

**BEHAVIOR PATTERNS OF A GROUP OF BLACK HOWLER MONKEYS
ALOUATTA CARAYA (HUMBOLDT, 1812) IN A FOREST FRAGMENT IN
TERENOS, MATO GROSSO DO SUL: A SEASONAL ANALYSIS**

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Abstract. The behavior of the members of a group of black-and-gold howlers (*Alouatta caraya*) was monitored in Terenos (Mato Grosso do Sul) over a 15-month period. The group was composed of an adult pair and 4 immature individuals. Quantitative data were collected in 5-minute scan samples, with a 15 interval. The general activity budget (n = 3282 records) was 50.85% rest, 29.89% movement, 14.69% feeding, 4.33% social behavior, and 0.24% others. Time spent at rest was relatively reduced by the standards of the genus, whereas movement was more as accentuated. The diet was composed primarily of leaves, 47.92% (n = 482 records) and fruit (35.48%), supplemented by flowers (12.86%) and shoots (3.74%). The consumption of reproductive plant parts was relatively prominent by the standards of the more southerly populations of the species. While group members rested significantly more during the wet season, they fed less. Leaves were a staple of the group's diet throughout the study, making up 40.37-62.92% in a given season. The ingestion of flowers was most frequent during Dry Season 1 (20.45%), and of fruit, during Dry Season 2 (48.53%). A considerable difference in the behavior patterns of adults and immatures was also identified, in which adults rested significantly more, but dedicated less time to all other categories. Given this, it seems likely that the general activity budget was influenced by group composition, which was dominated by immature members, an atypical pattern for the genus. While this is a preliminary study, its results indicate behavior patterns and diet typical of the genus *Alouatta*, albeit marginal for the species. The contrasts may be related primarily to the more northerly geographic location of the study area, and concomitant ecological differences. There is a clear need for further research on *A. caraya* in the Bororo region, not only for a more systematic evaluation of ecological patterns, but also to contribute to the development of conservation strategies.

Key words: activity budget, diet, *Alouatta caraya*, methodology, Cerrado, Pantanal.

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Resumo. O comportamento dos membros de um grupo de bugios-pretos (*Alouatta caraya*), foi monitorado em Terrenos (MS) ao longo de 15 meses. O grupo era composto por um casal de adultos e 4 imaturos. Dados quantitativos foram coletados em varreduras de 5 minutos, com intervalo de 15 minutos. O orçamento geral de atividades (n = 3.282 registros) foi de 50,85% descanso, 29,89% deslocamento, 14,69% alimentação, 4,33% comportamento social e 0,24% outros. O nível de descanso foi relativamente baixo pelos padrões do gênero, e o deslocamento alto. A dieta foi composta principalmente por folhas, 47,92% (n = 482 registros) e frutos (35,48%), completada por flores (12,86%) e brotos (3,74%). O consumo de partes reprodutivas de plantas foi relativamente alto pelos padrões das populações mais meridionais da espécie. Enquanto os membros do grupo descansaram significativamente mais na estação chuvosa, se alimentaram menos. A dieta foi marcada pelo consumo de folhas ao longo de todo o estudo, com 40.37-62,92% dos registros em uma dada estação. A ingestão de flores foi maior na estação Seca 1 (20.45%) e o de frutos na Seca 2 (48.53%). Foi registrada também uma diferença considerável no padrão comportamental de adultos e imaturos, onde os primeiros descansaram significativamente mais, mas gastaram menos tempo nas demais categorias. Frente a esta situação, parece provável que o orçamento geral sofreu a influência da composição do grupo, onde predominou os membros imaturos, padrão atípico no gênero. Apesar de constituir um trabalho ainda preliminar, os resultados indicam padrões de comportamento e dieta típicos do gênero *Alouatta*, embora marginais para a espécie. Os contrastes podem ser relacionados principalmente à localização geográfica mais setentrional da área de estudo, e diferenças ecológicas concomitantes. É clara a necessidade de dar continuidade aos estudos de *A. caraya* na região Bororo, não somente para uma avaliação mais sistemática de seus padrões ecológicos, como também contribuir para o desenvolvimento de estratégias de conservação.

Palavras-chave: orçamento de atividades, dieta, *Alouatta caraya*, metodologia, Cerrado, Pantanal.

INTRODUCTION

Activity budgets provide an indirect measure of the strategies primates follow to balance their energy requirements (Altmann, 1980; Strier, 1987). Energetic demands vary considerably, not only between species, but also among populations of the same species, due to a range of factors, including body size, group size, and differences among age-sex classes (Clutton-Brock & Harvey, 1977).

The howlers (*Alouatta* spp.) are among the largest-bodied platyrrhines, and have the most ample geographic distribution (Neville *et al.*, 1988). The black howler, *Alouatta caraya* (Humboldt, 1812), is found primarily in Brazil, in the Cerrado and Pantanal (Santini, 1985; Hirsch *et al.*, 2002), and neighboring areas of Bolivia, Paraguay, and Argentina. One of the most prominent characteristics of the species is its sexual dichromatism, in which adult males are completely black, and females and juveniles are yellow.

The behavior of the howlers is relatively well understood (Crockett & Eisenberg, 1987; Zunino *et al.*, 1996; Bicca-Marques, 2003; Di Fiore & Campbell, 2007), and is

characterized primarily by polygyny, low activity rates, and high levels of folivory in the majority of populations. *Alouatta caraya* follows this general pattern, although few ecological data are available for the species, and most of these are from studies in the extreme south of the species' distribution (Santini, 1985; Rumiz *et al.*, 1986; Rumiz, 1990; Bicca-Marques, 1991; Agoramoorthy & Lohmann, 1999; Bravo & Sallenave, 2003). Until the present study, no ecological data were available from the contact zone of the Cerrado and Pantanal biomes, known as the Bororo region (Coimbra-Filho, 1982).

While *A. caraya* is not under any immediate risk of extinction, populations are shrinking almost everywhere under the ongoing advance of agricultural frontiers, and the widespread clearance and fragmentation of habitats. In addition to the evaluation of the basic behavioral and ecological patterns of the species in the Bororo of Mato Grosso do Sul, then, the present study also aimed to provide a data base for the planning of conservation and management initiatives for the species and its habitats in this region.

METHODS

Study site and group

The study site is located in a private forest reserve (RPPN) formed by two ranches, Nova Esperança and Nova Querência, owned by Dr. Fernando Barcellos, in the municipality of Terenos (20°43'S, 54°55'W), 48 km northwest of Campo Grande, the state capital of Mato Grosso do Sul. The reserve covers an area of 6267 hectares, mainly of gallery forest, characterized by elements of both the Atlantic and Amazonian forest biomes.

The *Alouatta caraya* study group had six members – an adult male, an adult female with dependent infant, a subadult male, an adolescent female, and a juvenile male. The group was selected after a preliminary survey of the study area.

Data collection

The study group was monitored between May, 2002, and July, 2003. Quantitative behavioral data were collected in scan samples (Martin & Bateson, 1993). Considering the importance of standardizing procedures in order to minimize sampling problems (Ferrari & Rylands, 1994), the sampling schedule used in previous studies of the species (Santini, 1985; Bicca-Marques, 1991; Bravo & Sallenave, 2003) was used here. It consists of a five-minute scan at 15-minute intervals.

Scans were conducted continuously throughout the daily activity period. For each scan, the time and location of the group was recorded, and for each individual, its identity and activity at the moment of sighting, and other relevant information, such as the type of food ingested. Behavior categories were based on previous studies of howlers (Glander, 1980; Milton, 1980; Mendes, 1985; Bicca-Marques, 1991). Four main categories were used: (a) Feed – manipulation and ingestion of food items; (b) Rest – subject inactive, not engaged in any other behavior; (c) Move – subject moving directionally, not engaged in any other behavior; (d) Social behavior – physical or vocal interaction between two or more individuals. A fifth category (Other) was added to cover infrequent behaviors, basically solitary play, not covered by the others.

Samples were collected on five consecutive days each month, and a total of 3282 individual records were collected in 916 scans. Activity budgets were based on the proportions of records of each behavior category during the period under analysis. The general budget refers to the study period as a whole, whereas partial budgets were collected for three distinct seasons: Dry Season 1 (May through September, 2002), Wet Season (October, 2002, through March, 2003), and Dry Season 2 (May through July, 2003). Pairwise differences between seasons were analyzed using binomial z scores (see Pina, 1999), considering a significance level of $p < 0.01$, in order to avoid “false positive” results (Martin & Bateson, 1993). Activity budgets were also calculated separately for adult and immature group members, for the evaluation of possible differences in behavior patterns related to the age of the subject.

The composition of the diet was estimated in the same way, by dividing the number of records of each item by the total number of feeding records collected during the period in question. Unfortunately, the reduced number of feeding records collected, principally during dry season months, precluded a reliable analysis of seasonal differences.

RESULTS

The general activity budget of the study group (Table 1) was typical of the genus, with a predominance of rest, and low levels of social interaction. The budget is nevertheless quite distinct in terms of the time spent moving, the highest value yet recorded for a species of this genus (Di Fiore & Campbell, 2007). In most cases, howlers dedicate less than 10% of their time to locomotion, and rarely more than 20%, although Williams-Guillén (2003) recorded a value similar to that of the present study (27,4%) for *Alouatta*

palliata. In *A. caraya*, Zunino (1986) recorded a value of only 2.4%, whereas that of Bicca-Marques (1991) was 17.1%.

The group's diet was dominated by vegetable matter, in particular leaves (Figure 2), a pattern typical of the genus *Alouatta* (Di Fiore & Campbell, 2007). However, leaves constituted a relatively small proportion of the diet in comparison with most other studies of howlers, including *A. caraya* (Bicca-Marques, 1991; Bravo & Sallenave, 2003). By contrast, both fruit and flowers were relatively important. While superior to the values recorded in other studies of *A. caraya*, frugivory levels in the present study were similar to those of some howler populations, in particular those of *Alouatta belzebul* (Bonvicino, 1989; Pina, 1999; Pinto, 2002).

The same general pattern, in terms of the order of importance of the different categories, was recorded in all three seasons (Figure 3). However, while rates of movement were stable, group members spent significantly more time at rest, and significantly less feeding in the wet season (Table 1). Social behavior was also slightly more frequent during the wet season, as might be expected from the increase in time spent at rest.

Leaves were a staple throughout the study period (Figure 4), varying between 40.37% and 62.92% in a given season, although it was replaced as the major item by fruit (48.53%) in Dry Season 2. The increased consumption of leaves during the wet season is unusual, given that this period is characterized by a relative abundance of fruit at most sites, although, as an average of only 32.1 feeding records were collected per month, the analysis of seasonal patterns should probably be approached with caution. In fact, the marked increase in frugivory recorded during Dry Season 2 was due entirely to the exploitation of the fruit of a large *Ficus enormis*, in which the group "camped out" for long periods. This same resource was also used by capuchins (*Cebus cay*) and coatis (*Nasua nasua*), which were even observed feeding in the same crown as the howlers on two occasions.

Considerable differences were also recorded between adult and immature study group members (Figure 5). Whereas the adults spent almost a third more of their time at rest than immatures, these individuals devoted more time to all other categories (solitary play was only observed in this class). With the exception of feeding, which was only slightly below the critical score (2.57), the differences between age classes were significant at the $p = 0.01$ level (Table 2). While this analysis is relatively simplistic, it does indicate that the general activity budget (Figure 1) may have been influenced significantly by the composition of the study group, in which immature members predominate (66.7% of the total).

DISCUSSION

The general behavior pattern recorded in the *A. caraya* study group was broadly similar to those observed in previous studies of howlers (Table 3), in which rest invariably predominates. While the values recorded for both rest and locomotion are lower and upper outliers, respectively, for the genus, it is important to remember the wide range of methodological factors that may influence any direct comparison among studies (see Ferrari & Rylands, 1994). In the present case, in addition to other potential variables, the relatively large proportion of immature group members may have had an important influence on the general results. In fact, if the adults only are considered (Figure 5), the activity budget would be much more similar to those recorded by Bicca-Marques (1991) and Bravo & Sallenave (2003), for example.

Obviously, the comparative analysis of age classes presented here was tentative and preliminary considering, among other questions, the marked difference between males and females in this species, as well as the heterogeneity of the immature class. Nevertheless, this analysis indicates clearly that a more systematic approach is needed for the comparative analysis of different studies, one which should include the standardization of sampling procedures, the age-sex composition of study groups, and the study period, all of which may influence recorded values considerably. In *Alouatta*, there is often as much variation within species as there is between species (Table 3). In addition to possible methodological questions, this may reflect the influence of local, population-level, or even individual factors, making the reliable identification of interspecific patterns almost impossible.

A similar overall pattern can be seen in the case of diet, where folivory predominates in most, but not all species (Table 4). It seems possible that methodological factors may be less important here, and in fact, there seems to be much less intraspecific variation. Overall, folivory appears to be more accentuated in populations at higher latitudes, especially those of *A. guariba* and *A. caraya*, in comparison with species located closer to the equator, such as *A. belzebul* and *A. seniculus*.

This may reflect both greater productivity levels and, principally, the less pronounced seasonality of more equatorial ecosystems. The reduced folivory and greater consumption of reproductive plant parts recorded in the present study group in comparison with other populations of *A. caraya*, located in the extreme south of Brazil and northern Argentina, would be consistent with this hypothesis, at the intraspecific level. Reduced resting would also be consistent with a more frugivorous diet (McNab, 1978, 1980), as observed in other atelids, in particular *Ateles* (Di Fiore & Campbell, 2007), although any such

interpretation demands a degree of caution, considering the methodological considerations outlined above.

Despite certain limitations, then, the results of the present study revealed activity patterns and feeding behavior typical of the genus *Alouatta*, while also pointing to possible intra- and interspecific differences that demand further, more systematic investigation. Obviously, there is a clear need for additional, complementary studies of *A. caraya* in the Bororo region, not only to provide further insights into ecological patterns, but also to contribute to the development of conservation strategies for the species and its habitats.

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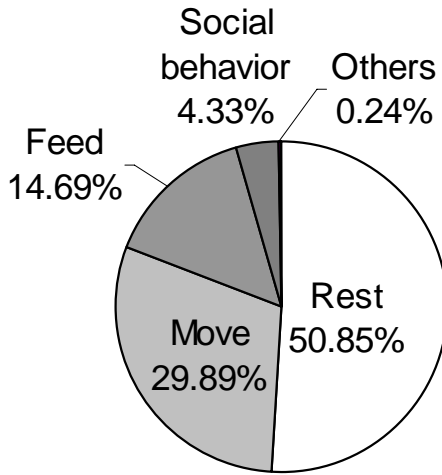


Figure 1. General activity budget of the members of the *Alouatta caraya* study group at Terenos, Mato Grosso do Sul (n = 3282 records).

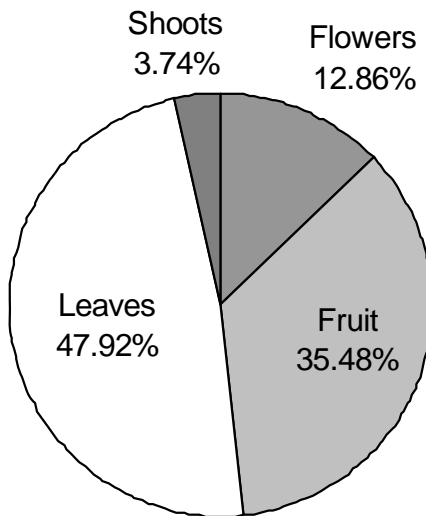


Figure 2. Composition of the diet of the *A. caraya* study group (n = 482 records).

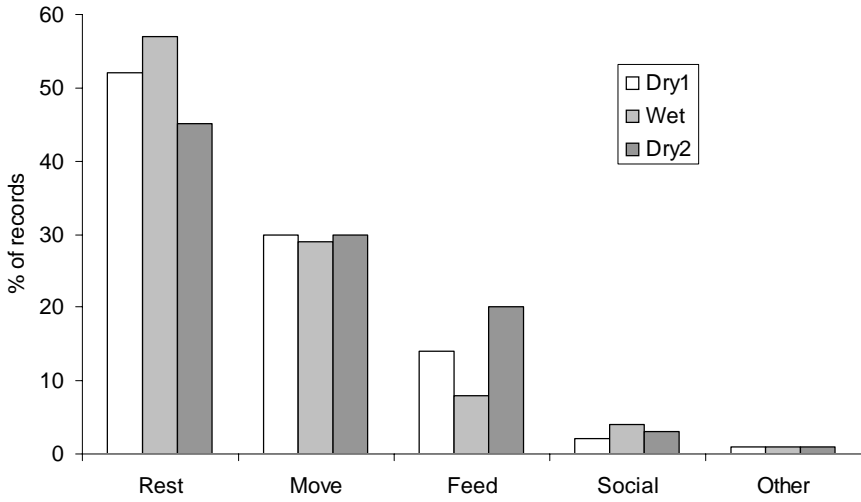


Figure 3. Seasonal variation in the activity budget of the *A. caraya* study group.

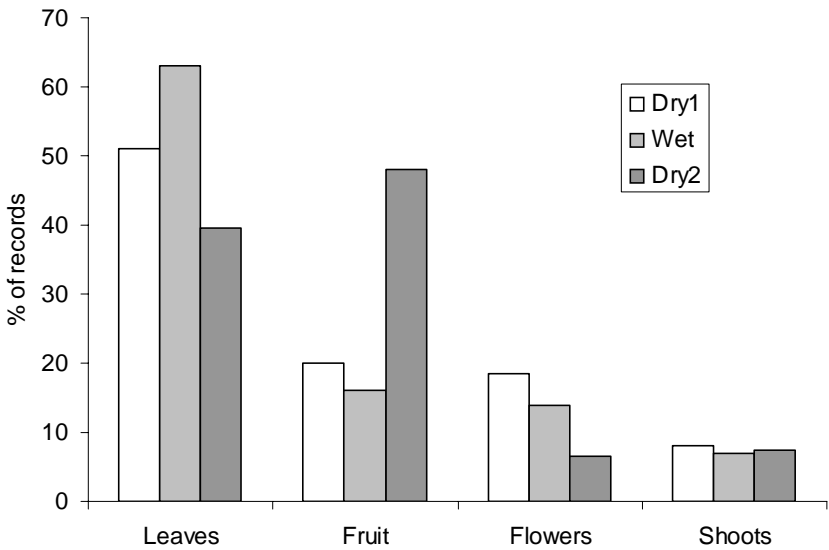


Figure 4. Seasonal variation in the composition of the diet of the *A. caraya* study group.

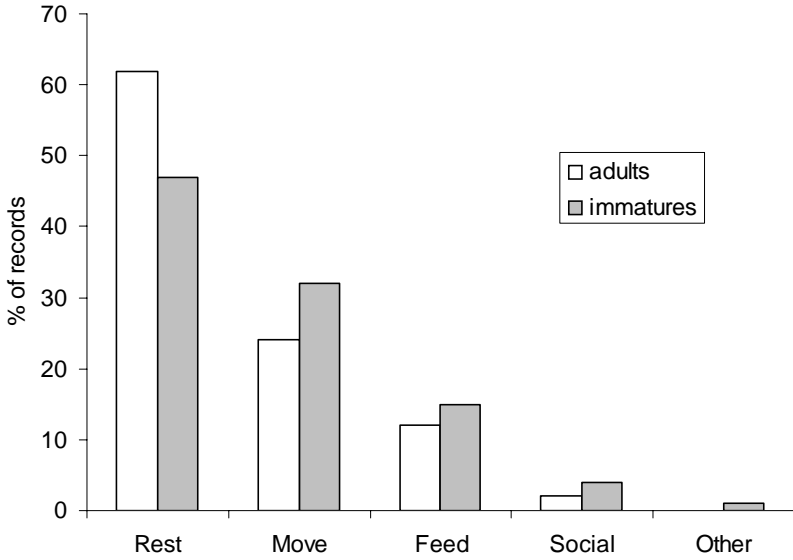


Figure 5. Comparison of the activity budgets of adult and immature *A. caraya* group members.

Table 1. Binomial *z* scores for comparisons between seasons (Figure 4). Significant values are in bold type.

Seasons compared	Binomial <i>z</i> score (<i>p</i>) for:		
	Rest	Move	Feed
Dry 1 vs. Wet	-1.33 (>0.05)	0.01 (>0.05)	3.88 (<0.01)
Dry 2 vs. Wet	-4.49 (<0.01)	0.68 (>0.05)	7.85 (<0.01)
Dry 1 vs. Dry 2	2.54 (<0.01)	-0.60 (>0.05)	-3.11 (<0.01)

Table 2. Binomial *z* scores for the comparison of adult and immature *A. caraya* (see Figure 4).

Category	<i>z</i>	<i>p</i>
Rest	5.48	<0.01
Move	-3.75	<0.01
Feed	-2.37	0.18
Social behavior	-4.43	<0.01

Table 3. General activity budget in *A. caraya* and other howler species.

Species	Behavior (% of records):			Source
	Rest	Feed	Move	
<i>A. caraya</i>	50.9	14.7	29.9	This study
	77.4	15.2	2.4	Zunino (1986)
	63.0	14.9	17.1	Bicca-Marques (1991)
	57.0	19.0	16.0	Bravo & Sallenave (2003)
<i>A. belzebul</i>	55.9	7.5	19.3	Bonvicino (1989)
	58.7	13.7	23.1	Pina (1999)
	58.7	20.0	14.2	Pinto (2002)
<i>Alouatta guariba</i>	71.8	17.3	11.0	Mendes (1985)
	67.0	10.0	12.0	Martins (1997)
	57.6	19.0	18.8	Marques (1996)
<i>A. palliata</i>	63.7	18.7	13.2	Chiarello (1993)
	65.5	16.2	13.4	Milton (1980)
	79.7	17.3	2.2	Estrada <i>et al.</i> (1999)
	57.0	13.6	27.4	Williams-Guillén (2003)
<i>Alouatta pigra</i>	61.9	24.4	9.8	Silver <i>et al.</i> (1998)
<i>Alouatta seniculus</i>	78.5	12.7	6.2	Gaulin & Gaulin (1982)
	76.3	6.0	16.0	Queiroz (1995)

Tabela 4. Composition of the diet in *A. caraya* and other howler species.

Species	Item (% of feeding records):			Source
	Leaves	Fruit	Flowers	
<i>A. caraya</i>	47.9	35.5	12.9	This study
	74.2	23.6	2.2	Zunino (1986)
	60.9	28.9	2.7	Bicca-Marques (1991)
	68.0	19.0	12.0	Bravo & Sallenave (2003)
<i>A. belzebul</i>	13.3	59.0	27.6	Bonvicino (1989)
	61.5	31.8	0.3	Pina (1999)
	24.8	55.6	5.7	Pinto (2002)
<i>A. guariba</i>	76.0	15.6	8.4	Mendes (1985)
	76.0	19.0	3.0	Martins (1997)
	73.0	5.2	11.7	Chiarello (1993)
<i>A. palliata</i>	48.2	42.1	9.6	Milton (1980)
	54.4	40.6	0.7	Estrada <i>et al.</i> (1999)
	55.8	34.8	7.9	Williams-Guillén (2003)
<i>A. pigra</i>	45.1	40.8	10.6	Silver <i>et al.</i> (1998)
<i>A. seniculus</i>	52.1	42.3	5.4	Gaulin & Gaulin (1982)
	57.0	25.5	12.6	Julliot & Sabatier (1993)
	45.5	47.3	1.5	Queiroz (1995)