DIETARY VARIATION IN THE MEXICAN FREE-TAILED BAT (*TADARIDA BRASILIENSIS MEXICANA*)

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In a field experiment designed to evaluate dietary variation in Mexican free-tailed bats (*Tadarida brasiliensis mexicana*) we found that lactating females fed largely on coleopterans and lygaeid bugs during evening feeding bouts and mostly on moths during morning feeding bouts. These results suggest that interpretations of food habits in this and other species may be biased unless samples from both nightly feeding bouts are included in the analyses. Diets of different individuals during the same feeding bout were strikingly similar, suggesting that lactating females either fed in the same general habitats or that they encountered and preferentially fed on similar prey items among those available. Bats captured upon return from evening feeding bouts produced significantly more fecal pellets than those captured following second feeding bouts. This difference suggests that either more food is eaten in the first feeding bout or, alternatively, highly chitinous insects such as coleopterans and lygaeids contribute more to fecal matter than relatively soft-bodied moths. We found no significant relationship between hardness of prey and number of pellets produced. Individual bats produced an average of 2–3.6 insects/pellet, but no consistent relationship was found between the number of insects eaten and the number of fecal pellets produced. Our analysis indicates that at least five pellets are needed to establish the number of insect taxa (families) consumed by a bat. Results from this study suggests that future research on food habits of insectivorous bats should examine fecal pellets or stomach contents from evening and morning feeding bouts to fully characterize the diet of a given species.

Key words: Bats, Chiroptera, dietary variation, fecal analysis, food habits, Molossidae, *Tadarida brasiliensis*

The food habits of insectivorous bats can be influenced by several factors, including the times of nightly emergence (Erkert, 1982), seasonally-changing energy and nutrient demands (Anthony and Kunz, 1977; Barclay, 1994; Kunz, 1974; Kunz et al. 1995), temporal and spatial distribution of their prey (Kunz, 1988; Wolda, 1988), and prevailing climatic and meteorological conditions (Anthony et al., 1981; Wellington, 1945). The diets of an insectivorous bat often can be assessed by analyzing the contents of stomach or feces produced following foraging bouts (Kunz et al., 1983; Whitaker, 1988). If bats engage in more than one nightly bout, dietary analysis should include samples from each bout to fully characterize food habits. Depending on location, time of year, and reproductive status of bats, the number of nightly foraging bouts may range from one during early pregnancy to two or more during lactation (Anthony and Kunz, 1977; Kunz, 1974; Kunz et al., 1995; Swift, 1980). If availability of prey differs from one bout to the next, we would expect differences in diet to reflect this temporal availability.

Previous studies of food habits of *T. brasiliensis* have been based largely on small samples of feces or stomach contents from bats taken at different localities without regard to the number or time of nightly feeding bouts (Ross, 1967), or from several bats from a single colony (Kunz et al., 1995). Surprisingly, no studies have examined dietary composition of insectivorous bats from different foraging bouts in the same night, or from bats captured at the same locality on successive nights. In the present study, we asked whether dietary composition of *T. brasiliensis* differed between feeding bouts in the evening and early morning and whether we could detect night-to-night variation in consumption of prey from these bouts. We also examined the relationship between composition of diet and the size of the fecal pellets, the number of insects per pellet, and the total amount of feces (mass or number of pellets) produced.

Materials and Methods

Fecal pellets were collected from bats at Eckert James River Cave, Mason Co., Texas, on 5 different nights during an 8-day period, 20–28 June 1991. We used fecal analysis based on evidence from a previous study that this method provides a reliable estimate of dietary composition for insectivorous bats (Kunz and Whitaker, 1983). Fecal samples were collected twice-nightly from individual bats as they returned from their evening foraging bout and again as bats returned from their pre-dawn feeding bout. Bats were captured by holding a hoop net of 60-cm diameter in the pathway of bats as they returned, and subsequently placed bats individually into small Styrofoam cups that were covered with cotton cloth to prevent them from escaping. A small piece of hardware cloth was placed inside each cup to provide a roost substrate. Bats were captured for the collection of fecal pellets 20–21 June (day 1), 21–22 June (day 2), 23–24 June (day 3), 26–27 June (day 4), and 27–28 June (day 5).

Evening samples were collected at 2300–2315 h, whereas morning samples were taken at 0630–0645 h. Bats were temporarily housed in a darkened building at temperatures ranging from 30 to 35°C, conditions similar to the cave environment in which this species normally roosts (Kunz and Robson, 1995). Individual bats were housed in separate cups until the following evening, when they were released at the site of capture. Thus, bats captured at 2300–2315 h were retained for nearly 19 h before being released, whereas those captured at 0630–0645 were held for 14 h. Bats voided most, if not all, feces within 12 h of feeding, although some individuals sometimes retained a single fecal pellet, which they usually expelled at the onset of nightly activity. We assumed that fecal pellets produced by bats captured at 2300–2315 h were from the evening feeding bout, and those captured at 0630–0615 h were mostly from the pre-dawn feeding bout.

We initially examined 10 fecal pellets from each bat, but after several pellets had been analyzed from three individuals it became evident there was great similarity between pellets, and that five pellets were sufficient to give a reliable estimate of the diet. Subsequently, five pellets were examined from 67 additional bats, yielding a total sample of 415 pellets. Pellets from each bat were air-dried in the field, placed in separate glass vials, refrigerated to retard decomposition, dried to constant mass at 60°C, and again stored in glass vials until samples were analyzed. Pellets were later counted or their numbers estimated if the pellets were broken or they adhered together. Five of the largest pellets from each sample were measured to the nearest mm. Each food item was identified to the lowest possible taxonomic level (usually family) within a reasonable amount of time, and the percentage volume of each food type was estimated visually.

We also estimated the number of insects per pellet. An insect was counted if any part of it was present in a pellet, whereas two or more insects were recorded if parts could not have come from the same individual (e.g., the bases of two right front wings, parts of three different antennae, or seven legs). Undoubtedly, there were some instances where more than one insect was present, but this could not be determined if duplicate parts were absent. Although a food item may have been recorded, this does not mean that a whole insect was present, because some species of bats including *T. brasiliensis*, regularly cull parts before ingesting them (Kunz et al., 1995). The presence of some taxa of insects such as green pentatomids that were easily recognized in fecal pellets, but not often eaten, served as natural markers to help document the distribution of insect parts in some fecal pellets. All pellets produced by one bat were examined to test the hypothesis that the number of food items differed according to size of pellet.

Statistical analyses were conducted using Systat for Windows, Version 5.04 (Wilkinson, 1992). Percentage data (percentage volume and percentage frequency) were arcsine transformed before using multivariate and univariate analyses to correct for non-normality (Zar, 1984). For all statistical analyses, except for the analysis of size of pellet, the experimental unit was the bat rather than the individual pellet. Thus, data from individual pellets (5 or 10) were combined to produce percentage volume and percentage frequency values for each bat. Overall differences in composition of pellets between evening and morning bouts, and over the 5 sample days, were examined using multivariate analysis of variance (MANOVA). In the multivariate model, the independent variables were: feeding bout (evening or morning), day (1–5), and bout × day; the dependent variable was a vector of the quantities of all food types. Relative contributions of the various food types to the differences found by MANOVA were assessed by examining the table of "standardized effects" produced by the analysis. Differences between feeding bouts, and variation over the 5 sampling days also were examined for each food type using two-way analysis of variance (ANOVA). In the univariate ANOVA, bout, day, and bout × day were used as independent variables and the arcsine-transformed percentage volume or percentage frequency of a food type was the dependent variable. Differences between morning and evening bouts were considered significant if the ANOVA produced $P \leq 0.05$ for bout and $P > 0.05$ for the bout × day interaction term. Differences between morning and evening bouts for each sample day were evaluated using one-way ANOVA. Differences among sample days within the morning or evening bouts, in cases where $P \leq 0.05$ for bout and $P \leq 0.05$ for the bout × interaction term, were evaluated using one-way ANOVA. In instances where $P \leq 0.05$, the ANOVA was followed by Tukey's multiple-comparison test. Multivariate and univariate analyses were performed to determine if size of pellet had an effect on overall composition of pellet (MANOVA) or on the content of individual food types (ANOVA). Mean separations were carried out using Tukey's test in cases where univariate ANOVA revealed a significant effect of size of pellet. One-way ANOVA was used to determine the effect of size of pellet on the numbers of insects present in each pellet; in these situations the small size classes were compared to a large size class using the Systat "contrast" option.

RESULTS

The overall composition of food items taken by *T. brasiliensis* as identified in fecal pellets differed significantly between evening and morning feeding bouts (Table 1). This was true whether the composition was expressed on a percentage volume ($P \leq 0.001$) or a percentage frequency (≤ 0.001) basis. The most significant differences between evening and morning bouts were in the quantities of carabid beetles, lygaeid bugs, and lepidopterans present. These three groups had the greatest effect in the multivariate analysis and each had significantly different evening and morning values on the basis of univariate analyses. Carabid beetles and lygaeids were the most important food items taken by females in evening feeding bouts. Carabid beetles ranged from 33.1 to 61.3% by volume, with a mean of 45.6% for evening bouts, and were significantly lower ($P \leq 0.001$) for morning bouts, ranging from 3.1 to 11.1% with a mean of 7.1%. Lygaeid bugs likewise were more prevalent ($P \leq 0.001$) after the evening bouts when they accounted for 12.2 to 27.4% of pellets by volume, compared with the morning bouts when they ranged from 0.5 to 5.5%.

By contrast, lepidopterans were the most important items from the pre-dawn feeding bout comprising 40.9–89.9% of the volume of pellets. In evening feeding bouts, lepidopterans dropped significantly ($P \leq 0.001$) to only 1.9–10.3% by volume. Although volume of lepidopterans was consistently greater in morning samples compared with evening samples, there was a significant ($P = 0.005$) day-to-day fluctuation in morning volumes of lepidopterans (Table 2). Scarabaeid beetles ranked second in volume in the morning samples, and third in the evening samples, but no clear trend was evi-

TABLE 1.—*Foods consumed by* Tadarida brasiliensis *during evening and pre-dawn feeding bouts from Texas, spanning an 8-day period (*n *= number of bats examined). See text for numbers of pellets examined from each bat. Food types where consumption as percentage volume or percentage frequency varied significantly between the evening and morning bouts are indicated with asterisks (*, P < 0.05; **, P < 0.01). Significance is based on univariate ANOVA for each type of food.*

	Evening feeding (n = 34)		Morning feeding (n = 39)	
Food	Volume	Frequency	Volume	Frequency
Carabidae	45.6**	91.2**	7.1**	21.5**
Lygaeidae	19.5**	83.3**	2.3**	17.5**
Scarabaeidae	8.6	26.0	15.6	39.5
Coleoptera	7.4	26.5	4.0	20.5
Lepidoptera	5.6**	37.2**	66.0**	96.0**
Cicadellidae	5.6*	29.3	1.9*	19.0
Cydnidae	2.0	4.7	0.1	1.0
Unidentified insect	1.5	7.9	0.5	4.5
Chrysomelidae	0.9	4.2	0.1	0.5
Pentatomidae	0.8*	4.7*	0.0*	0.5*
Curculionidae	0.6*	2.3	0.1	0.5
Diptera	0.6	6.0	0.7	7.0
Hemiptera	0.6	3.7	0.1	1.0
Zygoptera	0.6	0.9	0.0	0.0
Formicidae	0.2*	2.8*	0.0*	0.0*
Aranaea	0.1	0.5	0.0	0.0
Hemerobiidae	0.1	0.9	0.1	1.5
Cercopidae	0.02	0.5	0.1	0.5
Delphacidae	0.0	0.0	1.0	2.0
Muscoidea	0.0	0.0	0.1	0.5
Vegetation	0.0	0.0	0.1	0.5
Total	100.3		99.9	

dent in the distribution of scarabaeids between the two feeding bouts. The volume of scarabaeids in the morning samples varied significantly (P = 0.001) over the 5 sample days. Scarabaeids were taken about equally in morning and evenings on days 1 and 5 (P = 0.418 and P = 0.544, respectively); they were more abundant in pellets

TABLE 2.—*Percentage volume of major food items in the diet of* Tadarida brasiliensis, *as indicated by feces deposited after evening and morning foraging bouts. Superscripts indicate statistically significant pairwise differences between days for each food item. Within a column, values with the same superscript letter are significantly different (*P *< 0.05) based on Tukey's multiple-comparison tests. The* P*-values under each food item indicate the probabilities associated with the effect of day on the percentage volume of the item based on univariate one-way ANOVA.*

	Evening					Morning				
Sample	Pellets examined	Carabidae P = 0.137	Lygaeidae P = 0.486	Lepidoptera P = 0.312	Scarabaeidae P = 0.059	Pellets examined	Carabidae P = 0.640	Lygaeidae P = 0.009	Lepidoptera P = 0.005	Scarabaeidae P = 0.001
Day 1	55	33.1	21.3	7.4	13.5	40	7.0	2.2	63.5	12.6
Day 2	40	41.1	17.2	4.1	12.2	40	11.1	5.5^{AB}	40.9^{AB}	36.5^{AB}
Day 3	40	43.0	27.4	4.4	9.4	40	5.0	0.1^{A}	89.8^{A}	0.0^{AC}
Day 4	40	61.3	18.9	1.9	1.3	40	9.5	2.0	57.6	20.1^{C}
Day 5	40	51.5	12.2	10.3	4.9	40	3.1	1.1^{B}	83.6^{B}	4.4^{B}

TABLE 3.—*Relationship between size of fecal pellet produced by* Tadarida brasiliensis *and the taxonomic composition of insect prey* (n = *76 bats). Within rows, values for percentage volume with the same superscript letters are significantly different* (P < *0.05) based on Tukey's multiple comparison tests. The* P-*values following the name of the insect group indicate the effect of pellet size on the percentage volume of that insect type based on univariate one-way ANOVA.*

Pellet size (mm)		6–8		5		4		3		2	
n		11		24		17		16		8	
Food	*P*	Volume	Frequency	Volume	Frequency	Volume	Frequency	Volume	Frequency	Volume	Frequency
Carabidae	0.101	63.6	100.0	70.6	100.0	49.1	100.0	61.2	100.0	66.3	100.0
Lygaeidae	0.008	6.4^{AB}	81.8	17.7	79.2	25.0^{A}	100.0	29.4^{B}	87.5	28.7	87.5
Cydnidae	0.582	9.5	18.2	2.1	8.3	8.8	29.4	5.3	12.5	5.0	12.5
Cicadellidae	0.000	19.5^{ABCD}	100.0	5.8^{A}	33.3	3.5^{B}	41.2	0^{C}	0	0^{D}	0
Lepidoptera	0.132	0.5	9.1	0.4	8.3	1.5	23.5	0	0	0	0
Pentatomidae	0.866	0	0	1.7	8.3	2.1	5.9	2.2	6.3	0	0
Insect	0.846	0	0	0.8	8.3	0.9	5.9	1.9	6.3	0	0
Scarabaeidae	0.230	0	0	0.4	4.2	5.3	11.8	0	0	0	0
Hemiptera	0.492	0	0	0	0	0.9	5.9	0	0	0	0
Coleoptera	0.493	0	0	0	0	2.9	5.9	0	0	0	0
Diptera	0.206	0.5	9.1	0	0	0	0	0	0	0	0
Hemerobiidae	0.715	0	0	0.4	4.2	0	0	0	0	0	0
Total		100.0		99.9		100.0		100.1		99.9	

taken in the morning samples on day 2 and 4 ($P = 0.033$ and $P = 0.004$), and they were more abundant in pellets in the evening on day 1 ($P = 0.047$). This inconsistency also was evident as a significant bout × day interaction term ($P = 0.028$) in our two-way ANOVA of the scarabaeids.

To determine the similarity among all pellets within a single sample, and to establish if size of pellet was related to content of pellet, we examined all pellets deposited by one bat following an evening feeding bout on 26 June 1991 (Table 3). A total of 76 pellets produced by this bat was analyzed. These pellets ranged from 2 to 8 mm in length, but because there was only one pellet 7 mm long and one pellet 8 mm long, these latter samples were included with 6-mm-long pellets for the analysis. The overall composition of the largest pellets (6–8 mm) was significantly different ($P \leq 0.001$) from the composition of other size classes. This difference was due primarily to a greater percentage volume of cicadelids ($P \leq 0.001$) and a smaller percentage volume of lygaeids ($P = 0.002$) in the largest pellets compared with the other size classes. Other kinds of prey did not differ significantly among size classes of pellets, although smaller pellets and small numbers of pellets included fewer items. Each size of pellet included the top three food items. Carabids were present in 100% of the pellets from all size classes and ranged from 49.1 to 70.6% by volume. Lygaeids occurred in 79–100% of the pellets in each size class and ranged from 6.4 to 29.4% by volume, whereas cydnids ranged from 8.3 to 18.2% of the pellets and from 2.1 to 9.5% by volume.

The next size class (5 mm, $n = 24$ pellets) had the second largest number of items (nine of 12), whereas the third largest size class (4 mm, $n = 17$) had the largest number of items, at 10. The smallest pellets (3 mm, $n = 16$ and 2 mm, $n = 8$) contained the least number of items, five and three respectively. The sample from this bat provided one easily identifiable marked insect, a green pentatomid, thus allowing us to access the distribution of this taxon in each pellet. Four pellets from this bat contained

TABLE 4.—*Number of insects observed per fecal pellet produced by a single lactating female of* Tadarida brasiliensis *(n = 76 pellets).*

Length of pellet (mm)	8	7	6	5	4	3	2
n	1	1	9	24	17	16	8
Average number of insects per pellet	3	4	3.6	2.9	3.5	2.9	2.0
Range	3	4	2–4	1–5	2–6	1–3	1–3

parts of a green pentatomid; apparently all from one individual insect, indicating that the remains of this individual comprised a relatively small proportion of the four pellets. Minimum numbers of insects per pellet in this bat are summarized in Table 4. From these results, it is clear that more than one insect was present per pellet. The average number of insects present in each pellet ranged from 2.0 to 3.6. As might be expected, the smallest (2 and 3 mm) pellets had fewer insects than the largest (4 mm and above) ones ($P = 0.027$)

To assess whether there was any relationship between the types of prey items eaten and the number of pellets produced, we first analyzed the number of pellets produced by each bat. The mean number of pellets produced was significantly greater ($P \leq 0.001$) after the evening bout (45.9) than after the morning bout (26.7). Bats fed primarily on hard-bodied insects (mostly Coleoptera) in the evening and soft-bodied insects in the morning (often Lepidoptera). Based on these results alone, we cannot conclude that more pellets are expelled when hard-bodied insects are consumed because the absolute quantity of food consumed during the evening and morning bouts are unknown. No significant difference ($P = 0.907$) was found when the numbers of pellets from bats, which had mostly consumed coleopterans, were compared to those eating mostly lepidopterans. The 16 bats that consumed ≥70% Coleoptera averaged 37.1 pellets per bat, whereas the 21 bats that had eaten <70% Lepidoptera averaged 38 pellets per bat. Thus, there appears to be no relationship between hardness of prey and number of pellets.

DISCUSSION

This is the first study to report differences in the diets of an insectivorous bat based on samples of feces collected from two separate nightly feeding bouts. We have shown that coleopterans, collectively comprised 63.1% by volume of the insects consumed during the evening feeding bout, a value comparable to the percentage volume of lepidopterans taken in the early morning bout. These results may reflect: 1) the composition of insect taxa at different feeding sites during evening and morning bouts; 2) differences in feeding areas used by bats during evening and morning bouts; 3) differences in food preferences by bats during evening and morning bouts. We consider the first possibility to be the most likely, the second less likely, and the third to be least likely. Studies on flight activity of nocturnal insects indicate that the abundance of some insects is highest immediately after sunset, followed by a decrease throughout the night, often followed by a secondary peak of activity shortly before sunrise (Anthony and Kunz, 1977; Anthony et al., 1981; Swift, 1980; Wellington, 1945), although other species may remain active throughout the night (Beerwinkle et al., 1994; Raulston et al., 1986; Wolf et al., 1990).

Our analyses show a marked difference between insect prey eaten by *T. brasiliensis* in the morning and evening feeding bouts, although there was a high degree of similarity between days in the two feeding bouts. Carabids and lygaeids were the most important foods identified from each evening feeding bout (Table 2), totaling 54.4, 58.3, 70.4, 80.2, and 63.7% on each of the 5 nights, respectively. The similarities are actually much greater than indicated in Table 2, because within some of the groups, relatively few different taxa were taken. For example, the lygaeids were nearly all of one species, which was obviously common at this time and place. This taxon was observed in a large percentage of the pellets examined (83.3% of all pellets from the evening period). About four species of carabid and two species of scaribaeid beetles were found consistency in the samples. A large proportion of the cicadelids were all of one species. Lepidopterans were consumed at relatively low rates during evening bouts, totaling 1.9–10.3% by volume. However, during the pre-dawn feeding bout, lepidopterans became the dominant food on all days, ranging from 40.9 to 89.8% by volume. Lygaeids and carabids together at this time ranged from 4.2 to 16.6% by volume. The actual differences in numbers of lygaeids and carabids between evening and morning bouts might be more pronounced if some insects recorded from the morning foraging bout were retained from the evening feeding bout.

The insect fragments found in fecal pellets were consistently well-mixed. In many instances, pellets contained both lygaeids and carabids rather than a single pellet containing a lygaeid, a carabid, etc. Of the 415 separate pellets examined in our study, 49 (11.8%) contained one item (nearly always Lepidoptera), 109 (26.3%) contained two, 153 (36.9%) contained three, 74 (17.8%) contained four, 35 (6.0%) contained five, 4 (0.9% contained six, and 1 (0.2%) contained seven, for an average of 2.8 different items per pellet. Based on the expected high rates of food passage in insectivorous bats (e.g., Buchler, 1975), we expected less food mixing than was apparent in our samples. Surprisingly, we found a great homogeneity of food items in fecal pellets from each bat. Although most of the digesta may pass through the gastrointestinal tract rapidly, it may take ≤12 h for all of the contents of the gastrointestinal tract to be voided from any nightly feeding bout. Thus, most insects do not pass through the gastrointestinal tract as discrete bundles isolated from other food items that were ingested. It was first suggested by Coutts et al. (1973) in a study of *Eptesicus fuscus* and *Myotis lucifugus* that one fecal pellet typically included one large or several small insects. From our dietary analysis of *T. brasiliensis*, we found no such pattern. Other than those bats that consumed 100% Lepidoptera, there were few pellets with a single food item, although many included relatively large insects.

The significance of the greater number of pellets per bat from the evening sample versus those in the morning sample suggests that these bats ate more during the evening feeding bout than in the morning bout. This hypotheses is consistent with the length of time that lactating females of *T. brasiliensis* allocated each night to commuting and foraging activity. Lactating females typically spend an average of 5 h commuting and feeding during the first nightly feeding bout and an average of 3 h on the second (Kunz et al., 1995). We can rule out the hypothesis that feces produced following an evening bout include some feces from the previous morning bout (Anthony and Kunz, 1977; Kunz, 1974; Kunz et al., 1995).

Some investigators have suggested that one cannot reliably estimate the percentage volume of Lepidoptera in stomachs or fecal pellets because these items are retained longer in the digestive tract than other kinds of insects (Black, 1974). Because moths have large numbers of scales, some of these scales may be retained in the digestive tract for a longer time than parts from other insect taxa. However, because moths make up a small proportion of the diet of *T. brasiliensis* during the evening feeding bout, parts from these insects should contribute little to the material found in feces produced following a second bout. Freshly eaten moths usually can be recognized by a packed mass of scales and hair-like structures, and pieces of wing and body chitin.

Our observations that food items taken during morning bouts consist largely of lepidopterans are consistent with radar observations of enormous numbers of moths dispersing northward at night from the lower Rio Grande Valley in Texas and Mexico (Raulston et al., 1986; Wolf et al., 1990). Among these are the corn ear worm moth (*Heliothis zea*), the tobacco bud worm (*H. virescens*), and the fall army worm (*Spodoptera frugiperda*), which annually cause millions of dollars of damage to economically important crops. Radar observations indicate that large numbers of these moths, ranging in altitude from 200 to 800 m above the ground, move northward from infested areas at rates of 52 km/h during the night (Beerwinkle et al., 1994; Wolf et al., 1990, 1994). Judging from this rate of nightly dispersal of moths, the population of *T. brasiliensis* at the Eckert James River Cave, and members of other colonies of this species in southcentral Texas (Davis et al., 1962), are more likely to encounter these insects during their morning feeding bout than during the evening bout. Although we did not identify the species of moths in our samples, we suspect they would include many of the important agriculture pests reported from this region (Wolf et al., 1986).

An interesting and valuable future study would be to analyze the diet of a large number of bats from a single roost to determine the extent of variation in diet within a large colony. Maternity colonies of *T. brasiliensis* may vary upwards from several thousand to 20 million bats in a single roost (Davis et al., 1962; McCracken and Gustin, 1991). Thus, we would expect considerable variation in diet among members from such a colony, especially as they disperse to and feed over wide areas, in different habitats, and at different altitudes (Williams et al., 1973). Future studies are needed to investigate the relationships between nightly and seasonal dispersal flights of these agriculturally important insect species, the ecological and economic impact that Mexican free-tailed bats may have on these insects, and how these insects in turn may influence the local distribution, density, and life-history characteristics of the bats.

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