HOW SWEET IT IS - NECTAR PROTECTION IN *IPOMOEA* SP.

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Abstract. Temporal variation in nectar production and solute concentration were proposed as mechanisms by which *Ipomoea* sp. minimize pre-anthesis nectar robbery and maximize nectar availability to pollinators. Results indicated that most nectar production took place within three hours after flower opening although extreme variation in nectar quantity was observed between flowers. Solute concentration peaked near anthesis, but again, there was high variation among flowers. Insect robbers were not found inside buds experimentally injected with sugar solution. Patterns in nectar production may have been selected for in the past to increase chances of successful outcrossing by reducing chances for nectar robbery.

Key words: Ipomoea, *nectar, nectar robbery*

INTRODUCTION

The interaction between flowering plants and pollinating insects is a classic example of mutualism. To encourage potential pollinators to visit their flowers, many plants offer nectar which may contain sugars, proteins, amino acids, and lipids (Baker, 1983). *Ipomoea* sp. also dysunset (16:45-17:45), a vine with flowers resembling those of the common morning glory (*Ipomoea trifida*), are frequented by nocturnal sphingid moths which may metabolize at rates of up to 18 calories per minute (Baker 1983). To encourage visitation by sphingids, *Ipomoea* produces large quantities of sucrose-rich nectar. This represents a significant energy expenditure and, presumably, *Ipomoea* has developed mechanisms for defending this resource against nectar robbing insects. Sphingid moths are most active at dusk and at dawn (Baker 1983) whereas our observations indicated that small flies, the most likely nectar robbers, were most active from early morning throughout the afternoon. Therefore, we hypothesized that *Ipomoea* regulates both nectar production and quality so as to minimize robbery and maximize nectar availability to its intended pollinator. We predicted that nectar production would be low throughout bud development and would only increase with the nocturnal opening of the flower. Nectar quality should follow a similar pattern. Finally, we predicted that if robbery is indeed a threat, buds treated with sugar solution before natural nectar production begins should show greater insect infestation than untreated buds.

METHODS

Studies were conducted on 19-20 January, 1996 at the San Luis Natural Preserve, Costa Rica. *Ipomoea* flowers, located 250 m east of the dining hall, were surveyed to assess temporal trends in nectar production, solute content (presumably sugar), and abundance of nectar robbers. Independent sets of five flowers were examined for nectar volume and sugar content at 1730, 1900, 2115, and 2345 on the first day and at 0645, 1300, and 1500 the following day. Nectar quantity was measured by siphoning the liquid with 10 μL micropipets. A refractometer was used to measure the sugar concentration of the collected nectar. To control for nectar robbery, buds expected to open during the proceeding night (yellowish and large) were enclosed within mesh bags during the early afternoon of 19 Jan. These bags excluded insects while maintaining exposure to typical weather and light conditions. We tested for temporal variation with an ANOVA (sugar concentration) and with a Kruskal-Wallis non-parametric analysis of variance (nectar quantity).

To assess the numbers and types of insects stealing nectar (occurring inside bud or flower) we observed five unbagged flowers at 1900 on 19 Jan and at 0645 and 0100 on 20 Jan. At 1400 on 20 Jan, 10 mature buds were injected with 150 μL of Hi-C pear juice to simulate the presence of nectar and to test if insects were attracted to nectar within closed buds. An additional ten buds were merely pierced with the micropipet to control for the effects of breaching the bud. Because the pear juice was not nectar and because it measured only 12 Bricks on the refractometer (average nectar readings were 22 Bricks), an additional five buds were drenched with juice to assess whether pear

juice was an effective attractant. We counted insects on the flowers at 1700 and used a student's t-test to compare the numbers of insects found in each treatment.

RESULTS

Maximum nectar production appeared to coincide with anthesis. Both nectar volume and solute concentration changed with time of day ($H = 26.97$, $df = 6$, $P < 0.001$; $F = 6.99$, $df = 5$, $P < 0.001$, respectively). No nectar was found in small or medium sized buds. Nectar volume, however, increased dramatically within three hours of flowering (Fig. 1), while sugar concentration peaked at the time of anthesis (Fig. 2). The fluctuation in nectar volume after flowering reflects the high variation in the amount of nectar observed in flowers at any one time period.

The injection of sugar solution into mature buds did not seem to attract insect robbers. The number of flies found within treated and control buds did not differ (total insects per 10 buds = 0.0 vs. 1.0). Pear juice applied externally, however, was effective in attracting insects and drew a total of 25 flies to 5 buds (mean ± SE = 5.0 ± 4.4 flies per bud).

DISCUSSION

Nectar volume and sugar concentration in *Ipomoea* flowers increased to a maximum following anthesis. This was consistent with our hypothesis that the night-blooming flowers regulate nectar production in order to mirror the activity of their intended pollinator and reduce robbery by non-pollinating insects. The fact that nectivorous flies were not found inside flowers supplemented with juice suggests that either bud walls are effective protection against robbery or that the flies have been habituated to the lack of nectar in developing buds. Alternatively, *Ipomoea* flowers may be defending against an insect robber that acted in the past.

Insect robbers may not have been the driving force behind the evolution of temporal variation in nectar production. Physiological constraints such as resource limitation may affect the time at which nectar is produced. Nectar production began early on 20 January when rain fell earlier and heavier than the day before. Alternatively, physical constraints may dictate the time of nectar production. Perhaps buds develop such that nectar must be added last. Finally, it is possible that the pollinator-plant mutualism alone has driven the development of this phenomenon. The temporal variation in nectar production may reflect a

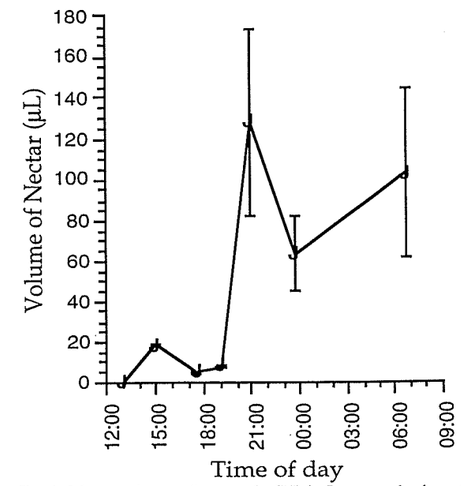

Fig. 1. Mean volume of nectar (± SE) in Ipomoea buds and flowers over a 19 h period from 19-20 January (n = 5 bagged flowers in each sample period). Anthesis occurred at approximately 1900.

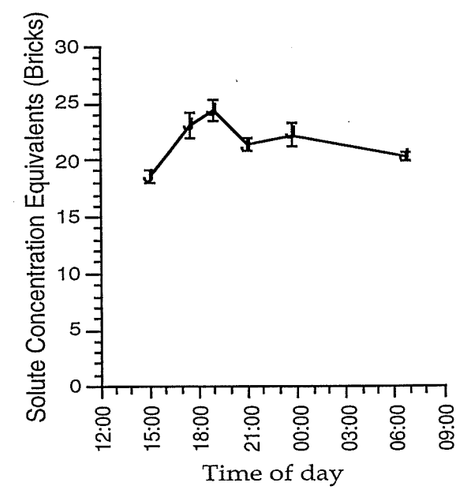

Fig. 2. Mean nectar sugar concentration (± SE) in Ipomoea buds and flowers over a 16 h period from 19-20 January (n = 5 bagged flowers in each sample period). Anthesis occurred at approximately 1900.

dynamic equilibrium in which both plant and pollintor have shaped the activity of the other.

Throughout our two nights of observation, we saw neither a pollination event, nor a single sphingid moth. Future investigation might focus on the actual pollination of *Ipomoea* flowers and the consequences

of outcrossing for reproductive success. In addition, the high variation in nectar production among individual flowers may represent a mechanism to encourage pollinators to move from one vine to the next. Resolving this spatial variation would likely cast more light on the nocturnal flowering and pollination biology of *Ipomoea*.

LITERATURE CITED

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