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IMPACTOS DA PERCEPÇÃO DE RISCO NOS COMPORTAMENTOS DE UM PRIMATA AMEAÇADO EM UM AMBIENTE FRAGMENTADO

IMPACT OF RISK PERCEPTION ON THE BEHAVIOR OF AN ENDANGERED PRIMATE IN A FRAGMENTED ENVIRONMENT

Rio Claro - SP
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Orientador: Felipe Soares Bufalo

Supervisora: Laurence Marianne Vincianne Culot

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ABSTRACT

Risk perception is a key factor for the interactions between animals and their environment, directly shaping the use of space and resources. Animals that can effectively read environmental signals and adjust their behavioral patterns could minimize exposure to risk and thus enhance their probability of success. In this study, we investigated how black-lion-tamarins (BLTs - *Leontopithecus chrysopygus*) perceived risk of aerial and terrestrial predators and if they accordingly adjusted their behaviors along the day and between seasons in a 100ha forest fragment. We specifically examined whether: the frequency of alarm calls increased in response to higher aerial predator activity and seasonal variation on leaf coverage; if the vertical use of the forest changed in response to perception of risk; and if silent movement is a strategy to avoid detection by terrestrial predators. Our findings suggest that alarm calls were more frequent in the morning, period when raptors activity is higher, and in the dry season, when leaf coverage in the canopies is lower. Additionally, BLTs used the higher strata of the forest less frequently in the dry season and in periods with higher number of alarm calls in the rainy season. Finally, we found that cryptic movements are more prevalent during dawn and dusk and are predicted by increases in the probability of terrestrial predators activity. Thus, our results indicate how BLTs adjust their behavior in response to different predation risks, reinforcing the role of risk perception in shaping space use and behavior in different time scales.

Keywords: Landscape of Fear - black lion tamarin - animal behavior - risk perception

RESUMO

A percepção de risco é um fator determinante nas interações animal-ambiente, influenciando o uso do espaço e dos recursos. Animais que interpretam de forma eficaz os sinais do ambiente e ajustam seus padrões comportamentais podem minimizar a exposição ao risco e aumentar sua probabilidade de sucesso. Neste estudo, investigamos como a percepção de risco em micos-leões-pretos (BLTs – *Leontopithecus chrysopygus*) varia ao longo do dia e das estações em um fragmento de floresta de 100 ha. Especificamente, examinamos se: a frequência de vocalizações de alarme aumenta em resposta à maior atividade de predadores aéreos e à variação sazonal da cobertura foliar; se o uso vertical da floresta é alterado em resposta à percepção de risco; e se o movimento silencioso é estratégia para evitar detecção por predadores terrestres. Nossos resultados indicam que as vocalizações de alarme foram mais frequentes pela manhã, período em que a atividade de aves de rapina é maior. Na estação seca, houve também maior número de emissões de alarmes. Além disso, observamos que BLTs utilizaram menos os estratos superiores da floresta na estação seca e em períodos de maior percepção de risco (i.e., maior número de alarmes) na estação chuvosa. Por fim, BLTs manifestaram movimentos crípticos com maior frequência no amanhecer e entardecer, comportamentos preditos pelo aumento da atividade de predadores terrestres. Nossos resultados sugerem que BLTs ajustam seu comportamento em resposta a diferentes riscos de predação, reforçando o papel da percepção de risco no uso do espaço e no comportamento em diferentes escalas temporais.

Palavras-chave: Paisagem do medo – mico-leão-preto – comportamento animal – percepção de risco

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CONTEXTUALIZAÇÃO DO ESTUDO

Este manuscrito foi redigido em inglês já em formato de artigo para futura submissão para revista AJP (*American Journal of Primatology).* Os dados para este estudo foram coletados no âmbito da pesquisa de doutorado do orientador deste estudo, Felipe Soares Bufalo. Participei da coleta de todos os dados durante 5 campos, nos períodos de 10/11/22 a 18/11/22, 06/01/23 a 15/01/23, 23/01/23 a 05/02/23, 21/07/23 a 02/08/23 e 20/08/23 a 31/08/23, totalizando 54 dias em campo para a coleta dos dados desta pesquisa. Os dados foram analisados durante o ano de 2024 e o manuscrito foi redigido em 2025.

1. Introduction

Predation is a crucial factor influencing individual-environment interactions, directly affecting behavior and habitat use (Ferrari; Ferrari, 1990; Mangel; Clark, 1986). How an individual perceives and assesses the risk of predation is linked to an individual's fitness. Thus, animals capable of interpreting environmental signals and adjusting their behavior to minimize risk exposure have a greater likelihood of success (Frid; Dill, 2002; Gaynor *et al.*, 2019; Wirsing; Heithaus; Dill, 2007). However, this can become problematic in forested environments that are chronically exposed to anthropogenic disturbances, such as poaching, deforestation and habitat fragmentation (Laundré; Hernandez; Ripple, 2010). These disturbances can lead to changes on both animal health and their habitat use patterns, potentially leading to negative effects on their ecological roles (Côrtes; Uriarte, 2013; Kaisin *et al.*, 2021; Suscke; Presotto; Izar, 2021). Therefore, understanding how risk perception influences the habitat use in wild animals is essential for comprehending its role in decision making processes and habitat utilization (Laundré; Hernandez; Ripple, 2010).

The variation in potential risks that an animal faces within an ecosystem over time and space—such as fluctuations in predator presence—is often referred to as the Landscape of Fear (Laundré; Hernández; Altendorf, 2001). Each animal species perceives the Landscape of Fear and incorporates risk response in the decision making differently (Gaynor *et al.*, 2019). Primates are particularly well-suited for studying the consequences of risk perception on behavior because of their marked behavioral flexibility (Ferrari; Ferrari, 1990). For instance, a study on two sympatric African cercopithecids—*Chlorocebus aethiops* and *Cercopithecus mitis*—showed that predation risk was the key factor shaping habitat use in both species, although each experienced a distinct Landscape of Fear (Coleman; Hill, 2013). While the semi-

terrestrial *C. aethiops* experienced greater predation pressure from predators such as leopards and baboons, the behavior of *C. mitis*, an arboreal primate, was primarily influenced by birds of prey (Willems; Barton; Hill, 2009). This highlights that risk perception is not a uniform force: predators with different hunting patterns elicit different adaptive responses from their prey (Ferrari; Ferrari, 1990; Zuberbuhler; Jenny, 2007).

In habitats perceived as more dangerous, prey animals can spend less time foraging in a single site as a strategy to avoid exposure to risk (Stephens; Brown; Ydenberg, 2007). Consequently, to maintain the same amount of food intake, they must forage across a larger number of sites. This may lead to the necessity of a larger home range (Teckentrup; Kramer-Schadt; Jeltsch, 2019), which poses a challenge in already reduced and fragmented habitats affected by human disturbance (Ciuti *et al.*, 2012). This is particularly relevant for the black-lion-tamarin (*Leontopithecus chrysopygus* - BLT), an endemic primate from the state of São Paulo, classified as “Endangered” by the “IUCN Red list of Threatened Species”, with an estimated population of only 1.600 individuals distributed across mostly small forest fragments and riparian forests (Rezende *et al.*, 2020).

To effectively preserve species such as the BLT, it is essential to first understand how individuals perceive risk and how this perception shapes their behavior, particularly in disturbed habitats. Thus, in this study we investigated how risk perception influenced BLT behavior by assessing its responses to potential threats and the resulting changes in habitat use and movement dynamics. Knowing that raptors correspond to one of the most important threats to callitrichids (Stafford; Murad Ferreira, 2008), we first hypothesized that risk perception would be more accentuated in periods of higher activity of avian predators. Accordingly, we expected a higher

frequency of alarm calls (Halloy; Kleiman, 1994; Lobão Cruz, 2009) during the morning, when raptors are most active (Canuto, 2009). In addition, as BLTs inhabit seasonal forests where canopy cover fluctuates with rainfall (Morellato; Altomare; Gressler, 2025), we hypothesized that the perception of aerial predation risk would be greater in the dry season, when reduced foliage increases exposure, than in the rainy season. We therefore predicted a higher frequency of alarm calls in the dry season. Finally, since BLTs are more vulnerable to predation in the upper forest strata (Enstam; Isbell, 2004; Ferrari; Ferrari, 1990), we hypothesized that they would avoid these areas during periods of elevated risk perception. Specifically, we predicted a reduction in the use of higher strata when alarm calls are more frequent.

Another strategy employed by primates in response to risk perception is the use of cryptic behaviors to avoid being detected (Caine, 1987). Such behaviors may be associated with locations or periods of the day of higher probability of predator activity (Broom; Ruxton, 2005). Most terrestrial predators in the Atlantic Forest have their peak of activity in the period during dusk and dawn (Bolze *et al.*, 2023; Villafañe-Trujillo *et al.*, 2021). During dusk, BLTs normally select specific locations of the environment as shelters to spend the night, while at dawn they leave such sleeping sites to perform their daily activities around the home range. Sleeping sites normally consist of tree hollows, which may be limited in availability within forest fragments (Giancola, 2021; Silva, 2019), and are used by all individuals of the group both for thermal comfort and protection against possible predators (Aquino; Encarnación, 1986; Franklin *et al.*, 2007; Smith *et al.*, 2007). Considering that BLTs may be more vulnerable to predation while inside sleeping sites, and that predator activity could overlap with periods when BLTs are near these sites, we hypothesized that BLTs would adopt cryptic behaviors when in the vicinity of sleeping sites to reduce the risk

of its detection by potential predators. Thus, we first evaluated if possible terrestrial predators were more active during dusk and dawn. If so, we hypothesized that individuals would perform cryptic behaviors both in the beginning and the end of the day, when entering or leaving sleeping sites. Therefore, we expected BLTs to perform higher frequencies of cryptic behaviors (i.e., silent movement), in periods with higher terrestrial predator activity.

2. METHODS

This research complied with the American Society of Primatologists (ASP) Principles for the Ethical Treatment of Non-Human Primates and the ASP Code of Best Practices for Field Primatology. Authorization to study BLT was granted by the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), Ministry of the Environment (SISBIO permit #80802-4), and by the Animal Use Ethics Committee of the Institute of Biosciences, UNESP, Rio Claro (CEUA #2596).

2.1 Study Area

This research was conducted in a 100 ha sub-tropical semi deciduous seasonal Atlantic Forest fragment located in the municipality of Guareí, in the southern region of São Paulo state, approximately 186 km from the capital. The area (23º25'07''S, 48º14'27''W) is characterized by two well-defined seasons: hot humid summers (October to March) followed by dry winters (April to September) (Alvares *et al.*, 2013; Morellato; Camargo; Gressler, 2013). The surrounding landscape is composed of sugarcane, soybeans plantations and pasture areas (Figure 1).

In previous studies in the area, the presence of at least three social groups of BLTs has been identified (Jeanbaptiste, 2021), with the number of individuals ranging from 5 to 8 individuals. Also, we registered the occurrence of a large number of

mammals in the area, such as coatis (*Nasua nasua*), anteaters (*Myrmecophaga tridactyla*), wild pigs (*Pecari tajacu*) and maned-wolves (*Chrysocyon brachyurus*), besides possible BLT predators such as ocelots (*Leopardus pardalis*) and tayras (*Eira barbara*) (Kaisin *et al.*, 2022). Markings, tracks, and personal observations also showed the presence of other possible predators of these primates, such as pumas (*Puma concolor*), jaguarundis (*Puma yagouaroundi*) and species of hawks as the *Spizaetus tyrannus* and *Buteo brachyurus* (personal observations).

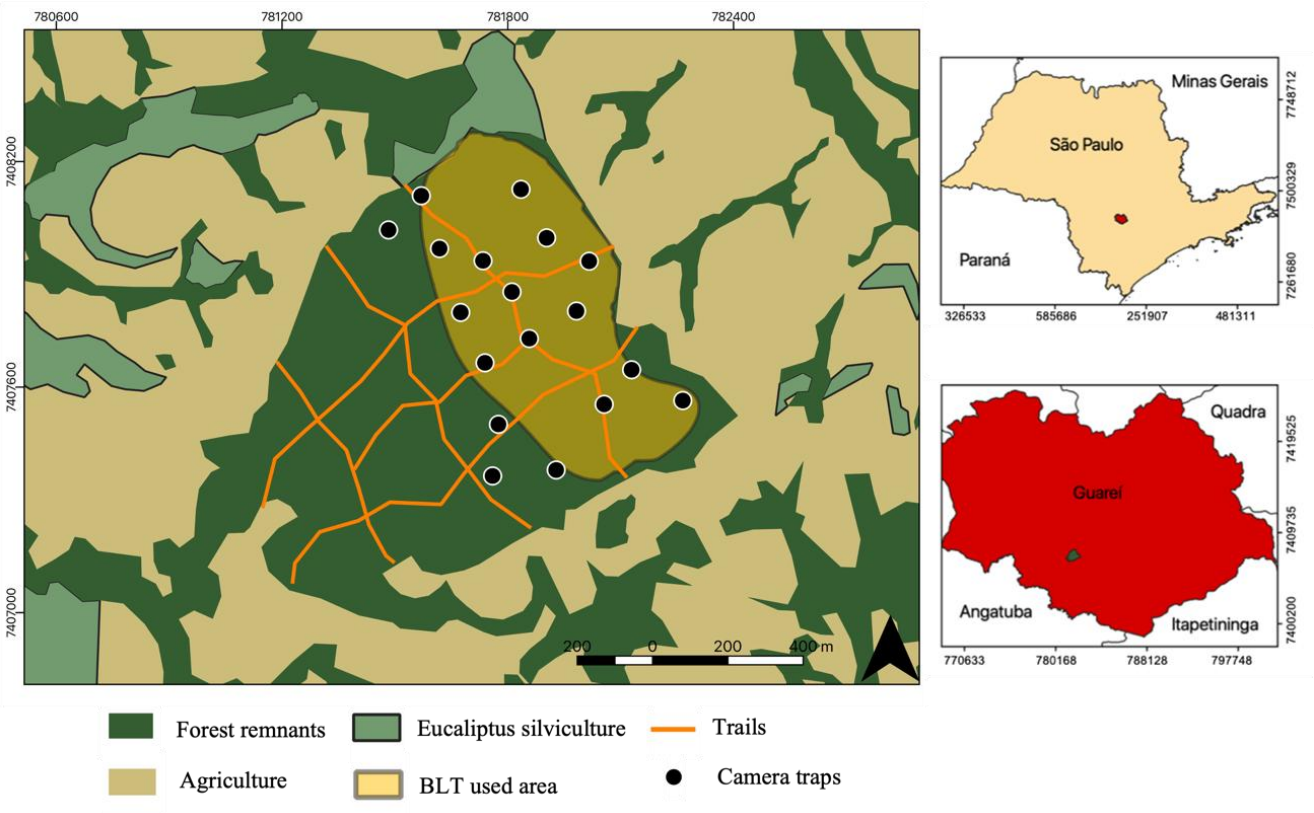

Figure 1. Land use map and location of the study site in the municipality of Guareí, São Paulo state. Orange lines represent a trail system implemented in the area by the researchers. Location of camera traps indicated by black circles. Area used by black lion tamarins estimated through 95% $AKDE_c$ Home Range Estimation (Bufalo *et al.*, 2025).

2.2 Data Collection

We monitored an already habituated group of BLTs from December 2022 to September 2023. The group consisted of seven individuals, including three adults, two sub-adults and two juveniles. Except for the juveniles, we marked all individuals with colored sections on the tails, which allowed individual recognition. Additionally, two of the adults were equipped with VHF radio collars (RI-2D, Holohil® model) to facilitate group localization. We located the group each morning before the start of their activities and followed them continuously throughout the day until they reached a sleeping site, to spend the night. This monitoring was conducted for a total of 23 complete days - 11 during the rainy season and 12 during the dry season. We defined the rainy season as the period between October and March and the dry season as from April to September (Morellato; Altomare; Gressler, 2025).

During the study, we used GPS devices (Garmin® 64S) to record the location of the group every five minutes. Concomitantly, we recorded the behavior of all individuals in sight using the scan sampling method (Altmann, 1974) (Table S1). Using the all occurrences sampling method (Altmann, 1974), we registered all the occurrences of alarm calls emitted along the day.

To assess how BLTs used the different strata of the vegetation, we assigned all observed behaviors and vocalizations observed to four height categories (i.e., H_0 = on the ground (0 m); H_1 = 1-4 m, H_2 = 5-9 m; H_3 = 10-14 m). Observations above 14 m were excluded from the analysis due to limited number of records. Also, to allow for comparisons between behaviors across different periods of the day, we divided the day into six two-hour time classes (i.e., A = 05:30 to 07:29 a.m.; B = 07:30 to 09:29 a.m.; C = 9:30 to 11:29 a.m.; D = 11:30 to 13:29; E = 13:30 to 15:29; and F =

15:30 to 17:29). We used the software “Animal Behavior Pro”, version 1.7.1 (Newton-Fischer, 2020) to record all BLT behavioral data.

Finally, to investigate if there were periods of the day with higher activity of possible terrestrial predators, we distributed 18 unbaited camera traps (Bushnell Core DS-4k) within the home range of the study group (Figure 1). We placed the cameras 150 m apart from one-another on tree trunks at approximately 30-40 cm above ground and programmed for continuous operation (24h/day). Camera traps were set to take pictures at intervals of 15 seconds whenever triggered, recording predator activity from August/2023 to September/2023, resulting in a total of 34 days of monitoring. No camera trapping has been done during the rainy season due to material unavailability.

2.3 Statistical Analyzes

To understand if the frequency of alarm calls (response variable) varied according to different periods of the day and season—i.e., rainy and dry— (predictor variables), we fitted a Generalized Linear Model (glm) with a poisson family using the function “*glm()*” from the *stats* package (R Core Team, 2025).

To test if the use of the higher strata of the vegetation—height 3 (10–14 m)—varied according to possible aerial predator activity, we first found the hourly proportion of time spent in height 3 for each time class and season (number of scans in heigh 3 divided by the total number of scans in that time class). Then, we used a Generalized Additive Model (GAM), using the function “*gam()”* from the *mgcv* package (Wood, 2017), to test how the frequency of alarms (predictor variable) affected the proportion of use of the higher strata (response variable) of the forest in both seasons.

Finally, using the registers from the 18 camera traps, to find if there was a variation on the probability of terrestrial predator activity along the day we divided the number of predator records in that time class by the total number of records in that

time class. Then, to test whether the frequency of cryptic behavior (i.e., silent movement) in BLTs was associated with periods of higher predator activity, we fitted a linear regression model using the function *lm()* in the stats package(R Core Team, 2025). The response variable was the hourly proportion of silent movement (silent movement occurrences divided by the total number of scans in that hour), and the predictor variable was the hourly proportion of predator records.

All analyses were performed using the R Environment for Statistical Computing, version 4.2.3 (R Core Team, 2025). All significance values in test were set at $p \leq 0.05$.

3. RESULTS

We sampled the group of BLT for a total of 11 full days, 114 total hours in the rainy season (from December/2022 to February/2023) and 12 full days, 123 total hours in the dry season (from August to September/2023). The activity period of BLTs consisted of an average of 10 hours and 12 minutes in the rainy season (from ~6:39 a.m. to ~4:50 p.m.), and 10 hours and 15 minutes in the dry season (from ~6:48 a.m. to ~5:01 p.m.).

When comparing the frequency of alarm calls throughout the day, we found that BLTs emitted alarm calls most frequently during time classes B (07:30–09:29; 67 calls) and C (09:30–11:29; 56 calls), and least frequently during time classes A (05:30–07:29; 29 calls) and F (15:30–17:29; 18 calls; Figure 2). These differences were statistically supported by a GLM with Poisson distribution, which showed significantly higher alarm call rates in time classes B ($p = 0.0001$) and C ($p = 0.004$) compared to the rest of the day.

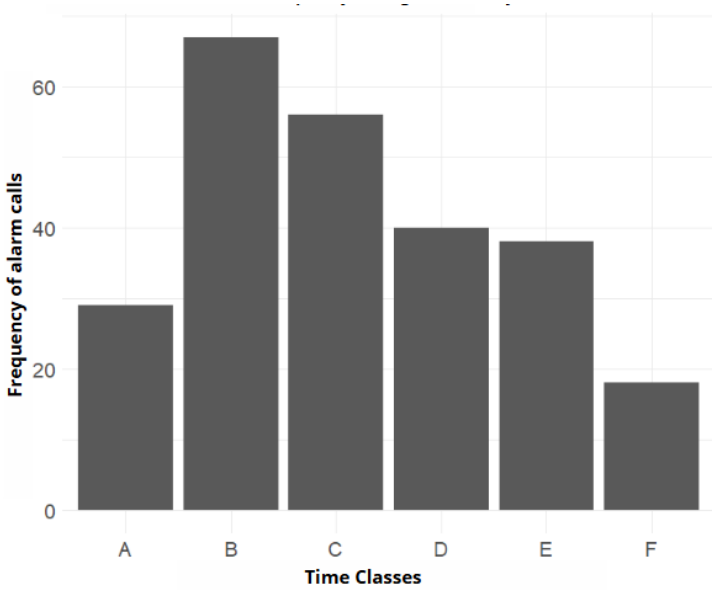

Figure 2. Frequency of alarm calls emitted by black lion tamarins on each period of the day. Periods divided into five two-hour time classes: A = 05:30 to 07:29 a.m.; B = 07:30 to 09:29 a.m.; C = 9:30 to 11:29 a.m.; D = 11:30 to 13:29; E = 13:30 to 15:29; and F = 15:30 to 17:29.

When comparing the frequency of alarms calls in both seasons, we found that BLTs emitted a significantly higher number of alarm calls in the dry season (186 calls) than in the rainy season (62 calls) ($p < 0.0001$).

When comparing the use of the higher strata of the forest we found through an additive model that BLTs used these higher levels significantly less during the dry season (21,8 ± 16,5) than during the rainy season (29,8 ± 21,1) ($p = 0.03$) (Figure 3). The additive model further indicated that, in the dry season, alarm frequency did not affect the usage of the higher strata ($p = 0.68$). In contrast, during the rainy season, BLTs significantly reduced their usage of the higher strata when emission of alarms were higher ($p = 0.04$) (Figure 4).

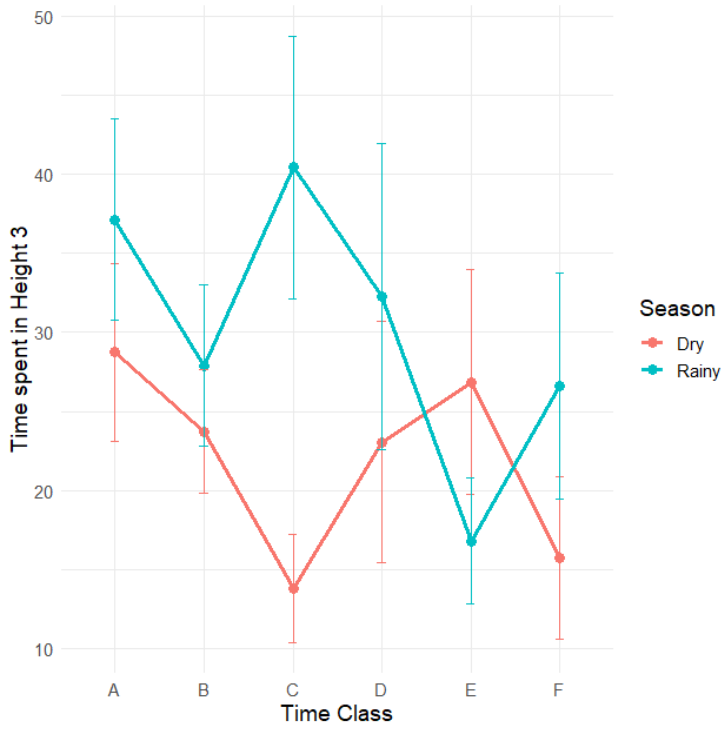

Figure 3. Percentage of use of height 3 by black lion tamarins throughout the day in both seasons (dry and rainy). Time classes divided in: A = 05:30 to 07:29 a.m.; B = 07:30 to 09:29 a.m.; C = 9:30 to 11:29 a.m.; D = 11:30 to 13:29; E = 13:30 to 15:29; and F = 15:30 to 17:29. Height class correspond to: H3 = 10-14 m.

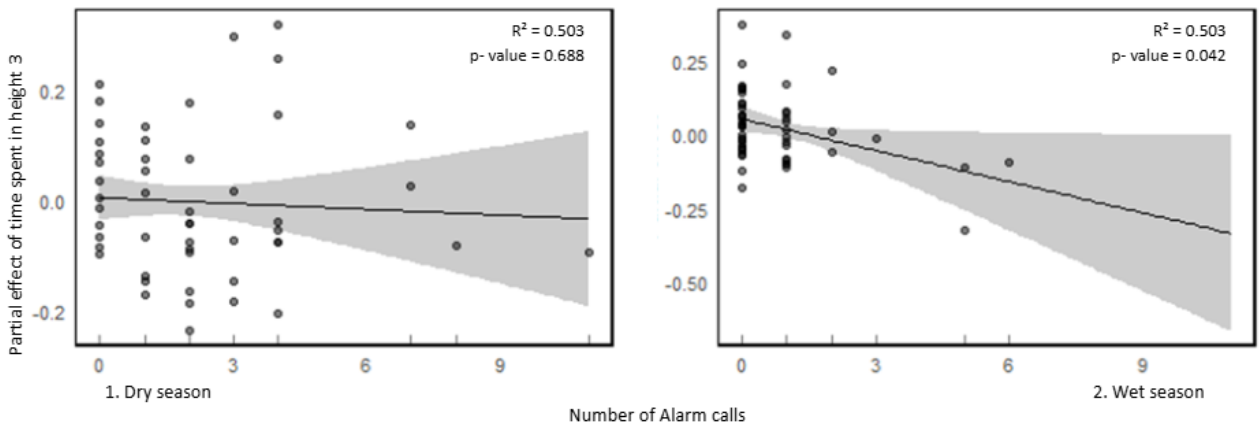

Figure 4. Results of Generalized Additive Model (GAM) testing if the proportion of time black lion tamarins spent in height 3 could be predicted by the number of alarm calls emitted in both dry (1) and rainy (2) seasons.

Overall, our camera traps recorded three potential predator species, totaling 33 detection events. Tayras (*Eira barbara*) corresponded to 29 registers, ocelots (*Leopardus pardalis*) corresponded to three, and pumas (*Puma concolor*) to one register. Camera trap data indicated a higher probability of predator activity during the earlier hours of BLT activity period (i.e., time classes A = 9,4%) (Figure 5). Accordingly, we found BLT to perform a significantly higher probability of silent movement when the probability of predator activity was also higher (i.e., dusk and dawn) (p = 0.012) (Figure 6).

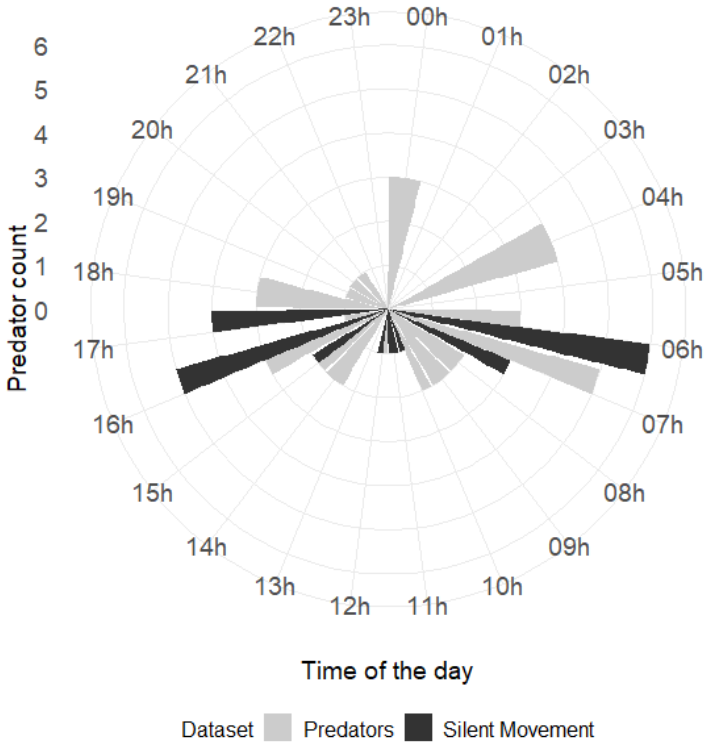

Figure 5. Number of records of predators throughout the day, in gray, estimated through 18 camera traps distributed across the home range of the group of black lion tamarins. Number of silent movement occurrences, in black, estimated using scan sampling method.

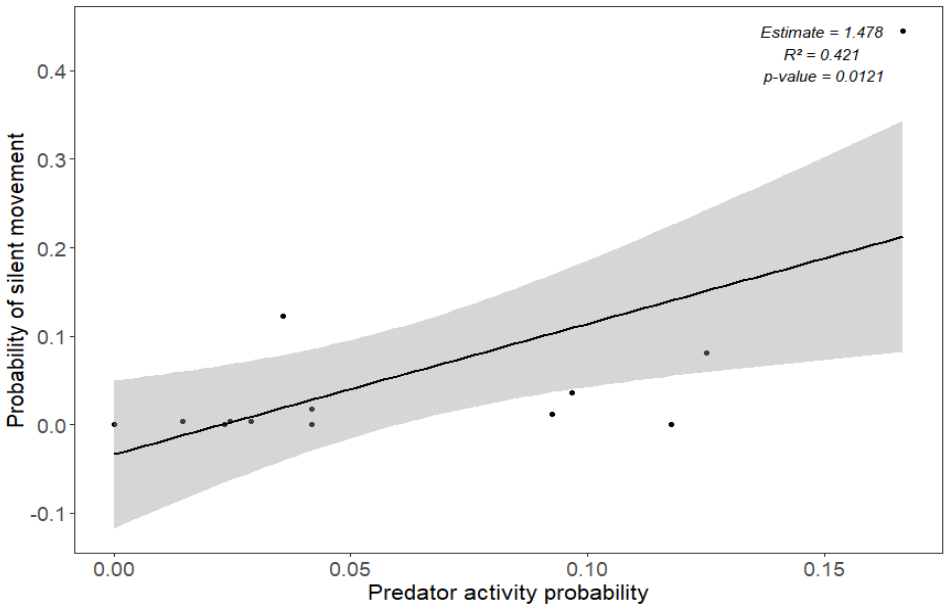

Figure 6. Results of a linear model testing if the probability of silent movement performed by black lion tamarins (BLTs) could be predicted by the probability of predator activity. Probability of predator activity estimated from the registers of 18 camera traps distributed across the home range of the BLT group.

4. DISCUSSION

We found risk perception to play a significant role in the daily activity of BLTs in a seasonal 100 ha forest fragment. Our results indicate that BLTs employ different strategies to evade or escape different predators while performing the activities necessary for their daily management. In a seasonal forest fragment, where the leaf coverage varies throughout the year, BLTs seemed to stay more alert while foraging and feeding on fruits in periods of higher exposure in the canopies. Also, we found the group to stay more silent during periods with higher probability of presence of terrestrial predators.

We found a higher frequency of alarm calls during the morning in both seasons. Considering that alarm calls are a vocalization associated with aerial threats in Callitrichids (Kleiman, 1988), our results suggest that BLTs tend to be more alert to

these threats in the morning in both seasons, period of the day in which raptors have been reported to be more active in the Atlantic Forest (Canuto, 2009). This time of the day also consists of the period in which BLT have a higher probability of foraging and feeding on fruits, leading to a possibly higher exposure to aerial predators in the canopies (Bufalo et al., in prep.). We also observed BLTs to display a significantly higher number of alarm calls in the dry season compared to the rainy season. In seasonal forests, canopy leaf coverage varies between seasons, being denser during the rainy period and sparser in the dry season (Morellato; Camargo; Gressler, 2013; Nunes *et al.*, 2020). Therefore, the seasonal variation in alarm frequency could be a consequence of a higher exposure and perception of risk in the canopy. Consequently, the observed variation on the frequency of alarm calls along the day and seasons suggests that BLTs are more vigilant in periods with higher raptors activity, especially in the dry season where the exposure in the canopy results in higher frequency of vigilance.

We found that BLTs spent less time in the higher levels of the forest in the dry season compared to the rainy season, although we did not observe a significant variation in the use of higher strata in response to the frequency of alarm calls in the dry season. This lack of variation in the use of higher levels of the forest in response to the frequency of emission of alarm calls could be a result of the reduction of leaf coverage, which increases the exposure of individuals in the canopy and consequently their perception of risk, irrespective of the time of the day. Contrastingly, we found that the use of the higher strata decreased in the rainy season as the frequency of the emission of alarm calls increased. Differently from the dry season, when BLTs seemed to emit higher amounts of alarm calls irrespective of vegetation height, our results suggest that in the rainy season BLTs avoided higher levels only when they perceived

higher risk (i.e., when there was higher raptor activity – morning). As primates tend to avoid areas where perceived risk is higher (Enstam; Isbell, 2004; Suscke; Presotto; Izar, 2021), our results suggest BLTs tend to change how they use the higher strata of the forest seasonally, according to the exposure of individuals and their consequence perception of risk.

We found that silent movement was positively associated with the periods of the day with higher terrestrial predator activity, which also corresponded to the moments of the higher BLT vulnerability when leaving or entering a sleeping site. This suggests a possible strategy to avoid detection by predators such as the tayra, the most often recorded predator of BLTs (Broom; Ruxton, 2005). This mustelid has even been observed attempting to prey on BLTs on two occasions during our fieldwork. Tayras are known to predate on primates due to their semi-arboreal and predominantly diurnal behavior (de Luna *et al.*, 2010; Payne *et al.*, 2024; Stafford; Murad Ferreira, 2008). Considering that BLTs enter a state of semi-torpor during the night (Rezende, 2022), avoiding being detected or even avoiding declaring the location of sleeping sites to possible predators could represent an important strategy for the survival of the individuals. These findings align with previous studies on other primates, which suggest that although not always the primary antipredator strategy, cryptic behaviors such as silent movement may play an important role in enabling small-bodied primates to evade terrestrial predators (Caine, 1987).

Aligned with other studies on the effects of predation and perception risk in habitat use in tropical primates, we found that BLTs' response to risk varies with the type of risk perceived, changing their habitat use pattern in response to predation risk while also adapting their behavior depending on where they are (Albernaz, 1997; de Almeida Rocha *et al.*, 2015; Enstam; Isbell, 2004).

5. CONCLUSION

With this study we show for the first time some important variation in how BLTs perceive and react to risks in their environment over time and to different predators. The frequency of alarm calls over time shows that there is a significantly higher perception of aerial risk during the morning, and an increase in vigilance behavior with the reduction of leaf coverage in tree canopies according to seasonality. The increase in vigilance leads to individuals alerting other group members of the possibility of predator presence more often. We also observed that BLT avoid canopy areas when the perception of aerial risk increases. The strategies to avoid risks associated with aerial predators were markedly different from the observed in relation to the behavioral adaptations used to avoid risks associated with terrestrial predators. As a possible strategy to avoid predation risk by terrestrial predators, we observed BLTs to perform cryptic behaviors in periods of the day of higher vulnerability—i.e., when entering a sleeping site, in the end of the day, or when leaving it at the early morning. Our results suggest that BLTs have different responses to different risks, revealing variation in how this small primate reacts to the landscape of fear. With this study, we provide evidence that risk perception plays an important role in shaping space use in a small Endangered primate living in a forest fragment.

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APPENDIX

Table S1. Adapted ethogram for the study of black-lion-tamarins (*Leontopithecus chrysopygus*) conducted by the "Laboratório de Primatologia da Unesp" (LaP), Rio Claro campus.

Scan sampling			
Behavior		**Definition**	**Abbrev.**
Moving	Traveling	Individual moving quickly, in line, showing a clear direction/objective	M_T
	Feed-moving	Individual moving without clear direction, switching to foraging behaviors along the way	M_TF
	Silent moving	Individual moving slowly and carefully, without vocalizations	M_TS
Frugivory		Individual searching for or ingesting fruits in a feeding tree	FRU
Gummivory		Individual feeding on gum or biting tree barks to induce the exudation of sap	GUM
Foraging		Individual searching for or feeding on animal prey	FOR
Affiliative behavior - grooming		Individuals in direct social interactions, such as grooming or copulation (but except play)	AFG

Affiliative behavior - play	Individuals chasing one another without aggression or having positive and active nonsexual contact	AFP
Intra-group agonistic behavior	Individual displaying vocalizations and/or aggressions to individuals from its group	AGIN
Inter-group agonistic behavior	Individual displaying vocalizations and/or aggressions to individuals from another group	AGOUT
Long calling – inter-group	3-phrase long call composed by a series of 'wah-wahs', followed by 'descending whines', and a repetition of 'clucks'. Emitted during inter-group encounters. Associated to territory defense	.LC_OUT
Long calling – intra-group	2-phrase long call composed by a series of 'wah-wahs' followed by 'descending whines'. Emitted when individuals become separated from the group. Also observed when group aims to declare presence in the territory	.LC_IN
Scent marking	Individual rapidly rubbing pelvic and thoracic glands against environmental structures	SM
Fur rubbing	Individual rubbing the body against cabreuva's balsam (or another species)	FR
Resting	Individual lie down with eyes closed	R
Inactive	Individual is stationary, with eyes open, and may present vocalizations or vigilant behavior	I
Unknown	Behavior cannot be assessed due to lack of visibility	U