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Temporal Variation in Prey Consumed by Big Brown Bats (*Eptesicus fuscus*) in a Maternity Colony

Abstract

We hypothesized that prey consumed by bats in maternity colonies differed by season and perhaps by time of day during postnatal development of young. Such was based on information that availability of prey to aerial-foraging bats differs spatially and temporally, some bats are selective of prey, and activity of lactating females varies with stage of development of young and their demands for energy. We identified prey in fecal samples collected at 2400 and 0600 h at weekly intervals from beneath two clusters of big brown bats (*Eptesicus fuscus*) in a maternity colony in a barn in Benton County, Oregon during postnatal development of young. Only consumption of moths (Lepidoptera) differed significantly by week; neither percent frequency nor average percent volume for any taxon of prey differed significantly by time of day. The overwhelming preponderance of caddisflies (Trichoptera) consumed possibly obscured variation in frequency and volume of other taxa of prey eaten. A maternity colony more distant from a single abundant, highly desirable, source of easily captured prey possibly would exhibit greater differences in prey consumed during postnatal development of young.

Introduction

In most regions, including Oregon where our study was conducted, beetles (Coleoptera) are considered the primary prey of big brown bats (*Eptesicus fuscus*), whereas moths (Lepidoptera) usually are not eaten or constitute only a small portion of the prey consumed (Hamilton 1933; Phillips 1966; Ross 1967; Whitaker 1972; Black 1972, 1974; Whitaker et al. 1977, 1981; Henny et al. 1982; Brigham and Saunders 1990). An exception is in British Columbia, where prey consumed by this bat was largely flies (Diptera) and caddisflies (Trichoptera; Brigham 1990). Nevertheless, essentially all of these studies were conducted with little regard to season, time of day, foraging behavior, or life-history events that possibly impact either availability of various prey or energetic demands of the bats. In Indiana, however, where beetles composed 48.6-85.0% of the prey consumed by *E. fuscus* in several colonies, the contribution of major insect groups consumed by the species in one colony where guano was sampled at 1-2-week intervals differed significantly at various times during late spring and summer (Whitaker 1995). Also, Whitaker et al. (1996) found significant differences in proportions and frequencies of several prey species consumed by Mexican free-tailed bats (*Tadarida brasiliensis*) during evening and pre-dawn foraging bouts in an 8-day period.

Availability of various prey to aerial-foraging bats differs spatially and temporally (Denno and Dingle 1981; Aldridge and Rautenbach 1987; Brigham 1990; Brigham and Saunders 1990); some bats are selective of available prey on the basis of size and perhaps other characteristics (Barclay 1985; Fenton 1990; Whitaker 1994); and lactating bats spend the least time in torpor (Audet and Fenton 1988), exhibit the greatest demands for energy (Kurta et al. 1989, 1990), and alter their foraging behavior in response to development of young (Davis et al. 1968). These features suggest that bats in maternity colonies during the period of postnatal development of young possibly consume different proportions of various taxa of prey either actively (and selectively) in reponse to the increasing energy demands of young (Kurta et al. 1989), or passively because of variation in availability of prey diurnally, seasonally, and spatially.

We hypothesized that before young are capable of foraging flights (about 4 weeks of age; van Zyll de Jong 1985), prey consumed by lactating females might vary temporally. Such might occur if the females shifted foraging areas or times in response to their changing nutritional needs and those of their offspring or in response to differences in availability of various taxa of prey. To assess variation in prey consumed, we analyzed fecal samples collected at midnight and early morning at weekly intervals from beneath two clusters in a maternity colony while young were being reared.

Methods

Fecal pellets produced by big brown bats in a maternity colony located in the loft of a two-story barn near Fairplay School approximately 3.2 km north of Corvallis, Benton Co., Oregon were collected. The barn, owned by Oregon State University, is used for storage; human activity there is infrequent. The bats occurred in two clusters about 10 m apart; they occupied spaces between strippings and rafters near the ridgepole of the barn. Piles of accumulated guano on the floor were evidence of the precise location of the roosts; the piles were removed the afternoon before collection of samples commenced. The guano piles contained several newly fallen dead neonates indicating that parturition in the colony was ongoing.

A piece of white bed sheet marked with 32 (4 by 8) 25-cm, numbered squares and with 3.8-cm wooden slats attached to each end, was spread on the plywood floor directly beneath each cluster at 1800 h each evening. Samples were collected at 2400 h and again at 0600 h the following morning. The sheets were cleaned and repositioned after each midnight collection, then removed after each early morning collection. Sampling was repeated at 7-day intervals from 1 to 23 July 1995. A random-numbers generator was used to determine the squares from which fecal pellets were collected. For each cluster, two fecal pellets were selected from each of 12 squares plus one pellet from a 13th square for a total of 25 pellets at each sampling period. Each pellet was placed in a labeled envelope and the envelope sealed. A flashlight, always directed toward the floor, was the only light used; we also collected samples quickly to avoid disturbing the bats more than necessary.

Each fecal pellet was placed in a Syracuse watch glass with sufficient water to cover the prey fragments after the pellet was teased apart. Prey taxa contained therein were identified and the proportion of each estimated visually (Whitaker 1988). Data were summarized by average percent volume and percent frequency. Multivariate analysis of variance followed by Fisher's least-significant difference tests were used with arcsine- transformed data to test for significant differences among clusters, time of day, and week of collection for each of the seven orders of insects preyed upon most. STATGRAPHICS Plus Version 2.1 for Windows was used for the statistical tests; 0.05 probability was accepted as significant.

Results

Eleven orders of insects plus mites (Acarina) and spiders (Araneae) were identified in the fecal pellets (Figure 1). In all collections, caddisflies occurred most frequently and contributed most to the volume of prey remains in the feces from the bats. Beetles usually ranked second in both percent frequency and average percent volume, and commonly were followed by moths, true bugs (Hemiptera), and flies. However, the rank in percent frequency or average percent volume of no taxon other than caddisflies was consistent among collections (Figure 1). Of the beetles, June bugs (Scarabaeidae) occurred in 115 (28.8%) samples and composed 10.7% of the volume of prey remains; unidentified beetles occurred in 103 (25.8%) samples and composed 5.9% of the volume of prey remains. Other families of beetles identified (followed parenthetically by percent frequency and average percent volume) were Carabidae (ground beetles; 1.25, 0.6), Curculionidae (snout beetles; 1.5, 0.2), Dytiscidae (predaceous diving beetles; 0.5, 0.1), Alleculidae (comb-clawed bark beetles; 0.25, 0.06), Cerambycidae (long-horned beetles; 0.25, 0.05), and Chrysomelidae (leaf beetles; 0.25, 0.1). Most flies were not identified to family (12.0, 1.7), but Culicidae (mosquitos; 0.75, 0.1), Chironomidae (midges; 0.75, 0.04), and Tipulidae (craneflies; 0.25, 0.05) were identified. Conversely, most hemipterans were identified to families Corixidae (water-boatmen; 10.25, 2.1), Pentatomidae (stinkbugs; 0.05, 0.2), and Miridae (leaf bugs; 0.25, 0.05); relatively few were not identified to family (3.25, 0.5). Orthoptera consisted entirely of Gryllidae (crickets; 5.5, 2.9). Hymenoptera was represented by Formicidae (ants; 1.25, 0.2), Ichneumonidae (ichneumons; 2.75, 0.5), and unidentified taxa (0.25, 0.04); Homoptera included Cicadellidae (leaf hoppers; 2.0, 0.4), Delphacidae (delphacid planthoppers; 0.25, 0.01), and unidentified taxa (0.25, 0.01). The other three orders of insects, insects not identified to order,

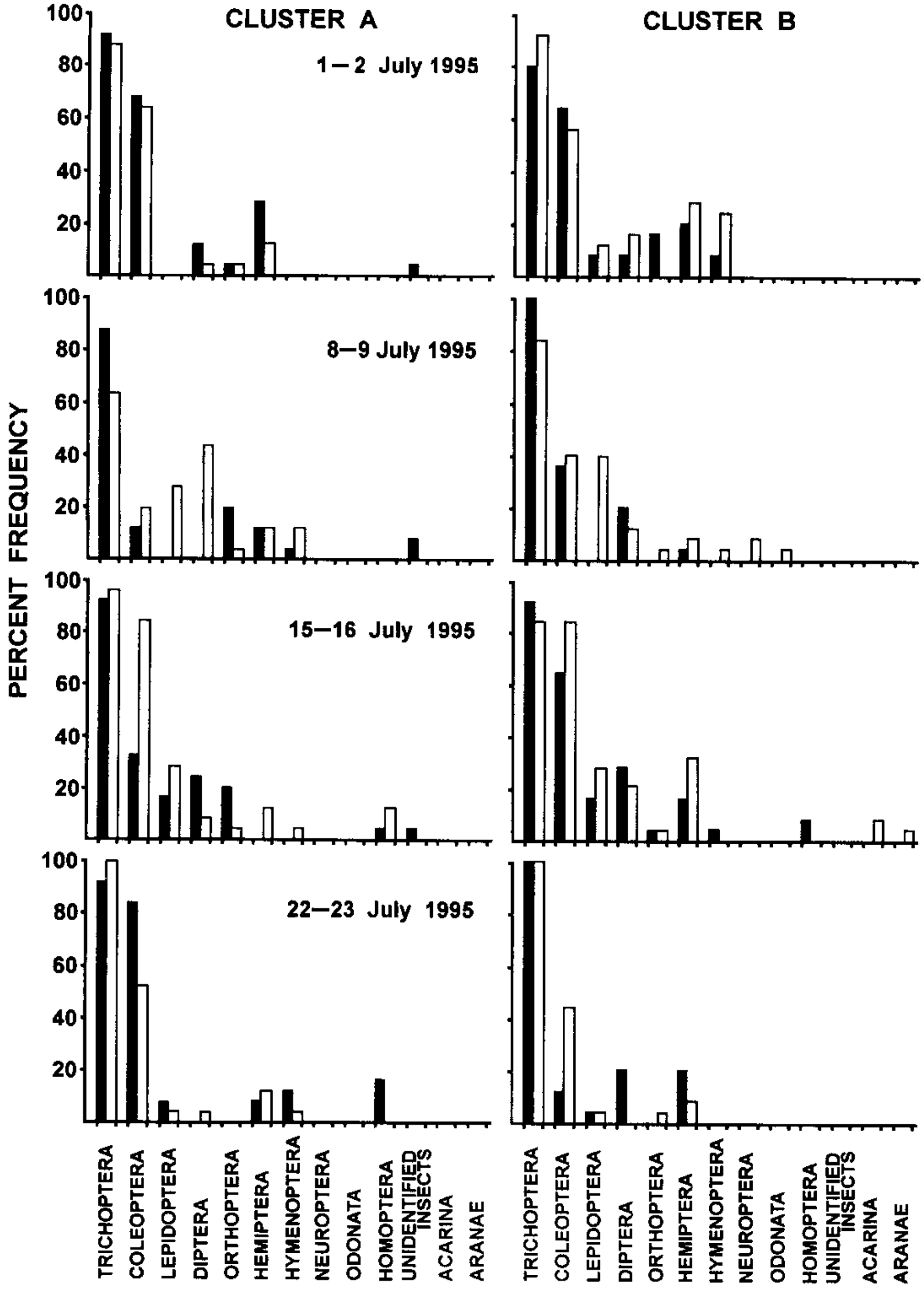
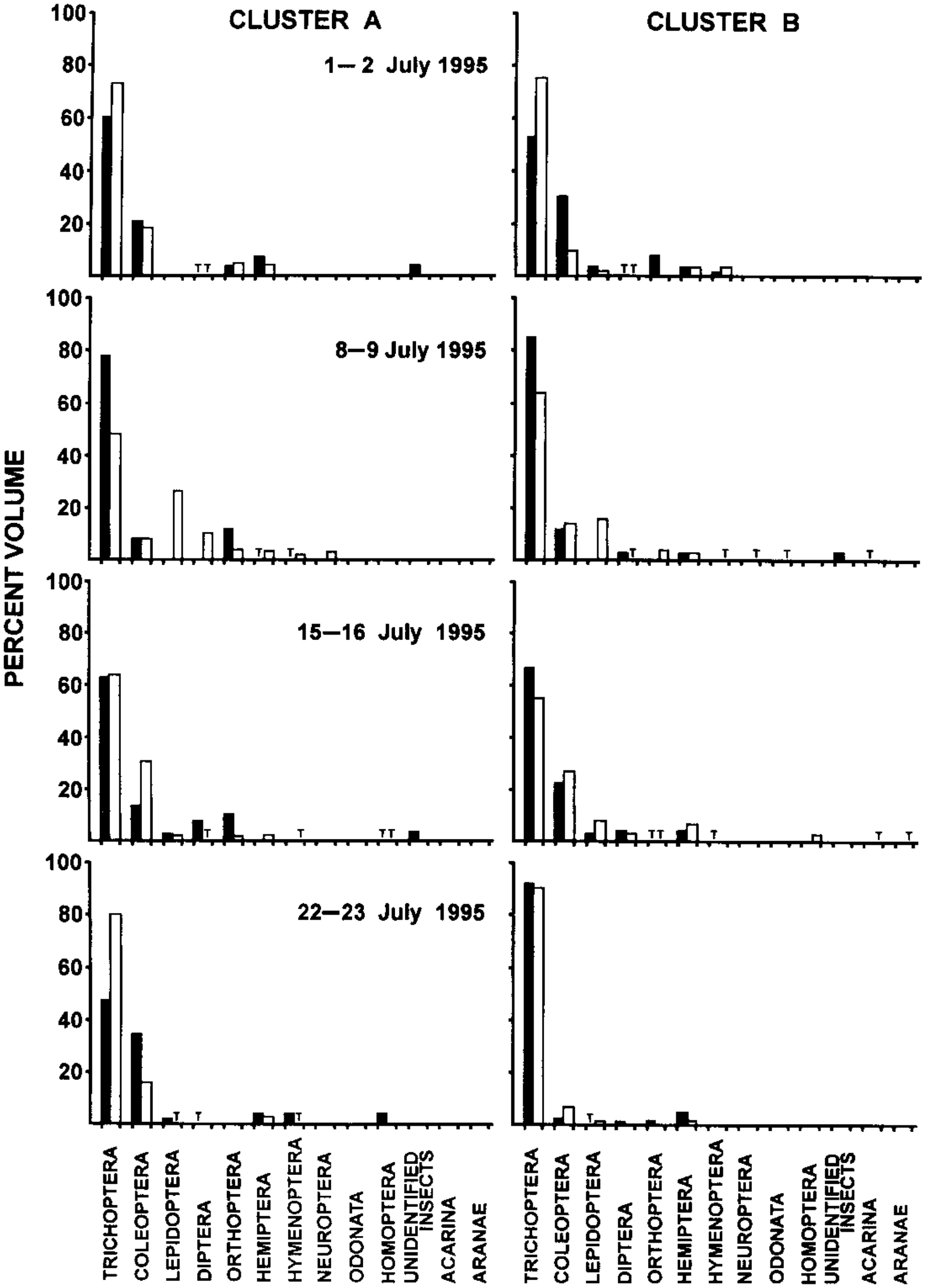


Figure 1. Percent frequency and average percent volume of 10 orders of insects, unidentified insects, Acarina, and Araneae in 1-23 July 1995. Samples of pellets deposited between 1800 h and 2400 h are represented by solid bars and those of



fecal pellets collected at weekly intervals beneath two clusters in a maternity colony of *Eptesicus fuscus* in Benton Co., Oregon. pellets deposited between 2400 h and 0600 h are represented by open bars; "T" indicates values <1%.

Acarina, and Araneae were rare and contributed little to the diet of big brown bats (Figure 1).

When all variables (cluster, week of collection, and time of day) were considered simultaneously, percent frequency and average percent volume of moths were significantly greater in collections made during weeks 2 and 3 than during weeks 1 and 4. These were the only significant differences observed with multivariate analysis of variance (Table 1). However, Fisher's least-significant difference test indicated homogenous groups by week of collection within clusters A and B (Figure 1) were significantly different in percent frequency between clusters for beetles (A: weeks 1, 3, and 4; B: weeks 1, 2, and 4), hemipterans (A: weeks 2, 3, and 4; B: weeks 1, 3, and 4), and caddisflies (A: weeks 3 and 4; B: weeks 1, 2, and 3). No similar groupings were observed in average percent volume by week of collection.

Discussion

Prey consumed by big brown bats in the maternity colony from which we obtained fecal pellets differed greatly from that reported for the species throughout most of its range north of Mexico (Hamilton 1933; Phillips 1966; Ross 1967; Black 1972, 1974; Brigham and Saunders 1990; Whitaker 1972, 1995), including Oregon (Henny et al. 1982; Whitaker et al. 1977, 1981). An exception was along the Okanagan River, British Columbia, where caddisflies also constituted a major component (61.6-65.3%) of prey items identified (Brigham 1990). We suspect that our findings are similar to those of Brigham (1990) because our colony was located only 0.8 km west of the Willamette River. At dusk in summer, mating flights of caddisflies frequently were observed along the river. The preponderance of caddisflies and other taxa associated with aquatic environments (Dytiscidae, Culicidae, Chironomidae, Corixidae) among prey remains suggests that the river served as a major foraging area for bats in the maternity colony. The proximity to water of collections of samples for previous dietary analyses of big brown bats in Oregon was either not described (Whitaker et al. 1977, 1981) or samples were obtained from specimens collected over ponds (Henny et al. 1982).

Greater percent frequency and average percent volume of moths and the lesser percent frequency of hemipterans preyed upon during weeks 2 and 3, and the relatively low percent frequency of beetles consumed during week 2 (Figure 1) possibly indicate changes in foraging behavior, habitats, or timing, or in availability of prey during development of young. Neither percent frequency nor average percent volume were significantly different for any taxon of prey between midnight and morning collections, but more moths occurred in fecal samples collected in the morning and more hemipterans occurred in midnight samples (Figure 1). Although we cannot exclude the possibility of temporal variation in prey selectivity by the bats, these differences more likely are a reflection of changes in relative abundance of these taxa of prey within a foraging area temporally or

TABLE 1. Results of multivariate analyses of variance of arcsin-transformed percent frequency of occurrence and average percent volume by cluster, date of collection, and time of day for the seven most common orders of insects consumed by big brown bats in a maternity colony in Oregon, July 1995. Values in bold are significant.

Order of insects	Percent volume						Percent frequency					
	Cluster[a]		Date[b]		Time[a]		Cluster[a]		Date[b]		Time[a]	
	F	*P*	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*
Trichoptera	1.60	0.23	1.03	0.42	0.01	0.93	0.66	0.44	2.46	0.12	0.24	0.64
Coleoptera	0.48	0.51	0.96	0.45	0.07	0.80	0.08	0.79	2.50	0.12	0.60	0.46
Lepidoptera	0.20	0.67	**12.26**	**0.01**	0.08	0.79	0.25	0.64	**12.54**	**0.01**	1.97	0.21
Diptera	2.18	0.18	1.39	0.32	0.66	0.44	0.03	0.88	1.32	0.34	0.50	0.50
Orthoptera	0.93	0.38	0.80	0.54	4.47	0.09	0.27	0.62	0.23	0.87	4.87	0.08
Hemiptera	1.28	0.29	1.30	0.34	0.60	0.46	0.47	0.51	2.53	0.12	0.00	0.95
Hymenoptera	0.00	0.99	0.81	0.57	0.01	0.93	0.07	0.81	0.85	0.55	0.32	0.61

[a] *d.f.* = 1
[b] *d.f.* = 3

that adult females were foraging in different areas at different times of the night. The increase in consumption of moths, usually an uncommon prey of *E. fuscus*, tends to support our contention that observed differences were not related to temporal variation in prey selectivity by the bats. Also, differences in weekly homogenous groups between clusters suggest that bats composing the two clusters may have foraged in different areas at times.

As energetic demands of young increase with age, adult females possibly spent more time foraging over agricultural fields and along wooded areas that lay between the barn housing the colony and the river. Such would be consistent with optimal foraging theory in that maternal females would forage closer to the colony and possibly spend less time in foraging. Foraging over agricultural fields and along wooded areas also would be consistent with the increase in moths preyed upon during weeks 2 and 3 of our study. Nevertheless, the overwhelming preponderance of caddisflies in all 16 samples (Figure 1) suggests that maternal females continued to use the nearby riverine area as a major foraging area. This, in turn, suggests that what might have been even greater temporal differences in other taxa of prey consumed likely were obscured by the greater consumption of the presumably abundant and easily available caddisflies. We speculate that similar sampling of feces produced by big brown bats in a maternity colony remote from a single abundant source of easily captured prey possibly would reveal greater temporal variation in prey consumed during development of young.

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