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Activity patterns and habitat selection by terrestrial mammals in a mosaic landscape of silvopastoral system and forest fragments in the Andean piedmont in Colombia

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Abstract

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Traditional livestock ranching impacts biodiversity by fragmenting and isolating habitats first as habitat loss, then as habitat isolation, affecting local fauna that occupies native habitats that rely on forest. In degraded areas, silvopastoral systems (SPS) are an agroforestry practice that integrates trees and livestock and they could provide new habitats for this fauna, though their effects are not well understood for Neotropical mammalian assemblages. This study assessed habitat selection and activity patterns in the Andes piedmont of Colombia. Using camera traps, we evaluated records in an intervened area, which was located around two fragments of native forest. A total of 17 mammal species were recorded, with 5 species using the SPS, of which *Cerdocyon thous* was exclusive to the SPS, whereas 12 species were found only in the forest, including six carnivorous species. Two anteater species showed overlapping activity in the forest but different patterns in the SPS. Despite more anteater records in the forest, both species selected the SPS. These results suggest that SPS could benefit certain species and alter interactions among Neotropical mammals.

Keywords

agroforestry system, Andean piedmont, anteaters, livestock farming, Orinoquia

Introduction

Human activities such as cattle ranching and agriculture are among the main causes of loss of natural habitats, affecting ecological processes and biodiversity (Dudley and Alexander, 2017). In many regions, land-use change driven by productive activities such agriculture and monoculture plantations and commercial forest has significantly reduced and fragmented natural habitats (Chaudhary et al., 2016). Among these activities, livestock production plays a particularly important role, and it is estimated that between the years 2000 and 2030, meat consumption will increase by 68% (Alexandratos et al., 2006), which will increase the transformation of forests into pastures (Van Huis, 2013). In countries such as Colombia, livestock production represents approximately 1.4% of GDP and about 14 million hectares of the country are dedicated to this activity (Etter and Zuluaga, 2017; Igac, 2017). Also, 60% of deforestation in Colombia is a consequence of cattle ranching by replacing forests and natural savannahs (Romero and García Romero, 2013). For this reason, there is a need for alternatives to reduce the negative impacts of cattle ranching on biodiversity, while maintaining productivity. One of these alternatives are the silvopastoral systems (SPS). SPSs is a type of habitat that mix trees and/or shrubs with grasslands to rise livestock, seeking to reduce open areas by implementing in the system live fences, scattered trees or fragments of forests in different arrangements (Murgueitio, 2005). SPS have proven to decrease soil compaction, and improve the regulation of

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local water cycles, in addition to providing shade and forage for livestock (Harvey, 2003). In addition to this, SPS promote soil and insect diversity (Giraldo et al., 2011) promoting interactions at the ecosystem level. Nevertheless, knowledge about the response of the Neotropical mammals to SPS is limited.

Studies in several localities in Mexico and Nicaragua report SPS function as areas that promote the establishment of native vegetation and serve as habitats for terrestrial mammals (Estrada et al., 1994; González Valdivia, 2003). In the Colombian Caribbean, there is evidence that the diversity of phyllostomid bats to be higher in SPS than in conventional pastures (Ballesteros Correa, 2015), and the fruit bat *Artibeus lituratus* had better body condition in SPS than in conventional systems. However, some bats species in SPS accumulate heavy metals due to the use of agrochemicals (Chacón-Pacheco and Ballesteros-Correa, 2019; Racero-Casarrubia et al., 2017). In the Andean foothills in Colombia, aerial insectivorous bats can use forests, SPS, and grasslands, but there is a differential use of space depending on the species and most of the insectivorous bats preferred the grasslands (Hernández Leal et al., 2021). Another study in the Colombian Caribbean in a SPS with grasslands and forest fragments, showed that maintaining forest corridors within the cattle landscape provides areas that favor the presence of native carnivores (Pineda-Guerrero et al., 2015). Most of the studies about the effects of SPS on Neotropical mammals have aimed to measure effects on responses at ensemble or assemblage levels. However, the effects of agroforestry arrangements on Neotropical mammals may well include changes in the diversity and abundance of species, as well as effects on ecologically relevant variables such as habitat and time use (Beca et al., 2017; Ramírez-Mejía and Sánchez, 2016), whose answers have not been fully understood.

Habitat selection predicts the likelihood of an animal being found in a specific habitat type, serving as a key tool in ecological research to understand species distributions and asses the impacts of habitat changes (Avgar et al., 2017). Species that share resources with others can partition the use of time or space as mechanisms to reduce competition, and therefore may facilitate their coexistence (Abramsky et al., 2001; Di Bitetti et al., 2013; Kotler et al., 1991). Also, changes in landcovers may affect the interactions between species because they can alter resource availability, modify movement patterns, and change predator-prey dynamics, which may be detected via changes in the use of space and/or time. Currently, there is a need to evaluate how biodiversity reacts to changes caused by multiple human activities. The responses of biodiversity to changes in the landscape measured as population size, composition or diversity are considerably slower than those related to behavioral indicators such as habitat use and foraging as a type of resources, and also fragmentation. Indeed, behavioral responses are cost-effective indicators which allow to detect the effects of changes in the environment on biodiversity in a short time (Lindell, 2008; Morris et al., 2009). Therefore, may be advantageous to those interested in the management of rural systems to have indicators that will provide information of how the modifications done to a productive system affect a species or group of species in particular. In the light of all the above, and as a way to fill those information gaps we evaluated the responses of native mammals to a small SPS in a Neotropical rural area. Particularly, we compared the behavioral response, in terms of the use of time and space, of mammals in a SPS and two adjacent native forest fragments and near pastures for cattle in the Andean foothills of Colombia. We tested whether the mammals perceive these covers as different habitats, and consequently show in their habitat selection and activity patterns even with the small size of the SPS.

Materials and methods

Study area

We did the study at Finca La Rosanía, municipality of San Luis de Cubarral, department of Meta, the Andean piedmont of Colombia; coordinates 3°50’17.34”N, 73°30’19.7”W, between 600 and 800 m asl. (Fig. 1). The municipality has an annual rainfall of 2,000–4,000 mm and average annual temperature of the air varies between 20–27 °C (Callejas Ávila, 2017; González Rey, 2017). Precipitation has a bi-seasonal, unimodal pattern with a dry season between December and February, and a rainy season between March and November; 10-year IDEAM data, station: 32060030 (IDEAM, 2017). At La Rosanía, there was a SPS adjacent to two forest fragments, and there were also pastures for cattle (Fig. 1). The SPS was 3–4 years old at the time of the study, had 1 ha planted with ~5 m tall *Mimosa trianae* and *Acacia magium* trees; there was a distance of 4–6 m between neighboring trees. The two rainforest fragments covered 67 ha and had an upper stratum of 12–25 m trees, a medium stratum of 5–12 m trees, and an understory made of 1.5–5 m herbs, shrubs and small trees (Rangel-Ch and Velázquez, 1997). The matrix surrounding the evaluated habitats mainly consists of pasture areas for cattle ranching and remnants of forest. The silvopastoral system included in this study was the only available and accessible area of its kind within the study region at the time of sampling. As such, it was selected to represent this land cover type despite its limited spatial extent.

Data collection

We did four visits to the study site in February, June, and October–December of 2017. On each campaign; first two campaigns were 18 days and the last ones one month each. We installed 19 camera traps from three different manufacturers; seven Bushnell Trophy Cam© standard edition, six Trophy Cam HD©, and six Moultrie Game spy A-5Gen2©. The cameras were installed in two groups, one group with 10 camera traps in the SPS, and another group of nine cameras in the forest fragments. In each field trip the cameras were moved to a different location.

We placed the cameras on trees, approximately 30 cm above the ground; within the silvopastoral system, cameras were spaced approximately 50–100 meters apart due to the limited size of the area. In the forest, cameras were

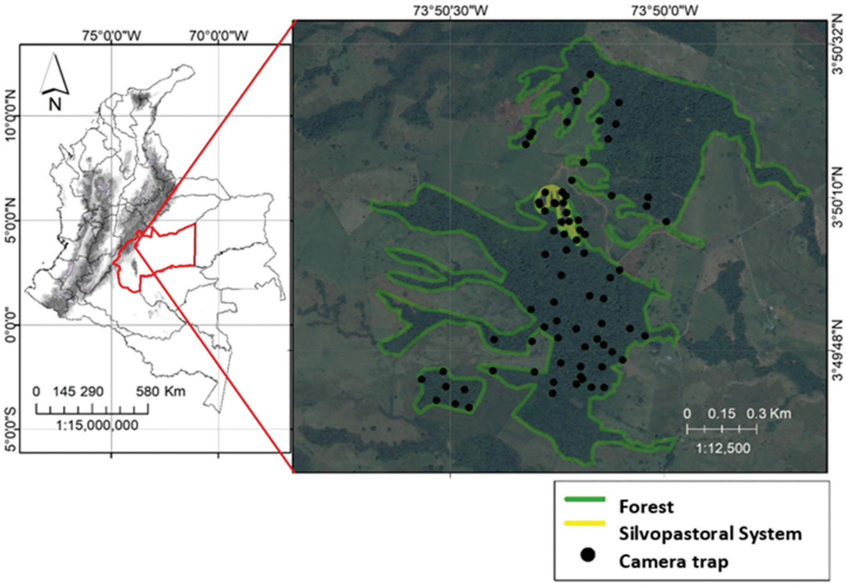

Fig. 1. Livestock landscape in the municipality of Cubarral, Meta, Colombia, with a silvopastoral system area of 1 ha adjacent to two forest fragments (67 ha). The farm is located at an altitude between 600–800 m asl. The points on the map correspond to the location of the camera traps along the study. Satellite image obtained through Google Earth (February, 2018).

placed between 100 and 150 meters apart, prioritizing locations where mammal spoor. Only in the first sampling we used sardines as bait, as a way to increase detectability (Siegfried et al., 2024). We set the cameras to take three consecutive photos at one-second intervals after the motion sensor was activated. The number of independent records per species was defined as consecutive records taken with at least 60 minutes of difference in a particular landcover (Srbek-Araujo and Chiarello, 2005). We identified the photographs based on field guides and specialized literature (Emmons and Feer, 1997; Ramírez-Chaves et al., 2016; Tirira, 2007). The images were organized using the WildId software version 0.9.31, (Fegraus et al., 2011), and the following metadata were associated with each image: taxonomic identification, date, time, and location.

Habitat selection

We used Manly's selection coefficient (Wi), which indicates preference when its value is greater than 1, neutral use when equal to 1, and avoidance when less than 1 (Manly et al., 2002).The preference or avoidance was tested for each habitat, and the differences between selection ratios were calculated and tested using a χ^2 test. We measured habitat use as the number of independent records per species. To calculate the habitat available, we used a Google Earth image from the year 2018. We calculated the Manly selectivity measure using the wi function from the *adehabitatHS* package, the selection index ± 95% confidence interval is presented (Calenge, 2006) in the R software (Team, 2020).

Activity patterns

We used the R package "Overlap" to obtain activity patterns. Overlap fits density functions to the times of animal observations (Ridout and Linkie, 2009), and calculates the coefficient Δ1, which is calculated from vectors of densities estimated at *t* equally spaced times, between 0 and 2π (Meredith et al., 2021). Δ1 is a quantitative measure that goes from 0, which indicates no overlap, to 1, indicating identical activity patterns. Δ1 is appropriate for small samples and we obtained 95% confidence intervals based on 1,000 bootstrap resamples (Meredith et al., 2014).

Results

During the study, our sampling effort was of 1,290 camera × nights in the SPS and 1,161 camera × nights in the two forest fragments. We registered a total 17 species of mammals from six orders of mammals, records per species: *T. tetradactyla* 32, *M. tridactyla* 24, *Philander cf canus* 26, *S. cassiquiarensis* 25, *D. marsupialis* 14, *E. Barbara* 11, *C. paca*, *P. cancrivorous* and *L. pardalis* with 8, *C. thous* 7, *S. granatensis* 5, *P. concolor*, *L. wiedii* 4, *D. novemcinctus*, *P. yagoarundi* 3, *C. unicinctus* 2, and *G. vittata* 1. The order with the highest number of species was Carnivora with eight species, whereas Didelphimorphia, Pilosa, Cingulata, and Rodentia were represented with two species each. Primates had one species, *Saimiri cassiquiarensis* (Fig. 2). The forest fragments had 16 species and 12 were unique to this landcover. In the SPS, we recorded only five species: *Didelphis marsupialis*, *Myrmecophaga tridactyla*, *Tamandua tetradactyla*, *Cerdocyon thous, Eira barbara*; *C. thous* was exclusive to the SPS. The relative abundance of the five species found in the SPS and the forests was higher in the later cover (Fig. 2).

Habitat selection

Twelve species were only found in the forest fragments and consequently, the Manly index indicated that they preferred this habitat, whereas *C. thous* was exclusive to the SPS. Despite the higher number of records in the forest,

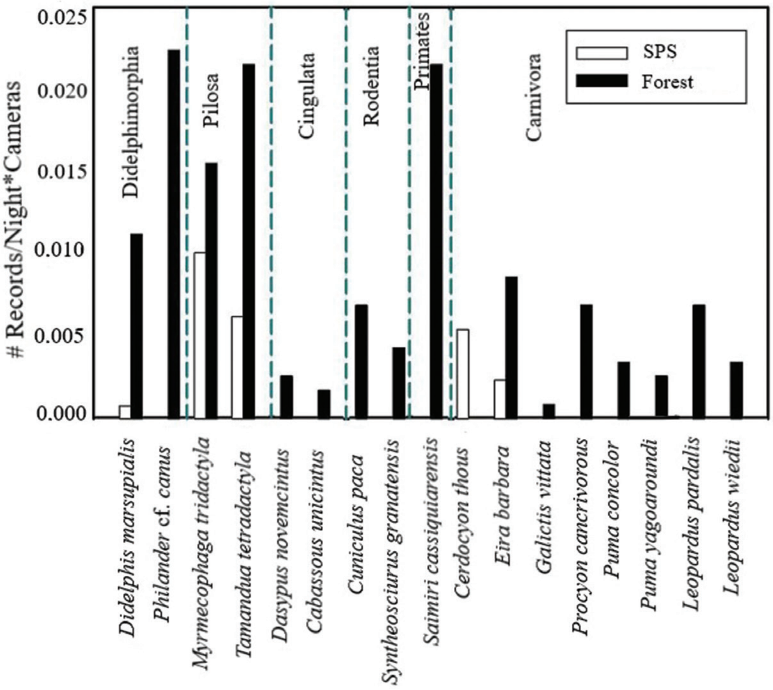

Fig. 2. Relative abundance, measured as the number of records/camera traps × sampling nights, of six orders of terrestrial mammals in a silvopastoral system (SPS) and two adjacent forest patches in the Colombian foothills. Carnivora was the order with most species in the study and only five species of mammals used the SPS.

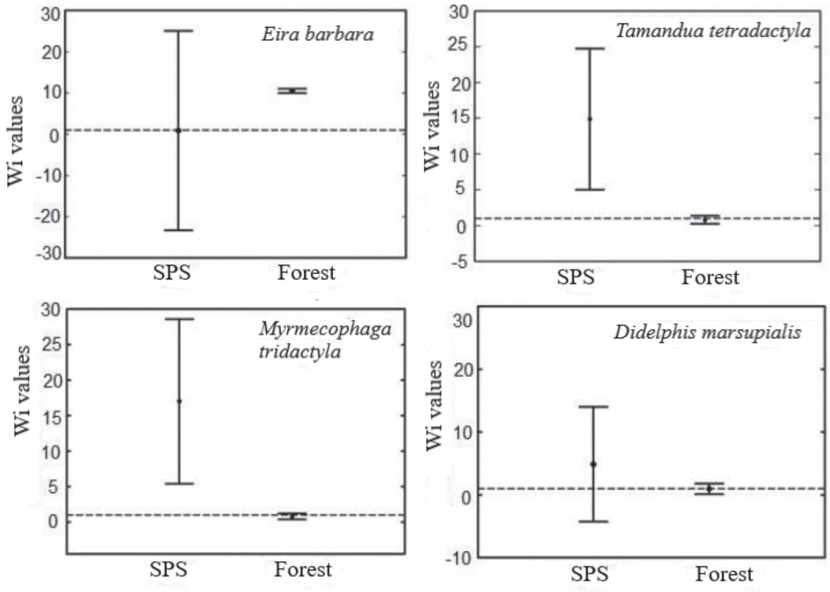

Fig. 3. Habitat selection by species recorded in a livestock landscape with a silvopastoral system (SPS) and two adjacent forest patches in the Colombian foothills, based on the Manly index for four mammals. The selection index ± 95% confidence interval is presented; the dotted line corresponds to an index = 1, which indicates that there is no selection. Note that each graph has a different scale on the ordinate axis.

Table 1. Manly selection index for the four species registered in the silvopastoral system

Wi	*Eira barbara*	*Tamandua tetradactyla*	*Myrmercophaga tridactyla*	*Didelphis marsupialis*
Silvopastoral	10.46	14.88	17.00	4.86
Forest	0.859	0.793	0.761	0.942
Chi^2	4.07	11.7	1.2	1.17

only one species, *E. barbara*, selected the forest and used the SPS proportionally to its availability. In contrast, anteater species, *M. tridactyla* and *T. tetradactyla* selected the SPS, and we found no evidence that *Didelphis marsupialis* selected any of the landcovers (Fig. 3) (Table 1).

Activity patterns

We had enough observations to evaluate the activity patterns of five species: *T. tetradactyla*, *M. tridactyla*, *D. marsupialis*, *E. barbara*, and *Philander* cf. *canus* (Fig. 4). In the SPS, *T. tetradactyla* had the greatest number of records between 00:00–06:00 h and had two activity peaks around 12:00 h and 18:00 h, whereas in the forest there were three periods with most of the activity: 00:00–06:00 h, 08:00–15:00 h, and 18:00–24:00 h. The overlap coefficient of this species in the two coverages was 0.570 (95% confidence interval [95% CI] = 0.37–0.8). The giant anteater *M. tridactyla* was mostly active from 15:00 h to 12:00 h on the plantation, whereas in the forest was mainly nocturnal, with activity from 18:00 h to 24:00 h and the overlap coefficient for the two coverages was 0.536 (95% CI = 0.33–0.86). The comparison of the activity patterns of the two anteater species indicates a differential use of the two covers, with a low overlap in the SPS (Δ1 = 0.191 95% CI = –0.12–0.42; Fig. 4a) and high overlap in the forest (Δ1 = 0.786 95% CI = 0. 71–1.03; Fig. 4a).

In the forest, *D. marsupialis* showed a nocturnal activity pattern, whereas *E. barbara* was active during a few hours before dawn and in the morning, and had an accentuated peak around noon. Thus, there was a low overlap in the activity patterns of these two species (Δ1 = 0.032 IC95% –0.11–0.09, Fig. 4j). In the forest patches, *Philander* cf. *canus* showed a pattern of nocturnal activity similar to that of *D. marsupialis* (Δ1 = 0.690 95%CI = 0.50–0.93, Fig. 4h). In contrast, *Philander* cf. *canus* and *E. barbara* in the forest they had a clear temporal separation (Δ1 = 0.078 95%CI = –0.098–0.167, Fig. 4i).

Discussion

Habitat selection

We found a differential use of forest and SPS by most mammals, indicating that they perceive them as different habitats, there may be a set of factors: requirements, forms of avoidance, which vary according to the species. Twelve species were found only in the forest fragments, and six of them belonged to the order Carnivora. In the forest fragments we found four Felidae and two Mustelidae: *Leopardus wiedii*, *Leopardus pardalis*, *Puma yagoarundi*, *Puma concolor*, and *Galictis vittata* and *E. barbara*, respectively. These carnivorous species have different habitat requirements, such as being forest specialist and having specific prey preference (Sunquist, 1989). The availability of prey in bushes and forests may explain the preference of *P. yagoarundi* and *L. pardalis* for native forest cover (Sánchez-Lalinde and Pérez-Torres, 2008). However, it is also possible that the forest fragments are perceived as safer than the SPS, where there is more human activity related to the maintenance by the plantation. Indeed, it has been reported that the habitat selection by *P. concolor* is negatively related to human activity even in protected areas (Davis et al., 2011). In addition, Neotropical felids tend to have wide home ranges and preference for sites with native vegetation (Cruz-Rodríguez et al., 2015; Nielsen et al., 2015; Payán and Soto, 2012). Our results indicate that forest fragments can be used as habitat for multiple carnivores, highlighting the importance of maintaining forest fragments in cattle landscapes because not all species are able to take advantage of human-created landcovers such as SPS or grasslands.

Cerdocyon thous was the only species exclusively recorded in the SPS. This fox species has a wide distribution and is characterized by benefiting from human disturbance, showing greater occupancy and intensity of use near anthropogenic habitats (Santos et al., 2024), and it has been suggested that its omnivorous habits allow it to take advantage of different ecosystems, including savannahs, dry forests, and humid forests (Berta, 1982; Guerrero and Cadena, 2000). This fox has been recorded in oil palm plantations using this cover as a passageway and feeding place because it can eat fruits of different palms and small vertebrates (Forero Simijaca, 2016; Pardo-Vargas and Payán-Garrido, 2015). This species has also been recorded in pastures for livestock and in pastures with *Crescentia cujete* plantations (Botero and De La Ossa, 2011). However, in the Colombian Caribbean, *C. thous* showed a preference for the forest and had low use of grasslands (Pineda-Guerrero et al., 2015). Our results confirm the versatility of *C. thous*, which can take advantage of non-native landcovers such as SPS and may help this fox to avoid the other carnivores inhabiting the forest which could be potential competitors or predators (Ruth and Murph, 2009). *C. thous* is considered a generalist species whose diet may overlap with that of other mesocarnivores such as *P. yagoarundi*, *L. pardalis*, *E. barbara*, *G. vitatta* (Bisbale, 1986; Farrell et al., 2000; Massara et al., 2016). Larger predators like pumas and ocelots can consume carnivores similar in size to *C. thous* (Bianchi et al., 2014; Cassaigne et al., 2016; Hernández-SaintMartín et al., 2015). Future studies must evaluate these ideas.

Only five species were found in the two landcovers studied and they had higher relative abundances in the forest than in SPS. *Eira barbara* did not show a preference for the SPS, but it selected the forest fragments. This species seems to be tolerant to environments with different degrees of disturbance and has been reported in forests associated with cocoa agroforestry systems (López-Ramírez et al., 2020) and areas with wood extraction, hunting, livestock, and crops, where it is one of the most abundant species (Lizcano et al., 2016). This mustelid appears to prefer low-altitude habitats (Lima et al., 2020) and is rarely found outside forested habitats (Presley, 2000). This agrees with our results, as *E. barbara* preferred the forest fragments, which are at ~700 m asl. This species was one of the few carnivores found in the SPS and it remains to be defined whether this mustelid only passed through the plantation when moving between fragments or if it took advantage of particular resources available in the SPS. *Didelphis marsupialis* was the only species that did not seem to perceive

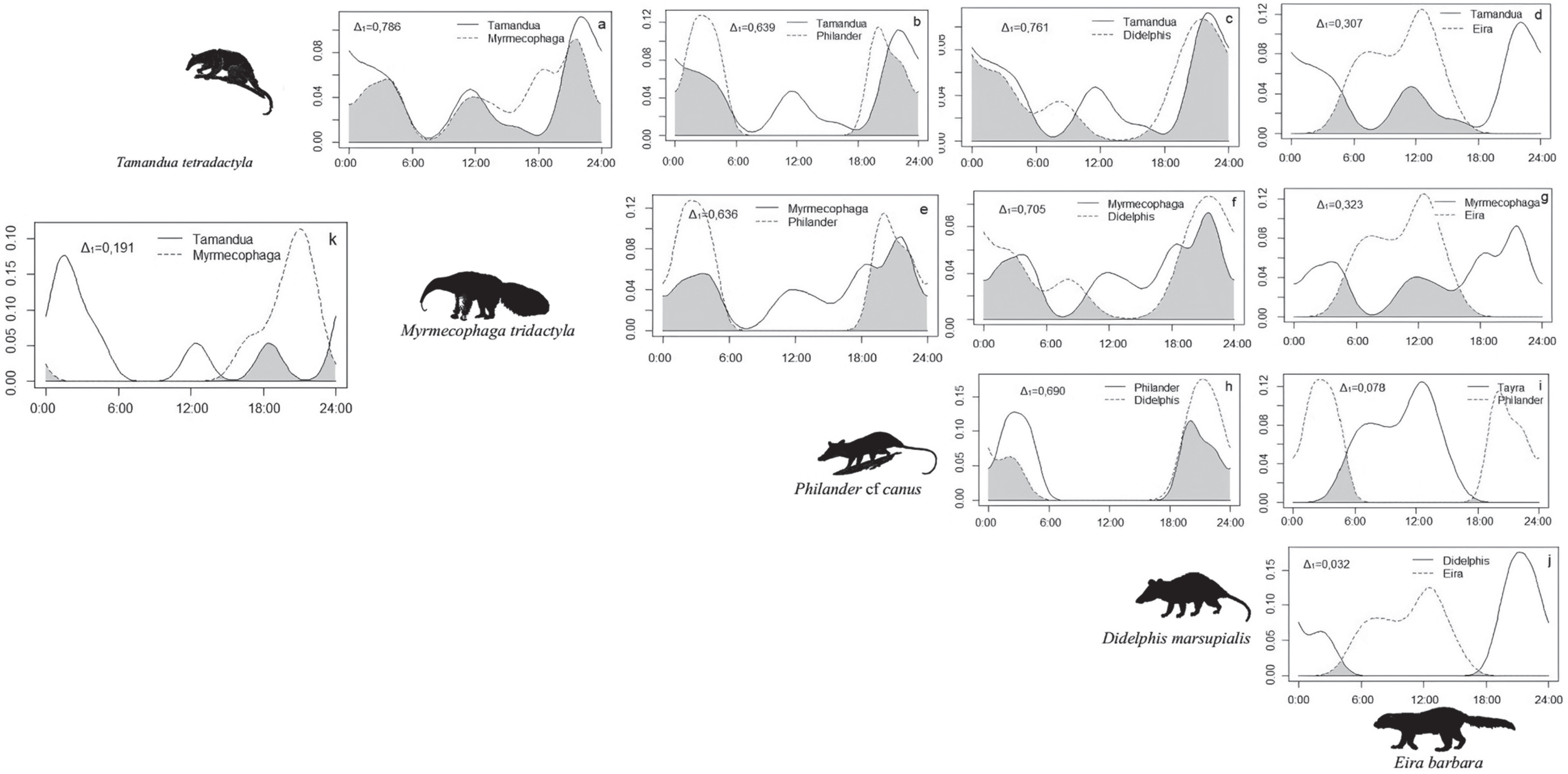

Fig. 4. Activity patterns in the eastern foothills of the Andes, Meta, Colombia of *Tamandua tetradactyla*, *Myrmecophaga tridactyla*, *Didelphis marsupialis*, *Eira barbara* and *Philander* cf. *canus* in two forest fragments of native forest (a–j), and of T. tetradactyla, M. tridactyla in a silvopastoral system (k). In the graphs, the shaded region corresponds to the overlap in the activity of the species.

the two landcovers as different habitats, i.e., it behaved as an opportunist species (Rosenzweig, 1981). This species has also been recorded in areas with high human disturbance (Adler et al., 1997; Alfonso and Sánchez, 2019; Benavides et al., 2020), which has been attributed to their omnivorous habits and their adaptability to different types of intervention in the landscape (Eisenberg et al., 1989).

Despite the higher number of records of two species of anteaters in the forest, both selected the SPS. The giant anteater *M. tridactyla*, a species categorized as vulnerable, is able to use different types of plantations, including SPS with *Acacia* sp., (Rojano et al., 2015; IUCN, 2020). Habitat suitability for *M. tridactyla* has shown to be affected by human intervention, forest connectivity, sugarcane crops, and distance to forested areas, but also private areas are important in the conservation (Bertassoni et al., 2019). We did the study in a private area dedicated to cattle ranching that established an SPS, and this landcover was preferred by *M. tridactyla*, which reinforces the idea that the use of SPS in private areas with livestock may help the conservation of this species. The second anteater at our study site, *T. tetradactyla*, also preferred the SPS, which is in agreement with multiple studies showing the versatility of this species that can be found in livestock landscapes, including natural vegetation in the pantanal (de Souza et al., 2018), and in eucalyptus plantations in Amapá, Brazil (Piña et al., 2019) where was abundant and even exclusive to some plantations. This indicates that both species of anteaters tolerate plantations associated with forest fragments in human-dominated landscapes, and future work should focus on explaining why they use and even prefer SSP over forest fragments. Several possible explanations are discussed in the next section.

Activity patterns

Given that *M. tridactyla* and *T. tetradactyla* feed primarily on ants and termites, and are regularly found in sympatry, it has been suggested that they may compete for food (Voss et al., 2001). We recorded greater activity of these species at night, coinciding with what was reported for these two species in floodplains dedicated to livestock in Paraguay (Laino et al., 2020), but the use of time depended on the particular landcover. In the forest fragments, the two anteaters had high overlap in their use of time, whereas in the SPS there was a marked differentiation in their activity pattern. The high overlap in the forest is possibly due to a higher density of trees or greater availability of food there, which probably allows the use of the same hours of the day to forage or seek refuge. A study in the pantanal evaluated the density and habitat use of *M. tridactyla* and *T. tetradactyla* and found no differentiation in the use of forest between these species (Desbiez and Medri, 2010). In contrast, the temporal separation in the SPS suggests that *M. tridactyla* and *T. tetradactyla* consider the SPS and forest fragments as different habitats. In the SPS, *M. tridactyla* was mainly diurnal and showed a higher activity peak in the afternoon, coinciding with what was reported for forests in other Neotropical areas (Blake et al., 2012; Kreutz et al., 2012). In contrast, in the SPS *T. tetradactyla* was mainly nocturnal-crepuscular, in agreement with another study done in another SPS (Huck et al., 2017). Temporal separation has been reported as a mechanism for the coexistence of sympatric species and it has also been suggested that the appearance of new environments created by humans may affect the interactions between species that share food resources (Kronfeld-Schor and Dayan, 2003; Ramírez-Mejía and Sánchez, 2016; Ziv et al., 1993). Given that anteaters preferred the SPS, the temporal separation in that habitat may reduce competition between them. Also, the preference for the SPS could reduce the risk of predation for the anteaters, given the high concentration of carnivore species in adjacent forest fragments. Indeed, it has been reported that both species can be prey of carnivores such as ocelots and pumas (Bianchi et al., 2014; Moreno et al., 2006). Another additional or complementary explanation is that there is a difference in the resources exploited by each species, given that *T. tetradactyla* prefers to forage on termite and ants on trees (Montgomery, 1985), whereas *M. tridactyla* generally forages on the ground (Gallo et al., 2017). This could explain the temporal separation in the SPS, given the low abundance of ants and termites in the trees and *T. tetradactyla* probably has to forage on the ground increasing possible competition with *M. tridactyla*. Additional studies in larger SPS areas that also examine the diet or foraging habits of both species of anteaters and their predators should help to understand the mechanisms that allow the coexistence of these species in livestock landscapes. Among the largest predators recorded in this study were *Puma concolor* and *Eira barbara*. One study demonstrates the puma's preference for *Myrmecophaga tridactyla* (Azevedo et al., 2025). *Eira barbara*, on the other hand, has been reported to prey on medium and large-sized species mammals (Grotta-Neto et al., 2021), which could represent a pressure that leads anteaters to prefer the use of silvopastoral systems (SPS), coexisting within this land cover and avoiding predation by the larger carnivores present in the forest.

Eira barbara showed a diurnal activity pattern, consistent with a study of different populations of this species from southern Mexico to northern Argentina (Villafañe-Trujillo et al., 2021). The activity patterns of *D. marsupialis* and *E. barbara* show low overlap in their use of time. A possible explanation could be that *D. marsupialis* avoids *E. barbara* because the latter is characterized by being omnivorous and opportunistic, and *E. barbara* may include *D. marsupialis* in its diet (Galef et al., 1976; Rodríguez et al., 2020). However, the presence of other carnivorous mammals and birds of prey active during the day probably explain the nocturnal activity of *D. marsupialis.*

Philander cf. *canus*, formerly *P. opossum* (Voss et al., 2018), showed a pattern of nocturnal activity that is consistent with that reported in the literature for other members of the genus *Philander* (Castro-Arellano et al., 2000; Huck et al., 2017), although in Suriname they have been seen active during the day (Nowak and Walker, 1999). In agreement with our results, studies in Mexico and Brazil report a nocturnal activity pattern for *D. marsupialis* (Mella-Méndez et al., 2019; Norris et al., 2010). The two marsupials found at our study site have similar food requirements (Voss and Emmons, 1996), suggesting that they may compete, but in the forest fragments, we did not find time differentiation between these species, suggesting that the forest fragments offer enough resources for both species or maybe they forage on different prey. A study in Brazil with *Didelphis aurita* and *Philander frenatus* found that the later consumed more vertebrates than *D. aurita*, which preferred a greater diversity of fruits (Ceotto et al., 2009). These differences in feeding habits could decrease competition and may explain the coexistence of *D. marsupialis* and *P.* cf. *canus*. The separation in time between *P.* cf. *canus* and *E. barbara* could be a mechanism used by *P.* cf. *canus* to avoid predation by *E. barbara*, given that the mustelid is a known potential predator of *P. opossum* (Castro-Arellano et al., 2000). However, as in the case of *D. marsupialis*, multiple alternative explanations may be behind the nocturnal nature of these two marsupials.

Conclusions

We have observed that most species did not use the SPS, but three species; *T. tetradactyla*, *M. tridactyla*, and *C. thous* preferred the SPS, indicating that the presence of SPS generated differences at the level of habitat selection and may favor these mammals. We found that the appearance of this new environment may affect habitat selection and activity patterns of some mammals, potentially as a result of interactions among the mammal species present in the study area. Our results demonstrate how behavioral indicators based on the use of space and time can be used to evaluate the response of mammals to the addition of human-created covers in rural environments.

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