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Efeito do Fogo e da Caça na Abundância de Mamíferos na Reserva Xavante do Rio das Mortes, MT, Brasil.

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TESE DE DOUTORADO

MANRIQUE PRADA VILLALOBOS

TITULO DA TESE:

"EFEITO DO FOGO E DA CAÇA NA ABUNDÂNCIA DE MAMÍFEROS NA RESERVA XAVANTE DO RIO DAS MORTES, MT, BRASIL"

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A memória, Marcelo Bagno (BG), por ter me ensinado a gostar mais da vida.

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HISTÓRICO

Atualmente o grande desafio da biologia é encontrar um equilíbrio entre o desenvolvimento humano e a conservação dos recursos naturais. Geralmente as nossas demandas sociais estão em contraposição com os princípios básicos da conservação da natureza. Nesta situação, a criação de unidades de conservação e a demarcação e proteção de Reservas indígenas se torna necessário. Alem disto, o manejo dos recursos naturais dentro das Reservas é indispensável devido a situação de isolamento da maioria destas unidades. No entanto, existe uma grande dificuldade na execução de projetos que visem o manejo de recursos naturais, principalmente para reservas indígenas. Esta dificuldade se deve basicamente a profundas diferenças culturais entre grupos indígenas e a nossa sociedade branca.

Os indios Xavantes pertencem ao "Tronco Macro-Jê", cujo maior constituinte é a família lingüística Jê. Como os Xavante, pertencem a esta família os Xerente, Kaingáng, Kayapó, Canela e Apinayé. Até quase a metade do século passado, os Xavante viviam no território entre os rios Araguaia e Tocantins. Em seguida, por motivo de perseguições, se deslocaram para o território compreendido entre os Rios Coluene e das Mortes, no Mato Grosso. No final dos anos 50, todas as facções Xavantes que tinham migrado para o Estado de Mato Grosso já tinham sido "pacificadas"- o último dos grandes grupos tribais do Brasil a iniciar contato regular com o mundo externo (Maybury-Lewis 1984). Os primeiros Xavantes que estabeleceram contato pacífico com agentes do SPI em 1946, após vários conflitos, foram aqueles que permaneceram na área do Rios das Mortes, contato longamente procurado por aquele órgão . Este grupo subseqüentemente dividiu-se em duas facções que na atualidade, habitam a Reserva Xavante do Rio das Mortes e a

Reserva Areões. Nenhuma missão religiosa permanente foi estabelecida em nenhuma dessas áreas, embora os índios já fossem assistidos pelos missionários salesianos da região (Maybury-Lewis 1984).

Atualmente, habitam as reservas Xavante do Rio das Mortes, Areões, Parabubure, Marechal Rondon, São Marcos e Sangradouro; faltando executar ainda a demarcação de Suiá-missu. Os Xavante são cerca de 10.000, distribuídos em 80 aldeias, sendo que as comunidades ainda resguardam boa parte da sua cultura tradicional. As reservas Xavante localizam-se dentro do bioma Cerrado no Estado de Mato Grosso. Os índios Xavantes do cerrado são explicitamente caçadores e dependem dos animais silvestres para sua sobrevivência. Existem vários tipos de caçadas, como a caçada individual, a caçada comunitária e a caçada de casamento. O fogo possui importante valor cultural dentro dos Xavantes e as caçadas utilizando fogo fazem parte da tradição.

Para os Xavantes, os sonhos servem na tomada de decisões da comunidade e existem os " sonhadores" encarregados desta função. Foi assim que um sonhador, Sibupá, na década de 1940 teve um sonho sobre o futuro da comunidade Xavante. Ele sonhou que as as terras Xavantes ficariam isoladas pelas fazendas dos brancos e que a fauna da Reserva iria começar a diminuir. Sibupá atribuía essa diminuição a incapacidade dos Xavantes de explorar outras áreas naturais, deixando recuperar as áreas já muito exploradas por eles mesmos. Para Sibupá, o isolamento das terras Xavantes significava a mudança de uma vida semi-nômade para sedentária, o que traria como conseqüência a superexploração dos recursos naturais dentro da Reserva. Sibupá também sonhou que o povo Xavante deveria pedir ajuda dos brancos para tentar solucionar o problema da diminuição de fauna na sua Reserva e para isto devia ser mandado um grupo de Xavantes

jovens para estudar e morar com os brancos. Desta maneira o grupo de jovens voltariam para comunidade sabendo como lidar e negociar com o "sistema branco".

Esse grupo de jovens foi escolhido e mandado a estudar e morar na cidade de Ribeirão Preto, no Estado de São Paulo. Depois da volta do grupo de jovens à comunidade Xavante foi criada a Associação Xavante da Pimentel Barbosa, que serviria como uma ponte de comunicação entre a comunidade Xavante e o "mundo branco". Foi a comunidade Xavante que entrou em contato com a WWF e contaram a sua preocupação com uma diminuição de fauna dentro da Reserva. Assim começou o então chamado Projeto Jaburu, que em 1990 contratou o biólogo Frans Leeuwenberg para começar os primeiros estudos de avaliação da situação dos animais na Reserva Xavante.

Os trabalhos começaram com a contagem de animais abatidos por unidade de tempo, análise de crâneos (principalmente análise de dentes das espécies caçadas para determinar a estrutura da população) e análise da razão sexual das espécies caçadas. Após a obtenção dos primeiros resultados, detectou-se a necessidade da contagem de animais para cálculo de densidades. Após várias tentativas falhas fui contratado em 1995 para trabalhar nesta questão. Após as primeiras tentativas de trabalho recomendou-se à WWF uma mudança de metodologia utilizando contagem de rastros de animais para cálculo de índices de abundância. Assim, foram estabelecidos 24 transectos na Reserva Xavante para o monitoramento de mamíferos de médio e grande porte. Depois da primeira amostragem, metade da Reserva pegou fogo e foram coletados dados sobre o efeito do fogo nas populações de mamíferos.

Se as atuais queimadas na Reserva estiverem afetando negativamente as populações animais, os Xavantes correm o risco de esgotar a sua principal fonte

alimentar. Por outro lado, existem espécies animais utilizadas pelos Xavantes como o tatu canastra *{Priodontes maximus)* e o cervo do pantanal *{Blastocerus dichotomus)*, que são consideradas em perigo de extinção pela ciência. Os resultados obtidos através do presente trabalho, portanto, são úteis para traçar diretrizes conservacionistas, visando a manutenção nutricional e cultural de um povo tradicional e a diversidade de seus recursos naturais.

Os objetivos deste trabalho foram avaliar os efeitos do fogo na abundância de grandes mamíferos na Reserva Xavante do Rio das Mortes e comparar os efeitos do fogo e da caça. Além disto tentei resgatar o conhecimento tradicional Xavante relacionado com o manejo do fogo e de maneira geral tentei também contribuir com informações que possam ser úteis para programas de manejo de fauna. As perguntas envolvidas foram as seguintes:

1) A abundância das espécies de mamíferos estudadas responde ao fator fogo de maneira diferenciada?
2) Existem diferenças entre os mamíferos nas taxas de utilização das áreas após as queimadas ao longo do tempo?

3) Qual fator fêm um efeito maior nos mamíferos, fogo ou caça?

4) Qual o significado do fogo para os Xavantes e como o conhecimento tradicional deste povo, neste aspecto, poderia contribuir para um melhor entendimento do manejo do fogo no Cerrado?

Os dados gerados foram utilizados para elaboração desta tese de doutorado e para elaboração do Plano de Manejo da Reserva Xavante do Rio das Mortes publicado no ano 2000 pela WWF (World Wild Fundation). A Tese de Doutorado foi dividida em 4 capítulos, sendo que cada um destes pertencem a um determinado grupo funcional: mamíferos herbívoros, tatus e tamanduás e porcos do mato. Finalmente o quarto e último capítulo compara os fatores fogo e caça como variáveis que afetam a abundância de mamíferos. O capítulo 1 já foi publicado na revista francesa especializada em mamíferos, MAMMALIA, ano 2001, Volume 65, Número 1, páginas (55-62). O capítulo 2 foi apresentado oralmente no 8th Theriological Congress, África do Sul e já foi submetido a revista australiana Journal of Austral Ecology especializada em trabalhos ecológicos do hemisfério sul. O capítulo 3 e 4 já estão na forma de manuscrito e serão submetidos em breve.

Mammalia

Running head: Fire and herbivores in Brazil

Effects of fire on the abundance of large mammalian herbivores in Mato Grosso, Brazil.

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Key Words: cerrado, Xavante indians, tracks, food resources, deer, tapir, burning.

SUMMARY. Fire is an important ecological factor in Cerrado vegetation of Central Brazil. The effect of fire on the abundance of large mammalian herbivores was studied at Reserva Xavante do Rio das Mortes, a 329,000 ha cerrado Reserve in Mato Grosso, Brazil. Track counts were used to compare the abundance of tapir, marsh deer and pampas deer along 7 burned and 7 unburned transects on 7 occasions between August 1995 and August 1996. The number of tracks in burned and unburned areas did not have significant differences. Mammal herbivores use burned areas probably because of renewed food resources. Fire management is recommended at Reserva Xavante do Rio das Mortes.

RESUMÉ. Le feu represente un facteur ecologique important pour la vegetation de type Cerrado du centre du Bresil. L'effet du feu sur l'abondance des grands mammiferes herbivores a ete etudie dans la reserve Xavante du Rio das Mortes, une reserve Cerrado de 329000 hectares situee dans le Mato Grosso au Bresil. Le comptage des traces des animaux a ete realise sept fois entre Aout 1995 et Aout 1996, afin de comparer l'abondance du tapir, du cerf des marais et du cerf des champs au niveau de sept zones briilees et de sept zones intactes. Aucune difference significative pour le nombre de traces n'a ete observee entre les zones briilees et les zones intactes. Les mammiferes herbivores utilisent les surfaces briilees probablement a cause de la regeneration des ressources alimentaires. L'usage controle du feu est recommande dans la reserve Xavante du Rio das Mortes.

INTRODUCTION

The cerrado, a savanna like vegetation, covers approximately 2 million km on almost 22% of Brazil's landscape (Sarmiento and Monasterio 1975, Eiten 1972, Ratter and Dargie 1992). Fire can occur naturally and represents an important ecological factor (Coutinho 1978, 1990, Lamotte 1975, Miranda et al. 1993, Kauffman et al. 1994). Some studies have shown that fire stimulates regrowth in cerrado vegetation and augments plant productivity (Murakami and Klink 1996, Rodrigues 1996). Few studies have investigated the effect of fire on cerrado fauna. Morais and Benson (1987) studied the effects on ants and Vieira and Marinho-Filho (1998) observed the relation of fire with habitat utilization by rodents. Prada *et al*. (1995) studied the effects of fire on plants and herbivorous insects and showed a positive effect with increasing number of flowering plants and insects in burned areas.

The objective of this study was to investigate use of burned areas by large herbivores and to detect positive or negative effects of fire on the abundance of mammal species. The null hypothesis was that track numbers on burned transects would not differ from track numbers in unburned transects.

STUDY SITE AND METHODS

Reserva Xavante do Rio das Mortes is a large (329,000 ha) cerrado reserve in central east Mato Grosso, (longitude 51° 52' and latitude 13° 14'). There are 5 Xavante villages with approximately 1000 indians within the Reserve. The vegetation consists of patches of cerrado, open grasslands and gallery forests. About one third of the reserve consists of flood plains that are partially underwater in the wet season. Two thirds of the Reserve has

relatively level with permanent dry terrain, although it also includes the rocky slopes and ridge tops of Serra do Roncador. Fauna at the Reserve is abundant (per.obs.), with representatives of almost all large mammals found in Cerrado (see Leeuwenberg 1994). Xavante indians are mainly hunters, and hunts using fire are concentrated from June to September (dry season peak). The first two or three rains of the season occur in mid September and the wet season starts in late October.

The effect of fire on large mammals was investigated by counting the number of sets of fresh tracks on burned and unbumed transects. Where animal densities are highest, one finds a greater abundance of tracks (see Hill et al. 1997, Fragoso 1991), thus when I refer to a higher abundance of animals in this study, I am referring only to higher track densities. Transects were established by a WWF wildlife management project at Reserva Xavante do Rio das Mortes using a stratified random method. They were established in a seasonally flooded area known locally as Pantanal do Rio das Mortes where the dominant vegetation type is open grasslands with a mixture of cerrado patches and gallery forest. The two areas where burned and unbumed transects were established had a similar community of plant species, similar topography and aspect. A prefire census established the quantitative similarity of control and treatment areas and showed no significant differences in the number of tracks of herbivorous mammals (Kruskall-Wallis, $p>0.05$ in all cases, $n=7$). All transects were established at more than 15 kms from Xavante villages, in a lightly hunted area (see Fragoso et al. 1998) to avoid any hunting effect. Fire occurred in late August 1995 when approximately half the reserve was burned (164000 ha). Starting points of 7 burned and 7 unbumed transects were marked and one hour walks were made in a previously determined direction (perpendicular to one of the two dirt roads which gave access to the

study area). Each transect was approximately 4 kms long. Minimum distance between transects within each treatment was of 1km and the minimal distance between burned and unburned transects was of 10km. Trails were searched for tracks by the author and three newly trained Xavantes 20, 64,100, 159, 203, 252 and 321 days after burning. We tracked 49 hours in the burned transects and 49 hours in the unburned transects which was approximately, 187 kms walked in each treatment. Fresh tracks were identified with Xavante help and experience. The direction of the animal and the size of the track was recorded to try to avoid recounting tracks of the same individuals. The species studied were tapir (Tapirus terrestris), marsh deer (Blastocerus dichotomus) and pampas deer (Ozotoceros bezoarticus). All species are important to Xavantes as food source (Leeuwenberg 1994) and have easily identifiable tracks. Tracks are easily detected in burned areas due to the lack of vegetation and the quality of the track impression in ash. Sets of tracks are also easily detected in unburned areas due to spaces in between grass tufts which leave soil exposed and tracks in evidence. The author believes that all sets of tracks present in the transects where found in both burned and unburned areas although more attention was needed when tracking in unburned transects. The same 14 transects were used for each sample.

Statistical analysis included a two-way analysis of variance with number of tracks as the dependent variable and burned/unburned transects (treatment), transects and visits as factors. In the analysis transects were kept as blocks, because there was no interest in the interaction between transects and the other factors. When necessary, a Tukey test was utilized to verify where differences existed (Zar 1999, Sokal and Rohlf, 1995).

RESULTS

Tapir

There was no significant difference in the number of tapir tracks when comparing burned and unburned areas (TWO WAY ANOVA n=98, p=0.0.106). Number of tapir tracks had a strong significant difference through time (TWO WAY ANOVA, n=98, p=0.000) with more tracks 321 days after burning then the number of tracks found 100 days after burning (TUCKEY TEST). Note that the number of tracks 100 days after burning was zero in this sampling session (Table 1). There was no interaction between time (days after burning sampling sessions) and number of tracks in burned and unburned areas (TWO WAY ANOVA n=98, p>0.05).

Marsh deer

The number of tracks of marsh deer in burned and unburned transects had no significant difference although in most cases tracks were more abundant in unburned transects (Table 2). When comparisons were made through time there was no time effect on the number of tracks. The number of tracks through time (in each sampling session) does not have interaction with the number of tracks in burned and unburned areas (TWO WAY ANOVA n=98, p>0.05 in all cases).

Pampas deer

There were no significant differences between the number of Pampas deer tracks in burned and unburned transects (TWO WAY ANOVA, n=98, p=0.311). There was also no time effect and no interaction was found between number of tracks through time

and number of tracks in burned and unburned transects. Although with no significant differences mean number of tracks were always higher in burned areas (Table 3).

For all species there was no differences in the abundance of tracks in burned and unburned transects so Ho is true. During the fieldwork we did not found any dead burned animals on trails, suggesting that direct mortality caused by fire is negligible.

Another interesting result is that large herbivore mammals live in simpatry at Reserva Xavante do Rio das Mortes. In 71.4% of the transects tapir, marsh deer and pampas deer tracks were present together, 14.3% of the transects were used only by tapir and pampas deer and in 14.3 % just tapir tracks were found.

DISCUSSION

Pampas deer are mainly grazers but will also browse (Pinder 1997) with preference for new leaves and shoots (Rodrigues 1996). Marsh deer is a grazer/browser and tapir is a generalist herbivore that feed on leaves, fruits and grasses (Eisenberg 1989). Fire is a major disturbance factor in cerrado, resulting in flushes of newly grown grass, juvenile shoots in trees and flowering in many herbs (Raw and Hay 1985, Morais and Benson 1987, Miranda and Klink 1996, Murakami and Klink 1996). In the study area, 20 days after fire, new shoots and green juvenile grass sharply contrasted with the black burned vegetation. That herbivores use burned areas may be related to increasing numbers of young shoots and grasses. In this sense, results are in agreement with the plant vigor hypothesis (see Price 1991). In Chaparral of California (USA), a study with white tailed deer (Odocoileus hemionus virginianus) showed that densities were higher in burned areas because of renewed food resources (Taber and Dasmann 1957). In temperate North America, willow

regrowth after fire attracted elk (Stein et al 1992). My work showed that herbivores continue using burned areas in cerrado and I suggest that food resources may be the reason.

Fruits are an important food resource for tapir (Bodmer 1990,1991) and account for finding more tracks on unburned transects than on burned ground in a certain regeneration stage. Tapir may switch from herbs and grasses when particular fruit species are abundant in other areas.

The use of burned areas by large herbivore species may be related to the stage of plant regeneration, plant productivity and diet. Detailed studies will be necessary to understand better the interactions between fire and mammals. In cerrado of Goias (Brazil), plant productivity is higher in burned areas for herbivore animals and grass productivity diminishes drastically 4 months after burning in contrast with herbaceous plant productivity (Rodrigues 1996). For grazers and browsers of cerrado this difference must be extremely important when utilizing burned areas.

All species were present in all sampling sessions (except for tapir 100 days after burning) which suggest that there is not a regular succession of large mammal species after fire in the study area. On the African plains, grazing ungulates follow a regular succession of species through an area, each using different types of forage (Jarman and Sinclair 1979).

The absence of any dead animals on transects may be due to two rivers and many other smaller water courses with gallery forest functioning as natural barriers against fire. These areas may represent important refugees for terrestrial mammals (Redford and Fonseca 1983). Vieira and Marinho Filho (1998) suggest that gallery forest does not function as refugees for small mammals, but they observed higher densities of some species of rodents in unburned areas.

Traditionally, Xavante Indians use fire to corner and hunt wildlife, with fire hunts concentrating from July to August Old Indians complain that in the past, intervals between fires for each vegetation type were important and that actually new generations are not respecting this matter. I asked 5 old Xavantes (in different moments and at different circumstances) about these intervals and they all agree that open grasslands were burned every 1 - 2 years and cerrado every 3-4 years. They also talked about the importance of the burning area and that to control fire they used the wind direction and the presence of streams and gallery forest were generally fire stops. An important matter for Xavantes is to conserve this traditional knowledge for future generations because the irrational burning system of Brazilian farmers is already influencing the Xavante community.

Fire management at Reserva Xavante do Rio das Mortes is important and the Xavantes knowledge about burning could be used as a basis for this management Fire management has been used with success in Africa, Australia, North America (Vogl 1974) and possibly by the Xavantes of Brazil.

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TABLES

TABLE I: Tapir abundance in burned and unburned transects. ± = standard deviation. Reserva Xavante do Rio das Mortes, MT, BRASIL.

DAYS AFTER BURNING	MEAN NUMBER OF TRACK SETS	
	BURNED	UNBURNED
20	1.71 ±2.63	2.43 ±2.99
64	0.71 ±1.25	2.43 ±2.30
100	0.00	2.00 ±2.38
159	3.00 ±3.70	3.71 ±4.68
203	2.00 ±2.77	7.43 ±6.53
252	2.86 ±1.46	9.00 ±8.33
321	3.71+3.20	9.14 + 6.89

TABLE 2: Marsh deer abundance in burned and unbumed transects. ± = standard deviation. Reserva Xavante do Rio das Mortes, MT, BRASIL.

DAYS AFTER BURNING	MEAN NUMBER OF TRACK SETS	
	BURNED	UNBURNED
20	1.14+1.86	1.28 ±2.21
64	0.28 ±0.48	2.57 ±3.78
100	0.14 ±0.38	1.28 ±2.36
159	0.28 ±0.48	0.57 ±0.79
203	1.00 ±1.52	3.10 ±4.05
252	1.43 ±1.98	1.57 ±2.44
321	2.71+6.31	2.28 + 4.38

TABLE 3: Pampas deer abundance in burned and unbumed transects. ± = standard deviation. Reserva Xavante do Rio das Mortes, MT, BRASIL.

DAYS AFTER BURNING	MEAN NUMBER OF TRACK SETS	
	BURNED	UNBURNED
20	1.28 ±1.79	0.57 ± 0.78
64	3.00 ± 3.26	1.43 ±1.51
100	0.57 ± 0.79	0.14 ±0.38
159	5.00 ± 7.64	0.00
203	3.43 ±3.64	1.00 ±1.73
252	3.57 ±3.95	1.00 ±1.73
321	1.86 + 2.54	1.14 + 3.02

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Running head: Fire and Xenarthrans in Brazil

Effects of Fire on the Abundance of Xenarthrans in Mato Grosso, Brazil.

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Abstract. Fire is an important ecological factor in Cerrado vegetation of Central Brazil and in other savanna ecosystems. The effect of fire on the abundance of *Priodontes maximus* Kerr, 1 7 9 2 (giant armadillo), *Euphractus sexcinctus* Linnaeus, 1758 (yellow armadillo), *Myrmecophaga tridactyla* Linnaeus, 1758 (giant anteater) and *Tamandua tetradactyla* Linnaeus, 1758 (collared anteater) was studied at Reserva Xavante do Rio das Mortes, a 329,000 ha Indian reserve in the Cerrado of Mato Grosso, Brazil. Track counts were used to compare the abundance of these mammals along seven burned and seven unburned transects on seven occasions between August 1995 and August 1996. The number of tracks in burned and unburned areas did not have significant differences. Xenarthrans use burned areas probably because of food resources, basically termites and ants. Xavante traditional fire hunts may avoid fuel accumulation functioning as a mechanism to prevent more destructive fires. Fire management at Reserva Xavante is recommended because the irrational burning system of Brazilian farmers is already influencing the Xavante community. Xavante traditional knowledge about fire could be an important instrument for this management.

Key Words: anteaters, armadillos, Cerrado, Xavante indians, tracks, food resources.

INTRODUCTION

Fire is a dominant factor in savannas and provide unique opportunities to study important ecological processes (Andersen *et al*. 1998). Interactions between mammals, vegetation and fire may be of extreme importance for the conservation of biodiversity and the natural resources of savanna vegetation ecosystems.

In Africa recent studies suggest that large mammals and fire are the keys to explain the dynamics of forests and savannas (Dubling *et al*. 1990). Other studies in this continent show that fire may be declining populations of some species (Mutschler *et al*. 2001)

In Australia, fire management has been an important issue of mammalian studies (Johnson 1997) being pointed out as one of the most important factors in the distribution and abundance of this group (Catling & Burt, 1994).

The cerrado of Brazil is a savanna like vegetation (see Eiten 1972) wich covers more than 2 million km^2 (Eiten 1972, Sarmiento & Monasterio 1975, Ratter & Dargie 1992) representing the second largest biome in the country and in South America It is composed of a mosaic of habitats which range in degree of cover from open grasslands to gallery forests, with intermediate formations like wooded savanna (savanna with shrubs and small trees). The climate, with a wet warm season from October to April and a cooler dry season from May to September, favors the occurence of periodic natural (Ramos-Neto & Pivelo 2000) and man-made wildfires. As in other savanna ecosystems, fire in Cerrado is a strong ecological factor (Lamotte 1975, Coutinho 1978, 1990, Miranda *et al*. 1993,Kauffinan *et al*. 1994).

Few studies in Cerrado are related with the effect of fire on Xenarthrans. Silveira *et al.* (1999) observed that a large-scale fire killed up to 16 giant anteaters and two giant armadillos in Emas National Park, Central Brazil. Prada (2001), working in the Xavante Indian Reserve, investigated the effect of fire on the abundance of large herbivorous mammals and found out that there were no significant differences between burned and unbumed areas.

There are 11 genera and 24 species of anteaters and armadillos in the New World (Emmons 1990). The Cerrado is well represented by these two groups, with 7 genera and 10 species (Marinho-Filho *et al.* 2002).

The objective of this study was to investigate use of burned areas by Xenarthrans and to detect positive or negative effects of fire on the abundance of these mammal species. The null hypothesis was that track numbers on burned transects would not differ from track numbers in unburned transects.

METHODS

The present study was conducted in Reserva Xavante do Rio das Mortes localized in central eastern Mato Grosso, in the Cerrado biome. The Reserve has an area of 320,000 ha and represents one of the largest continuous areas of Cerrado in Brazil. The vegetation within the Reserve consists of patches of cerrado (wooded savanna), open grasslands and gallery forests. About one third of the reserve consists of open areas that are partially under water in the wet season. Two thirds of the Reserve has a regular plain topography with permanent dry terrain, although the rocky slopes and ridge tops of Serra do Roncador are also present.

Fauna at the Reserve is rich and abundant (pers. obs.), with representatives of almost all large mammals found in Cerrado (Fragoso *et al.* 2000).

There are five Xavante villages within the Reserve with approximately 1000 indians, which depend on natural resources for survival. Xavante indians are mainly hunters, and hunts using fire are concentrate from June to September (dry season peak). The first rains of the season occur in mid September and the wet season starts in late October, lasting until March/April.

The effect of fire on Xenarthrans was investigated by counting the number of sets of fresh tracks on burned and unburned transects. Where animal densities are higher, one finds a greater abundance of tracks (Fragoso 1991, Hill *et al.* 1997), thus when we refer to a higher abundance of animals in this study we are referring only to higher track densities. Transects were established by a WWF wildlife management project at Reserva Xavante do Rio das Mortes using a stratified random method. They were established in a seasonally flooded area known locally as Pantanal do Rio das Mortes where the dominant vegetation type is open grassland with a mixture of cerrado patches and gallery forest. The two areas where burned and unburned transects were established had a similar plant community, similar topography and aspect. A pre-fire census established the quantitative similarity of control and treatment areas and showed no significant differences in the number of tracks of Xenarthrans (Kruskall-Wallis, $p>0.05$ in all cases, $n=7$). All transects were established at more than 15 kms from Xavante villages, in a lightly hunted area (see Fragoso *et al.* 2000) to minimize hunting effect. Fire occurred in late August 1995 when approximately half the reserve was

burned (164,000 ha). Starting points of 7 burned and 7 unburned transects were marked and one hour walks were made in a previously determined direction (perpendicular to one of the two dirt roads which gave access to the study area). Each transect was approximately 4 kms long. Minimum distance between transects within each treatment was of 1km and the minimal distance between burned and unburned transects was of 10km. Trails were searched for tracks by the author and three newly trained Xavantes 20, 64, 100, 159, 203, 252 and 321 days after burning. We tracked 49 hours in the burned transects and 49 hours in the unburned transects which was approximately, 187 kms walked in each treatment. Fresh tracks were identified with Xavante help and experience. The direction of the animal and the size of each track were recorded to try to avoid recounting tracks of the same individuals. The species studied were giant anteater *(Myrmecophaga tridactyla* Linnaeus, 1758), collared anteater *(Tamandua tetradactyla* Linnaeus, 1758), giant armadillo *(Priodontes maximus* Kerr, 1792) and yellow armadillo *{Euphractus sexcinctus* Linnaeus, 1758). All species are important to Xavante people as food source (Fragoso *et al.* 2000) and have easily recognizable tracks. Tracks are easily detected in burned areas due to the lack of vegetation and the quality of the track impression in ash. Sets of tracks are also easily detected in unburned areas due to spaces in between grass tufts, which leave soil exposed, and tracks in evidence. We believe that all sets of tracks present in the transects were found in both burned and unburned areas although more attention was needed when tracking in unburned transects. The same 14 transects were used for each sample.

Statistical analysis included a two-way analysis of variance with number of tracks as the dependent variable and bumed/unburned transects (treatment), transects and visits as factors. In the analysis transects were kept as blocks, because there was no interest in the interaction between transects and the other factors. When necessary, a Tukey test was performed to verify where differences existed (Sokal & Rohlf 1995, Zar 1999).

RESULTS

Giant anteater

There was no significant difference in the number of giant anteater tracks when comparing burned and unburned areas (TWO WAY ANOVA, n=98, p> 0.05) (Table 1). Number of giant anteater tracks had a strong significant difference through time (TWO WAY ANOVA, n=98, p=0.009) with more tracks 203 days after burning than the number of tracks found 64 days after burning (TUCKEY TEST) (Table 1). There was no interaction between time (days after burning sampling sessions) and number of tracks in burned and unburned areas (TWO WAY ANOVA, n=98, p>0.05) suggesting that abundance of these mammals do not vary seasonally (Table 1).

Collared anteater

No tracks of this species were found in burned or unburned transects. The collared anteater was tracked three times in dirt roads, out of the transects within the Reserve.

Giant armadillo

The number of tracks of giant armadillo in burned and unburned transects had no significant differences (TWO WAY ANOVA, n=98 pX).05)(Table 2). When comparisons were made through time there was no time effect on the number of tracks (TWO WAY ANOVA, n=98 pX).05) and the number of tracks through time (in each samphng session) does not have interaction with the number of tracks in burned and unburned areas (TWO WAY ANOVA, n=98, p>0.05).

Yellow armadillo

There were no significant differences between the numbers of yellow armadillo tracks in burned and unburned transects (TWO WAY ANOVA, n=98, p=0.311) nor there was any time effect (TWO WAY ANOVA, n=98, p>05). No interaction was found between number of tracks through time and number of tracks in burned and unburned transects (TWO WAY ANOVA, n-98, p>05).

During the fieldwork we did not found any dead burned animals on trails, suggesting that direct mortality caused by fire is negligible.

Another interesting result is that xenarthrans coexist and may use exactly the same areas in Reserva Xavante do Rio das Mortes. In 9.2% of the transects giant anteater and giant armadillo were found together. In 3.1% of transects giant anteater and yellow armadillo were present and in 2.0% the two armadillos were found utilizing the same transects.

For all species there were no differences in the abundance of tracks in burned and unburned transects so the null hypothesis is accepted.

DISCUSSION

The giant anteater, collared anteater and giant armadillo feed mainly on ants and termites and eventually other insects (Redford 1985a; Eisenberg 1989, Emmons 1990; Anacleto & Marinho-Filho 2001). The yellow armadillo feeds on a wide range of foods including much plant material, ants, other insects, small vertebrates, and carrion (Redford 1985a; Emmons 1990).

Lack of difference on the utilization of burned and unburned areas by Xenarthrans may be related to food resources. In the case of the giant anteater and giant armadillo, termites continued available as food resources because well protected termite mounds like those of *Cornitermes* sp in the study area permit termite survival after wildfires. In a study in Australia, construction of hard protective clay mounds was pointed as an strategy of termites to persist after intense fire (Abenspergtraun & Milewski 1995). In Cerrado, *Cornitermis cumulans* did not suffer any impact from fires and seem to be adapted to periodically burned areas (Dias 1994). In this same study, Dias detected an

increase in densities of *Armitermes euamignathus* after burning, indicating that this species is also adapted to fire. A recent study on feeding habits of *Priodontes maximus* in cerrado showed that *Cornitermis* and *Armitermes* termites were among the most frequent searched and ingested food items (Anacleto & Marinho-Filho 2001). In a study with free-living giant anteaters, *Cornitermis* was the fourth more frequently eaten termite out of eight species on which the anteaters preyed (Redford 1985b). Recolonization is intense by some species of terrestrial ants that are very active soon after fire, and some of them, like *Camponotus spp* did not showed differences in numbers in burned and unburned areas (Morals & Benson 1988). *Camponotus*, a common genus in the study area, was also an important food item in giant armadillos diet (Anacleto & Marinho-Filho 2001). It seems that myrmecophagous species like giant anteater and giant armadillo do not suffer with lack of food resources after fires in Cerrado and continue utilizing these burned areas in which termites and ants are also present.

Fire is a major disturbance factor in cerrado, resulting in flushes of newly grown grass, juvenile shoots in trees and flowering in many herbs (Raw & Hay 1985, Morais & Benson 1987, Miranda & Klink 1996, Murakami & Klink 1996, Rodrigues 1996) that can attract insects (Prada *et al.* 1995) and large herbivore mammals (Prada 2001). In the study area, 20 days after fire, new shoots and green juvenile grass sharply contrasted with the black burned vegetation. The utilization of burned areas by the yellow armadillo may be related to increasing numbers of young renewed shoots, grasses, roots and other resources as insects. In this sense

the yellow armadillo as a diet generalist will find a wide variety of food items after fire in Cerrado.

The giant anteater was the only species which presented a time effect with the highest mean number of tracks 203 days after burning in August 1995. This sampling period was in the month of March. The other two higher means were for February and May. Silveira *et al.* (1999) found out the highest densities of giant anteatears in Emas National Park in the period between December and May after a fire in August 1994. Xavante Indians made observations and comments that the giant anteater is more abundant in the middle-end of the wet season, which goes from October through March. The fact that anteaters are more abundant in middle-wet season may be due to reproduction. In fact, giant anteaters were seen five instances in courtship during January and 10 agonistic encounters where observed between December and May in the Cerrado region (Shaw *et al.* 1987). Probably giant anteaters are more active and not necessarily more abundant in terms of numbers during wet season, its reproduction period. Long-term studies in this matter should be encouraged to elucidate important aspects on the biology of the giant anteater.

The absence of any dead animals on transects may be due to two rivers and many other smaller water courses with gallery forest functioning as natural barriers against fire. Although gallery forests have been invoked as important refuges for terrestrial mammals during fire events (Redford & Fonseca 1986), Vieira & Marinho-Filho (1998) found no evidence that gallery forests could function as refuges, at least for small mammals. They did not found any dead

mammal immediately after fire and suggested that small mammals can survive wildfires by simply staying in their burrows while fire passes. However, Vieira & Marinho-Filho (1998) observed higher densities of some species of rodents in neighboring unburned areas of the same habitat type. In the case of armadillos, they can also survive fires in their underground holes.

The absence of the collared anteater tracks in burned and unburned areas reflects that this species is rare in the study area as pointed by Fragoso *et al*. (2000). In other areas out of the Reserve, the collared anteater is easily seen or tracked (per. obs.). The collared anteater is an easily hunted species which is killed even by Xavante children or woman because its small, slow and easy to detect. More profound studies should be conducted on the status of this species for its local conservancy.

Xavante traditional fire hunts may avoid fuel accumulation functioning as a mechanism to prevent more destructive fires. In Emas National Park, the absence of fire in grasslands for over three years generated an intense wildfire, which burned 100% total Park and killed 16 giant anteatears and two giant armadillos. A year later, with much less fuel accumulation fire was not so intense and no mortality was detected (Silveira *et al*. 1999). Fire management at Reserva Xavante do Rio das Mortes is important and the Xavantes knowledge about burning could be used as a valuable instrument for this management.

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TABLES

TABLE I: Giant anteater abundance in burned and unburned transects. ± = standard deviation. Reserva Xavante do Rio das Mortes, MT, BRASIL.

DAYS AFTER BURNING	MEAN NUMBER OF TRACK SETS	
	BURNED	UNBURNED
20	0.43 + 0.53	0.57+1.13
64	0.14 ±0.38	0.29+0.49
100	0.29 + 0.76	0.14 + 0.38
159	1.29 ±1.11	0.57 ±0.53
203	1.43 ±1.51	2.57±2.93
252	1.14 ±1.68	0.71 ±1.25
321	0.57 ±1.13	1.43 + 1.81

TABLE 2: Giant armadillo abundance in burned and unburned transects. ± = standard deviation. Reserva Xavante do Rio das Mortes, MT. BRASIL.

D A Y S AFTER BURNING	MEAN NUMBER OF TRACK S E T S	
	BURNED	UNBURNED
20	0.14 ±0.38	0.00 ±.0.00
64	0.14 ±0.38	0.00 ±0.00
100	0.00 ±0.00	0.14 ±0.38
159	0.86 ±1.07	0.00 ±0.00
203	0.14 ±0.38	0.29 ±0.49
252	0.14 ±0.38	0.43 ±0.79
321	0.43 ±0.53	0.29 ±0.49

TABLE 3: Yellow armadillo abundance in burned and unbumed transects. ± standard deviation. Reserva Xavante do Rio das Mortes, MT, BRASIL

DAYS AFTER BURNING	MEAN NUMBER OF TRACK SETS	
	BURNED	UNBURNED
20	0.43 ±0.53	**0.14** ±0.38
64	0.28 ±0.49	0.14 ±0.38
100	0.57 ±0.78	0.57 ±0.53
159	0.00 ±0.00	0.14 ±0.38
203	0.14 ±0.38	0.14 ±0.38
252	0.29 ±0.49	0.14 ±0.38
321	0.14 + 0.38	0.00 + 0.0

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Running head: Fire and peccaries in Brazil

Effects of fire on the abundance of peccaries in Mato Grosso Brazil

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Abstract: Fire is an important ecological factor in Cerrado vegetation of Central Brazil. The effect of fire on the abundance of peccaries was studied at Reserva Xavante do Rio das Mortes, a 329,000 ha cerrado Reserve in Mato Grosso, Brazil. Track counts were used to compare the abundance of peccaries along 7 burned and 7 unbumed transects on 7 occasions between August 1995 and August 1996. The number of tracks in burned and unbumed areas did not have significant differences although there was a strong time effect in the case of white-lipped peccary. Peccaries use burned areas probably because of renewed food resources. Fire management is recommended at Reserva Xavante do Rio das Mortes.

Key Words: cerrado, Xavante indians, tracks, food resources, peccaries, burning.

INTRODUCTION

Peccaries *{Pecari tajacu* and *Tayassu pecari)* are two of the most important game species of terrestrial vertebrates in the neotropics (Peres 1996, Fragoso et ai 2000,) and also represent an important food resource for large neotropical vertebrates such as jaguar (*Panthera oncd)* (Crashaw and Quigley 1984, Garla & Gobi 2001)) and puma *{Puma concolor)* (Brito 2000, Harverson et al 2000,). Studies on peccaries are mainly related to diet (Barreto et al 1997), home range (Fragoso 1998) and population status (Peres 1996, Fragoso et al 2000).

The Cerrado vegetation of Brazil is the second largest biome, representing almost one fourth of the total area of the country (Eiten 1972, Sarmiento and Monasterio 1975, Ratter and Dargie 1992). Vegetation is similar to other tropical savannas (Eiten 1972). It is composed of a mosaic of habitats which range in degree of cover from open grasslands to gallery forests, with intermediate formations like wooded savanna (savanna with shrubs and small trees). The climate, with a wet warm season from October to April and a cooler dry season from May to September, favors the occurence of periodic natural (Ramos-Neto & Pivelo 2000) and man-made wildfires. In Cerrado vegetation of Central Brazil, white-lipped peccary has been pointed out as a more vulnerable species to hunting pressure then the collared peccary (Fragoso et al 2000). Effects of fire on peccaries in Cerrado have never been investigated.

Fire is an important ecological factor in cerrado (Lamotte 1975, Coutinho 1978, 1990, Miranda et al. 1993, Kauffman et al. 1994) as in other savanna ecossitems.

Regeneration of vegetation after fire has already been studied in Cerrado (Murakami and Klink 1996, Rodrigues 1996) suggesting that vegetation is well adapted to fire. Some studies in Cerrado investigated the relation between fire and the abundance of animals like insects (Prada et al 1995) birds (Abreu 2000), small mammals (Vieira & Marinho-Filho 1998) and large herbivorous mammals (Prada 2001). It is interesting that in a general way, there was no negative effect of fire on the abundance of these groups of animals. Thus, Cerrado vegetation in cerrado is adapted to fire with a rapid regeneration and animals seem capable of escaping fire and utilize burned areas as soon as vegetation starts to recuperate. Indeed, Vieira & Marinho-Filho (1998) did not found any dead mammals immediately after fire and suggested that small mammals can survive wildfires by simply staying in their burrows while fire passes. Prada & Marinho Filho (in press) also did not found any dead animals on transects and suggested that armadillos could escape fire by utilizing underground holes. Larger species of mammals could escape fire by crossing gallery forests that function as natural barriers where fire stops (Prada 2001).

The objective of this study was to investigate use of burned areas by peccaries and to detect positive or negative effects of fire on the abundance of these mammal species. The null hypothesis was that track numbers on burned transects would not differ from track numbers in unburned transects.

STUDY SITE AND METHODS

Reserva Xavante do Rio das Mortes is a large (329,000 ha) Cerrado reserve in central east Mato Grosso, (51° 52' W 13° 14'S). The vegetation consists of patches of cerrado, open grasslands and gallery forests. About one third of the reserve consists of flood plains that are partially underwater in the wet season. Two thirds of the Reserve have relatively level with permanent dry terrain, although it also includes the rocky slopes and ridge tops of Serra do Roncador. Wildlife is abundant in the Reserve with representatives of almost all large mammals found in Cerrado (pers.obs.). In a general way, Reserva Xavante do Rio das Mortes is well conserved and represents one of the largest continuous protected areas of Cerrado in South America.

There are five Xavante villages with approximately 1000 indians within the Reserve. Xavante indians are mainly hunters, and hunts using fire are concentrated from June to September (dry season peak). The first two or three rains of the season occur in mid September and the wet season starts in late October. Xavante indians hunt mainly in the dry season and rely on field crops in the wet season.

The effect of fire on peccaries was investigated by counting the number of sets of fresh tracks on burned and unburned transects. Where animal densities are highest, one finds a greater abundance of tracks (Fragoso 1991, Hill et al. 1997,). Transects were established by a WWF wildlife management project at Reserva Xavante do Rio das Mortes using a stratified random method. They were established in a seasonally flooded area known locally as Pantanal do Rio das Mortes where the dominant vegetation type is open grasslands with a mixture of cerrado patches and gallery forest. The two areas where burned and unburned transects were established had a similar community of plant

species, similar topography and aspect. A pre-fire census established the quantitative similarity of control and treatment areas and showed no significant differences in the number of tracks of herbivorous mammals (Kruskall-Wallis, $p>0.05$ in all cases, $n=7$). All transects were established at more than 15 kms from Xavante villages, in a lightly hunted area (see Fragoso et al. 2000) to avoid any hunting effect. Fire occurred in late August 1995 when approximately half the reserve was burned (164000 ha). Starting points of 7 burned and 7 unbumed transects were marked and one hour walks were made in a previously determined direction (perpendicular to one of the two dirt roads which gave access to the study area). Each transect was approximately 4 kms long. Minimum distance between transects within each treatment was of 1km and the minimal distance between burned and unbumed transects was of 10km. Trails were searched for tracks by the author and three newly trained Xavantes 20, 64, 100, 159, 203, 252 and 321 days after burning. We tracked 49 hours in the burned transects and 49 hours in the unbumed transects which was approximately, 187 kms walked in each treatment. Fresh tracks were identified with Xavante help and experience. The direction of the animal and the size of the track were recorded to try to avoid recounting tracks of the same individuals. The two species studied the white lipped peccary, *Tayassu pecari* and the collared peccary, *Pecari tajacu* are important to Xavante indians as food resource and have easily identified tracks. Tracks are easily detected in burned areas due to the lack of vegetation and the quality of the track impression in ash. Sets of tracks are also easily detected in unbumed areas due to spaces in between grass tufts which leave soil exposed and tracks in evidence. The authors believes that all sets of tracks present in the transects where found in both burned and unbumed areas although more attention was needed when

tracking in unburned transects. The same 14 transects were used for each sample. Groups of peccaries were divided in three categories: white-lipped peccary groups were divided in small (from 0-20), medium (from 21-60) and large (larger then 60) and collared pecari in small (from 0-10), medium (from 11-20) and large (larger then 20).

Statistical analysis included a two-way analysis of variance with number of tracks as the dependent variable and burned/unburned transects (treatment), transects and visits as factors. In the analysis transects were kept as blocks, because there was no interest in the interaction between transects and the other factors. When necessary, a Tukey test was utilized to verify where differences existed (Sokal and Rohlf 1995, Zar 1999).

RESULTS

Collared peccary

There was no significant differences between collared peccaries when comparing abundance in burned and unburned areas (Table 1). Collared peccaries were present in all sample sessions in the burned area and was absent 64 days after burning in the unburned area. The highest mean of collared peccaries in all sampling session including burned and unburned areas was 203 days after burning, aproximately six months after burning. Although we found no statiscally significant difference, mean abundances of collared peccary in burned areas were higher than in unburned areas (Table 1). No mortality was detected in transects during field work.

TABLE I: Collared peccary abundance in burned and unbumed transects. + = standard deviation. Reserva Xavante do Rio das Mortes, MT, BRASIL

DAYS AFTER BURNING	NUMBER OF SETS OF TRACKS	
	BURNED	UNBURNED
20	3.28 + 7.41	2.86 + 7.56
64	1.71+3.69	0
100	4.43 + 7.78	0.29 + 0.49
159	11.43 + 10.7	3.00 + 7.51
203	9.00+10.30	3.29 + 7.39
252	8.58 + 9.00	8.58 + 10.70
321	7.43 + 9.30	7.30 + 9.46

White-lipped peccary

There were no significant differences in the abundance of white lipped peccary when comparing burned and unbumed areas. Although we found no differences between burned and unbumed areas there was a strong time effect (p=0.00, n=14). White-lipped peccaries disappeared during 5 sampling sessions in burned areas and in 4 sampling sessions in the unbumed areas. (Table 2). No mortality was detected in transects during field work.

TABLE 2: White lipped peccary abundance in burned and unbumed transects. + = standard deviation. Reserva Xavante do Rio das Mortes, MT, BRASIL

DAYS AFTER BURNING	NUMBER OF SETS OF TRACKS	
	BURNED	UNBURNED
20	0	0
64	0	0
100	0	0
159	0	0
203	0	17.14 + 21.40
252	5.71 + 15.11	5.71 + 15.11
321	1.43 + 3.78	2.86 + 7.56

Peccaries live in simpatry at Reserva Xavante do Rio das Mortes. In the unbumed area, collared and white-lipped peccaries utilized 42.86% of the transects in common and in burned areas they shared 14.29 %. No agonistic encounters were seen between white-lipped and collared peccaries.

DISCUSSION

The white lipped peccary *(Tayassu pecari)* forms large herds of 50-300 individuals and feeds mostly on fruits, palm nuts, insects and also browse (Emmons 1990). Home range of white lipped peccaries are large (Fragoso 1998) when compared with the home range of collared peccaries *(Pecari tajacu)* (Taber et al 1994, Judas & Henry 1999). Collared peccaries form groups of 1-20 individuals and feed on fruits, palm nuts, browse, snails and other small animals (Emmons 1990). Both species can be considered generalists (Bodmer 1989, Bodmer 1991).

That collared peccaries utilize burned and unburned areas may be related to diet. In Cerrado, some palm fruits are resistent to fire and function as a possible food alternative for peccaries in burned areas. It is well known that peccaries are well adapted to crush hard resistant seeds (Kiltie 1981) like those of *Orbygnia phalerata* (PALMAE) present in the study area. Other resources are also present such as roots, young stems (Murakami and Klink 1996, Rodrigues 1996) and insects (Prada et al 1995) which already have been determined to be part of the diet of collared peccaries (Barreto et al 1997). In the same way as large herbivore mammals (Prada 2001) collared peccaries escape fire and return to utilize burned areas.

The white lipped peccary dissapeared during five months after fire in the burned area and was also absent during 4 months in the unburned area. There are three possible reasons for such a long absence of white lipped peccaries from burned and unburned areas:

l)The species has a large home range and during five months utilize a distant unburned region in the Reserve.

2) White lipped peccary escapes fire crossing the Mortes River (south limit of the Reserve) and utilizing the Rio das Mortes Wetlands that would serve as temporal refugia during and after burns.

3) White lipped peccaries during this period are more restricted to gallery forests of the Rio das Mortes and other smaller water courses. Some studies show that white lipped peccaries are more dependent of forest then collared peccaries (Kiltie & Terborgh 1983). Another study showed that white-lipped peccaries utilized more palm wetlands and savanna wetlands and collared peccaries utilized more forest areas (Fragoso 1999).

The second posibility seems more plausible due to the shorter distance of transects from the Mortes River than to any other unburned region within the Reserve. Rio das Mortes Wetlands neighboring Reserva Xavante do Rio das Mortes.are extremely important not just for peccaries but for the conservation of mammalian fauna in a general way. Those wetlands do not suffer much hunting pressure and large mammal diversity is extremely high (pers obs). The area has aproximately 600,000 ha and can function as a source of animals to the Reserve and also as refuge for certain species during and after fires. Fragoso *et ai* (2000) do not mention the importance of the Rio das Mortes Wetlands which are fundamental for the conservation of the natural resources of Reserva Xavante do Rio das Mortes.

White lipped peccaries may be more vulnerable to fire than collared peccaries due to behavioural aspects, basically the strong tendency of white lipped peccary to form large herds that if cornered by fire may kill all individuals. A large herd of white lipped peccary is also more easily detected by predators (jaguar, puma, Xavante indians) in open burned areas than small herds of collared peccaries which are less conspicuous.

The fact that no burned animals were found at the Reserve suggests that both species manage to escape fire, probably utilizing gallery forests as natural barriers. Some studies suggest that gallery forests can serve as refugee for both terrestrial and arboreal mammals during fires and can serve also as sources of colonization following a fire (Redford & Fonseca 1986). Other studies suggest that species of terrestrial mammals may escape fire by crossing gallery forests that function as barriers against fire (Prada 2000) returning when plant regeneration starts.

The two species of peccaries live in simpatry at Reserva Xavante do Rio das Mortes utilizing the same areas. Other studies with peccaries have already shown this ecological characteristic of native neotropical peccaries (Smythe 1986, Sicuro & Oliveira 2002). Considering that the two species of peccaries are very similar in diet and other ecological requirements, the fact that they coexist may be related to behavioural differences in exploring resources. White lipped peccaries have large herds with huge home ranges and strong group cohesiveness whereas the collared have small groups, are more sedentary (Robinson and Eisenberg 1985) and vary more in group cohesiveness. These characteristics of the two species may be responsible for the differences observed in the utilization of burned and unburned areas. An important issue when thinking about conservation of peccaries in Reserva Xavante do Rio das Mortes is to manage fire considering the differences observed in the utilization of burned and unburned areas by the two species of peccaries. Probably white lipped peccary in Reserva Xavante do Rio das Mortes is more vulnerable to fire and requires large well conserved neighboring areas to escape large-scale fires in the Xavante Reserve.

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Running head: Fire and Hunting in Brazil

HUNTING AND BURNING: WHICH FACTOR HAS THE GREATEST EFFECT ON ANIMAL POPULATIONS?

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ABSTRACT: Fire and burning are important ecological factors in Cerrado. The effects of burning and hunting on the abundance of large mammals was studied at Reserva Xavante do Rio das Mortes, a 329,000 ha Indian Reserve in the Cerrado of Mato Grosso, Brazil. Track counts were used to compare the abundance of these mammals along three hunted transects, three burned transects and four transects in a control area without fire nor hunting. The burned and hunted areas where searched for tracks on seven occasions between August 1995 and August 1996. The four transects in the control area where searched once before fire. The number of tracks in burned areas was higher for marsh deer when compared with hunted areas. In the other hand, gray brocket deer abundance was higher in hunted areas when compared with burned areas. Tapir, although no differences was founded between hunted and burned areas, was more abundant in the control transects (without hunting nor burning). Differences between the effect of burning and hunting on mammals should be considered when recommending management strategies for Reserva Xavante do Rio das Mortes

Key Words: cerrado, Xavante indians, tracks, food resources, mammals, burning, hunting

INTRODUCTION

One of the challenges of conservation biology is to evaluate factors that affect animal poupulations and to determine the intensity of the impact of each one of them. Hunting has been pointed out as an important factor affecting animal populations to the point that scientists supports the hypothesis that extinction of large mammals in the Pleistocene was due to Paleolithic hunters (Smith 2002). Actually, subsistence hunting is very important in the diet of traditional human populations of the tropical region (Redford e Robinson 1987, Bodmer etal 1988, Bodmer et al 1993, Fragoso 2000) and in some cases can affect animal populations in-a negative way with a strong decrease in animal abundance (Fragoso et al 2000). Generally, areas near indian villages suffer a strong game depletion when compared with areas located far from the human settlement (Fragoso et al 2000, De Souza-Mazurec et al 2000). In some cases subsistence hunting lead to local extintion of some species like the white lipped pecari in the north of Rondônia state (Fragoso com pess).

Another factor affecting animal populations is fire, which depending on its intensity and frequency can have catastrophic consequences. In Emas National Park (Brazil), a high intensity fire caused a strong mortality in populations of the giant anteater *(Myrmecophaga tridactyla)* and the giant armadillo *(Priodontes maximus)* (Silveira et al 1999). Other studies in Cerrado show that mammalian fauna generally escapes fire and that mammals are able to use burned areas (Prada 2001). An important issue is to make a comparison between burning and hunting to determine which effect is greatest on animal populations.

The Cerrado is a savanna like vegetation (Eiten 1972) and covers approximately 2 million km^2 representing the second largest natural ecosystem in Brazil (Sarmiento and Monasterio 1975, Eiten 1972, Ratter and Dargie 1992). Fire can occur naturally and is an important ecological factor (Coutinho 1978, 1990, Lamotte 1975, Miranda et al. 1993, Kauffman et al. 1994) which can affect plant and animal populations (Prada et al 1995, Prada 2001). Hunting by traditional human populations in Cerrado vegetation is another important factor that can affect animal populations (see Fragoso et al 2000).

The objective of the present work is to compare burning and hunting as factors affecting animal populations.

METHODS

Reserva Xavante do Rio das Mortes is a large (329,000 ha) cerrado reserve in central east Mato Grosso, (longitude 51o 52' and latitude 13o 14'). There are 5 Xavante villages with approximately 1000 indians within the Reserve. The vegetation consists of patches of cerrado, open grasslands and gallery forests. About one third of the reserve consists of flood plains that are partially underwater in the wet season. Two thirds of the Reserve has relatively level with permanent dry terrain, although it also includes the rocky slopes and ridge tops of Serra do Roncador. Fauna at the Reserve is abundant (per.obs.), with representatives of almost all large mammals found in the Cerrado (Fragoso et al 2000). Xavante indians are mainly hunters, and hunts using fire are concentrated from June to September (dry season peak). The first two or three rains of the season occur in mid September and the wet season starts in late October.

The effect of hunting and burning on mammals was investigated by counting the number of sets of fresh tracks on burned, hunted and control transects (without fire nor

hunting). We chose three transects in a burned area with no hunting, three transects in a hunted area with no burning andfour transects in a control area with no fire nor hunting. Transects in burned and hunted areas were searched for tracks on 7 ocasions starting in September 1995 till June 1996. Transects with no burning nor hunting where searched once before fire. We did not register tracks of the same individual. To evaluate the effect of fire and hunting we utilized a one way ANOVA to compare our data. When significant differences where detected a Tuckey test was utilized to determine which factor was responsible for these differences.

RESULTS

Marsh d e «

Marsh deer was more abundant in the control transects then in any other area. When comparing burned and hunted transects marsh deer was more abundant in burned areas (ANOVA $p< 0.05$, $n=21$) (Table 1).

Tapir

Tapir was more abundant in control transects than in burned transects. There was no significant differences between hunted and control areas (ANOVA $p< 0.05$, $n=21$) (Table 1).

Gray brocket deer

Gray brocket deer was more abundant in hunted areas when compared with control and burned areas (ANOVA $p< 0.05$, $n=21$) (Table 1).

The other species did not present statistically significant differences between hunted, burned and control transects (Table 1).

Tabela 1: Mean number of tracks in burned, hunted and control areas.

species COMMON NAME	BURNED	CONTROL	HUNTED
Blastocerus dichotomus Marsh deer	0.810-1.167	3.12 ±2.23	0.190 ±0.512
Ozotocerus bezoarticus Pampas deer	3.476 ±4.792	1.75 ±3.49	1.00 ±2.049
Tapirus terrestris Tapir	2.524 ±2.768	7.25 ± 6.77	4.429 ±4.238
Myrmecophaga tridactyla Giant anteater	0.857 ±1.108	0.75 ±1.75	1.048 ±2.312
Priodontes maximus Giant armadillo	0.286 ±0.717	0.50 ^0.75	0.238 ±0.539
Euphractus sexcinctus Yellow armadillo	0.190 ±0.512	0.12 ±0.35	0.381 ±0.590
Pecari tajassu White lipped pecari	0.476 ±2.182	00^00	0.000 ±0.000
Tayassu tajacu Collared pecari	3.524 ±4.191	8.50 ±9.50	4.619 ±6.659
Mazama americana Red brocket deer	0.190 ±0.512	00 ±00	0.048 ±0.218
Mazama gouazoupira Gray brocket deer	0.238+ 0.768	0.63 ±0.85	1.381 + 1.596

DISCUSSION

Fire and hunting have been pointed out as an important anthropogenic threat for the conservation of tropical biodiversity (Dos Santos et al 1999, Bruner et al 2001). Some studies suggest that a dramatic decrease in some populations of mammals is related to human induced fires coupled with heavy hunting (Melzer et al 2000, Mutschler et al 2001). Although it is clear that hunting and burning are important anthropogenic factors there is a need to determine which effect affects animal populations more .

Large mammalian herbivores

Tapir and marsh deer did not show any significant differences when compariung burned and hunted areas although the abundance of this species in control areas was higher. This indicates that fire and hunting affect negatively the abundance of these species with a similar intensity. It is well known that hunting can cause a strong decline in the populations of deer (Langvatn and Loison 1999, Rabinowitz et al 1999, Jenks et al 2002) but recently it was shown that numbers of deers were not affected by fire in Cerrado (Prada 2001). More studies are necessary to investigate the differences between hunted and burned factors.

In the other hand, the gray brocket deer seem to be more affected by fire then by hunting. Xavantes track their prey and traditionally there is no use of traps or other hunting strategy. Generally they track in open areas and avoid hunting in the forest where tracks are difficult or impossible to find. Although Xavantes also track in the cerrado vegetation they complain that it is much harder then tracking in open areas and that visibility is much more limited. They also complain that in the cerrado an arrow or a

bullet is more easily intercepted by vegetation. For Xavantes, the gray brocket deer is a very difficult species to hunt because it is very quick and found generally in cerrado vegetation. Furthermore, its meat is not much appreciated by Xavantes. After fire in cerrado, fruits are absent, so the gray brocket deer, which is a frugivorous species that relies on fruits (Emmons 1990), will have no food resources in burned areas. In the other hand, species like the pampas deer and the marsh deer are species that generally utilize open areas and feed on grasses and herbs ((Pinder 1997)). For Xavantes these species are easily sighted and hunted and both species are very appreciated for their meat. New shoots and green juvenile grass are present in recently burned areas in Cerrado (Raw & H a y 1985, Morais & Benson 1987, Miranda & Klink 1 9 9 6 » Murakami & Klink 1996, Rodrigues 1996), thus offering food resources for these species.

It is clear that the effects of fire and hunting on the populations of mammals differs depending on the species. This differences must be considered when recommending conservation strategies.

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EPÍLOGO

Novamente ressaltamos que o grande desafio da biologia é encontrar um equilíbrio entre o desenvolvimento humano e a conservação dos recursos naturais. Grupos tradicionais que dependem diretamente dos recursos naturais para sua sobrevivência também se deparam com este conflito. A principal demanda social do povo Xavante é alimento, e para suprir essa demanda os Xavantes dependem fortemente da caça. A caça obviamente entra em conflito com a conservação de mamíferos de médio e grande porte na Reserva Xavante do Rio das Mortes .O grande desafio, no caso dos Xavantes, é alimentar seu povo sem esgotar os recursos faunísticos. Segundo Fragoso et ai (2000) algumas populações animais estariam já comprometidas, como o tamanduá bandeira *(Myrmecophaga tridactyla).*

Uma questão interessante em termos de conservação da fauna da Reserva Xavante que não foi mencionada por Fragoso et ai (2000) é a importância do Pantanal do Rio das Mortes como fonte de animais. O Pantanal do Rio das Mortes é uma vasta área de campos abertos com manchas de Cerrado que alaga periodicamente. Esta área é extremamente rica em mamíferos de médio e grande porte (obs pess). Além disto a área é pouco habitada, com fazendas de criação extensiva de gado (sem substituição do capim nativo) e aparentemente com uma baixa pressão de caça. Segundo a teoria de metapopulações esta área poderia representar uma fonte de animais para a Reserva. Assim, o Pantanal do Rio das Mortes agiria como uma área "source" e a Reserva Xavante como uma área "sink".

Outro fator que está relacionado com a conservação dos recursos naturais nas terras Xavantes é o fogo. Baseado nos nossos resultados o fogo parece não ter efeitos negativos sobre as populações animais. Podemos concluir que a freqüência e intensidade de

queimadas na Reserva Xavante não põe em risco as populações de animais. Uma questão intrigante é como com um histórico tão longo de queimadas o cerrado e a fauna associada ainda estão em um bom estado de conservação. A resposta pode ser o próprio manejo de fogo feito pelos Xavantes. A continuidade de estudos relacionados com etnoecologia do fogo são importantes e fundamentais para poder entender melhor a relação fogo/cerrado.

Talvez os fatores mais evidentes relacionados com a conservação dos recursos naturais na Reserva Xavante do Rio das Mortes sejam o fogo e a caça . Mesmo com caça e com fogo a Reserva Xavante do Rio das Mortes ainda representa uma das maiores áreas bem conservadas do Cerrado brasileiro. Isto leva a pensar que em termos de conservação de mamíferos estes dois fatores não são limitantes. O grande problema em termos de conservação de mamíferos no Brasil é á substituição de habitats naturais por atividades agrícolas. A substituição do Cerrado para criação de gado (com troca do capim nativo por exótico) ou então para o desenvolvimento descontrolado de monoculturas tem posto em risco as populações de mamíferos nativos do Brasil. Talvez o grande problema e risco do povo Xavante seja o isolamento das suas terras. Assim, a criação de uma unidade de conservação no Pantanal do Rio das Mortes se torna indispensável para a manutenção da cultura e do povo Xavante. Foi o Pantanal do Rio das Mortes que os Xavantes avaliaram como uma "barreira" para o desenvolvimento dos brancos. Também representa o cemitério dos seus antepassados, possuindo portanto alto valor cultural. Atualmente a Funai está considerando a área com intenções da ampliar as terras Xavantes. Recomenda-se que a área do Pantanal do Rio das Mortes seja transformada numa unidade de conservação que possa servir como fonte de animais para Reserva Xavante do Rio das Mortes.

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CONCLUSÕES GERAIS

1 - O fogo não afeta a abundância de grandes mamíferos herbívoros como anta *(Tapirus terrestris)*, cervo do pantanal *(Blastocerus dichotomus)* e veado campeiro *(Ozotocerus bezoarticus)*.

2- O fogo não afeta a abundância dos edentata.

3- O fogo não afeta a abundância dos porcos do mato

4- Os recursos alimentares disponíveis após as queimadas devem ser o fator fundamental para explicar a utilização de áreas queimadas pelos mamíferos da Reserva Xavante do Rio das Mortes.

5- A mortalidade de mamíferos devido as queimadas é minima na Reserva Xavante.

6- O cervo do pantanal e a anta são mais abundantes nas áreas controle e sem diferença significativa quando comparando areas queimadas e caçadas.

7- O fogo afeta a abundância do veado catingueiro (*Mazama gouazoupira)* mais do que a caça.