entire mass and also attached firmly to the leaf. Although actual egg deposition required only about 1 min, egg case construction required 1 to 2 hr.

Three abnormal cases were constructed in the laboratory. One nearly spherical, unstriped case was apparently constructed of the normal elements, except for the stripe, but was not of normal form. Another was apparently normal but lacked eggs. The last lacked both the dark stripe and the net-like canopy. All abnormal cases were spun in large test tubes. However, normal cases also were spun in test tubes.

Eggs, Incubation, and Hatching.—The following data were obtained from both field-collected and laboratory-deposited egg masses. Egg counts were made on cases soaked for 15 to 30 min in 5.25% sodium hypochlorite before rinsing and preserving them in 70% ethanol. Eggs were hatched in small stender dishes.

Egg counts were made on 15 egg masses collected from 5 different groves. A minimum of 101 eggs and a maximum of 256 were counted; the mean was 169 eggs per case. Five cases contained a mean of 119 spiderlings per case but some spiderlings may have previously emerged or escaped prior to preservation.

At laboratory temperatures of 75 to 85° F and variable humidities, eggs completed incubation in 11 to 13 days. All eggs in an individual mass did not hatch, indicating sterility. No counts could be made of sterile eggs without destruction of the cohesive mass. Two of the abnormal cases discussed above contained nothing but sterile eggs.

Hatching apparently was initiated by the deutoval action of lifting the carapace away from its folded position against the spherical abdomen. This elongated the egg and stretched the chorion causing it to break free of the deutovum in open areas between legs and at the union of cephalothorax and abdomen. The egg ruptured over the chelicerae, and the split extended dorsally and backward toward the posterior margin of the carapace and the region of the pedicel. The first appendages to be freed were the palpi followed by legs 1, 2, 3 and 4 in order. Most deutova then squirmed or wiggled free of the egg shell within 5 to 10 min. Some specimens, however, either got legs trapped in the chorion or the chorion stuck to the abdomen. One observed specimen took 25 min to free its appendages.

Deutova have white to yellow-white spherical abdomens with the carapace, chelicerae, palpi, legs, and sterna a pale, translucent pink (Fig. 6). Egg masses containing deutova have a pink cast.

Deutova and Spiderling Activity.—The activities of deutova and spiderlings were studied on groups and individuals in stender dishes and vials.

Deutova (first and second post-embryo of Eason 1969) were relatively inactive. When egg masses containing hatched deutova were disturbed by removing the silk, the deutova feebly waved their legs but did not accomplish coordinated or purposeful walking. Deutova that hatched from desilked egg masses became randomly distributed over the bottom of the restraining dish or vial. Most of them eventually rolled onto their backs and sporadically waved their legs feebly in a walking motion. This apparently random action was continued at intervals until the deutova molted to first instar spiderlings in 2 to 3 days.

First instar spiderlings (second instar of Eason 1969), which had pale-white to yellow-white spherical abdomens and grey carapaces, sterna, chelicerae, palpi, and legs when newly molted (Fig. 7), moved more purposefully than deutova but had a tendency to remain clustered or clumped together as they would be within the egg case. Spiderlings from desilked egg masses regrouped from the random distribution caused by deutoval activity. They clustered over the mass of egg shells and apparently webbed themselves in with their drag lines. When the mass of egg shells was fragmented, the newly molted first instar spiderlings formed several clusters over the fragments. Egg cases containing newly molted first instar spiderlings developed a grey cast.

Within 5 to 7 days, first instar spiderlings darkened to the typical color for the species (Fig. 8). They had black legs, palpi, chelicerae, carapaces, and sterna; the abdomen was basically black with a dorsobasal yellow to white, posteriorly pointed triangular spot and a pair of ovate, dorsolateral, posterior white to yellow-white spots just in front of the spinnerets. These species-typical spiderlings caused the egg case to be dark grey in color. Darkened, first instar spiderlings dispersed within a week from disturbed egg cases or desilked egg masses. Under field conditions or when the cases are not disturbed, the spiderlings did not disperse for 2 to 5 weeks.

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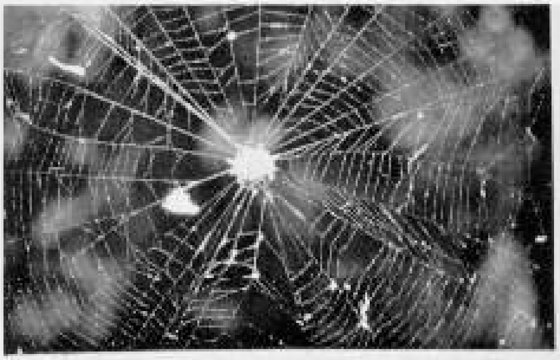

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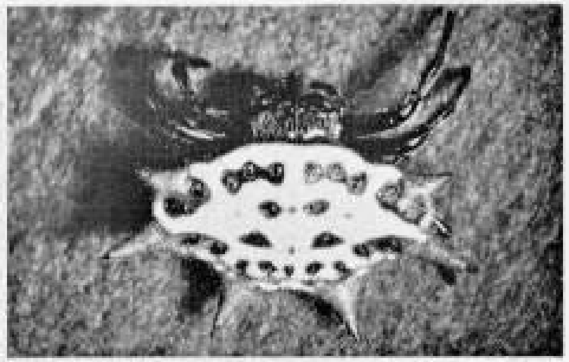

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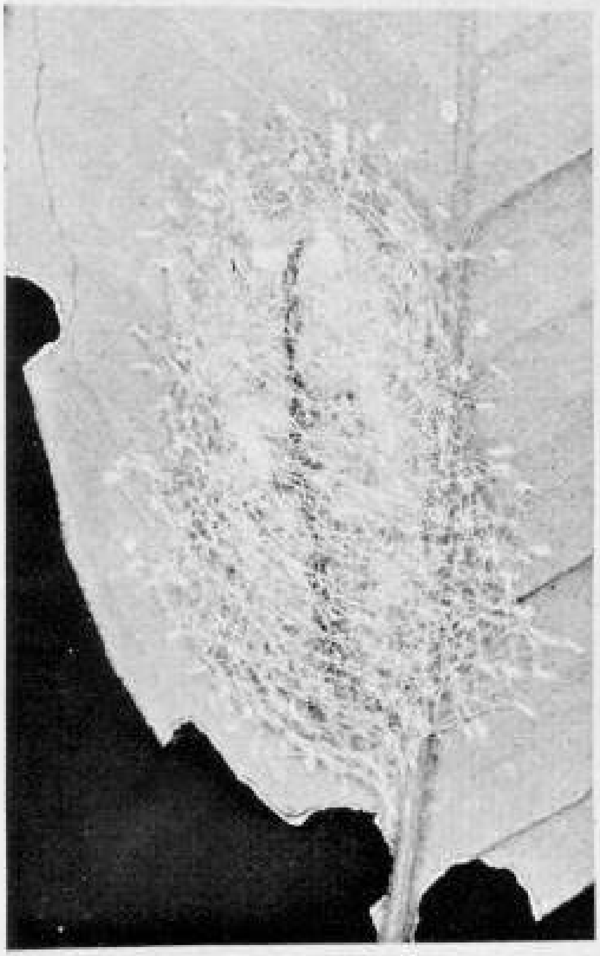

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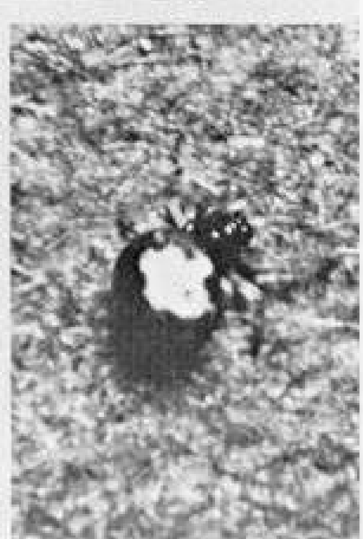

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