part of the newly established territory.

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Relative Reproductive Success In The Mantled Howler Monkey: Implications For Conservation

Introduction

The structure of primate groups is thought to result from the tendency of females to select rich patches of food and that of males to select large aggregations of females (Wittenberger, 1980; Emlen and Oring, 1977). Because patch richness and the consequent number and quality of females may vary, the relative reproductive success (RRS) of females may also vary over space and time. Relative reproductive success is a population parameter, since it is one characteristic of demographic or life history traits describing sub-units of a species within and between environmental regimes (see Vehrencamp and Bradbury, 1984). RRS is important to the field of conservation biology since an increase in the variance of reproductive success in a population reduces effective population size (Primack, 1993). Information about RRS facilitates viability analysis of population fluctuations required for recovery from environmental perturbations.

Methods

This report analyzes relative reproductive success (RRS) of mantled howler monkeys (*Alouatta palliata* Gray) in two Central American forests as the mean number of juveniles plus infants (J + I) per female group size per site. This report uses data from several studies (Carpenter, 1934; Mittermeier, 1973; Thorington, 1975; Malmgren, 1979; Clarke *et al.*, 1986; Glander, 1980; Jones, unpubl., Table 1) at two research sites where mantled howler monkeys have been studied most intensively: Guanacaste (GTE), Costa Rica in a tropical dry forest environment (Heltne *et al.*,1975) (n= 51 groups) and Barro Colorado Island (BCI) in a semideciduous lowland tropical forest environment of Panama (Heltne *et al.*, 1975) (n= 73 groups). Mantled howler monkeys, large cebids distributed throughout the forests of Middle America and the Pacific coast of northern South America, are classified as endangered in the United States Endangered Species Act of 1991 (Groves, 1993).

Results and Discussion

Fecundity is thought to be related to group size (see Pulliam and Caraco, 1984; Terborgh and Janson, 1986; Wittenberger, 1980; Robinson, 1988). Results differ, however, depending on methods of calculation. Calculations of absolute values per group (i.e., the total number of juveniles and infants per group compared to the total number of adult females in a group) may exhibit

significant linear regressions. For the surveys used in the present analysis, 6 out of 7 show a significant positive correlation, with a mean correlation of +0.62 ($P \leq 0.05$) for the comparison just stated. Thus, within-group productivity appears directly related to group size.

Table 2 exhibits relative reproductive success (RRS), a between-group analysis, for different sized female groups for the present sample. The number of females per group ranges from 2-15. RRS at Guanacaste (GTE) ranges from 0.55-1.00 (0.75±0.17) and at Barro Colorado Island (BCI) from 0.17-1.23 (0.92±0.29). There is no correlation between female group size and RRS at either location (r_s = -0.15 and +0.06 for GTE and BCI, respectively), suggesting that different groups with the same number of adult females are not similarly productive when different censuses are compared. Further, RRS does not differ overall between the two sites (Wilcoxon's Signed Ranks Test, $P>0.05$), possibly due to an optimal birth rate, death rate, and/or dispersal rate. Females in GTE, then, do as well as females at BCI, on average. The range in RRS, however, is significantly greater at BCI than at GTE ($P \leq 0.001, \chi^2 = 24.64$, df = 1), possibly reflecting greater carrying capacity at BCI, the wetter site. Further, coefficients of dispersion for RRS (0.22 and 0.21 for GTE and BCI, respectively) show that the frequency distributions of RRS at both sites are "repulsed" (more observations than expected at the center of each distribution) and that the standard deviation is less than one would expect by chance alone.

Modal female group size is eight for both GTE and BCI. The frequency distribution of female groups was compared between sites and the mean (±S.D.) number of females per group is significantly larger in GTE (8.38±3.24) than in BCI (7.10±2.58) (Randomization Test, T = 2.58, df = 121, $P \leq 0.01$), a result that might be accounted for by the higher degree of seasonality and consequent variance in resource patchiness in GTE (see, Heltne *et al.*, 1975), although both sites are characterized by relatively moderate levels of primary productivity (Whittaker, 1975). Howler populations, thus, appear to be limited by environmental potential, with greater potential for large group sizes in the more heterogeneous GTE forests (see Heltne *et al.*, 1975).

Table 1. Results of the author's counts of 11 howler groups at various locations throughout the Guanacaste Province, Costa Rica.

Group	Ad.males (n)	Ad.fem. (n)	Juv. (n)	Inf. (n)	Total (n)
A	2	7	4	1	14
B	2	6	3	2	13
C	2	8	3	2	15
D	2	9	4	3	18
E	2	6	4	4	16
F	3	9	3	1	16
G	3	14	12	2	31
H	3	13	6	5	27
I	4	11	5	2	22
J	5	14	8	6	33
K	6	15	12	2	35
Total	34	112	64	30	240

Table 2. Relative reproductive success (RRS) as a function of group size at two Central American howler monkey sites, Guanacaste (GTE), Costa Rica, and Barro Colorado Island (BCI), Panama. (f) = number of times a female group of a given size (n) occurred at BCI and at GTE. RRS calculated as mean (X) number of juveniles plus infants (J + I) per female group size per site (see Methods).

Females/ Group (n)	Mean J + I/Females/Group GTE		BCI	
	RRS	(f)	RRS	(f)
2	0.75	(2)	0.66	(3)
3	0.67	(1)	0.17	(2)
4	1.00	(2)	1.21	(7)
5	0.81	(4)	1.23	(7)
6	0.99	(4)	1.20	(11)
7	0.79	(6)	0.99	(10)
8	0.55	(10)	1.01	(15)
9	0.58	(8)	1.03	(8)
10	0.55	(2)	0.80	(4)
11	0.64	(1)	0.82	(1)
12	0.75	(1)	1.00	(2)
13	0.86	(5)	0.66	(2)
14	1.00	(2)	1.14	(1)
15	0.57	(2)	-	(0)

Extinction may occur where the rate of environmental fluctuation (heterogeneity) outweighs a population's ability to respond. Under these conditions, mortality may outweigh reproduction. Knowledge of the determinants of variation in howler RRS across habitats using the simple method presented in this note would permit a comparative viability analysis of populations as a function of environmental regime. Such an understanding would permit an assessment of a species' adaptation across ecological conditions emphasizing responses to habitat fragmentation, patchiness, or heterogeneity. Differential quantification of RRS across populations and microclimates could yield a robust level of prediction for estimating population viability and for generating workable conservation plans. This approach underlines the importance of careful censuses comparing source areas with disturbed and fragmented areas.

Acknowledgments

I thank E. Tobach, A. Harcourt, and M. Kalinichev for constructively criticizing an earlier draft of this manuscript. S. Vehrencamp provided stimulating discussion of relative reproductive success. This work was supported by The National Fellowships Fund.

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The Muriqui in the Parque Estadual de Ibitipoca, Minas Gerais

The report of Martuscelli *et al.* (1994) recording 14 new localities for muriquis, *Brachyteles arachnoides*, inspired further efforts to locate additional areas where this endangered primate survives (Antonietto and Mendes, 1994; Câmara, 1995). Hirsch *et al.* (1994) recently surveyed the Parque Estadual de Ibitipoca, state of Minas Gerais, and recorded only three primate species: *Callicebus personatus, Alouatta fusca* and *Callithrix penicillata*. Although they did not observe capuchin monkeys, *Cebus apella*, this species had been recorded for the park previously (Drumond, 1987). Here we report on the occurrence in the park of the muriqui *Brachyteles arachnoides*, and provide further observations on the capuchin monkeys.

The Ibitipoca State Park (1,488 ha) is located in the Serra do Ibitipoca, municipality of Lima Duarte, Minas Gerais (21° 42'S; 43° 53'W) (Fig. 1). The park is comprised mainly of moorland vegetation (*campos de altitude*) and riverine forests. The forested area of the park can be classified as cloud forest, and the most common plant families are Rubiaceae, Lauraceae, and Myrtaceae (M. A. L. Fontes, unpubl. data). All the primates we observed in this study were in an 80 ha forest fragment in the center of the Park.

Brachyteles arachnoides: On 17 May 1995, at 1000 h, a female muriqui was observed on a forested slope at 1500 m altitude. It was apparently traveling with a group of three howler monkeys, *Alouatta fusca*. On 13 July 1995, at 1600 h, the same *Alouatta* group was found close to where it was first seen. The female muriqui was observed again. The group was composed of 6 to 8 howlers and the one muriqui. On 16 October 1995, a female muriqui was observed again in the same area. However, it was alone and we believe it was another individual judging by the marks on the face. Both muriquis were pink-faced, confirming the subspecies *B. a. hypoxanthus*. In addition, two tourists we interviewed confirmed the existence of "large white monkeys", which were possibly muriquis, inside the Park as well as in neighboring forest outside the area of the Park.