THE EFFECT OF NECTAR VOLUME ON FLOWER VISITATION BY ANARTIA JATROPHEA (LEPIDOPTERA: NYMPHALIDAE)

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ABSTRACT (HMF)

We examined Anartia jatrophea visitation to nectar producing plants. We hypothesized that the amount of nectar a flower produces has an effect (1) on the time a potential pollinator spends on a given flower and (2) on the number of potential pollinators attracted to that flower. We predicted that both of these variables would increase with increasing nectar volume. We found an increase in visitation time to nectar treated subplots, but not an increase in number of visitors post treatment. Our study plant appears to manipulate nectar volume such that cross-pollination is maximized and the costs of nectar production are limited.

Key Words: Anartia jatrophea, nectar, pollination

INTRODUCTION (PSW)

The plant-pollinator relationship has evolved as a complex set of strategies in both parties to maximize their individual fitness. A small number of birds and mammals are known to pollinate tropical plants, but most pollination is performed by insects. To entice pollinators, plants use a variety of floral attractants (i.e. color, shape, aroma, and nectar).

In this study, we examined how nectar volume influences the plant-pollinator relationship. Presumably, natural selection should favor nectar levels that maximize pollination rates while minimizing the costs of production. We hypothesized that butterfly foraging behavior is related to floral nectar rewards. We predicted that an increase in nectar volume per flower (an increase in cost for the plant) would result in an increase in time spent on each flower visited, and an increase in the number of butterflies visiting the patch (an increase in potential pollination). Observing the butterfly Anartia jatrophea (Lepidoptera: Nymphalidae), we tested these predictions with a nectar manipulation in a tropical dry forest shrub that produces pale-purple, salveform flowers.

METHODS (DML)

We performed our study on 13 January, 1994, ≈75m northeast of the bird tower at Laguna Palo Verde, Palo Verde National Wildlife Refuge, Guanacaste Province, Costa Rica.

We divided two 2.5m x 1.5m plots, Plot 1 and Plot 2, each with ≈75 flowers/m^2, into four 1.5m x 1.25m subplots (1A, 1B, 2A, 2B). From 10:30 to 11:00, we observed subplots 1A and 1B and recorded: a) the number of A. jatrophae visiting each subplot; b) the duration of each visit; and c) the number of flowers visited. An A. jatrophae individual was considered a visitor to the subplot if it landed on at least one flower within the subplot.

At 11:00, we used eye droppers to add one drop of nectar solution (1 part honey to 5 parts water) to each flower in subplot 1B. The added nectar solution filled the corolla to >5x

Table 1: Total number of A. jatrophae visitors, and time spent per flower in control and treatment plot prior to and following nectar addition.

		Prior to nectar addition		Following nectar addition	
		Control	Treatment	Control	Treatment
Total number of visitors:	Patch 1	18	10	8	5
	Patch 2	11	14	7	6
Time spent in patch: (seconds)	Patch 1	26±8	29±5	12±1	105±34
	Patch 2	13±3	20±7	11±4	45±18
Number of flowers visited:	Patch 1	6±2	7±4	2±2	2±1
	Patch 2	4±1	2±1	2±1	2±1
Time spend per flower[a]: (seconds)	Patch 1	5	7	16	140
	Patch 2	4	9	10	77

[a]Based on regressions in Figures 1 and 2.

the natural nectar level. We then observed subplots 1A and 1B for 30 more minutes and recorded A. jatrophae visits as before.

Starting at 13:00, we repeated the above procedure for subplots 2A and 2B.

We analysed treatment effects on flower visitation rate by comparing the slopes of linear functions relating number of flowers visited to time spent in the patch.

RESULTS (HMF)

Prior to nectar addition, total number of A. jatrophae visitors to the control subplot A and the treatment subplot B was very similar for Patch 1 (n = 18 vs. 10 butterflies) and for Patch 2 (n = 11 vs. 14 butterflies, Table 1). The number of visitors did not increase following nectar addition for either Patch 1 (n = 8 vs. 5 butterflies) or Patch 2 (n = 7 vs. 6 butterflies).

The average time an individual spent in each patch did not differ between control and treatment subplots in Patch 1 or in Patch 2, prior to nectar addition (Tables 1 and 2). However, following nectar addition, individuals spent significantly more time in nectar treated subplots (13) than in untreated controls (Table 1 and Table 4).

Table 2: Total number of A. jatrophae visitors, and time spent in patch before nectar addition.

Source	MS	F	p
Patch	2077	3.10	0.08
Nectar Addition	150.6	0.23	0.64
Patch x Nectar Addition	2	0.00	0.95

Error = 669

Table 3: ANOVA results for number of flowers visited by each A. jatrophae before nectar addition.

Source	MS	F	p
Patch	1.13	0.02	0.90
Nectar Additon	36.40	0.50	0.482
Patch x Nectar Additon	21.3	0.29	0.59

Error = 72.7

Table 4: ANOVA results for time on A. jatrophae spent in a patch following nectar additon.

Source	MS	F	p
Patch	5755	3.43	0.08
Nectar Additon	25624	15.30	0.0007
Patch x Nectar Additon	51680	3.40	0.08

Error = 1675

The number of flowers that A. jatrophae visited was not affected by nectar addition (Table 1). Prior to nectar addition, the number of flowers visited were similar between the control and treatment subplots (Table 3). After nectar addition the number of flowers visited still remained the same between the control and the treatment (Table 5).

Time spent per flower, estimated as the inverse slope of flowers visited versus time spent in patch, did not differ between control A and treatment B plots (Table 1) prior to nectar addition (6 vs. 7 seconds/flower in Patch 1, t = 0.69, df = 26, $p > 0.05$; 9 vs. 4 seconds/flower in Patch 2, t = 1.06, df = 23, $p > 0.05$, Figure 1).

However, following nectar addition there was a dramatic increase in time spent per flower (Table 1) in the treatment subplots: 16 vs. 140 seconds/flower in Patch 1 (t = 3.16, df = 11, $p < 0.05$) 10 vs 77 seconds/flower in Patch 2 (t = 3.24, t = 11, $p < 0.05$; Figure 2).

Table 5: ANOVA results for number of flowers visited by each A. jatrophae following nectar additon.

Source	MS	F	p
Patch	0.570	0.36	0.56
Nectar Addition	0.16	0.10	0.76
Patch x Nectar Additon	0.00	0.00	0.95

Error = 1.59

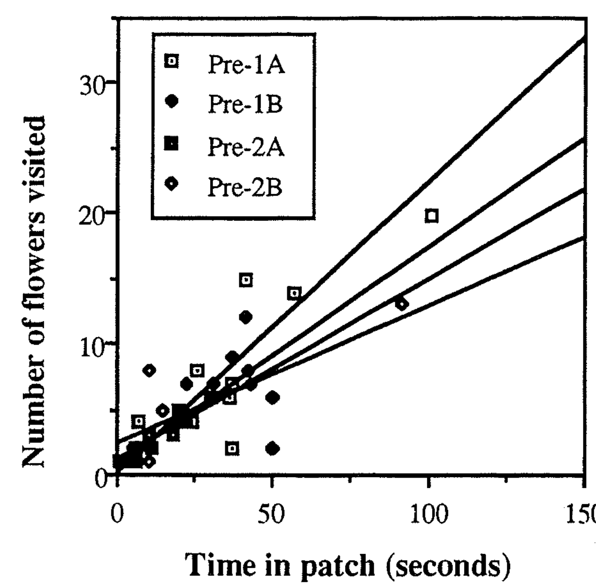

Figure 1. Prior to nectar addition, number of flowers visited by A. jatrophe as a function of time spent in the patch. Lines show best fit regressions for plots A and B within flower patches 1 and 2.

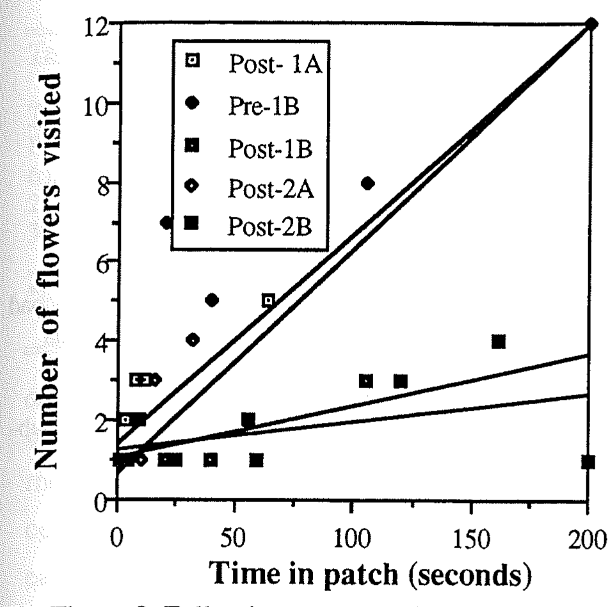

Figure 2. Following nectar addition, number of flowers visited by A. jatrophe as a function of time spent in patch. Lines show best fit regressions for plots A and B within flower patches 1 and 2.

DISCUSSION (DJG)

This study supported our prediction that an increase in thenectar volume per flower will increase the amount of time A. jatrophae spends per flower. Although the increase in nectar volume did not attract more A jatrophae individuals to the manipulated patch, the individuals that did enter the patch stayed for a longer period of time (presumably due to the increase in nectar). In addition, the number of flowers visited in the manipulated patch did not change or alter nectar additon.

Nectar production is crucial to attracting pollinators. These plants must provide a reward (nectar) to attract A. jatrophae to the flowers. Yet, producing too much reward can be detrimental to the plant because A. jatrophae may become quickly satriated, visit fewer flowers throughout the day thereby minimizing pollen movement to conspecifics and decreasing reproductive success. An optimal strategy for the plant should be to offer the minimum reward necessary to attract butterfly visits. Nectar production in the study plants appears to be consistent with this prediction.

An unresolved question is how A. jatrophae select which patches to visit. Apparently, nectar volume does not influence A. jatrophae recruitment to a patch. It may be that flower color, flower aroma, or flower density within the patch, could be important cues that affect A. jatrophae visitation patterns.