



Original Research Article

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AREA OF USE AND SPACE USED BY *ALOUATTA CARAYA* IN THE CENTER-WEST OF BRAZIL

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ABSTRACT: Ecological and behavioral factors influence the size of the home range and how space is used among primates. The objective of this study was to describe the home range use, daily range behavior and activities budgets developed along the vertical landscape extract of a group of *Alouatta caraya* in fragment inserted in the Savannah (Cerrado) biome in the period of August/2012 to March/2013. For the study of the daily range use, the individuals were monitored and the routes transferred to maps. Points were scored for each movement of the major part of the group at rest, feeding and sleeping sites. In order to analyze the intensity of the use of space within the home range area of the group and the vertical use of the space was verified with the method “Scan Sampling” with intervals of 10 minutes. Through the Kernel density analysis it was possible to determine that the group used 35.06 hectares as an area of use and 7.71 hectares of nuclear area. The vertical use of space showed that the height range most used by the group for the development of the various behavioral activities occurred between 11 and 15 m. Through the results found that the adaptability and use of fragmented areas by the howler monkeys is related to the quality and availability of resources in the environment being limiting factors in the general activities budget.

KEYWORDS: Space ecology, daily ranging behavior, howler monkeys, primates.

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1. INTRODUCTION

For behavioral and population ecology it is important to try to understand how mammals distribute their activities in space and time [76]. Human activities pose the greatest threat to biological diversity leading to loss of habitat. Problems such as hunting, burning, selective cutting, opening of trails by humans and domestic animals, construction of roads in forest regions, use of areas for agriculture and livestock, among others, affect the distribution and abundance of primates [84]. The use of space by primates includes concepts such as home range, core area and daily range [61]. The area of use is defined as a region where an animal moves by performing its basic activity patterns [14]. Core areas are the smallest parts within the most frequently used area of use [6], where resources for survival and reproduction are found, being ecologically important compared to less-used areas within the area of use [6], [65], [66]. The distances traveled represent the daily movement of the animals during the movement of the group [79], and partly reflects the needs for food resources [17] and their values can be correlated to the nutritional balance between the gains from resources acquired and potential losses caused by risk factors [62].

1.1 *Alouatta caraya* (HUMBOLDT, 1812)

Species of the genus *Alouatta* are more adaptable to changes in habitat up to certain levels [12], [28], [53]. The diet with high leaf consumption, coupled with the ability to move in an altered environment, allows the howler monkeys to survive certain levels of fragmentation and degradation of the environment [15], [16], [30], [51], [67]. Even though these species of primates are able to adapt to degraded environments, they are also susceptible to local extinction, since the isolation generated by the fragmentation of the habitat causes a reduction in the population size [64] and in breeding. *Alouatta caraya* is a species with wide distribution in Brazil, occurring in the Savannah (Cerrado), Pantanal, Caatinga, Mata Atlântica and Pampa biomes. Its extension of occurrence is superior to 3,000,000 km² and its area of occupation is well greater than 2,000 km². This species suffers population decline mainly due to loss, fragmentation and disconnection of habitats, increase of the road and energy matrix, agriculture, livestock, fire, hunting and vulnerability to epidemics [35]. It presents sexual dichromatism in the coat, with adult black male and light brownish yellow female, with a mid-dorsal range, from the head to the lumbar region, from dark brown to grayish color. Youngsters of both sexes show coat coloration similar to that of adult females. When they reach sexual maturity, between four and five years of age, the young male changes from grayish-brown to black [82]. As regards diet, *Alouatta caraya* has a great capacity for food adaptation [42], [47] and are considered to be frugivorous folivores [23]. They live in groups of two to eight individuals [19], and can form groups of up to 21 individuals [12]. The social groups are formed by a male leader, several females and their offspring of different ages and sexes, but other adult males can be found in the group [23]. Males and females abandon their original group before the first reproduction to form new groups [24], [72]. In general, studies with primates of the *Alouatta* genus

show small areas of life relative to their body size [23]. The low activity and small percentage of time spent in movement cause the animals of this genre to travel small distances daily. This characteristic is mainly due to the function of the individuals economic energy strategy (folivorous diet), where there is a tendency to reduce energy expenditure by reducing the time spent during the foraging trip [9], [37]. The objective of this study was to determine the area of use of a group of black howler monkeys, identifying the size of the core area, daily displacements and the use of the vertical space of the group in a semi-deciduous submontane seasonal forest fragment inserted in the Savannah (Cerrado) biome, located in the center-west of Brazil. Since in the dry season there is a shortage of resources, thus waiting for the animals to spend more time on the displacement behavior, and less time for rest and social interactions, as well as a significant diet change according to the availability of resources, animals move along a larger area. In this context, the basic hypothesis would be that in the months corresponding to the dry season, in this study would be the months of August and September, where there is a greater food shortage, it is expected that: hypothesis 1: the animals devote more time to the displacement behavior, and less time to rest and social interactions.

2. MATERIALS AND METHODS

2.1 Study Area

This research was carried out in an 83-hectare fragment inserted in the Savannah (Cerrado) Biome, located in the municipality of Dois Irmãos do Buriti, Mato Grosso do Sul, at Estância Crioula Farm, in the following geographic coordinates: 55°32'5,778 "W 20°31'13,598" S (Zone 21 South, WGS84). This area is inserted in a segment of the Serra de Maracajú, which extends in the state from north to south, delimiting the Pantanal (western) plain from the highlands of the plateau (east), surrounded by areas of planted pasture (*Brachiaria brizantha* cv. Marandu) and with a connection to the southeast of the fragment, as shown in Fig 1.

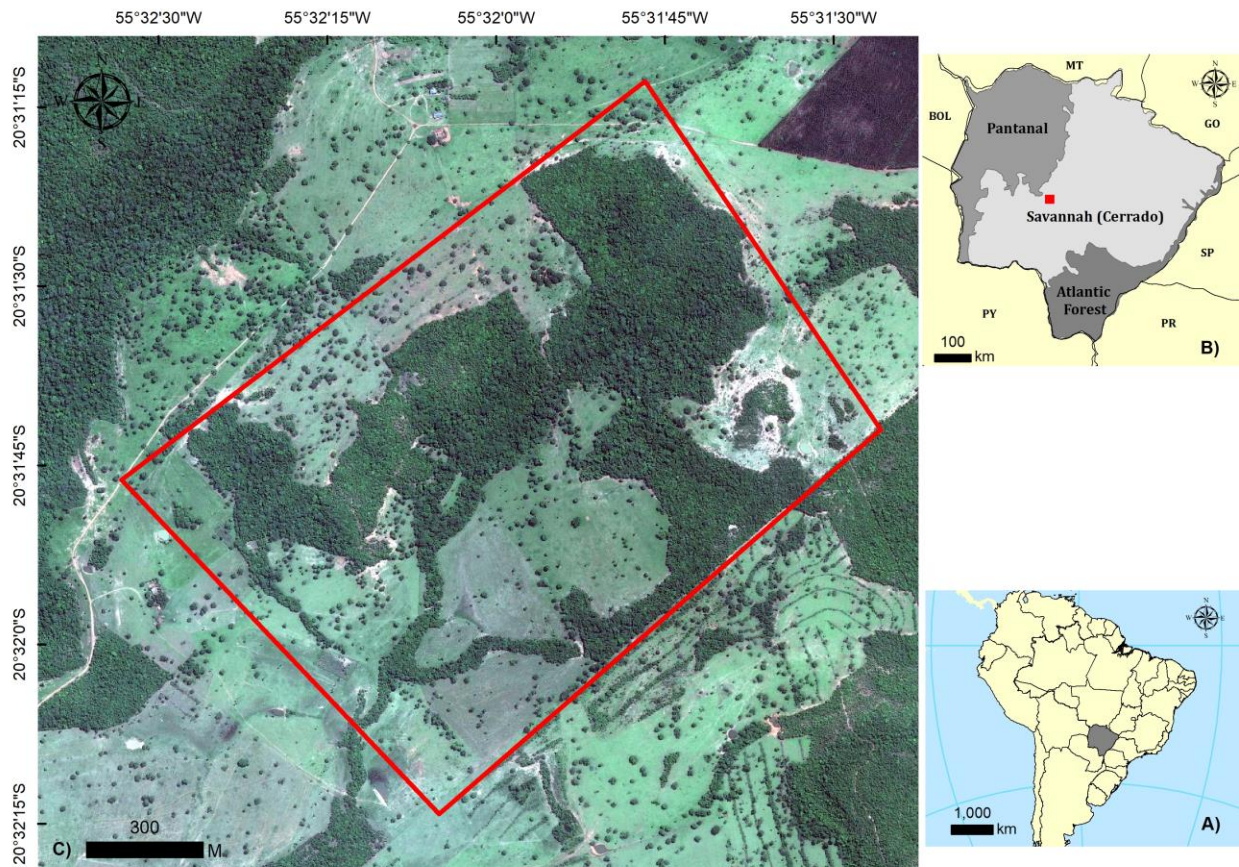


Figure1: High-resolution image of the Geoeye satellite, available in the ArcMap 10 database (ESRI®) (A) Location of the state of Mato Grosso do Sul - Brazil; (B) Representation of the biomes inserted in the state of Mato Grosso do Sul with a red spot marking the location of the fragment within the state; (C) Fragment of 83 ha surrounding the pasture area formed by submontane semi-deciduous seasonal forest and gallery forest, inserted in Estancia Crioula Farm – Dois Irmãos do Buriti - MS.

In the higher areas predominates semi-deciduous submontane seasonal arboreal forest vegetation and in the margins of the channels predominates gallery forest [34]. The topography of the study area presents smooth undulating and flat relief, with dimensions ranging from 219 m to 316 m (data extracted from the MDE / SRTM 30 m). The average height of the plant species that make up the area is 20 meters, consisting of species such as jequitibás (*Cariniana estrellensis*), angicos (*Anadenanthera macrocarpa*), jatobás (*Hymenaea courbaril*), copaíbas (*Copaifera langsdorffi*) whose leaves are consumed throughout the year, figs (*Ficus* sp), ipês (*Tabebuia* sp), which fruits and flowers are consumed by howler monkeys, among others [43]. The analysis of the seasons was based on rainy season and dry season, the latter being characterized by low rainfall and low temperatures and the rainy season the opposite, abundance of rain and high temperatures [26]. For this analysis the data were grouped considering the months of dry season June to September and rainy season the months of October to March. Although they do not get independent measures of availability of resources, howler monkeys seem to consume the items that are part of their diet according to availability for the seasons. The analysis of the seasonal pattern in the diet, increase of

consumption of new leaves and fruits in the rainy season are in agreement with the productivity of the period, which is characterized by a relative abundance of these items in other studies [29], [41], [63], [81].

2.2 Study Group

The size of the *Alouatta caraya* group ranged from 11 to 13 animals as shown in Table 1. The distinction between the sex-age classes was performed by body size, coloration, genitalia and behavior parameters, according to [7].

Table 1: Composition of the group of black howler monkeys (*Alouatta caraya*) of the semi-deciduous submontane seasonal forest fragment of 83 ha. Data from 13 individuals monitored at the Estancia Crioula Farm - Dois Irmãos do Buriti, MS, between June 2012 and March 2013.

Class	2012	2013
Adult males (≥ 4 years)	3	3
Adult females (≥ 4 years)	3*	2
Subadult males (3-4 years)	0	0
Subadult females (3-4 years)	1	1
Young males (1-3 years)	3*	3
Young females (1-3 years)	0	1
Infant males (≤ 1 year)	1	1
Infant females (≤ 1 year)	1	1
Total	13	12

* In November 2012, there was an immigration of an adult female and a young male. In January 2013, the adult female who had immigrated was no longer in the group.

2.3 Data Collect

The behavioral data collection comprised the period from June 2012 to March 2013, the collections were conducted during five days a month, from dawn to sunset, totaling at least ten hours of observations per day. The monthly sampling effort was those according to [7], [31], [45], [46] and [47]. Due to the large periodic variation, the number of hours of a day of collection ranged from 10.5 hours to 13.5 hours. Scan sampling was performed with 5-minute samples and 10-minute intervals [3], [44]. A protocol similar to that of other studies with *Alouatta caraya* [7], [54], [68], [73] and other species of *Alouatta* [31], [45], [46], [47].

For each member of the group visible during sampling, within a maximum of 5 minutes, were registered: their identity; their activity; its height in relation to the ground according to the following categories (in the ground, 2-5 m, 5-10 m, 10-15 m, 15-20 m, > 20 m); his posture (sitting, lying, grasped, suspended by the tail and anterior limbs, suspended by the tail and hind limbs, quadrupedalism or bipedalism). The behavioral categories that were used in this study, based on those used according to [7], [31], [45], [47], were: **Moving** - when animals to shifted during the

record. **Resting** - subject standing, sitting or lying down, with no apparent activity. **Feeding** - subject eating or chewing food items. **Social Interactions** - any activity that involves peaceful interactions as grooming parasites, hugs, play behavior, or in some cases characterized by physical aggression or behavior, pushing, biting, throws or by displacement of another individual due to simple arrival at the site of a dominant individual. **Other Behaviors** - activities that do not fit into any of the above categories: solitary play, self-grooming, scratching, drinking water.

2.4 Data Analysis

The data were tabulated in spreadsheet and organized by day, month and season (dry and rainy). For the comparisons between the behavior of the animals, the data were grouped by season. At the level of significance of $p = 0.05$ [44], the binomial z test was used as a way of analyzing, according to the basic hypothesis, if there were significant differences according to climatic season, frequency behavior of displacement, rest and social interactions. The chi-square test was used to test if there was a preference for a certain tree stratum and its correlation with the behavioral activity presented.

2.5 Use Of Space

To determine the pattern of space use in the study group, the Scan sampling method was used with 10 minutes of interval [3], during five days in each month from August/2012 to March/2013. The group was followed from dawn (preferably in a dorm tree) until sunset. The daily movements were marked using a GPS Mobile Mapper 100, through geographic coordinates (Lat Long coordinates, Datum WGS 84). These points were demarcated when the observer was in the place with the largest possible number of animals ($> 50\%$). During the long displacements the points were marked every 30 meters. During short shifts, the animals remained basically in the same area, going to the next tree and vice versa, so it was expected about 30 minutes that they were in that place to mark the point and when they moved between a tree and another for consumption of food items was expected 30 minutes for the marking of a new point. All the points obtained were stored in a digital cartographic database and later plotted in ArcMap 10 environment (ESRI®) on a map covering the study area. To determine the area of use and the core area, we used the Kernel Fixed Analysis method, which is a non-parametric method that produces a distribution of use that describes the intensity of use of different areas by an animal [39], [40], [65], [86] to provide more reliable measures for the area of use ("home range"), a fixed kernel analysis method of 95% and core area was applied the fixed kernel analysis method 50%. We determined the length of the daily trajectories by adding the measured straight distances between sites marked with the GPS during the daily displacement of the group, and we calculated the mean of the trajectory values monthly [1], [32]. In order to characterize the use of vertical space, that is, the height of the animals in the arboreal stratum with respect to the soil was annotated in each sampling of "Scan sampling", the height with respect to the soil of each individual of the group of howler monkeys in the tree strata and behavioral activity performed. These heights were categorized into the following classes: 0 to 5 m; 6 to 10 m; 11 to 15 m; 16 to 20

m; 21 to 25 m and > 26 m following categories proposed by other authors [46], [49], [83].

3. RESULTS AND DISCUSSION

During the period from June/2012 to March/2013, 510 hours of direct observation of the study group were obtained, being 200 hours in the dry season and 310 in the rainy season. There were 6873 records of behavior, between the seasons of the year, there were differences in behavioral categories in which the highest frequency was observed in the behavior of displacement in the dry season, 31%, $n = 793$ ($z = 5.65$, $p < 0.05$), social interaction ($z = 2.78$, $p < 0.05$) and other behaviors 3.5%, $n = 90$ ($z = 3.53$, $p < 0.05$). In the rainy season, rest behaviors were significant 41%, $n = 1767$ ($z = -1.93$, $p < 0.05$) and feeding 27.6%, $n = 1189$ ($z = -5.92$, $p < 0.05$). The diet of the *Alouatta caraya* group of this study resulted in a predominance of the leaf item in its diet with 46.5% ($n = 794$) of the records, followed by fruits 34.8% ($n = 594$) and flowers 18.7% ($n = 319$) over the 10 months of observations. In the dry season, despite the shortest feeding time, there was a significant consumption of flowers, 25.1%, $n = 130$ ($z = 6.34$, $p < 0.05$) and leaves 58.7%, $n = 304$ ($z = 4.86$, $p < 0.05$), recalling that there is less availability of fruits at this season. In the rainy season, fruit consumption was significant 42.8%, $n = 510$ ($z = -8.83$, $p < 0.05$) in relation to the dry season. The month of February registered the lowest average of displacement (681 m), being the month where the consumption of flowers exceeded the other items (49%), the leaf item was more consumed in October (78%) and in the last month (2624 m) and fruits (84%) were most consumed in the month of January, which is part of the rainy season in the region, where there is greater availability of this item (Fig 2).

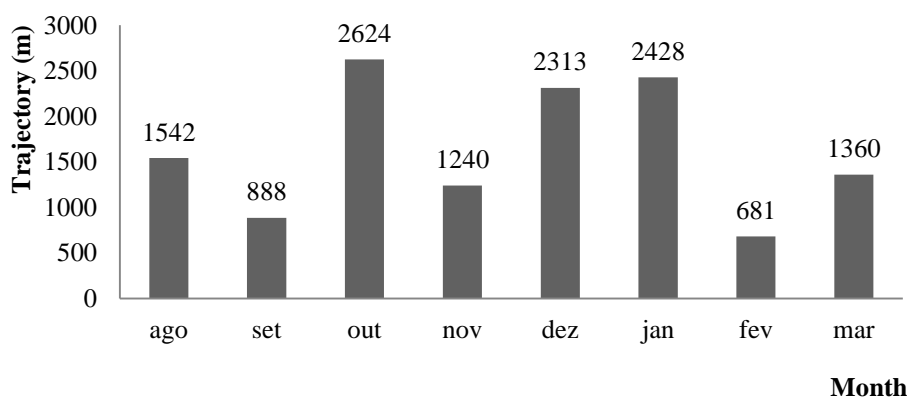


Figure 2: Average of the daily displacements of the *Alouatta caraya* group in the semi-deciduous submontane seasonal forest fragment of 83 ha. Data from 13 individuals monitored at Estancia Crioula Farm, Dois Irmãos do Buriti, MS, between August 2012 and March 2013.

Of the 83 hectares available, 36.47 ha are gallery forest and 46.53 ha are forest. According to the fixed 95% Kernel analysis, to determine the area of use, the observed group used 35.06 ha ("home range") and the fixed kernel analysis of 50% was determined as the core area a total of 7.71 ha inserted in the border of the streams that cut the fragment (Fig 3A). In the areas marked as "core area" there were plant species exploited at various times of the year as food, mainly the fruits of *Ficus* sp and *Inga vera*. In Fig 3B it is possible to observe that the light green areas correspond to

the Gallery Forest where the core areas are concentrated with greater intensity and the dark green and magenta areas correspond to the Forest areas which are part of the area of use, lower intensity.

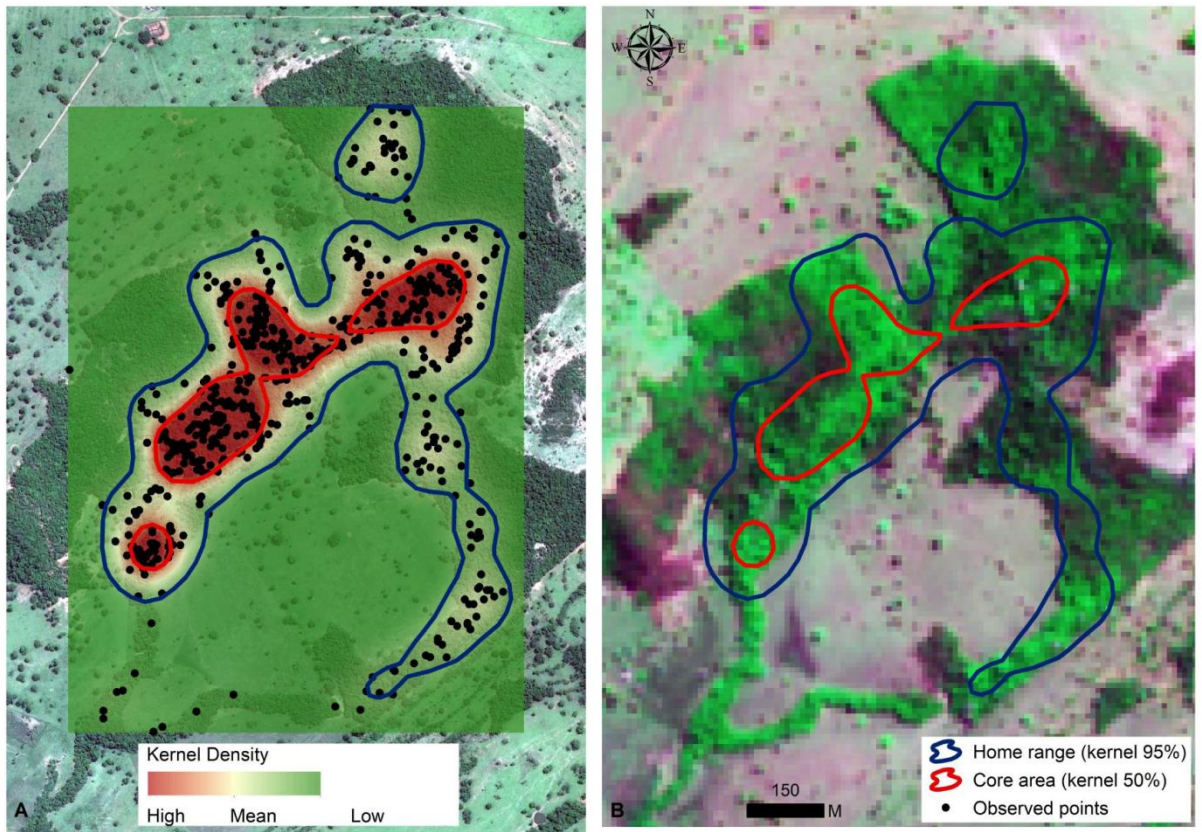


Figure 3: (A) Intensity of the use area within the semi-deciduous submontane seasonal forest fragment of 83 ha by a group of howler monkeys, *Alouatta caraya*. The blue contour corresponds to the 95% kernel analysis representing the area of use, and the red contour corresponds to 50% kernel analysis, representing the most intensively used areas or core areas. Data from 13 individuals monitored at Estancia Crioula Farm, Dois Irmãos do Buriti, MS, between August 2012 and March 2013. (B) is an image of the Sentinel 2 satellite, with spatial resolution of 10 m, color composition 3B4G8R dated from 09/09/2017. It used a dry period image, as it presents a better view of the gallery forest that corresponds to 36.47 ha (light green color) within the semi deciduous forest fragment that corresponds to 46.78 ha (dark green color and magenta).

Regarding the vertical use, within the height classes cited, the class between 11 and 15 meters of howler monkeys was the most used by the animals of the group to perform behavioral activities in general, with 51.5% of the records (n = 6873), as shown in Fig 4.

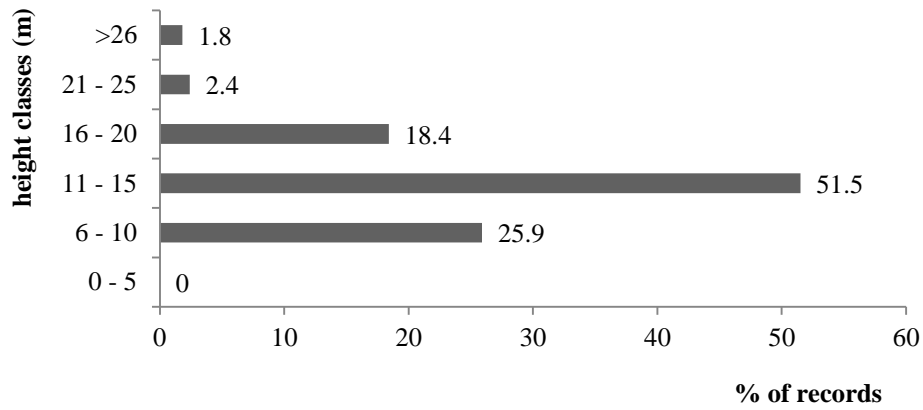


Figure 4: Percentage of records of use of the different height classes by the *Alouatta caraya* group studied in the submontane semi-deciduous seasonal forest fragment of 83 ha. Data from 13 individuals monitored at Estancia Crioula Farm, Dois Irmãos do Buriti, MS, between June 2012 and March 2013. Table 2 specifies the frequency of the behavioral categories within each height class, showing that the displacement and feeding occurred with a higher percentage in the height of 6 to 10 meters, for social interaction activities the group frequently used the height class of 16 at 20 meters, the rest had a greater percentage in the height of 21 to 25 meters and the behavior of the category "others", like drinking water remained with percentages close in the classes of 6 to > 26 meters of height. It is observed that the height class of 21 to 25 meters was the most used for the rest activity, probably because it maintains a wider field of vision and the comfort of the thicker branches. The chi-square test showed preference in the behavior of displacement and social interaction at the height of 16 to 20 meters, the other behavioral categories varied along the height classes distributed among the classes of 6 to > 26 meters, avoiding heights near the ground as from 0 to 5 meters.

Table 2: Distribution of the behavioral categories of the *Alouatta caraya* group in the use of the different height classes in the semi-deciduous submontane seasonal forest fragment of 83 ha. Data from 13 individuals monitored at Estância Crioula Farm, Dois Irmãos do Buriti, MS, between June 2012 and March 2013 n=6873.

Category	Height Classes					
	0 – 5 m	6 – 10 m	11 – 15 m	16 - 20m	21 – 25 m	>26 m
Moving	01(100%)	651(36.6%)	937(26.5%)	207(16.4%)	13(7.9%)	06(4.8%)
Feeding	0(0.0%)	652(36.7%)	879(24.8%)	138(10.9%)	12(7.3%)	26(20.6%)
Social interactions	0(0.0%)	99(5.6%)	204(5.8%)	115(9.1%)	10(6.1%)	04(3.2%)
Resting	0(0.0%)	333(18.7%)	1430(40.4%)	767(60.6%)	123(74.5%)	86(68.3%)
Others	0(0.0%)	42(2.4%)	89(2.5%)	38(3.0%)	07(4.2%)	04(3.2%)
Total	1(0.0%)	1777(25.9%)	3539(51.5%)	1265(18.4%)	165(2.4%)	126(1.8%)

Diet and activity pattern

The persistence of genus *Alouatta* in fragmented habitats seems to be based on their ability to adapt diet to food availability [10], [56], [69], increase leaf consumption [5], [71], consumes secondary or exotic plant species [56], as well as epiphytic or parasitic plants [5], [71]. However, they are very selective in relation to food resources and the monthly diversity of their diet is generally low, with only a few species of plants regularly included [28]. The howler monkeys are also able to reorganize their reach pattern [27], [56], and their time budget [22], [38], [75]. *Alouatta* ecology has been extensively studied, although the factors regarding its persistence in different forest fragments are still unclear [4]. In general, the *Alouatta caraya* group living in the forest fragment of this study did not differ in terms of activity and diet patterns in relation to other groups studied in the different regions of this genus, where there is a predominance of leaves in the diet and periods of inactivity. In the central-eastern region, for example we can cite the work of [54] in a seasonal forest fragment in the Terenos - MS region with a group of *Alouatta caraya*, where it found dietary values similar to that of this study (leaves 47.5%, fruits 35.5% and flowers 12.9%), but with In relation to the pattern of activities only the displacement behavior was similar to this study (29.9%) and in general the studies with species of the genus *Alouatta* demonstrate the activity of displacement with smaller percentages than the one found in this work, we can cite the work of [67] with howler monkeys of the same species in the region of Aquidauana, near the Pantanal of Mato Grosso do Sul, where the behavior of displacement was below that found in this study (18.54%). [48] suggested that high inactivity values in *Alouatta* are the consequence of the large amount of leaves passing through the intestinal tract and slowing down the digestion due to the cellulosic material. Other studies do not support this hypothesis and indicate that inactivity is more of a phylogenetic characteristic of the genus, independent of diet [59]. In this study the inactivity was lower in the period where there was greater consumption of leaves and flowers, which leads to believe that inactivity is a phylogenetic characteristic.

Daily Routes

The daily *Alouatta* traits are related to habitat quality and are also related to the folivore diet [10], but it is not related to the size of the inhabited fragment [9]. The "leaf" item is widely distributed, difficult to metabolize and low energy, causing the animals to have long periods of inactivity [21], [80], but the animals in this study had more frequent rest periods in the months of consumption significant difference of fruits in the diet and the displacement was the behavioral category with a significant result during the dry season. According to [25], studies have shown that, when exploiting fruits, howler monkeys reduce the number of food sources explored and time spent feeding, leading to less feeding effort and increasing the time available for resting, as occurs during feeding foliar and in the dry season it was confirmed the hypothesis that the displacement behavior would be significant, but not as extensive as in the months of the rainy season, being able to infer that the

animals moved more frequently in the search for compensating resources. According to [46], the increase of areas used in the dry season is advantageous for the animals if this means an increase in the food supply relatively greater than the increase of the costs for the exploration of that area. [18] cites that a single tree in fructification can strongly influence the mode of use of space by any primate species. If we compare the mean daily displacements for the months of August and September (which are considered the months that correspond to the peak of the dry season), with the last two months of the rainy season that would be February and March there is no significant difference between the average of the routes as shown in Fig 4. [1] cites that groups of *Alouatta caraya* and *Alouatta guariba* of El Piñalito reduced the daily trajectories during the season of low food availability, as predicted hypothesis of strategy of energy minimization [47]. During the scarcity season, both groups of monkeys increase the consumption of low-quality but uniformly distributed foods such as mature leaves [1]. By reducing the daily commuting distance, howler monkeys may be able to minimize energy expenditure in this period [47], [78]. In contrast, the *Alouatta guariba* groups did not change their daily journeys and movement rates with the seasonality of food. In this study, during the month of February, when the smallest mean of displacement was observed, the group was camped in an area where a tree of the species *Tabebuia impetiginosa* (purple ipê) was found, with flowers consumed by the primates. The animals in this study used some routes repeatedly. The same was verified by [8] in his study with *A. caraya*. [33] and [47] also reported such behavior for *A. palliata*, [11] for *A. belzebul* and [2] for *A. guariba*. According to Hopkins [33], this behavior of choice of repeated routes is linked to the arboreal canopy connectivity and the availability of resources, being this a significant predictor, since the repeated use of tree routes helps the monitoring and acquisition of resources.

Area of use

The area of use of howler monkeys is reported by several authors as a strong relation with the disposition of some food resources [2], [8], [11], [18], [46], [53]. Primates forage on items and areas that provide them with the best immediate energy return [70]. The differences in size in the areas of use are more associated with environmental differences than with species differences. The results obtained in this study for the area of use of the *Alouatta caraya* group were within the expected variations for some species of the genus *Alouatta*: *A. guariba* [2], [20], [36], [46], [49]; *A. belzebul* [11], [74]; *A. palliata* [33], [53]; *A. pigra* [60]. However, for the target species of the study, the total value of area of use obtained here, 35.06 ha, is close to the value found by [33] on the island of Barro Colorado - Panama, for two groups of *Alouatta caraya* [1] and to *Alouatta palliata*, whose living area ranged from 18 to 44 ha in tropical forest and distant from values up to that time recorded by other authors, which were: [8] of 2 ha corresponding to the total available area; [12] from 1.7 to 2.2 ha, and [85] from 5 and 6 ha to two study groups. In a study carried out by Souza [74] with *Alouatta belzebul* in the state of Paraíba of the 266.53 hectares available, the observed group used

10.59 ha, according to a bibliographical survey carried out by the author, there is a great variation regarding the size of the area of use of the genus *Alouatta*, and can vary in average of 3.38 ha for *Alouatta caraya* up to 47 ha for *Alouatta Pigra*, relating such variation the following hypotheses arise: positive relation between body size and area of life, without considering the herbivorous habit; the density, distribution of food resources and the presence of competitors may influence the size of the area of life inversely proportional to the population density. This last item is considered a determining factor for the delimitation of the living area, in addition to showing that species of threatened biomes such as Savannah (Cerrado) and Mata Atlântica have high densities in smaller areas. In a study by [57] in a tropical forest in Colombia with *Alouatta seniculus*, an area of 182 ha was used and a displacement of 1150 meters. The core area in the study area was 7.71 ha, equivalent to 9.28% of the total area (83 ha) and 22% of the area of use (35.06 ha). These areas involve sleeping trees (when they stay in the area overnight), rest (when they remain in the area for a few hours) and food, are close to the waterways. This fact can be explained, probably because the animals know this area better and this is the region where they spend most of their time. Through familiarity with a small area, the animal can learn: 1- when and where it is possible to find food; 2 - places where they can be safe from predators and where and when these predators can be found [62]. [1] indicates that in a study with two groups of *Alouatta caraya* the core areas found varied between 0.97-27.03 hectares, this variation occurred according to the size of the groups, larger groups occupied larger areas.

Vertical use

Observing the height at which the individuals in the group of howler monkeys encounter during a given activity makes it possible to affirm that the preference for a height varies according to the activity performed [46]. The *Alouatta caraya* group of this study did not present statistical differences on height and behavior performed but presented a higher percentage in rest activity in height between 21 to 25 m which leads to the conclusion that larger heights are more sought to maintain a field of view and more ample, the comfort of thicker branches and the meeting of the greater part of the group in the same tree. According to several authors [13], [49], [83], the howler monkeys have a preference for upper strata and emergent trees, however, depending on vegetation physiognomy can use lower strata [55], [77]. In a study by [1] with *Alouatta caraya* and *Alouatta guariba* in northern Argentina, it was found that the *Alouatta caraya* group showed preference for the middle stratum (11-20 m), unlike the *Alouatta guariba* group that used the highest stratum (> 20 m). This result is similar to that of the *Alouatta caraya* group in this study where most behavioral activities occur at a height of 11 to 15 meters. This fact may be a reflection of the number of emergent trees in the environment, in addition, carrying out the activities at this time keeps the animals out of the reach of semi-arboreal predators, such as *Eira barbara*, *Leopardus pardalis*, *Puma concolor*, *Panthera onca* [46]. The use of intermediate classes can be a way of avoiding not only terrestrial

predators, but also aerial predators, such as large birds of prey: *Harpia harpyja*; *Caracara plancus*, *Spizaetus tyrannus* [50], [52].

4. CONCLUSION

From the information obtained in this study it is possible to conclude that within areas of semi-deciduous seasonal forests the primates of the genus *Alouatta* maintains the preference to attend environments whose vegetation is close to the water courses, which is probably due to the greater abundance of resources along of the year, since the vegetation that compose the gallery forest remains with green leaves even during the dry season, which was also recorded in the study of [58]. The results of this study show patterns of activity and food behavior typical of the *Alouatta* genus, however, it points to possible intra and interspecific differences, stimulating the idea of carrying out more systematic research with the species in environments inserted in the Savannah (Cerrado) biome. Obviously, there is a clear need to carry out other complementary studies of *Alouatta caraya* in the central-western region of Brazil, providing new information regarding the patterns of activities, use of space and daily displacements emphasizing the way of selecting food items identifying the composition chemistry of such items contributing to the development of strategies for the conservation of species and their habitats. It is essential to advance in the investigations about the intergroup dynamics in the *Alouatta* genus to characterize the strategies used in sites submitted to different degrees of disturbance and different areas of activity. This will help to better understand the ability to use space for howler monkeys.

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CONFLICT OF INTEREST

The authors wish to state that there is no conflict of interest associated with the study.

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