#### diet and activity patterns OF BLACK howler monkeys *Alouatta caraya* (HUMBOLDt, 1812, Primates, Atelidae) in ecotone Cerrado-PANTANAL IN THE LEFT BANK OF Aquidauana River, Mato Grosso do Sul, brazil

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**ABSTRACT**

The diet and activity patterns of a group of black-howler-monkeys (*Alouatta caraya*) were monitored on the left bank of the Aquidauana river over 11 months, from September 2008 to July 2009. The group was composed of eight individuals, two adult males, three females and three immature among subadults and infants. Quantitative data were collected using scan sampling method of 5 minutes with an interval of 15 minutes. The general activities budget (n = 6434 records) was 64,7% rest, 18,5% travel, 10,1% feeding, 3,2% for social behavior and 3,4% for miscellaneous behaviors. The level of rest was similar to patterns of genus (64,7%). The diet (n = 556 records) was composed mainly of leaves (72,8%) and flowers (14,8%) and supplemented by fruits (8,2%) and buds (4,0%). The consumption of reproductive parts of plants, especially flowers, was relatively high by the standards of southerly populations of the species. Members of the group rested significantly less than that feed during the rainy season. The diet was marked by the consumption of leaves throughout the study. The consumption was higher in the dry at flowers (17,8%) and fruits in the rainy season (12,9%). It also registered a considerable difference in the behavior of adults and immatures, where the first significantly more rested, but spent less time in other categories: food, travel and social interactions. Given this, it seems likely that the budget was under the influence of group composition, where there was a predominance of mature members, a typical pattern in the genus. The results indicate patterns of behavior and diet typical of the genus but marginal for the species. The contrasts can be related mainly to the geographic location of the ecotone Cerrado-Pantanal area of study, and concomitant ecological differences. There is a clear need to continue the studies of *A. caraya* in the Bororo region, not only for a more systematic assessment of their ecological patterns, but also contribute to the development of conservation strategies.

Key-words: black-howler-monkeys; animal biology; behavioural ecology. activity patterns

#### RESUMO

#### dieta e padrões de atividades de bugios-pretos (*Alouatta caraya,* HUMBOLDt, 1812, Primates, Atelidae) no ecótono cerrado-pantanal na margem esquerda do rio Aquidauana, Mato Grosso do Sul, Brasil

A dieta e o orçamento de atividades de um grupo de bugios-pretos (*Alouatta caraya)* foram monitorados na margem esquerda do rio Aquidauana ao longo de 11 meses, de setembro de 2008 a julho de 2009. O grupo era composto por oito indivíduos, dois machos adultos, três fêmeas adultas e três imaturos entre subadultos, jovens e filhotes. Dados quantitativos foram coletados em varreduras de 5 minutos, com intervalo de 15 minutos. O orçamento geral de atividades (n = 6434 registros) foi de 64,7% para o descanso, 18,5% para o deslocamento, 10,1% para alimentação, 3,2% para o comportamento social e 3,4 para comportamentos não mutuamente exclusivos. O nível de descanso foi similar aos padrões do gênero (64,7%). A dieta (n = 556 registros) foi composta, principalmente por folhas (72,8%) e flores (14,8%) e completada por frutos (8,2%) e brotos (4,0%). O consumo de partes reprodutivas de plantas, principalmente flores, foi relativamente alto para os padrões das populações mais meridionais da espécie. Os membros do grupo descansaram significativamente mais e se alimentaram menos na estação chuvosa. A dieta foi marcada pelo consumo de folhas ao longo do estudo. A ingestão de flores foi maior na estação seca (17,8%) e a de frutos na chuvosa (12,9%). 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: alimentação, deslocamento e interações sociais. Frente a esta situação, parece provável que o orçamento geral sofreu a influência da composição do grupo, onde predominaram os membros adultos, um padrão típico no gênero. Os resultados indicam padrões de comportamento e dieta típicos do gênero, embora marginais para a espécie. Os contrastes podem estar relacionados principalmente em relação à localização geográfica da área de estudo uma área de ecótono Cerrado-Pantanal 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: bugios-pretos; biologia animal; ecologia comportamental; padrões de atividades

**INTRODUCTION**

Patterns of daily activities or activity budget are indirect measures that seek to analyze how primates are and optimize their energy requirements (Altmann 1980, Strier 1987). Energy demands vary not only between species but also intra groups due to differences in the size of the gastro-intestinal tracts (Coelho *et al.* 1976, McNab 1978, 1980) group size and the different energy demands between themselves members of the group, reflections of the different states sex-age, the different reproductive states of females and sexual dimorphism (Clutton-Brock & Harvey 1977, Strier 1987, Aguiar *et. al.* 2009).

The genus *Alouatta* is composed of ten species with twenty subspecies (Gregorin 2006). The species are: *Alouatta caraya*, *Alouatta sara*, *Alouatta* *nigerrima*, *Alouatta belzebul*, *Alouatta* discolor, *Alouatta palliata*, *Alouatta coibensis*, *Alouatta guariba*, *Alouatta seniculus* and *Alouatta pigra* (Rylands *et al.* 1997, Gregorin 2006). In Brazil, we found five species: *A. seniculus* in the Amazon (Neville *et al.* 1988), *A. discolor* in the Mato Grosso (Pinto 2002, Pinto & Setz 2004), *A. belzebul* in the northeast Atlantic Forest and the Amazon (Pina 1999), *A. guariba* in the Atlantic Forest from Bahia to Rio Grande do Sul (Mendes 1985), and finally *Alouatta caraya* in the Cerrado and Pantanal regions (Santini 1985, Odalia-Rímoli *et al.* 2008) and the southern limits of their distribution (Bicca-Marques 1991, Miranda & Passos 2005, Miranda 2009, Aguiar 2010).

The howler monkeys (*Alouatta* spp.) are among the largest platyrrhines (Bonvicino *et al.* 2001) and have, together with *Cebus* spp., the widest geographical distribution (Neville *et al.* 1988). The black howler monkey, *A. caraya* (Humboldt 1812) is found mainly in Brazil, has a large geographic distribution, the largest of the genus, occurring throughout the Cerrado and Pantanal regions (Santini 1985, Odalia-Rímoli *et al.* 2008) and the southern limits of their distribution in Atlantic Forest (Bicca-Marques 1991, Aguiar *et al.* 2007, Passos *et al.* 2007, Miranda 2009, Aguiar 2010), and in adjacent areas of Bolivia, Paraguay and Argentina. One of the most outstanding features of the species is their sexual dichromatism, in which adult males are completely black and females and juveniles are yellowish.

The behavior of howler monkeys is relatively well understood (Crockett & Eisenberg 1987, Zunino 1986, 1987, Bicca-Marques 2003, Di Fiore & Campbell 2007). The social organization and behavior of the genus *Alouatta* can be characterized mainly by polygyny, low activity rates and high levels of folivory in most populations (Bicca-Marques 2003, Miranda & Passos 2004, Ludwig *et al*. 2008). *Alouatta caraya* follows this general pattern, although some ecological data available for the species, most of which were obtained from studies in the extreme south of the species geographical distribution (Santini 1985, Rumiz *et al*. 1986, Rumiz 1990, Bicca-Marques 1991; Agoramoorthy & Lohmann 1999, Bravo & Sallenave 2003). Until the present study, only two (Nantes & Rímoli 2008, Odalia-Rímoli *et al.* 2008) was available and provided ecological data of the contact zone of the Cerrado and Pantanal biomes, the region known as Bororo (Coimbra-Filho 1982), and one in Atlantic Forest/Cerrado contact zone (Ludwig 2006).

For purposes of the contribution to the knowledge of the species the main objective was to study the diet and activity patterns of *A. caraya* in wet landscape at Cerrado-Pantanal ecotone. Although *A. caraya* is not endangered, the populations are declining throughout most of their range due to the continuous expansion of farming and fragmentation of natural habitats. In addition to evaluating the ecological and behavioral patterns of the species in the Bororo region on the left bank of the Aquidauana river, Mato Grosso do Sul, Brazil, this study also aimed to provide a database for planning conservation initiatives and management for the species and their habitats in this region.

**METHODS**

*Study Area*

The survey was conducted in an urban fragment of Cerrado-Pantanal located on the left bank of the Aquidauana river, municipallity of Anastacio, Mato Grosso do Sul, Brazil (20°29’01’’S, 55°47’88’’W), in the period of September 2008 to July 2009. The area is located next to Unit I of the Federal University of Mato Grosso do Sul (UFMS). Its space was established a stronghold of vegetation subject to flooding (months from January to March), reflecting variations in the water regime of the Aquidauana river. Its vegetation, characteristic of the Cerrado-Pantanal ecotone, is formed by riparian forest distributed over an area exceeding 40 hectares. For temperature and rainfall information were used data from the weather station of EMBRAPA (Embrapa 2010).

*Study Group*

During the months of July and August 2008 the riparian forests along the Aquidauana river was explored intensively looking for groups of monkeys, after this period, one group was found and followed in the left bank. The selected group was already habituated, result of intense human activity in the area with strong anthropogenic pressure.

At the beginning of the study in September 2008, the group consisted of eight animals: two adult males, three adult females, and three subadults of different ages. In April 2009, with a birth and an emigration of one adult male the group composition remained with eight individuals. Table 1, presents the sex-age ratio of the group studied.

**Table 1.** Composition of the black howlers monkeys group (*Alouatta caraya*) on the left bank of the River Aquidauana throughout the study period (2008/2009). Include immature infants (<1 year), juveniles 1 and 2 (J1 = 1-2 years, J2 = 2-3 years) and subadults (3-4 years) and adults (> 4 years).

|  |  |  |
| --- | --- | --- |
| **Classes** | **2008** | **2009** |
| Adult Males | 2 | 1 |
| Adult Females | 3 | 3 |
| Subadults Males | 0 | 0 |
| Subadult Females | 1 | 1 |
| Juveniles Males | 0 | 0 |
| Juveniles Females | 0 | 1 |
| Infants Males | 1 | 2 |
| Infants Females | 1 | 0 |
| **Total** | **8** | **8** |

\*Note:In April 2009,occurredthe birth of one infant and the emigration ofoneadult male.

*ACTIVITIES BUGETS*

The activity patterns were investigated during eleven consecutive months of field work, from September 2008 to July 2009. During this period the animals were observed in 11 monthly sessions, generating 1723 scans of 5 minutes each, totaling 6434 records.

*Data collection*

The basic patterns of daily activities of members of group were registered by instantaneous scan-sampling (Altmann 1974, Martin & Bateson 1993). The method is suitable for the collection of reliable quantitative data on the social behavior of arboreal primates, which have a number of issues of visibility and observational bias (Ferrari & Rylands 1994). We used a sampling scheme for 5 minutes with an interval of 15 minutes between scans, similar to other studies with *A. caraya* (Santini 1985, Bicca-Marques 1991, Odalia-Rímoli *et al.* 2008, Nantes & Rímoli 2008).

Scans were performed continuously throughout the period of daily activity in the study group, from dawn to dusk during the sample period of five consecutive days per month. In each scan we recorded: (a) the time and location of the group relative to the tracks, and, for each member visible during scanning were recorded: (b) identity, (c) behavior (second pre-defined ethogram), (d) posture (sitting, lying down, grabbed, suspended by the tail and limbs), (e) neighbors observed within a 10m radius, (f) distance (s) between observed and the animal (s) other (s) member (s) of the group (g) height above the ground according to the categories (soil, ≤5m, 6-10m; 11-20m; ≥20m), (h) animal-observer distance, (i) other information deemed relevant.

The behavioral categories were considered: feeding, when the animal was observed biting, chewing and ingesting any item such as new leaves, mature leaves, fruits and seeds, buds and flowers; rest: when the animal was still observed (inactive), and when lying down or sitting asleep; travel: when the animal were observed moving over great distances or even short paths in the same tree or between trees and socialization: when the animal was observed engaged in social interactions with other(s) individual(s).

For the analysis of the general activities budgets all months of observation were utilized (see Table 1). However within the context surrounding the general pattern of activities of the study group, a seasonal analysis was based in rainy and dry period. The dry season was characterized by less rainfall and lower temperatures and the rainy season is the opposite table (Embrapa 2010). Thus, for this analysis, data were grouped seasonally, except for September 2008, rainy season (between October 2008 to March 2009) and dry season (April to July 2009). The differences between the seasons were analyzed using the binomial z test (Pina 1999), whereas the significance level of α=0.05 (Martin & Bateson 1993). The behaviors were calculated for the group as a whole and separately for the group members, adults and immature, to evaluate possible differences in the pattern of behavior related to the subject's age. Diet composition was calculated similarly, dividing the number of records of each item by the total number of feeding records collected during the study period.

**RESULTS**

The general activity budget for behaviors of the study group (Table 2) was typical of the genus with a predominance of rest periods and low levels of social interaction. The budget is, however, very different in terms of time spent in motion (18,5%), the value is almost half of that obtained for *A. caraya* (29,9%) living in gallery forests in Terenos (MS) (Odalia-Rímoli *et al*. 2008), the highest value recorded for a species of the genus (Di Fiore & Campbell 2007), and inferior to the other group *A. caraya* (25,4%) studied in central part of Aquidauana (MS) town between 2007 and 2008.

**Table 2.** Activities budgets observed for some species of the genus *Alouatta* (% of records).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Species** | **Rest** | **Feed** | **Travel** | **Source** |
| ***A. caraya*** | 64,7 | 10,1 | 18,5 | **This study** |
|  | 48,3 | 24,1 | 25,4 | Nantes & Rímoli (2008) |
|  | 50,9 | 14,7 | 29,9 | Odalia-Rímoli *et al.* (2008) |
|  | 56,5 | 14,9 | 23,4 | Prates & Bicca-Marques (2008) |
|  | 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) |
| ***A. belzebul*** | 58,7 | 13,7 | 23,1 | Pina (1999) |
|  | 55,9 | 7,5 | 19,3 | Bonvicino (1989) |
| ***A. discolor*** | 58,7 | 20,0 | 14,2 | Pinto (2002)1 |
| ***A. guariba*** | 56,0 | 12,0 | 24,0 | Kock & Bicca-Marques (2007) |
|  | 71,8 | 17,3 | 11,0 | Mendes (1985) |
|  | 67,0 | 10,0 | 12,0 | Martins (1997) |
|  | 57,6 | 19,0 | 18,8 | Marques (1996) |
|  | 63,7 | 18,7 | 13,2 | Chiarello (1993) |
| ***A. palliata*** | 65,5 | 16,2 | 13,4 | Milton (1980) |
|  | 79,7 | 17,3 | 2,2 | Estrada *et al.* (1999) |
|  | 57,0 | 13,6 | 27,4 | Williams-Guillén (2003) |
| ***A. pigra*** | 61,9 | 24,4 | 9,8 | Silver *et al.* (1998) |
| ***A. seniculus*** | 78,5 | 12,7 | 6,2 | Gaulin & Gaulin (1982) |
|  | 76,3 | 6,0 | 16,0 | Queiroz (1995) |

**1Sensu Gregorin (2006)**

Figure 1 shows the behavior of the study group by comparing the seasons. The general pattern of behavior in terms of different categories was recorded in dry and rainy seasons.

**Figure 1.** Comparison of behavioral patterns in dry and rainy seasons to *Alouatta caraya* study group (n = 1885, dry season; n = 3549, rainy season) in the left bank of Aquidauana river.

The analysis presents the results of principal activities correlated with the seasons. While the indices obtained for social behavior (z = 0,04, p> 0,05, n = 201) were stable, the members of the group spent significantly more time resting in the rainy season (z = - 2,29, p <0,05, n = 3605), and both, the feeding behavior (z = 2,23, p <0,05, n = 556) and the travelling over de home range (z = 2,57, p <0,05, n = 1072) were higher during the dry season.

The overall diet of the study group was similar to other species of genus, there was a predominance of leaves (72,8%), but fruit (8,2%) and especially flowers and plant material (stems and petioles and budding leaves and flowers) were well representative, with 14,9% and 4,0% respectively (Figure 2).

**Figure 2**. Diet for different feeding resources of *Alouatta caraya* (n = 556) in left bank of Aquidauana river.

The general diet for three different feeding items of the study group, leaves, fruits and flowers is presented in Table 3 which are also showed the comparison between the use of this different items for species of the *Alouatta* spp.The feeding items, and the diet, were typical of the genus with a predominance of leaves, but another items that fruits and flowers were consumed in significant proportions.

**Table 3.** Comparison that principal feed items in the diet from *Alouatta caraya* (% of feeding records) and other howler species.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Species** | **Leaves** | **Fruits** | **Flowers** | **Source** |
| ***A. caraya*** | 72,8 | 8,2 | 14,9 | **this study** |
|  | 78,3 | 6,8 | 14,8 | Nantes & Rímoli (2008) |
|  | 47,5 | 35,5 | 12,9 | Odalia-Rímoli *et al.* (2008) |
|  | 82,4 | 12,3 | 2,7 | Prates & Bicca-Marques (2008) |
|  | 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) |
|  | 65,0 | 24,0 | 10,0 | Ludwig *et. al.* (2008)1 |
|  | 49,0 | 46,0 | 5,0 | Ludwig *et. al* (2008)2 |
| ***A. belzebul*** | 13,3 | 59,0 | 27,6 | Bonvicino (1989) |
|  | 61,5 | 31,8 | 0,3 | Pina (1999) |
| ***A. discolor***3 | 24,8 | 55,6 | 5,7 | Pinto (2002) |
| ***A. guariba*** | 66,0 | 19,0 | 4,0 | Kock & Bicca-Marques (2007) |
|  | 76,0 | 15,6 | 8,4 | Mendes (1985) |
|  | 76,0 | 19,0 | 3,0 | Martins (1997) |
|  | 73,0 | 5,2 | 11,7 | Chiarello (1993) |
|  | 50,3 | 47,9 | 1,4 | Aguiar *et al.* (2003) |
|  | 57,0 | 41,0 | 1,7 | Miranda & Passos (2004) |
| ***A. palliata*** | 48,2 | 42,1 | 9,6 | Milton (1980) |
|  | 54,4 | 40,6 | 0,7 | Estrada *et al.* (1999) |
|  | 55,8 | 34,8 | 7,9 | Williams-Guillén (2003) |
| ***A. pigra*** | 45,1 | 40,8 | 10,6 | Silver *et al.* (1998) |
| ***A. seniculus*** | 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) |

**1,2Ludwig *et. al.* 2008, (1) island group and (2) mainland group, both in upper Paraná River; 3sensu Gregorin (2006).**

The leaves were used throughout that study period (Figure 3), varying little between the rainy season 77,0% and 75.5% in dry season, although this item has been replaced by the flowers (17,8%) in dry season.

**Figure 3.** Comparison of the diet of *Alouatta caraya* between dry and rainy seasons.

The analysis of the seasonal pattern in the diet, increased consumption of the fruits (12,9%) and new leaves in the rainy season (46,2%). Howlers consumed more fruits in rainy season and flowers in dry season (z = 4,10, p <0,05). The sharp increase in frugivory recorded during the season was entirely due to the consumption of genipaps (*Genipa americana*) and the fruits of a large fig (*Ficus enormis*), in which the group ‘camping out’ for long periods in this species. The frugivory was marked during the rainy season (12,9%) when compared to dry (3,7%) (z = -4,45, p <0,05). There were also significant differences between adult group members and immature (Figure 4). Considering that adults spend more of their time resting in shifts (78.79%) than immatures (59,3%), these in turn, devoted more time to all other categories (solitary play were only observed in this age group).

**Figure 4.** Comparison between adults and immatures in relation to the activity budget, of the black howler monkeys study group, in left bank of Aquidauana river.

The differences between age groups were significant at p = 0,05. Although this analysis is relatively simple, it does not indicate that the general activity budgets (Figure 1) may have been influenced significantly by the composition of the study group, which dominates mature members (62,5% of total). The comparison between adults and immatures for the general categories of behavior showed significant differences. With a tendency for adults; in relation to the activities budget categories, presented significantly differences for rest (z=8,9, p<0,05), travel (z=8,6, p<0,05) and feed (z=5,41, p<0,05). However, the immatures were more active in social activities such as play behavior and affiliative interactions such as grooming (z=-9,61, p<0,05).

**DISCUSSION**

The Aquidauana river monkeys spent 64,7% of their time inactive, 10,1% feeding, 18,5% traveling, 3,2% in social activities, and 3,4% involved in other miscellaneous behaviors. The study group is a typical primate group of howler monkeys, showing high levels of inactivity, normally associated with a highly folivorous diet. For the activity pattern of the studied group of black howler monkeys, the behavioral category “resting” was more frequently observed. In this context, some authors confirm the rest as a useful strategy for sparing energy for the genus *Alouatta*. For *A. caraya* at other southern sites (Zunino 1986, Bicca-Marques 1991) and Cerrado-Pantanal sites in the similar region of the study group (Nantes & Rímoli 2008) or other areas of Atlantic Forest (Odalia-Rímoli *et al*. 2008, Ludwig 2006, Ludwig *et al.* 2008) confirm this strategy.

In most cases, the howlers, *Alouatta* spp. spend less than 10% of their time traveling, and rarely more than 20%, although Williams-Guillén (2003) reported a value too high (27,4%) for *Alouatta palliata*. However, the time budget is very different in terms of time spent in motion (18,5%), the value is almost half of that obtained for *A. caraya* (29,9%) living in gallery forests in Terenos (MS) (Odalia-Rímoli *et al*. 2008), the highest value recorded for a species of the genus (Di Fiore & Campbell 2007), and inferior to the others groups *A. caraya* (25,4%) studied in central part of Aquidauana (MS) (Nantes & Rímoli 2008) and in Alegrete (RS) with 23,4% of their time traveling (Prates & Bicca-Marques 2008). In southern geographic distribution of *A. caraya*, Zunino (1986) showed a value of only 2,4% while Bicca-Marques (1991) registered 17,1%.

The rest tends to be higher in the middle of the day, in periods where temperatures are relatively higher in warmer seasons (rainy season) and during longer periods where temperatures are low, the colder seasons (dry season). The high rates of rest for *Alouatta* species, may be related to a strategy for minimizing energy expenditure, considering the standard folivory in the diet of these animals, i.e., high rates of inactivity seem to be a compensation (trade-off) for feeding behavior based on poor resources (Milton 1980, Neville *et al.* 1988, Bicca-Marques 1993, 2003).

Thus, the behavioral pattern observed in the study group, was very similar to those observed in previous studies with other species of the genus (Table 2), in which invariably the predominant periods of inactivity or rest. Although the values for rest, feed and travel were similar, respectively, for the genus, it is important to remember the wide range of methodological factors that can influence any direct comparison between studies (Ferrari & Rylands 1994).

In the present case, in addition to other potential variables, such as habitat type, floristic composition and biome, the age-sex class composition of mature group members may have had an important influence on the general results. In fact, the activity budget was much more similar to those recorded for *A. caraya* by Zunino (1986), Bicca-Marques (1991) and Bravo & Sallenave (2003). For *A. caraya* in Upper Paraná River, for example, a combination of environmental, social, phylogenetic and ecological factors may all influence group size and composition (Ludwig *et al*. 2008, Aguiar *et. al.* 2009). Obviously, the comparative analysis of age classes presented here was tentative considering, among other questions, the marked difference between males and females in this species, as well as the heterogeneity of age-sex class composition for 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 2). In addition to possible methodological questions, this may reflect the influence of local, population-level, or even individual. In addition to possible methodological issues, differences may reflect the influence of site (habitats and biomes, for example) at the population level (Aguiar *et al*. 2009), or even individual factors, making identification almost impossible at interspecific patterns (Odalia-Rímoli *et al.* 2008).

The differences between age groups were significant at p = 0.05(Figure 4). Although this analysis is relatively simple, it does not indicate that the general budget of activities (Figure 1) may have been influenced significantly by the composition of the study group, which dominates mature members (62,5% of total).

The diet was dominated by plant material, especially leaves (Figure 2), a pattern typical of the genus *Alouatta* spp. (Di Fiore & Campbell 2007). The use of leaves had a relatively similar diet in comparison with most other related studies with howlers monkeys (Table 3), including *A. caraya* (Bicca-Marques 1991, Sallenave & Bravo 2003). In contrast, both the fruits and flowers were relatively large, while the consumption of fruits has been lower than the values reported in other studies *A. caraya*, but similar to sympatric group that live in proximity in Aquidauana between 2007 and 2008 (Nantes & Rímoli 2008). Flowers were appreciated resources in the dry season (April-July 2009) and its consumption was higher (see Table 4) than other groups of *A. caraya* (Zunino 1986, 1987, Bicca-Marques 1991, Bravo & Sallenave 2003).

The analysis of the seasonal pattern in the diet, increased consumption of the new leaves in the rainy season is in accordance with the productivity of the period (Takahasi & Fina 2004, Lehn 2008, Ferreira *et al.* 2010), the same can be said of the consumption of fruits, since this period is characterized by a relative abundance of fruit in the majority of the other study sites (Pinto & Setz 2004). A similar pattern can be seen in case of leaves, where folivory predominates in most but not all, species of the genus (Table 3). It seems possible that methodological factors may be less important here, and indeed, there seems to be much less intraspecific variation (Odalia-Rímoli *et al.* 2008). Overall, folivory seems to be more pronounced in populations at higher latitudes, especially those of species howler monkeys that *A. guariba* (Miranda & Passos 2005) and *A. caraya* (Aguiar *et al.* 2008), compared with species whose populations are located closer to the equator in the Amazon region, such as *A. belzebul* (Pina 1999), *A. seniculus* (Julliot & Sabatier 1993) and *A. discolor* (Pinto 2002, Pinto & Setz 2004). This may reflect both productivity levels (Aguiar *et al*. 2008) and, especially, the less pronounced seasonality of the equatorial ecosystems (Odalia-Rímoli *et al*. 2008).

The highest consumption for the leaves and reduced folivory reproductive plant parts such as flowers and partly fruits, recorded for the study group compared to other populations of *A. caraya*, located in southern Brazil (Bicca-Marque & Callegaro Marques 1994, 1995), and northern Argentina (Zunino 1986, 1987), would be consistent with this hypothesis, the intraspecific level when as the availability of fruits is significant, direct their efforts in diet for the consumption of this item (Odalia Rímoli *et al.* 2008). For example, the diet of the red-handed howlers (*A. discolor*) (Pinto & Setz 2004) have complements the high frugivory observed in *A. belzebul* (Pina 1999)elsewhere and documents the use of uncommon items in other howler diets. Although intraspecific variation in howler diets is high and new studies with highly folivorous species have shown higher frugivory, *Alouatta belzebul* seems to be the most consistently frugivorous howler species (Pina 1999), in spite of its wide geographic distribution and sympatry with *Ateles chamek*, a highly frugivorous primate (Pinto & Setz 2004).

Also reduced by resting periods would be consistent with a diet frugivorous (Coelho *et al.* 1976, McNab 1978, 1980), as observed in other atelidae such as *Ateles* spp. (Chapman 1988, Di Fiore & Campbell 2007) and *Brachyteles* spp. (Strier 1987), although such behavior patterns for black howler monkeys, *A. caraya* require that these interpretations are made with some caution when considering the possible influence of methodological issues described above.

According Pinto & Setz (2004) howler studies evidence great variation of dietary specific richness, mostly due to differences in vegetation richness among habitats and study duration, and confirms high frugivory for several primate species commonly exhibit dietary changes following seasonal variation in fruit availability (Milton 1980, Terborgh 1983, Strier 1987, 1992, Rímoli *et al*. 2008, Odalia-Rímoli *et al*., 2008). Therefore, is expected that howlers would consume less fruit in the dry season in Cerrado/Pantanal (Takahasi & Fina 2004, Lehn 2008, Barbosa-Filho & Araújo, 2009, Ferreira *et al.* 2010), when there is a shortage of fruit production, the same seems to be the norm in other biomes as Amazon (Terborgh 1983, Setz 1993, Peres 1994, Pina 1999, Pinto 2002, Pinto & Setz 2004), and Atlantic forest (Rylands 1984, Strier 1987, 1992, Passos 1992, Rímoli 2001).

The results of this study showed activity patterns and feeding behavior typical of the genus *Alouatta*, while pointing to possible intra and interspecific differences, encouraging the idea of making more systematic research on the species. Obviously, there is a clear need for additional studies performed by *A. caraya* in the Cerrado-Pantanal region, not only to provide new information on the ecological patterns, but also to contribute to the development of strategies for the conservation of species and their habitats.

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