PREFERENCE OF SUPPLEMENTAL NECTAR BY THREE NATIVE BUTTERFLY SPECIES

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Abstract

Two diets, a sugar-water solution (Diet A) and nutritionally complete nectar solution (Diet B), provided in a mixed species enclosure as a source of nutrients for multiple nectivorous species were evaluated for preference among three North American species of butterflies. Preference was defined as number of visits to one of two nectar feeders. The feeder containing Diet B was preferentially visited over the feeder containing Diet A during the observation period ($P<0.01$). Although diets were randomly placed between two locations, Location 2 was preferentially visited over Location 1 during the observation period ($P<0.05$). There was a significant ($P<0.05$) interaction between location and diet. These results suggest that the animals selected the nutritionally complete solution (Diet B) over a solution that provides primarily carbohydrates and water (Diet A). However, solution characteristics that influence preference in these animals cannot be elucidated based solely upon these observations. The continued use of the sugar solution, in conjunction with the nutritionally complete nectar solution, appears unwarranted. Additional research should be conducted to minimize the confounding factors encountered in this study and further examine those variables that are influencing preference.

Introduction

Strategies for satisfying the projected nutrient requirements of nectivorous species in captivity vary widely from providing animals with access to wide range of nectar/pollen producing plants, supplementation with sugar solutions or provisioning with nutritionally "complete" nectar solutions. Most facilities that display these species employ combinations of strategies; however, the relative consumption of each individual source may vary widely based on seasonal influences on those food sources, particularly flowering plants.

The Smithsonian National Zoological Park (NZP) has maintained a mixed-species enclosure housing nectivorous insects and birds since 1996. The enclosure is heavily planted with nectar and pollen producing species, although those sources are most abundant during spring and summer months. Based on historical feeding practices, the enclosure has been provisioned with sugar and nectar solutions to feed the butterflies and hummingbirds, respectively. All specimens within the enclosure have free access to all feeders and offered diets and were frequently observed visiting all feeders.

The objective of this study was to determine if the butterfly species maintained within this exhibit demonstrated a preference for a nutritionally incomplete sugar solution, or a commercially available, nutritionally complete nectar solution.

Methods

Three North American butterfly species: zebra longwing (*Heliconius charitonius*), Julia (*Dryas julia*), Erato (*Heliconius erato*) were group housed in a free-flight green-house style, heavily planted enclosure. No attempt was made to quantify the total or relative number of individuals of each species within the enclosure. The publicly accessible enclosure was located on the northeast side of the Invertebrate Exhibit building with morning and mid-day exposure to sunlight. Weather conditions and ambient air temperature inside the enclosure were documented before the onset of that day's observation period. The enclosure was open to the public during the observation period, although no attempt was made to evaluate the influence of the public on these results.

Two nectar solutions were evaluated: a sugar solution composed of 150 g granulated sugar and 710 g water (Diet A); and a commercially available nectar substitute (Diet B) (Nectar 3, Roudybush, Inc., Alhambra CA 95682) composed of 66 g nectar substitute powder and 200 g water (Table 1). Both solutions were prepared immediately prior to each observation session.

Feeders used to present individual nectar solutions were identical in design, capacity (12 fl oz) and appearance (Flutterby™: Butterfly Feeder, Nature Products™, North Kingston, RI). Consistent with routine feeding practices, red plastic mesh sponges were placed in the feeders to encourage visitation by the animals. Two feeding locations were selected and both locations were simultaneously within the field of vision of the observer. Feeders were hung approximately 20 cm apart and at equal height above the ground. One site was near the interior public walkway, the other adjacent to the perimeter of the enclosure. The solution presented at each location was randomized at the beginning of the study to correct for a potential preference in animal feeding location.

Prior to each observation session, an equal, weighed quantity of each solution was added to one of each feeder. Observations were initiated upon presentation of the feeders at 1000 h (time 0). Using a scan sampling method, feeders were observed every 60 seconds, and the number of individuals of each butterfly species on each feeder at that time was quantified. Observations continued for 60 minutes from time 0.

At the conclusion of the observation period, both feeders were removed from the enclosure. The weight of the feeder with the remaining nectar solution was recorded to evaluate solution consumption.

Observations were conducted over six separate sessions between 27-Jan and 4-Apr-2007. This time period was selected based on the anecdotal observation that supplemental feeders are more heavily used during this time due to the absence of blooms on enclosure plantings.

Effects of location and diet were tested. Species effects (preference) were not tested due to the unequal distribution of individuals across species and the unknown total number of specimens within the enclosure. Arithmetic means and standard deviation are reported for all effects tested. Data were analyzed by the ANOVA method of SAS (SAS Institute, Cary, NC).

Results and Discussion

A total of 1080 events were recorded over six days of observation. The results were summarized by observation day across all species (Table 2).

Location 2 was preferentially visited during the observation period over Location 1 ($P<0.05$). The feeder containing Diet B was preferentially visited during the observation period over the feeder containing Diet A ($P<0.01$). Additionally, there was a significant ($P<0.05$) interaction between location and diet.

As the objective of this study was to determine if preference existed for the two diets currently offered in the enclosure, the diets were prepared in the manner that was consistence with current husbandry. The prepared nectar solution was significantly higher in total solids (24.8% DM) when compared to the sugar solution (17.5% DM). As a result, we cannot determine what characteristics of the nectar solution are influencing animal preference; although the suggestion is that the animals selected for the nutritionally complete solution over a solution that only provided carbohydrates and water.

Sugar concentrations and osmolarity are variables that influence preference and intake of nectar-feeding birds.[2,4] These characteristics, as well as total solids, sugar type, and/or energy concentrations may also play a role in food selection among butterflies. On-going work with Monarch butterflies (*Danaus plexippus*) suggests this species is very capable and discerning in food choices.[3]

This study used the presence of a butterfly on a feeder as the sole indicator of diet preference. Due to an error in recording weights of nectar before and after observations, total solution disappearance was not analyzed. In the absence of information on diet disappearance (consumption), with significant preference for one feeder location over the other, and a significant interaction between diet and location, we cannot conclude that visitation to a feeder containing a specific diet itself is analogous to diet consumed.

It is not realistic to think that with free access to all feeders, the hummingbirds would feed only from the feeder containing the nectar solution and butterflies from those feeders with the sugar solution. The justification for providing both sources of "nectar" in the enclosure studied was based on the "need" of the hummingbird to have a nutritionally complete diet and the historical use of the sugar solutions to supplement the butterflies. However, if one presumes that the nutrient requirements of nectivorous species is similar across taxa, then the butterflies would also benefit from the complement of nutrients provided in the nectar solution, rather than the limited nutrient package of the sugar solution.

Although the ultimate goal is to provide a diet that provides a nutrient package most appropriate for the target species, there are many practical benefits to offering only a single nectar type in this enclosure. The daily production of two nectar solutions is time consuming. Maintaining two inventory items for a similar application adds multiple layers of manpower, record keeping and resource allocation for several aspects of any operation.

Based on the results of these observations, further use of the sugar solutions appears unnecessary. Plant nectars are complex aqueous combinations of carbohydrates, amino acids, organic acids, vitamins, lipids and a host of secondary plant metabolites.[1] Additional research should be conducted to minimize the confounding factors presented in this study and further examine those variables that are influencing preference and enhance animal health.

Acknowledgments

The authors would like to thank Tom Lozito, Donna Stockton, and the Smithsonian National Zoological Park's animal care staff for their assistance and contributions to this study. Additionally, we would like to acknowledge the contributions of Dr. Daniel Peterson regarding statistical analysis of the data.

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Table 1. Ingredients and calculated nutrient composition of two test diets as prepared.[1,2]

	Diet A	Diet B[3]
Ingredient		
Dry component, g	150	66
Water, g	710	200
Composition		
Dry matter (total solids, %)	17.5	24.8
Metabolizable energy, kcal g^{-1}	3.85	-
Crude protein, %	0.0	3.0
Crude fat, %	0.0	1.1
Total carbohydrates, %	99.4	-
Total sugars, %	99.4	-
Calcium, %	0.01	0.13
Phosphorus, %	0.00	0.09
Iron, ppm	1.1	10.3
Zinc, ppm	1.7	6.9
Vitamin E, IU kg^{-1}	0.0	-

[1]Diet A = sugar solution; Diet B = commercially available nectar solution (Nectar 3, Roudybush, Inc.).
[2]All nutrients, except dry matter, expressed on a dry-matter basis.
[3]Insufficent information was available to calculate nutrient concentrations indicated with "-".

Table 2. Mean number of butterflies ± standard deviation (s.d.) observed on a feeder at one of two locations containing one of two test diets.[1,2]

	n	Mean (± s.d)
Location 1	6	52.0 ± 18.5
Location 2	6	66.8 ± 40.9
Diet A	6	49.0 ± 14.8
Diet B	6	69.8 ± 40.8
Effect[3]		
location		< 0.05
diet		< 0.01
location*diet		< 0.05

[1]Location 1 = near the interior public walkway, location 2 = adjacent to perimeter of the enclosure.
[2]Diet A = sugar solution (17.5% DM); Diet B = commercially available nectar solution (Nectar 3, Roudybush, Inc.) (23.8% DM).
[3]Probability of F-statistic.