FLORAL MIMICRY IN *EPIDENDRUM RADICANS, ASCLEPIAS CURASSAVICA, AND LANTANA CAMARA*

Erik W. Gunderson, Janis M. Hall and Stacey A. Wooley

Abstract. We examined the possibility that floral mimicry exists among *Epidendrum radicans, Asclepias curassavica,* and *Lantana camara* in Monteverde, Costa Rica. We found overlap in potential pollinators between *L. camara* and *A. curassavica,* but not between these species and *E. radicans.* Thus, it appeared that mimicry between the former two species was possible, while it appeared unlikely that *E. radicans* was involved. Furthermore, *A. curassavica* produces less sugar than *L. camara,* suggesting that it may be mimicking *L. camara.* (EWG)

INTRODUCTION (JMH)

It has been suggested by Bierzychudek (Todzia 1983) and Boyden (Schemske 1983) that floral mimicry has developed between three plants found in Costa Rica: the orchid *Epidendrum radicans* (Orchidaceae), the milkweed *Asclepias curassavica* (Asclepiadaceae), and *Lantana camara* (Verbenaceae). The inflorescences of these plants are similar in coloration and size, though flower structure differs.

One possible reason for this floral similarity is that the inflorescences of these species have converged on a similar appearance which benefits all of them (when they occur together) by making a larger target or denser patch to attract pollinators. Another reason could be that one (or two) of the species are "stealing" pollinators from the other(s) by mimicking it (them), but not offering a nectar reward. It is inefficient for a species to attract pollinators which frequent plants other than its conspecifics, since some of its pollen would be wasted on other species' flowers if the two species bloom simultaneously. However, if the mimic plant is able to offer less reward, it may be an energetically efficient sacrifice of pollen.

We propose that a mimicry relationship between these plants would require an overlap of pollinators between the plant species, and the production of less sugar by one species. It would also require that the species being mimicked is subject to less pollinator visitation in the presence of the mimic. According to Bierzychudek and Janzen (Todzia 1983), *E. radicans* offers little or no nectar. Considering this, we hypothesized that *E. radicans* would be a mimic of *L. camara* or *A. curassavica,* or of both. Although we were not able to test for the third condition necessary for mimicry (reduced pollination due to presence of mimic), we tested pollinator overlap by comparing insect pollinators found on each species, and reward offered by comparing sugar production of each species. We expected to find overlapping pollinators between *E. radicans* and at least one other species, and to find that *E. radicans* offered less reward to the pollinator. These data may also indicate a different mimicry relationship, such as *A. curassavica* mimicking *E. radicans* or *L. camara.* It is possible that all species share pollinators and one offers less reward; in such a case, we would need to test for the condition of reduced pollination in order to identify whether one or the other species, or both, was being mimicked.

METHODS (EWG)

We conducted our observations on 17-18 January 1992 in an area along a 3km stretch of road leading to the Monteverde Reserve, Costa Rica. The *A. curassavica* plot was 3km from the Reserve on a moderately steep embankment that was partially shaded and covered with ~0.5m high grass. The *L. camara* study plants were approximately 2.5km from the reserve in a yard opposite the Monteverde Cheese Factory. The yard was partially shaded, sheltered from the wind, and had ~1.5m high plants in it. The *E. radicans* plot was on a steep slope on the roadside, 200m from the Reserve. The area was sunny and windy with ~1.0m high grass and shrubs.

Flowers were observed individually or in groups from 1300 to 1600 on 17 January and 1100 to 1400 on 18 January. Flowers were chosen randomly to control for microclimate variation and a minimum observation period of 15 minutes was set to ensure a sufficient representation of insect visitors. Each investigator observed the insects that visited a single species of flower, classifying the insects by order. Observer distance from the flowers varied from 1-3m, with total observation times of 4.25hr (*L. camara*), 4.0hr (*E. radicans*), and 3.0hr (*A. curassavica*).

After the observation period on 17 January, bags were placed over *L. camara* and *A. curassavica* flowers to prevent visitation and allow nectar to build up. *E. radicans* was not bagged because the plot was frequented by tourists. To account for the discrepancy in design, nectar was sampled from *E. radicans* at 0630, before the arrival of potential nectar feeders. The nectar of *L. camara* and *A. curassavica* was sampled from 1100 to 1200. As much nectar as possible was drawn from *L. camara* and *A. curassavica* with capillary tubes, the amount was recorded, and an estimate of sugar concentration was made with a refractometer. We calculated the mass of sugar per inflorescence from measurements of Brix (a measurement of concentration) taken with an American Optical refractometer on our nectar samples. Because of difficulties in extracting nectar from *E. radicans,* a measured capillary length of water was added to the corolla and drawn back up. Since we were unable to withdraw the total volume of diluted nectar, our calculation of mass of sugar from the diluted nectar is an underestimate.

RESULTS (JMH)

Data from the pollinator visitation observations (Table 1) were not subjected to statistical analysis, since some of our expected values were too small for a chi-square or G-test. The most frequently seen insects on *L. camara* were Lepidoptera, and *E. radicans* and *A. curassavica* were frequented mostly by Hymenoptera (Table 1). Very few insects were found on *E. radicans* and although we were unable to calculate visitation rates which were comparable between plant species, we conclude that *E. radicans* attracted fewer potential pollinators than the other species. *L. camara* had the greatest mass of sugar per inflorescence and *E. radicans* had the least (Table 2). In calculating the mass

from Brix and volume collected, we assumed that 1g sugar/100g solution (or Brix) was equal to 1g sugar/100ml solution; although this assumption underestimated the actual mass of sugar, it was necessary because we were unable to accurately convert our data units from grams to ml. The inaccuracy of this method increases as the sugar content of the nectar increases; considering the small amounts which we measured, the error was acceptable to us.

Table 1: #visitors per flower species

	A. cur.	L. cam.	E. rad.
Hymenoptera	18	4	3
Lepidoptera	11	16	1
Diptera	3	1	1
Total Visits	32	21	5
# Plants Observed	51	18	12

The average volume of nectar per inflorescence was greater in *A. curassavica* than in *L. camara*, and was not determined in *E. radicans* (Table 3).

DISCUSSION (SAW)

The data collected challenges the validity of our original hypothesis that the orchid *E. radicans* maintains a mimicry relationship with either *L. camara* or *A. curassavica*. Although the orchid offers less reward than the other two species, it still fails to meet the stipulation of similar pollinators. The orchid's limited sugar reward seems to be a disadvantage in attracting pollinators. Even though the orchid was visited by Hymenopterans, they only touched down on the flower, failing to pollinate. We found one site containing the orchid and this plot contained only twelve plants, limiting our sample size.

Although the orchid failed to satisfy our predictions for a mimic, *A. curassavica* may be mimicking *L. camara*. Shared pollinators were evident between these two species and the amount of sugar per inflorescence was greater in *L. camara*. Unfortunately only two nectar measurements were taken from *L. camara* and they exhibited a wide range.

Differing flower morphology may also play a part in attracting or restricting pollinators. Although the orchid exhibits the largest nectary opening in its single inflorescence, it offers little nectar to its pollinators. *L. camara* has a longer, more narrow nectary opening, limiting reward to only those pollinators with an elongated proboscis (e.g., Lepidopterans). *A. curassavica* has a shorter, more cup-like nectar reservoir, allowing for a wide variety of pollinators as shown by the diversity of insects visiting it.

Given ample time, more nectar samples could have been collected, allowing statistical analysis. A study of flower morphology may show some correlation between nectary shape or size and pollinator type. This information may lead to stronger conclusions about mimics, the morphological relationship between the flowers involved, and competition for pollinators.

There may also be a problem with our original assumptions about mimicry. It may not be energetically efficient to offer less sugar but subsequently lose pollen to flowers other than conspecifics. To completely test our hypothesis we must also consider evidence for a reduction in pollination as a condition for mimicry. The question still remains as to whether a relationship of mimicry occurs between any two of these three species.

LITERATURE CITED

Schemske, D.W. 1983. *Lantana camara*. In *Costa Rican Natural History*, ed. D. H. Janzen, 266-68. Chicago: University of Chicago Press.

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Table 2: Amount of sugar per inflorescence (mean)

Sugar content	A. curassavica	L. camara	E. radicans
Mean (Brix)	9.82	11.25	0.28
range	5.5 - 20.25	9.0 - 13.5	0.10 - 0.35
Mean (grams)	2.19×10^{-4}	1.99×10^{-3}	3.71×10^{-5}
range	1.17×10^{-4} - 1.87×10^{-5}	1.76×10^{-3} - 2.22×10^{-3}	8.64×10^{-6} - 6.12×10^{-5}
Sample size	7	2	7

Table 3. Amount of nectar per inflorescence

	A. curassavica	L. camara	E. radicans
Mean (mm³)	7.90	7.26	*N/A
Range (mm³)	1.12 - 15.70	6.28 - 8.24	

*Since these nectar volumes were very small they were assumed to be zero. Brix readings were taken from nectar and water mixtures.