depredate nests of ground-nesting birds regularly in montane forests of southeastern Arizona or if this was simply an isolated incident. Nevertheless, this is the first time that any species of *Neotoma* has been documented depredating a bird nest or killing vertebrate prey, demonstrating that *Neotoma* has greater dietary plasticity than previously thought.

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DIETARY STUDY OF BIG FREE-TAILED BATS (*NYCTINOMOPS MACROTIS*) IN BIG BEND NATIONAL PARK, TEXAS

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Abstract—*Nyctinomops macrotis,* the big free-tailed bat, is relatively uncommon in the southwestern United States, and diet information for this species is sparse. The objective of this study was to examine the diet of *N. macrotis* in Big Bend National Park, Texas, by using fecal analysis to determine what these bats ate in an area where they were sympatric with 3 other species of free-tailed bats. We collected and analyzed fecal samples from 40 individuals and obtained the following results: Lepidoptera (87.5% volume, 100% frequency), Hemiptera (4.1% volume, 22.5% frequency), Coleoptera (4.6% volume, 17.5% frequency), Orthoptera (1.1% volume, 12.5% frequency), unidentified insects (2.4% volume, 30.0% frequency). The diet of *N. macrotis* largely overlapped that of the Mexican free-tailed bat (*Tadarida brasiliensis*) and pocketed free-tailed bat (*Nyctinomops femorosaccus*) in Big Bend National Park. However, *N. macrotis* consumed significantly more lepidopterans and significantly less hemipterans and coleopterans when compared to these other 2 molossid species. In addition, proportions of insects taken differed among the 3 bat species in some months.

Resumen—*Nyctinomops macrotis,* el murciélago-cola suelta mayor, es relativamente raro en el suroeste de los Estados Unidos y su información dietética es escasa. El objetivo de este estudio fue

examinar la dieta de *N. macrotis* en Big Bend National Park, Texas, usando análisis fecal para determinar lo que estos murciélagos comieron en una región donde son simpátricos con tres otras especies de murciélago-cola suelta. Recogimos y analizamos muestras fecales de 40 individuos y obtuvimos los resultados siguientes: Lepidóptera (87.5% volumen, 100% frecuencia); Hemíptera (4.1% volumen, 22.5% frecuencia); Coleóptera (4.6% volumen, 17.5% frecuencia); Orthóptera (1.1% volumen, 12.5% frecuencia); insectos sin identificación (2.4% volumen, 30.0% frecuencia). La dieta de *N. macrotis* mayormente se traslapó con la del murciélago guanero (*Tadarida brasiliensis)* y la del murciélago-cola suelta de bolsa (*Nyctinomops femorosaccus)* en el Parque National Big Bend. Sin embargo, *N. macrotis* consumió significativamente más Lepidópteros y significativamente menos Hemípteros y Coleópteros comparado con las otras dos especies. Además, las proporciones de insectos comidos difirieron entre las tres especies de murciélagos durante algunos meses.

Dietary studies of insectivorous bats are critical for understanding their role in the ecosystem and their role as regulators of insect abundance. Of particular interest is how bats interact as potential competitors in areas of sympatry. Intraspecific comparisons of food habits at different localities and times have revealed seasonal, sex, or temporal differences as reported for *Tadarida brasiliensis* (Whitaker et al., 1996; Whitaker and Rodriguez-Duran, 1999). There is little information on the diet of *Nyctinomops macrotis*. Easterla and Whitaker (1972) examined stomachs of 49 bats of this species captured over a 5-year period in Big Bend National Park (Big Bend NP), Texas, and found the contents to include (in percent volume) moths (86.1%), crickets (6.7%), flying ants (4.1%), stinkbugs (1.3%), froghoppers and leafhoppers (0.1%), and unidentified insects (1.7%) (Table 1). The stomach contents of one individual from Venezuela contained Coleoptera, Hemiptera, and some unidentified insects (Ochoa et al., 1988). In addition, one stomach from a bat captured in Arizona (Ross, 1967), as well as 4 fecal samples reported by Freeman (1981), contained only moths (Lepidoptera). Sparks and Valdez (2003) examined 56 fecal pellets collected from a maternity roost in northern New Mexico during July and found these bats to have a more diverse diet than previously thought. In their study, Homoptera was the most frequently encountered food item, which is in contrast to previous studies (Ross, 1967; Easterla and Whitaker, 1972; Freeman, 1981), which found predominantly Lepidoptera.

In this study, fecal analysis was used to examine the diet of *N. macrotis* in western Texas. This method has been shown to be an effective way of determining the diet of bats (Kunz and Whitaker, 1983). Our objective was to describe the diet for this species over several months in an area where it is sympatric with 3 other molossids. We compared our results to those of Sparks and Valdez (2003) and Easterla and Whitaker (1972) for *N. macrotis* and to Matthews (2002) for other free-tailed bat species.

TABLE 1—Composition of the diet (percent volume) for *Nyctinomops macrotis* in Big Bend National Park, Texas from this study compared to the results of Easterla and Whitaker (1972).

	Percent volume	
Order	1972	This study
Lepidoptera	86.1	87.5
Orthoptera	6.7	1.1
Hemiptera	1.4	4.1
Hymenoptera	4.1	0
Coleoptera	0	4.6
Unknown Insecta	1.7	2.4

Bats were captured in mistnets over Tornillo Creek (13R 684070E, 325295N) and Terlingua Creek (13R 0635512E, 3230630N) in Big Bend NP, Texas, during May, June, July, and September 2000, as well as May 2001. Both locations were characterized as river floodplain-arroyo formation, with associated vegetation including mesquite (*Prosopsis*), desertwillow (*Chilopsis linearis*), seepwillow (*Baccharis glutinosa*), cattail (*Typha*), cottonwood (*Populus acuminata*), and acacia (*Acacia*) (Wauer, 1971).

Bats were removed from nets throughout the night (from sunset to 12 hours after sunset) and placed in separate cloth bags. Each bat was measured and sexed before it was released. Fecal pellets were removed from the bags and were transferred to individually labeled micro-centrifuge tubes containing 70% isopropyl alcohol. Each sample (a sample represents all pellets from one individual) was

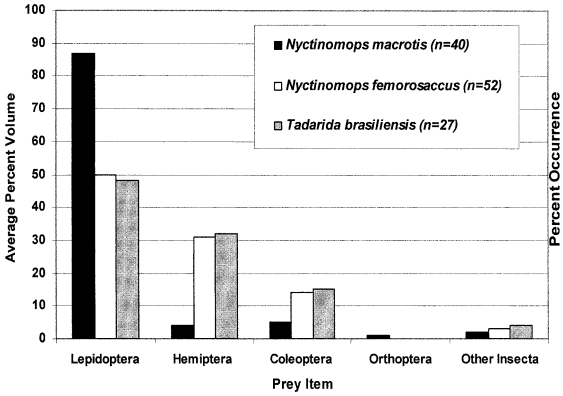

FIG. 1—Average percent volume of food items in the diets of *Nyctinomops macrotis, Nyctinomops femorosaccus,* and *Tadarida brasiliensis* in Big Bend National Park, Texas for all months when samples were collected (May through September 2000 and May 2001).

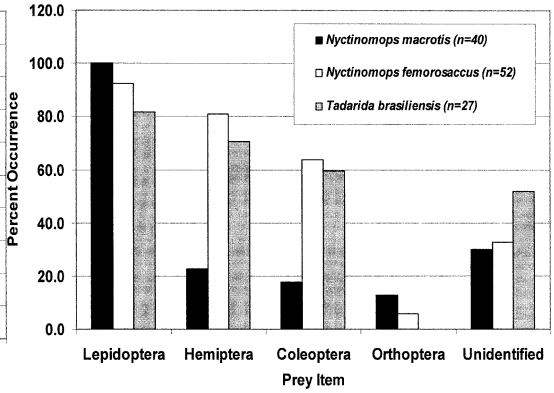

FIG. 2—Frequency occurrence of food items in the diets of *Nyctinomops macrotis, Nyctinomops femorosaccus,* and *Tadarida brasiliensis* in Big Bend National Park, Texas for all months when samples were collected (May through September 2000 and May 2001).

placed in a petri dish, covered with alcohol, and gently teased apart while viewed through a stereomicroscope (7.5× to 64× magnification). The insect remains in each sample were identified to the ordinal level when possible, and the percent volume of each food group in the sample was visually estimated to the nearest 1%, as described by Whitaker (1988). Several resources, including Borror and DeLong (1964), Borror and White (1970), Comstock (1966), Drees and Jackman (1998), Fox and Fox (1964), and Krunić (1992) were used as guides for identification of insect remains. In addition, digital pictures of some samples were shared with professional entomologists to confirm identification.

We examined fecal samples from 40 adult, female big free-tailed bats (*N. macrotis*). Individual samples contained from 1 to 21 pellets (total of 164 pellets; mean of 4 pellets per sample). Percent frequency of occurrence values represent the percentage of all sampled bats that had a specific food item in pellets, while percent volume represents the percentage of a specific food item in each sample. Data from *N. macrotis* in this study were compared to diet information for *T. brasiliensis* and *N. femorosaccus* collected in the same localities within the same time frame (Matthews, 2002). The data (percentages of food items in the diet) were arcsine transformed before statistical analysis was performed. ANOVA (Microsoft Excel, 2003 edition) was performed on both percent volume and percent frequency results. In addition, Student-Newman-Keuls (SNK) multiple range test (StatView, version 5.0.1; SAS Institute, Inc., Cary, North Carolina) was used to test for significant differences (2-tailed test; $\alpha = 0.05$) between species overall during the sampling period. Results obtained for all 3 species were then compared by month using both ANOVA and SNK.

Our results showed that, overall, the diet of *N. macrotis* consisted of Lepidoptera (moths) (87.5% volume, 100% frequency), Hemiptera (4.1% volume, 22.5% frequency), Coleoptera (4.6% volume, 17.5% frequency), Orthoptera (1.1% volume, 12.5% frequency), and unidentified Insecta (2.4% volume, 30.0% frequency) (Figs. 1 and 2, respectively).

Overall, the same orders of insects were present in the diets of the 3 molossid species. Furthermore, all 3 species seemed to be predominantly moth eaters. However, *N. femorosaccus* and *T. brasiliensis* exhibited a higher average percent volume of Hemiptera and Coleoptera than did *N. macrotis* (Fig. 1). Samples from all 3 free-tailed species had minimal amounts of Orthoptera (grasshoppers and crickets) (Figs. 1 and 2). ANOVA showed no significant difference among the 3 bat species for both percent volume and percent frequency ($F = 0.003$, $df = 2$, $P = 0.99$ and $F = 0.08$, $df = 2$, $P = 0.99$, respectively). A post hoc SNK analysis showed that *N. macrotis* consumed significantly more

lepidopterans and significantly less hemipterans and coleopterans when compared to the diet of sympatric species *N. femorosaccus* and *T. brasiliensis* at the 0.05 significance level.

Because complete data sets were unavailable for May and September, only results for June and July were compared separately among the 3 species. ANOVA showed no significant difference among *N. macrotis, N. femorosaccus,* and *T. brasiliensis* for either month ($F = 0.002$, $df = 2$, $P = 0.99$ and $F = 0.23$, $df = 2$, $P = 0.80$, respectively). Post hoc SNK analysis, at the 0.05 level of significance, showed that during June, *N. macrotis* consumed significantly more Lepidoptera than *N. femorosaccus* and *T. brasiliensis* and significantly less Coleoptera than *T. brasiliensis*. In addition, post hoc SNK analysis at the 0.05 level of significance showed that in July, *N. femorosaccus* took significantly more Hemiptera than did *T. brasiliensis* and *N. macrotis*.

In June, the diet of *N. macrotis* exhibited a much lower percent volume (1.9%) of Coleopterans than were seen in *N. femorosaccus* (19.2%) and *T. brasiliensis* (27.8%), while Hemiptera was represented in similar amounts in *T. brasiliensis* and *N. macrotis* (8.6% and 6.1%, respectively). In June, Hemiptera was the second most common prey type (after Lepidoptera—90.5%) according to percent volume (6.1%), while in July, Coleoptera was the second most common prey type (9.1%), with Lepidoptera as most common prey (88.9%) in diet of *N. macrotis*.

As has been reported by Freeman (1981), Easterla and Whitaker (1972), and Sparks and Valdez (2003), moths were the dominant food type for *N. macrotis*. However, our results differed concerning the representation of other orders. Easterla and Whitaker (1972) reported a substantial percent volume of Orthoptera, while we found little of this order. They also reported Homoptera (0.1%) and Hymenoptera (4.1%), which were not found in our samples. We found more Hemiptera, and while we found 4.7% Coleoptera, Easterla and Whitaker (1972) found none (Table 1).

Our results differed from those of Sparks and Valdez (2003) for *N. macrotis*. They reported moths as the most frequent food item, but not as the food item making up the highest volume. They found 5 orders of insects in the diet of *N. macrotis* and listed (in order of decreasing percent volume): Homoptera (26.7% volume, 62.5% frequency), Hymenoptera (19.5% volume, 37.5% frequency), Lepidoptera (17.2% volume, 82.1% frequency), Hemiptera (11.7% volume, 37.5% frequency), and Diptera (10.6% volume, 50.0% frequency). In their study, the predominant prey item by volume was Homoptera, an order that was absent from our samples. They found no Coleoptera or Orthoptera.

Due to temporal fluctuations in insect abundance and diversity, it is not surprising that there are differences in diet composition among studies. Differences seen in the diet of big free-tailed bats in our study was most likely a result of several factors. We employed different sampling strategies (roost versus net captures) than previous studies. Samples from the roost might bias diet analysis towards only those feeding bouts in the early morning, as has been shown for *T. brasiliensis* (Whitaker et al., 1996). *Nyctinomops macrotis* might also express variation in diet throughout a single night. Differences in our study might be from other factors, such as differences in sex and age of the bats, differences in habitat or elevation, or differences in competition pressures (presence or absence of other bat species).

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REDISCOVERY OF THE GRAY BAT (*MYOTIS GRISESCENS*) IN NORTHEASTERN MISSISSIPPI

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ABSTRACT—A male gray bat (*Myotis grisescens*) was discovered on private property in Tishomingo County, northeastern Mississippi, on 20 September 2004. The endangered gray bat previously had been known only from a site known as Chalk Mine in the northeastern corner of the county, where it was last documented in 1967. The 2004 specimen was recorded approximately 42 km south of the Chalk Mine site. The discovery of this specimen is noteworthy because it represents the first gray bat documented for the state of Mississippi in 37 years.

RESUMEN—Un murciélago macho (*Myotis grisescens*) fue descubierto en una propiedad privada en el condado de Tishomingo, del noreste de Mississippi, el 20 de septiembre del 2004. El murciélago, una especie en peligro de extinción, sólo se había encontrado en un lugar conocido como Chalk Mine en la esquina noreste del condado en el año 1967. El espécimen del 2004 fue registrado aproximadamente 42 km al sur de Chalk Mine. El descubrimiento de este espécimen es significativo debido a que representa el primer murciélago registrado de *Myotis grisescens* en 37 años en el estado de Mississippi.