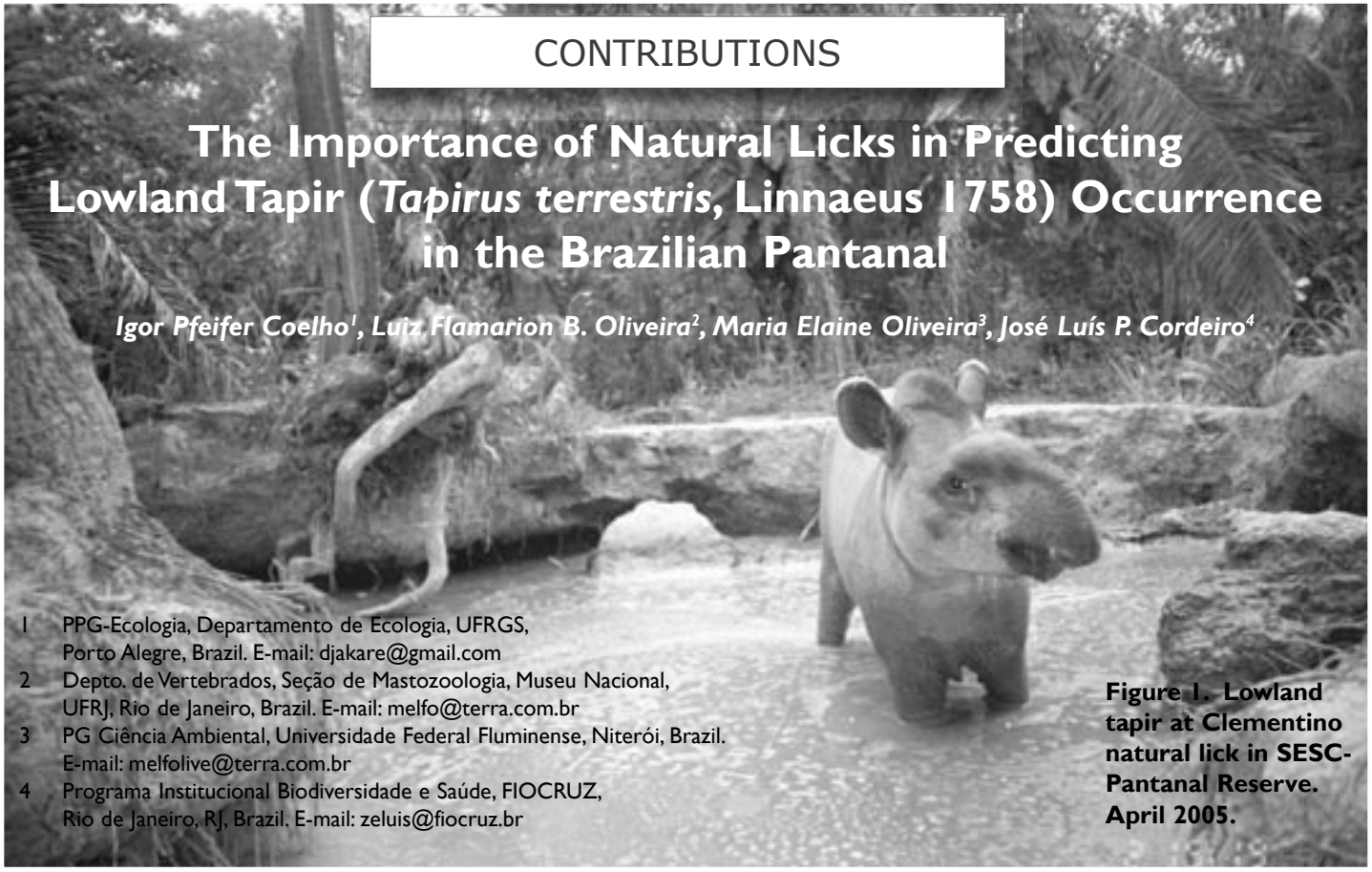


CONTRIBUTIONS

The Importance of Natural Licks in Predicting Lowland Tapir (*Tapirus terrestris*, Linnaeus 1758) Occurrence in the Brazilian Pantanal

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Figure 1. Lowland tapir at Clementino natural lick in SESC-Pantanal Reserve. April 2005.

Abstract

In the northeastern Brazilian Pantanal, lowland tapirs (*Tapirus terrestris*) regularly visit natural licks to eat soil and drink water. Here, we evaluate the importance of natural licks in predicting tapir presence in the region. We examined the relationship between the frequency of use of eight natural licks by tapirs and land cover composition at three spatial scales. We also test the relationship between frequency of use of licks and tapir probabilities of occurrence in areas surrounding natural licks (based on a landscape habitat model). Areas with similar landscape composition presented different intensity of use of the natural licks and areas with low occurrence probability exhibited high intensity of use. The results indicate that natural licks are discrete landscape units important to the occurrence of *T. terrestris* in the region and should be incorporated into models of local species' distribution.

Keywords: *Tapirus terrestris*, habitat scale, natural licks, Pantanal, species occurrence

Introduction

Predicting the occurrence and distribution of organisms is a very important step towards effective conservation strategies. Such information is essential in, for instance, identifying priority conservation areas. In-depth assessments of species' habitat requirements need to evaluate habitat preferences and species responses across multiple spatial scales (Wiens 2002). This is because organisms respond to environmental changes at different scales and hierarchical levels. The response at each scale is dependent on life history traits (Bissonette et al. 1997; Hobbs 2003). The finest spatial unit that an organism perceives habitat heterogeneity (grain) is defined by physiological and perceptual abilities. The coarser scale of heterogeneity to which an organism responds (extent) is determined by the lifetime home range of the individual (Kotliar & Wiens 1990). However, evaluating coarser scales than an organism's home range is relevant, because patterns and process emerging in such spatial resolutions can affect habitat selection by individuals (Bissonete et al. 1997).

Ungulates are able to respond to landscape heterogeneity across a broad range of scales because

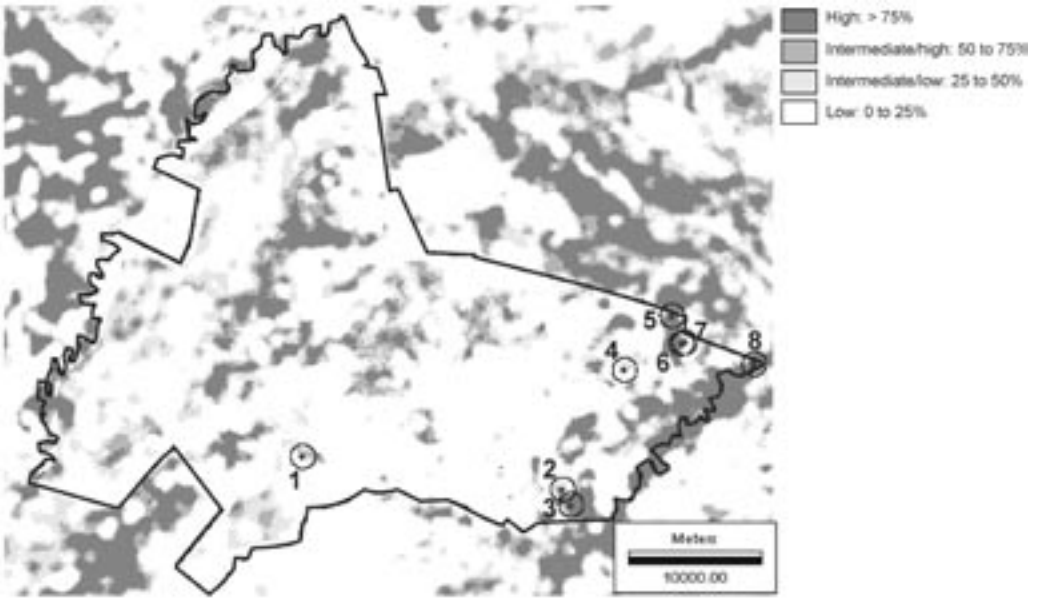


Figure 2. Occurrence probabilities of tapirs in SESC-Pantanal Reserve (modified from Cordeiro, 2004). Representation of 900 m radius size areas centered at eight natural licks: 1) Clementino, 2) Novateiro, 3) Morcegos, 4) Catraca, 5) Farofa, 6) Figueira, 7) Acauã and 8) Sal.

of their high mobility (Fragoso 1999; Hobbs 2003). The lowland tapir (*Tapirus terrestris,* Linnaeus 1758) weights about 250kg and inhabits a range of habitats in South America (Emmons & Feer 1997). The IUCN Red List of Threatened Species classifies the lowland tapir as Vulnerable (IUCN 2007). Tapirs feed on leaves, fruits and fibers; palm fruits (Arecaceae) are the main dietary component in many regions (Bodmer 1990; Fragoso 1997; Henry et al. 2000; Galleti et al. 2001). Thus, palm forests are thought to be important tapir habitat (Brooks et al. 1997). In the northeastern Brazilian Pantanal, tapirs show high preference for Acuri forests (*Scheelea phalerata*, Arecaceae) when compared to other vegetation types. Accordingly, potential tapir distribution models demonstrate high occurrence probabilities in such habitat areas (Cordeiro 2004).

Another important resource for many tapir populations is natural licks (lowland areas with little vegetation cover and moist soils, Figure 1) where the animals eat soil and/or drink water (Emmons & Feer 1997; Noss et al. 2003; Montenegro 2004; Coelho 2006). Although the reasons for soil consumption are not well understood, tapirs probably search for mineral supplementation and/or detoxification of plant's secondary compounds. Among 37 vertebrate species, white-lipped peccaries and tapirs are the most frequent visitors of natural licks in northeastern Brazilian Pantanal (Coelho 2006), suggesting that licks are important components of tapir habitat in the region. Licks are found in different land cover settings and may be such an important resource that the surrounding land cover would have no effect on tapir visitation rates.

We evaluated the importance of natural licks, as landscape elements, in predicting occurrence of tapirs in a reserve in northeastern Brazilian Pantanal. We hypothesized that licks are important habitat units at a fine scale relative to landscape components at the patch level, thus we expect that: (1) there is no correlation between natural licks' frequency of use by tapirs and licks' surrounding landscape composition, and (2) there will be no correlation between natural licks' frequency of use and tapir occurrence in surrounding areas (based on relationships between the species and vegetation cover classes).

Methods

The Brazilian Pantanal, a 140,000 km^2 wetland, is a sedimentary plain located in the upper Paraguay River basin. This study took place in the Natural Private Reserve SESC-Pantanal (16°41' S, 56°16' W), Mato Grosso State. The Reserve covers 1,070 km^2 and is recognized as a Priority Area for the conservation of the Pantanal's biodiversity (BDT 1998) and as a RAMSAR site (RAMSAR 2004). During the rainy season, from January to April, rainfall and overflow of the Cuiabá and São Lourenço rivers flood parts of the Reserve. During the dry season, from June to September, fires usually occur in the region. Nine vegetation physiognomies were identified in the Reserve (Cordeiro 2004): grassland with murunduns (where tree clusters are found on elevated hills normally associated with termite mounds, locally called *murunduns*), Cambara forest (seasonal flooded forests dominated by *Vochysia divergens,* Vochysiaceae), dense forest (mostly along the margins of rivers), Corixo forest (flooded forest vegetation along seasonal streams, locally known as *corixos*), Acuri forest (forest with the understory dominated by *Scheelea phalerata*, Arecaceae), dry

forest (forest with sparse trees and low developed understory), Taboca (forest with sparse trees and understory dominated by *Guadua* sp., Poaceae), mixed (grassland and forested transition physiognomies), shrub, open grasslands, and pasture (grassland covered by the nonnative *Brachyaria humidicola*, Poaceae).

We analyzed a sample of eight natural licks at three spatial scales. Land cover surrounding natural licks was defined from a classified satellite image (Cordeiro 2004). Some land cover types were grouped into one category (e.g., grassland with murunduns, grassland with small murunduns and grassland with murunduns over humid soil, were all considered as grassland with murunduns; Table 1). We estimated the area of each land cover type surrounding licks in buffers of 120, 510 and 900 m radius (numbers divisible by 30 m, the pixel resolution) centered at each lick. For each buffer size we used NMDS (Nonmetric multidimensional scaling) ordination analysis (Legendre & Legendre 1998) to characterize the main trends of variation in land cover composition. An index of frequency of use (IU = time of use / sampling time) was estimated using camera trap sightings between February-April and July-September 2005 (Coelho 2006).

We estimated the probability of occurrence of tapirs in the buffer zones using a habitat model for the species in the SESC-Pantanal Reserve (Cordeiro 2004). The model considers tapir preferences for each different land cover type (based on line transect abundance estimates) to generate a raster image (through logistic regression) where pixels correspond to the probability of tapir presence in a 500 m radius. Using the same buffer areas above, we calculated mean probabilities of tapir occurrence in areas surrounding each sampled lick (PO = sum of total pixels probabilities / number of pixels). Because of the peripheral location of some licks, we applied the model to areas adjacent to the Reserve (Figure 2).

The buffers result in 0.04, 0.8 and 2.5 km^2 areas, respectively. These values are within the range of estimates of home ranges size for tapirs (1.9 up to 3 km^2 in the Bolivian Chaco; Noss et al. 2003). Larger areas were not considered because of the proximity among licks. Because Acauã and Figueira licks are located very close to each other (Figure 2) both were analyzed as one sampling unit at 510 and 900 m scales. In this case, a corrected mean was used to estimate the index of use and the buffers were centered at the largest natural lick (Figueira). Even though at the 900 m scale, a small overlap area appeared between Novateiro and Morcegos licks (Figure 2), the areas were kept separate.

We calculated simple linear correlations (r, Pearson's coefficient) between IU and land cover composition (defined by the principal axis of the NMDS; Table 1), and between the IU and mean probabilities of occurrence (PO). Analyses were carried out using Statistica (StatSoft 2004) and Idrisi 32 (ClarkLabs 2002) software and significance was assessed at α=0.05 level.

Table 1. Observed correlation coefficients between first ordination axis (NMDS) and land cover classes of areas surrounding natural licks at three radii sizes. Significant values are presented in bold.

Land Cover Classes	120 m	510 m	900 m
Dense Forest	-0.33	-0.48	-0.49
Acuri Forest	**-0.98**	**-0.99**	**-0.98**
Dry Forest	**-0.83**	**0.85**	**0.89**
Tabocal	0.31	0.67	0.64
Mixed	**0.98**	0.71	**0.76**
Shrub		-0.64	**-0.78**
Grassland with Murundum	-0.21	0.36	0.4
Pasture			-0.36
Open Grassland		0.08	0.21
Bared Soil			-0.33
Water / Shadow		-0.35	-0.34

Results and Discussion

At all three examined scales, land cover composition surrounding licks were described by gradients especially associated to Acuri forests and dry forests (Table 1). Mixed land cover was highly correlated with the first NMDS axis at 120 m and 900 m buffers and shrub was highly correlated with the first axis at 900 m.

We did not find a significant association between frequency of use of licks and surrounding land cover composition at any of the examined scales (Figure 3). Instead, the observed curves show high IU values for licks in either dry forests or Acuri forests, and low values for intermediate cover types (Figure 3B and C). However, Cordeiro (2004) found that tapirs have a low preference for dry forests, which are dominant around the Clementino and Catraca licks. Thus, the licks are likely responsible for the high frequency of use registered at such sites. Nevertheless, Sal, Morcegos and Farofa licks are also surrounded by dry forest, but had low IU values (Figure 3A, B and C). These results suggest that land cover composition is likely not a significant factor determining the use of licks by tapirs, and natural licks constitute an attractive area for tapirs independently of neighboring landscape conditions.

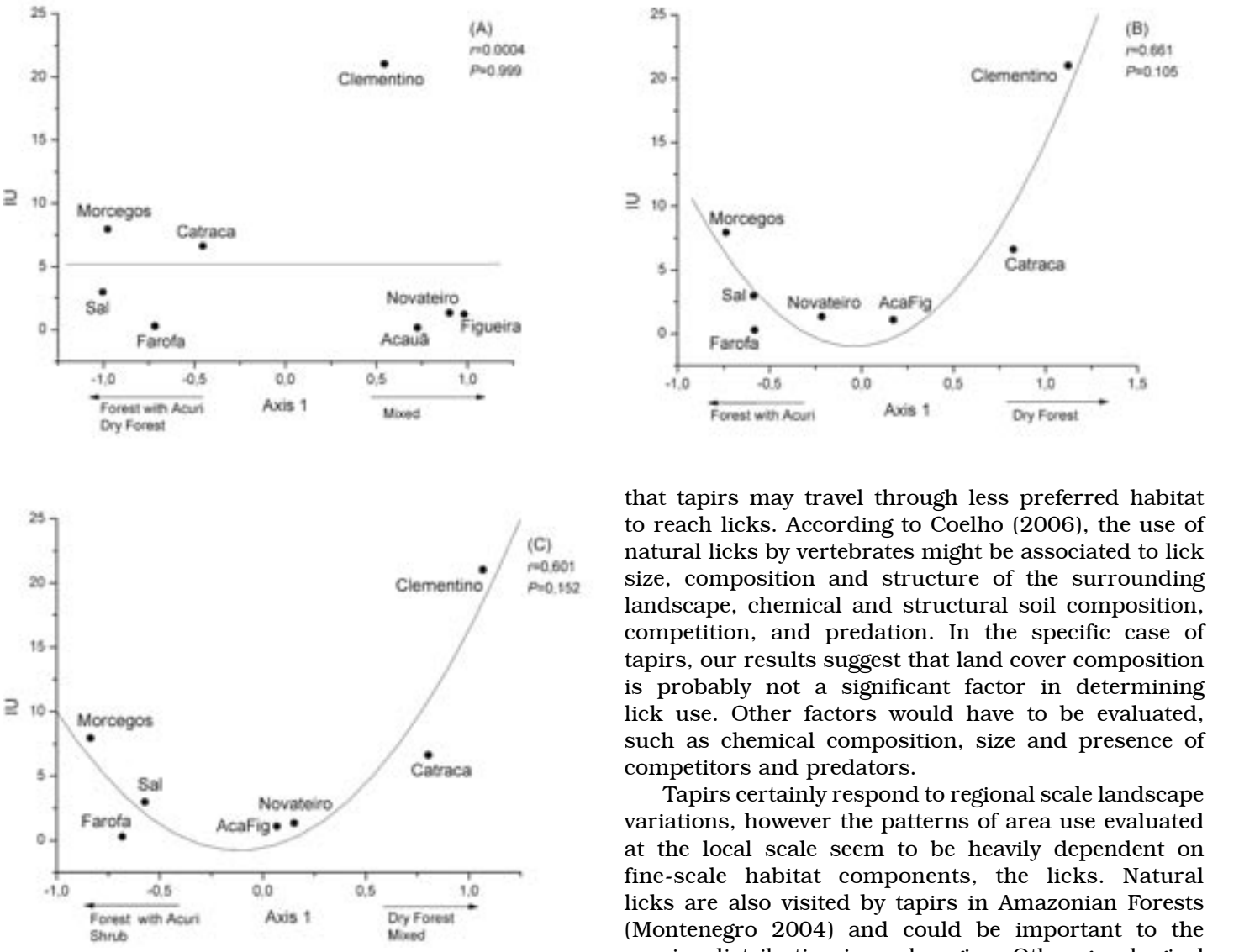


Figure 3. Relationships between frequency of use of natural licks (IU) by tapirs and landscape composition of surrounding areas (Axis 1, NMDS) across three radii: (A) 120 m, (B) 510 m and (C) 900 m. Correlation coefficients (r) represent linear relationships; polynomial curves are presented for interpretation. Linear correlation at 510 and 900 m were tested by log transforming the data.

Even though, we did not observe significant associations between frequency of visitation of licks and probabilities of tapir occurrence, there was a trend of low values of IU associated with high values of PO (e.g., Figueira and Farofa licks at 120 m scale; Figure 4) suggesting that tapirs, even being locally abundant, may seldom visit these licks. On the other hand, the existence of high IU values in low PO zones (e.g., Clementino and Catraca licks; Figure 4), suggests that tapirs may travel through less preferred habitat to reach licks. According to Coelho (2006), the use of natural licks by vertebrates might be associated to lick size, composition and structure of the surrounding landscape, chemical and structural soil composition, competition, and predation. In the specific case of tapirs, our results suggest that land cover composition is probably not a significant factor in determining lick use. Other factors would have to be evaluated, such as chemical composition, size and presence of competitors and predators.

Tapirs certainly respond to regional scale landscape variations, however the patterns of area use evaluated at the local scale seem to be heavily dependent on fine-scale habitat components, the licks. Natural licks are also visited by tapirs in Amazonian Forests (Montenegro 2004) and could be important to the species distribution in such region. Other geophagical sites (like riverbanks and rocks), and ponds could also be discrete habitat units related to local tapir densities across its range in different environments such as Cerrado, Caatinga, Chaco and the Atlantic Forest. Once identified in the mosaic of regional habitats, these sites should be included in potential distribution models and its contribution to tapir occurrence can be quantified related to other landscape elements.

Information regarding species/habitat relationships and the application of models are useless if they are not associated to a particular spatial scale or application (Wiens 2002). Considering applications at the national and global scales, associations between tapirs and landscape components at the patch level (as defined by vegetation physiognomies) can be enough to predict species occurrence. However, at the local scale, relationships between organisms and specific habitat components improve model precision, allowing for finer detailed habitat descriptions and conservation action planning for tapirs.

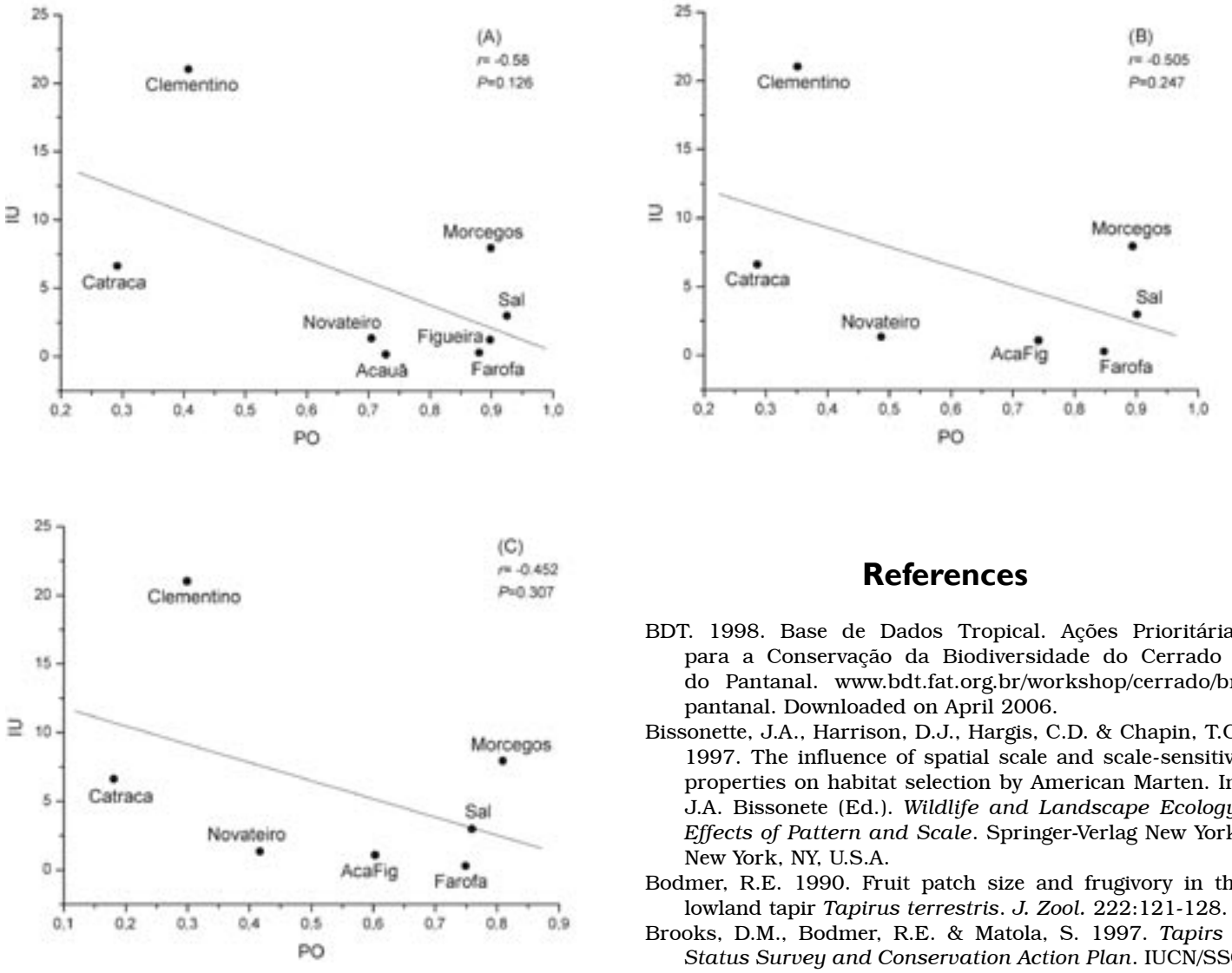


Figure 4. Relationships between frequency of use of natural licks by tapirs (IU) and mean probability of occurrence (PO) across circular areas with radius: (A) 120 m, (B) 510 m and (C) 900 m.

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Does Moonlight affect the Use of Natural Licks by Lowland Tapir (*Tapirus terrestris* Linnaeus, 1758) in the Northeastern Brazilian Pantanal?

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Abstract

We evaluated possible effects of moonlight on frequency of use of three natural licks by lowland tapirs (*Tapirus terrestris*) in the Brazilian Pantanal. Neither lunar phobia nor philia were detected. The frequency of use by tapirs (estimated by camera traps) during different classes of moonlight intensity varied between natural licks, but a similar frequency was observed across all moonlight classes when combining data across all licks. Further studies of activity patterns in lowland tapir in regards to moonlight intensities in other regions of the species' distribution are needed to elucidate if the absence of lunar phobia/philia is a local or a general pattern for the species.

Keywords: *Tapirus terrestris*, activity patterns, lunar, moonlight, Pantanal

Introduction

Species of mammals from diverse groups, such as rodents, rabbits, primates, carnivores, and bats, display nocturnal activity patterns and behaviors related to moonlight intensity. Several studies suggest that lunar phobia is a result of a higher predation risk during moonlit nights (Julien-Laferriere 1997; Leaver 2004; Griffin et al. 2005). Studies looking at the relationships between moonlight and bat behavior suggest lunar phobia as an adaptation to high predation risk by visually oriented predators, like owls and hawks (Meyer et al. 2004) and higher availability of prey (katydids) during dark periods (Lang et al. 2006). Large predators can also present lunar phobia and the mechanism involved in predator-prey relationship remains unclear. For example, in central Brazil the maned wolf (*Chrysocyon brachyurus*) reduces its activity during the full moon, probably as a response to reduced prey (rodents) availability (Sábato et al. 2006).