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Resumo

Nós estudamos a germinação e predação de sementes de *Erythroxylum ovalifolium* (Erythroxylaceae) dentro da bromélia terrestre *Neoregelia cruenta* na Restinga da Barra de Maricá, Rio de Janeiro, Brasil. As taxas de germinação e predação de sementes e, possivelmente a taxa de desenvolvimento das plântulas, parecem ser dependentes da localização (ie. periferia, meio ou tanque) de sementes dentro da bromélia. *E. ovalifolium* produz frutos apenas no verão mas suas sementes podem permanecer viáveis por cerca de seis meses no interior das bromélias, o que provavelmente prolonga o período de recrutamento.

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Roosting Assemblages of Bats in Arenitic Caves in Remnant Fragments of Atlantic Forest in Southeastern Brazil

Key words: Atlantic forest; Brazil; caves; Chiroptera; Desmodus.

IN SOUTHEASTERN BRAZIL, it is impossible to evaluate the loss of biodiversity as most of the Atlantic forest has disappeared within the last 50 years (Fowler *et al.*, in press). However, it is even more important to document existing species and evaluate their population viability before further habitat loss or modification occurs.

Bats are the most numerically abundant group of Neotropical mammals (Trajano 1985, Emmons 1990). Although their smaller size may make them less vulnerable to human hunting, many species are tightly linked to forest systems and are important pollinators, fruit dispersers, and general predators (Reis 1982). As such, bats should be highly vulnerable to habitat loss and modification. In this note, we examine bat roosting assemblages in caves which lie within an environmental protection area of central São Paulo state. Although this area is not under strict conservation, fragments of Atlantic forest still remain associated with the hilly topography in which the caves are situated.

The Corumbataí Area of Environmental Protection (AEP) (23.0° to 23.5°S, 48.5° to 47.5°W) was created in 1981 and covers approximately 2700 km². The included land is primarily privately owned, but owners must obtain governmental approval before making any type of development. Within this area, a number of remnant Atlantic forest fragments are found. They are principally associated with hills and mountains which abruptly rise 300 m, with woody vegetation limited primarily to their slopes. Most of the area dates from the lower Devonian period, and although there are basaltic deposits in the area, most of the area is sandy (Moraes 1985).

The three caves used for our samples are arenitic in origin and are consequently small. Over 30 caves exist in the area, which is still largely unexplored. All known caves harbor bat roosts, and all caves are situated in the sides of the abrupt topographic rises described previously. The largest cave, Fazendão, is

TABLE 1. Mist netted bats in three arenitic caves within Atlantic forest fragments of the interior of the State of São Paulo. Total number captured (N) is shown along with the proportion of males (Males) in the samples.

Species	Cave							
	Fazendão		Paredão		Cachoeira		Overall	
	Males	N	Males	N	Males	N	Males	N
<i>Desmodus rotundus</i>	0.417	224	0.714	30	0.716	98	0.525	352
<i>Carollia perspicillata</i>	0.667	7	0.742	36	0.619	21	0.694	64
<i>Glossophaga soricina</i>	0.486	38	0.467	15	0.677	9	0.508	62
<i>Anoura caudifer</i>	—	—	0.971	35	0.000	1	0.944	36
<i>Myotis nigricans</i>	0.625	8	0.500	2	—	—	0.600	10
<i>Miconycteris megalotis</i>	—	—	0.667	3	0.677	6	0.667	9
<i>Chrotopterus auritus</i>	0.333	3	1.000	2	1.000	2	0.714	7
<i>Vampyrops lineatus</i>	—	—	—	—	1.000	1	1.000	1
Total individuals		280		123		138		541
Total species		5		7		7		8
Collection net hours		54		30		30		114

located in the municipality of Ipêuna and is approximately 200 m long. The Paredão cave in Ipêuna and Cachoeira cave, located in the municipality of Itirapina, are each approximately 60 m long. Distances between the caves are: Fazendão–Paredão 150 m; Cachoeira–Paredão and Cachoeira–Fazendão 12 km.

A 2 × 6 m mist net was used in all of our collections and was placed in the cave entrance shortly before sunset; it was left for 6 hours. From February 1991 through January 1992, a total of 19 collections were made, with nine in the Fazendão cave and five, each, in the Cachoeira and Paredão caves. Collection dates coincided with new moon phases to standardize results and minimize other effects (Turner 1985, Sazima 1978). Captured individuals were identified to species and sexed. Individuals of *Desmodus rotundus* were marked with numbered tin bands on the left forearms, while other species were marked in the left ear lobe by distinctive, small cuts made with surgical scissors. Captured individuals were then held in cages until the end of the daily sampling period; they were then released. During subsequent collections, recaptured individuals were noted, and released.

Diurnal visits to examine roosting group-sizes of each species were also made at bi-weekly intervals. During these visits, we examined with a strong flashlight all bats present and noted group sizes.

We used a modification of Chao's (1982) modified moment estimator for unequal probability sampling to estimate the population of *D. rotundus*. In this modification, we used the number of recaptures as class variables. Data from the Paredão and Fazendão caves were pooled due to a high degree of reciprocal translocation. This method was chosen because of the difficulties of obtaining unbiased estimates of recapture probabilities and closed populations needed for mark–recapture estimates. Other tests used included a proportional Z test for sex ratios, and log-likelihood contingency tests (Sokal and Rohlf 1981) for frequency comparisons.

A total of eight species were captured in the three caves (Table 1), with significant heterogeneity in species composition from cave to cave ($G = 114.99$, $P < 0.001$). Collectors curves indicated that sampling was sufficiently intensive to detect the roosting bat assembly. The vampire bat, *D. rotundus*, was by far the numerically dominant species (Table 1). Fazendão cave had the largest population of *D. rotundus* and the smallest roosting species richness. However, the short-tailed bat, *Carollia perspicillata*, was the most abundant species in the Paredão cave, closely followed by the long-tongued bat, *Anoura caudifer*; *D. rotundus* was third. Four bat species were found in all three caves, three were found in two caves, and *Vampyrops lineatus* was represented by a single individual in the Cachoeira cave (Table 1).

A total of 276 specimens of *D. rotundus* were marked in the three caves; 19.9 percent of these were recaptured once, while 2.5 percent were recaptured twice. A high degree of translocation was observed between the Paredão and Fazendão caves, while the Cachoeira roost was apparently closed to these cave roosts. The Cachoeira cave roost was thus considered one unit, while the Fazendão–Paredão cave system was considered as another roost unit. Our estimate of the *D. rotundus* population for the unit comprised by the Fazendão and Paredão caves was 613 individuals, with 95 percent confidence intervals of 490 and 799. For the Cachoeira cave roost, the estimated population was 832, with 95 percent confidence intervals of 386 to 1952.

Sex ratios among species and among caves showed a high degree of heterogeneity. Sex ratios of *D. rotundus* were significantly biased toward males in the roosts of Cachoeira and Paredão; it was significantly different from that found in the Fazendão. Significantly more male short-tailed bats, *C. perspicillata*, and hairy-legged long-tongued bats, *A. caudifer*, were found in roosts (Table 1).

During diurnal visits to roosts, we observed roosting groups of *A. caudifer* and *C. perspicillata* to consist of five to 10 individuals, while *Chrotopterus auritus* formed compact roosts of two to three individuals. *Chrotopterus auritus* was always found in close proximity to the cave entrance, under which a deposit of guano and small bones and mammal fur were present. *Desmodus rotundus* was found to roost either solitarily or in groups of two to five individuals in the Cachoeira and Paredão caves. Dozens of individuals were grouped in roosts in the Fazendão cave, which also contained a large number of recently born offspring.

The occurrence of large populations of *D. rotundus* had been previously reported, but not quantified, for caves in the Corumbataí AEP (Trajano 1987). This species was encountered in all of our collections and comprised 65 percent of all captured individuals. Sizeable populations, comparable to our estimates, should be expected due to the prevalence of cattle in adjacent deforested areas (Turner 1985). Of the sampled caves, the Fazendão cave was characterized by statistically higher female sex ratios and the presence of a large number of young. We suggest that this cave acts as a nursery, with males roosting in other caves from which they move frequently (Turner 1985).

The presence of remnant Atlantic forest fragments associated with the mountainsides apparently provides suitable habitat for eight other cave roosting species, all of which are characterized as being faunal elements of rain forests (Emmons 1990). These species have been shown to be important elements in other Atlantic forest remnants (Trajano 1985, Marinho-Filho & Sazima 1989). The island array of forest remnants in this area provides the only Atlantic forest intact within the interior of São Paulo. *Glossophaga soricina* is a nectar feeding bat, and the major pollinator of *Ceiba* trees (Emmons 1990) which occur at low densities in the AEP forest fragments. The other nectar feeder, *A. caudifer*, is only common in areas of caves (Emmons 1990). Both of these species, along with the fruit-eating *C. perspicillata* and *V. lineatus* are probably important seed dispersers, and their movement between forest fragments may be important in maintaining forest diversity. *Vampyrops lineatus* is, however, rare and is on the CITIES list of endangered species. The only entirely insectivorous species, *Myotis nigricans*, probably forages along forest edges and deforested regions, but the previously mentioned species also supplement diets with insects (Emmons 1990). *Chrotopterus auritus*, as noted earlier, is a predator of small mammals, but it is also known to prey on large insects, reptiles, and birds (Medellín 1988).

Although our survey was restricted to cave-roosting species, we were able to document sizeable populations of some species and the presence of others which are not characteristically restricted to cave roosts. These results, however, suggest that a larger number of non-cave-roosting bats are still present in the forest fragments. The most abundant species, the vampire *D. rotundus*, attains large populations, and because of the risks of rabies transmission (Turner 1985), these populations are of special concern in the area (Trajano 1987). However, we have shown that only one of our caves is a nursery, and if intervention is needed, it should be restricted to that cave, as most control programs are indiscriminate at the species level. Our results also suggest that species diversity is decreased in the presence of vampire bats, as suggested by Turner (1985). As human exploitation of the habitat increases, vampire bats are favored and may drive other species out. These results also suggest that special attention be given to the protection of caves associated with Atlantic forest remnants due to their importance in providing roosts for bat species that provide seed dispersal and pollination roles, as well as providing occasional refuge for endangered species, in this rapidly vanishing forest system.

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Varietal Taste Preference for Cacao *Theobroma cacao* L. by the Neotropical Red Squirrel *Sciurus granatensis* (Humboldt)

Key words: cacao; feeding deterrent; taste preference; *Theobroma cacao*; *Sciurus granatensis*; squirrel.

IN TROPICAL FORESTS HERBIVORE DAMAGE of unripe fruit is widespread and can greatly diminish a plant's reproductive success (Fenner 1985, Peres 1991). Unripe fruit tend to be cryptic green in color and may contain compounds to deter herbivore damage before the seeds are mature (Bell 1984). Changes associated with fruit ripening are considered a primary mechanism for the attraction of animal vectors which disperse seeds (Rhodes 1980). The foraging behavior of the animal vectors involved will also influence the reproductive success of the plant whose seeds they disperse. Arboreal frugivores such as squirrels can exploit most of the fruit crop, and because they have first food choice they tend to be more selective than terrestrial ones (Kinzey and Norconk 1990). Optimal foraging models have had much success in predicting how long animals spend in a patch of food (Charnov 1976, Stevens & Krebs 1986). Factors influencing food preference within a patch are less well understood.

The neotropical red squirrel *Sciurus granatensis* (Humboldt) is common throughout much of Central and northern South America. It feeds on a variety of fruits and seeds (Eisenberg 1989). The natural distribution of *S. granatensis* is similar to that of cacao, *Theobroma cacao* L. (Cheesman 1944). In addition to monkeys and rats, squirrels are considered to be among the natural seed dispersal agents of *T. cacao* (Toxopeus 1985). In commercial plantations, however, squirrels may be a serious pest of cacao (Lawrence 1991).