OVIPOSITION AND DEVELOPMENT OF *VOLUCELLA ISABELLINA* (DIPTERA: SYRPHIDAE) ON SAGUARO CACTUS, *CEREUS GIGANTEUS*[1]

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ABSTRACT: *Volucella isabellina* flies were observed ovipositing on green surfaces, callus tissue, ooze, and mostly on spines of a giant cactus. Only females were found on the cactus at the time of ovipositing. Egg masses contained up to 198 eggs. Oviposition rate was one egg every 3.1 to 5.5 seconds, and hatch time was between 42 and 65 hours. The larval period was 27-28 days and the pupal period 14-17 days. Briefly described are the eggs and an unidentified (probably undescribed) mite egg predator. Up to 3,000 eggs may have been deposited within one hour by 15 females. The intensity of observed ovipositing suggests that oviposition may be timed for especially warm morning twilight on saguaro cacti with symptoms of incipient decay.

On June 7, 1985 at 6:05 a.m. ca. 15 female *Volucella isabellina* Williston flies were found flying about and intermittently ovipositing on a diseased and apparently dying saguaro cactus, *Cereus giganteus* Engelmann. The female flies were observed for one hour during which no males were seen. The cactus was located near the top of a prominence on a ridge (elev. ca. 1340m = 4400 ft.) between Finger Rock and Box Canyons in the Santa Catalina Mountains just north of Tucson, Arizona. The saguaro was about four meters high and had no side branches but had three constrictions at the one, three, and three and a half meter levels. The plant's eastern side was thickly encrusted with coin-sized scabs and most of the spines below the three meter level were missing. Below the one meter level the entire trunk was brown. Black sap oozed from between several ribs on the western and northern sides and from near the base.

Ovipositing was observed at several different places on the tree. The favored site for deposition of egg masses appeared to be the few remaining cactus spines. Eleven egg masses of varying sizes were found on spines, eight of which were formed during the observation period. Five other egg masses were found. Two of these were directly on the black septic ooze, both of which had been laid before observation began. The three other egg masses were on smooth green surfaces between ribs; one of these was formed during the observation period. Numerous flies (up to seven) congregated in a fist-sized hole. They appeared to be ovipositing in cracks of the dry black callus tissue in the hole but egg masses could not be seen from the ground. Numerous eggs were also laid singly or in strings in cracks

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around and under scabs. Egg masses may also have been laid under scabs but if so were hidden from view. Numerous eggs were also found between ribs in small dense spider webs. Fogleman, *et al.* (1981) have noted the importance of oviposition site preference in niche separation of cactophilic Drosophilidae; such preference may play a similar role in cactophilic Syrphidae.

Four females were timed for the duration of ovipositing on spines. These ovipositing bouts lasted about 18, 7, 5 and 2 minutes during which ovipositing was more or less continuous. Three of the masses, those produced by the 18, 7 and 5 minute bouts, were collected and the eggs were counted in the laboratory. The egg counts were 198, 135, and 83, respectively. Thus the egg laying rate varied from one egg every 3.1 to 5.5 seconds. Close observation of several laying females revealed maximal rates of one egg per second for short periods. Probing and stroking movements of the ovipositor frequently interrupted egg laying for several seconds accounting for the lower sustained rate of laying. Some of the uncollected masses appeared larger than the largest collected mass. Extrapolating from these data, the 15 females may have laid a total of up to 3,000 or more eggs on the saguaro during the hour of observation.

Females ovipositing on spines always assumed a characteristic position hanging below the spine with the head toward the cactus so that the egg masses accumulated on the ventral sides and distal halves of the spines. Eggs were white immediately after being laid but appeared gray 24 hours later in the laboratory. Since all observed masses were white, they probably were laid on the morning of the observation. The eggs were cylindrical to spindle-shaped, measured ca. 0.6mm x 0.1mm, and appeared to be covered with tiny white diamond-shaped scales or reticulations, though bare in places. Six yellowish, spherical, gravid(?) mites (ca. 0.2mm dia.) were found on one of the collected egg masses.

The day before observations, June 6, was the first day of 1985 to exceed 100°F in Tucson (WSO airport), reaching 103. On the night preceding observations the low was 77. On the day of the observations the temperature reached 109. These temperatures exceed the average daily minimum, 67.3, and maximum,, 98.5, for June (Sellers, *et al.,* 1985). Sunrise in Tucson occurred at 5:17 a.m. and light fell on the saguaro at 6:30. Ovipositing activity seemed to diminish by 7:00 a.m. although eight females were still present.

To determine whether the cactus was attractive because of its position on the ridge top or because of its diseased condition other saguaros in the vicinity were examined. Several other ridge-top saguaros had scabs but no others had oozing sepsis and no flies were found on the other saguaros. The intensity of ovipositing activity at the time of observation suggests that

females of *V. isabellina* may time their ovipositing to some combination of factors that prevailed at the time. These may include seasonal meteorological, diel, host plant, or plant condition cues. The congener *V. vesicularia* also shows crepuscular activity (Waldbauer, 1963).

No eggs hatched by 42 hours in the laboratory at 84°F. By 65 hours, however, at least 50% of the eggs had eclosed leaving rips near the micropylar ends of the chorions. Also by this time one ruptured dry hull of a mite was found and numerous young mites of at least two instars were present and all appeared to be feeding on the fly eggs. The first instar fly larvae burrowed into a slice of moistened prickly pear (*Opuntia spp.*) fruit that was provided since no saguaro was available. By the fifth day after eclosion 7mm larvae were present in the now-rotted fruit. A sliced *C. giganteus* fruit was supplied on the sixth day. Larvae measured 10mm by the seventh, 20mm by the twelfth, and 25mm by the fifteenth day. This was the maximum length attained but larvae continued to increase in girth. On about July 1 the mature larvae escaped from the glass rearing container. Some were found still healthy up to 30m away and two floors down attesting to the desiccation tolerance and migratory powers noted by Mangan (1984). Ten recovered larvae pupated, secreting a milky (meconium?) fluid, by July 7. A pair of posterior respiratory horns and three pair of tiny anterior appendages were found everted on pupae three days after pupation. Eight adults emerged between July 22-24 with a sex ratio of 5♀: 3♂. Thus total developmental time was 46-48 days at 76-84°F.

Observations on *V. isabellina* by Mangan (1984) are generally similar but differ somewhat from those reported here. Mangan found only 1-3 females per cactus and did not note the absence of males. He estimated egg masses with from 200-500 eggs, and reported developmental time greater than 50 days. He noted egg masses on protrusions, spider webs, and spines but did not indicate that spines were the main oviposition site. He characterized the larval medium as "old, anaerobic liquid tissue." In this study, however, the larvae were given fresh moistened cactus fruit which only became deliquescent as a consequence, not a precondition, of their feeding. The ability of larvae to survive under a high alcohol concentration in an environment of microbial fermentation was confirmed by the observation that four mature larvae remained alive 1.5 hours after pickling in 70% ethyl alcohol!

Specimens in the collection of the University of Arizona Entomology Department indicate that puparia have been taken from "saguaro rot" and adults have been reared from "saguaro" and "saguaro rot." The flies have been taken in every month of the year in Arizona. Specimens have been taken at the following plants: *Encelia farinosa*, *Prosopis juliflora* (flowers), *Nicotiana trigonophylla*, *Lesquerella gordoni*, *Lycium exsertum*, *Melilotus*

alba, "arrow weed," and "alfalfa sweeps."

Distribution records from Cole (1969) indicate that *V. isabellina* "was first collected in Ariz., N. Mex., and northern Sonora, Mexico, in desert areas." It thus appears to be mainly coextensive with areas where saguaro occurs. However, Stone, *et al.* (1965) list the species from "Ariz.; Calif. to Colo., S. to Mexico," thus, it may occur outside the range of saguaro.

The most complete synopsis of insects infesting decaying saguaro is given by Hubbard and Schwarz (1899). They state that insect infestations are rare and secondary to other injuries. But where decay had started "the rotting was constantly advanced by great numbers of huge dipterous maggots (*Volucella avida* O.S.), aided by several small species (*Ceratopogon, Limosina, Scatopse, Drosophila*) and all parts of the mass overrun with Coleoptera." Santana (1961) studied ten species of dipteran larvae in saguaro rot. He recognized *V. isabellina* as "doubtless the most common and prominent of the cyclorrhaphous dipterous larvae occurring in rotting saguaros. . .," noting that "the larvae work at the periphery of these lesions from shortly after initial infection until all healthy tissue has been broken down." He also recorded *V. clarki* in later stages of decay. Mann (1969) lists 11 species of *Volucella* as "scavengers feeding on cactus." This information together with the observations of ovipositing suggest that *V. isabellina* does not initiate the disease condition but may be very important in overwhelming the cactus in the early stages of fatal decay. It may be that diseased plants could recover were it not for the early and heavy myiasis caused by *V. isabellina.*

Steenbergh and Lowe (1983) state that adult saguaro suffer relatively little depredation due to natural enemies. They attribute most mortality to "mechanical agencies" (freezing, lightning, wind) with bacterial and insect invasion being secondary events. Freezing almost certainly was the initial cause of this saguaro's illness considering its high elevation and the occurrence of snow below this elevation a few times during the previous winter (C. Lowe, personal communication).

Schuyler (1968) was unable to confirm the conclusion of Boyle (1949) that the pyralid *Cactobrosis fernaldialis* vectors the pathogen responsible for bacterial rot, *Erwinia carnegieana. V. isabellina* would seem to be a likely vector candidate, or at any rate, involved in the short range spread of the sepsis. The relative importance of *V. isabellina* compared to other saguaro-infesting insects, and its relationship to mechanical agencies and plant pathogens in the death of saguaros remain to be determined.

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