

Observations on the reproductive ecology of some Neotropical bats

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L'examen de 384 femelles d'*Artibeus jamaicensis* dans les « llanos » du Vénézuéla a permis de constater qu'un grand nombre d'entre elles étaient gestantes et allaitantes à la fin de la saison sèche. Les jeunes sont sevrés au début de la saison des pluies. Cette observation concorde avec les études sur la reproduction effectuées sur les populations d'*Artibeus* d'Amérique centrale. On a des données sur la fréquence des gestations et des lactations et sur le nombre des jeunes par portée de 32 espèces de chauve-souris des « llanos » collectées à la fin de la saison sèche : 28 d'entre elles ont été gestantes ou allaitantes à cette saison. Ces observations sont discutées en rapport avec le rôle de l'abondance et de la qualité des ressources dans l'écologie de la reproduction des chauve-souris tropicales.

Available data on the reproductive biology of Neotropical bats indicate that most are seasonal breeders with reproductive activities timed so that young are weaned near the onset of or during the wet season (Fleming *et al.*, 1972; Wilson, 1979). This seasonal pattern of reproduction corresponds to seasonal increases in food abundance for both frugivorous and insectivorous species. Bats that feed on continuously available food resources, such as the sanguivorous *Desmodus rotundus*, show little reproductive seasonality (Wilson, 1973). The selective advantages in limiting breeding activities to those periods of the year when food resources are most plentiful ultimately relate to increased fitness. Most data used to develop hypotheses on the reproductive ecology of Neotropical bats are based on studies conducted in Costa Rica or Panama (Fleming *et al.*, 1972; LaVal and Fitch, 1977; Humphrey and Bonaccorso, 1979). Additional data on geographic variation in the timing of bat reproduction are needed to determine the ubiquity of the presently identified tropical life history strategies. Here we report on the breeding chronology of *Artibeus jamaicensis* throughout the dry season in Venezuela. Additionally, data on litter size and reproductive activity are presented for 31 other taxa. These data are used to examine the hypothesis that breeding activity is influenced by seasonal abundance of food resources.

Data on *A. jamaicensis* were obtained at Fundo Pecuario Masaguaral, 45 km S Calabozo, Estado Guarico, Venezuela (8°33' N' 67°36' W). Masaguaral is located in dry tropical forest in the llanos of Venezuela. Eisenberg (1979) gives a thorough review of the flora and fauna of the region. All *A. jamaicensis* were mist-netted

adjacent to fruiting fig (*Ficus* spp.) trees from October 1977 to May 1978. Pregnancy was determined by palpation for embryos and individuals were considered lactating if milk could be expressed from their teats. All bats were released immediately after examination.

In the course of collecting tissue samples for genic and chromosomal studies, we obtained additional data on the frequency of pregnancy and lactation, and litter size for 32 species of bats. Specimens taken between 14 April and 28 April 1978 were fluid preserved and subsequently deposited with the Ministerio del Ambiente y de los Recursos Naturales Renovables (MARNR), Caracas or The Museum, Texas Tech University, Lubbock. Collections were made under permit from MARNR at Fundo Pecuario Masaguaral and Parque Nacional Guatopo, 80 km SE Caracas, Estado Miranda. Catalog numbers and collecting localities will be furnished on request to the authors.

Artibeus jamaicensis data summarized in Table 1 indicate that one litter is produced at the end of the dry season (the dry season extends from December to May). These results are consistent with observations made on *A. jamaicensis* in Panama and Costa Rica by Fleming *et al.* (1972). Their data show a second litter produced in the middle to late wet season. This situation may be true for *A. jamaicensis* in our study area also but we do not have data for the wet season to confirm this. Reproductive data summarized in Table 2 show that individuals of 27 of 31 other taxa were either pregnant or lactating during April regardless of size or trophic category.

TABLE 1. — Reproductive data from female *Artibeus jamaicensis* at Fundo Pecuario Masaguaral, Venezuela.

Month	Number of adult females examined	% pregnant	% lactating	Number of subadults captured
Oct.	121	0	0	0
Nov.	59	0	0	2
Dec.	45	0	2	0
Jan.	27	0	0	0
Feb.	34	9	0	0
Mar.	55	9	85	0
Apr.	30	27	70	1
May	13	15	85	8

There is considerable information available on phenology patterns of tropical trees and shrubs. Monasterio and Sarmiento (1976) reviewed the phenological strategies of several plant species in llanos habitat approximately 40 km NE of Fundo Pecuario Masaguaral. The habitat in our study area is quite similar and many of the trees and shrubs in their report are found in our study area as well. Their data indicate that most plant species that could serve as food for frugivorous bats flower and fruit in the wet season. However, there are a number of species that show no seasonality in fruit production or produce fruits only in the dry season. Notable among these are *Ficus* spp., an extremely important component in the diet of *A. jamaicensis* (Bonaccorso, 1975; Morrison, 1978 a, 1978 b). *Ficus* density on Masaguaral is generally high in all habitats, for example; there are approximately 8 *Ficus*/ha in savanna habitat, 35/ha in deciduous forest habitat, and 37/ha in mata bajo (Troth, 1979) habitat. Because *A. jamaicensis* may commute up to 8 km while foraging (Morrison, 1978 a), it is reasonable to

TABLE 2. — Reproductive data for 32 species of Venezuelan bats captured in April 1978 at Fundo Pecuario Masaguaral and Parque Nacional Guatopo, Venezuela. Crown-rump lengths (CRL) were measured from fresh specimens and include the extraembryonic membranes. The size classes are: 1, forearm length less than 40 mm; 2, forearm length between 41-50 mm; 3, forearm length between 51-60 mm; 4, forearm length greater than 61 mm.

Species	Size	Number		% Pregnant	% Lactating	Litter size	\bar{X} (range) CRL (mm)
		examined					
Insectivores							
<u>Rhynchonycteris naso</u>	1	2	50	0	0	1	17.0
<u>Saccopteryx bilineata</u>	2	8	63	0	0	1	13.4 (6-18)
<u>S. canescens</u>	1	7	29	0	0	1	12.0
<u>S. leptura</u>	1	2	100	0	0	1	12.0 (6-18)
<u>Noctilio albiventris</u>	4	1	0	0	0	0	
<u>Pteronotus parnellii</u>	4	2	50	0	0	1	24.0
<u>Tonatia venezuelae</u>	1	1	0	0	0	0	
<u>Mimon crenulatum</u>	3	1	100	0	0	1	22.0
<u>Myotis nigricans</u>	1	10	90	0	0	1	6.6 (2-12)
<u>Eptesicus brasiliensis</u>	1	11	82	0	0	2.2 (2-4)	7.8 (2-11)
<u>Rhogeessa tumida</u>	1	5	100	0	0	1.4 (1-2)	9.2 (5-18)
<u>Lasiurus ega</u>	2	15	100	0	0	2.3 (1-3)	9.8 (4-18)
<u>L. borealis</u>	1	2	100	0	0	2	6.0 (4-8)
<u>Molossops temminckii</u>	1	1	0	0	0	0	
<u>M. planirostris</u>	1	1	100	0	0	1	8.0
<u>Eumops dabbenei</u>	4	1	0	0	0	0	
<u>Molossus molossus</u>	1	14	79	0	0	1	6.3 (4-9)
<u>Promops sp.</u>	2	4	100	0	0	1	17.3 (16-18)
Frugivores/Nectarivores							
<u>Micronycteris minuta</u>	1	5	100	0	0	1	21.0 (18-26)
<u>M. nicefori</u>	1	1	100	0	0	1	
<u>Phyllostomus discolor</u>	4	4	0	25	0	0	
<u>P. elongatus</u>	4	3	67	0	0	1	28.0
<u>P. hastatus</u>	4	7	0	15	0	0	
<u>Glossophaga soricina</u>	1	3	33	0	0	1	23.0
<u>Anoura caudifer</u>	1	3	33	0	0	1	15.0
<u>Carollia perspicillata</u>	2	17	76	6	0	1	20.3 (10-28)
<u>Sturnira lilium</u>	2	20	25	50	0	1	25.5 (13-31)
<u>Artibeus jamaicensis</u>	4	14	71	21	0	1	12.3 (2-32)
<u>A. lituratus</u>	4	2	0	50	0	0	
<u>A. phaeotis</u>	1	1	100	0	0	1	15.0
<u>Vampyrops helleri</u>	1	5	60	40	0	1	19.0 (1-28)
Sanguivores							
<u>Desmodus rotundus</u>	3	15	33	40	0	1	10.2 (7-17)

assume that, at least in our study area, there is always a fruiting fig tree available regardless of the season or time of year.

Considering the year-round high abundance of food resources for *A. jamaicensis*, an extension of the current hypotheses on the reproductive ecology of bats (Wilson, 1973) would result in a prediction that *Artibeus* would produce young throughout the year. However, our data (Table 1) and the observations of others (Fleming *et al.*, 1972) show that *A. jamaicensis* is a seasonal breeder with the birth of young more or less synchronized to the wet season. What may be of major importance to *A. jamaicensis*, as well as other frugivorous bats, is the diversity of available food resources rather than abundance *per se*. Although energetically rich (Morrison, 1978 *b*), fig fruits alone may not contain the full nutritional complement needed by immature or adult bats to successfully cope with the demands of reproduction and growth. Heithaus *et al.* (1975) have shown a positive correlation between utilization of protein rich pollen (Howell, 1974) and pregnancy in *A. jamaicensis*. *Artibeus* are not obligate fig-eaters and consume a wide variety of other fruit species when available. Gardner (1977) lists 92 taxa of fruits and flower parts reported in the diet of *A. jamaicensis*. Pollen and other fruit species may supply the essential amino acids and nutrients that figs lack.

Our data indicate that there is marked reproductive synchrony in bats from the llanos of Venezuela. These observations are consistent with those made on other bats in Central America. Breeding is timed so that young are weaned during periods of abundant food, however, resource abundance alone is insufficient to explain why *Artibeus jamaicensis* limits its reproductive activities to the wet season. In these bats, the diversity of available resources probably is of major importance. This likely relates to the nutritional demands of growth in young bats and pregnancy, lactation, and spermatogenesis in adults.

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SUMMARY

Examination of 384 female *Artibeus jamaicensis* over a complete dry season in the Venezuelan llanos showed a high frequency occurrence of pregnant and lactating individuals at the end of the dry season. Young are weaned early in the wet season. This observation is consistent with studies of reproduction in Central American populations of *Artibeus*. Data on the frequency of pregnancy and lactation, and litter size are reported for 32 species of llanos bats collected at the end of the dry season. Eighty eight percent of these species were either pregnant or lactating during this period. These observations are discussed with regard to the role of resource abundance and resource quality in the reproductive ecology of tropical bats.

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