

Feeding habit of the Brazilian tapir, *Tapirus terrestris* (Perissodactyla: Tapiridae) in a vegetation transition zone in south-eastern Brazil

Sônia A. Talamoni ^{1,2} & Miguel A. C. Assis ¹

¹ Programa de Pós-graduação em Zoologia de Vertebrados, Pontifícia Universidade Católica de Minas Gerais. Avenida Dom José Gaspar 500, Prédio 41, 30535-610 Belo Horizonte, Minas Gerais, Brasil.

² Corresponding author. E-mail: talamoni@pucminas.br

ABSTRACT. Tapirs are considered generalist herbivores and the differences in the proportions of dietary items are often attributed to differences in the habitats where individuals live. This study characterized the feeding habit of *Tapirus terrestris* (Linnaeus, 1758) in a nature reserve in south-eastern Brazil, located in a region considered a transition zone between the Cerrado (Brazilian savanna) and the Atlantic Forest biomes. Fecal samples from *T. terrestris* individuals were collected monthly at six sampling areas that encompassed a total of 242.22 ha. There were 147 fresh samples found (77 during the dry season and 70 during the wet season). The diet of the tapirs in this reserve was characterized by the prevalent browsing on leaves and stems. There was a low frequency of fruit seeds in the diet of the tapirs during both the wet and dry seasons. However, in the dry season a higher percentage of samples containing seeds was observed. Fruits of Rubiaceae, Solanaceae, and Annonaceae were most consumed during the dry season. Most of the fruit seeds found presented small mean diameter (3.7-8.4 mm) and most of the fruits were capsules and dry fruits. The characteristics of the fruits consumed by the tapirs indicate that they forage in the lower forest stratum and upon species from Cerrado. Additionally, *Psidium myrtiloides* O. Berg. clusters found in the study site suggest that the tapirs may be acting as dispersal agents of this species.

KEY WORDS. Diet; *Psidium*; seasonality; Serra do Caraça.

The diet of large herbivores is usually composed of leaves and/or fruits (GILL 2006). The Brazilian tapir, *Tapirus terrestris* (Linnaeus, 1758), which is the largest mammal present in the Neotropical region, feeds upon sprouts, leaves, stems, fruits and their seeds, aquatic plants, and grass-like plants of the families Poaceae and Cyperaceae (BODMER 1990). Differences found in the diet of different populations are usually attributed to characteristics of the habitats where they live (HENRY *et al.* 2000). In a tropical forest at the French Guiana, for instance, a higher consumption of fiber material, such as stems and wooden vegetal parts, was recorded (HENRY *et al.* 2000). However, in the Brazilian (FRAGOSO 1997) and Peruvian (BODMER 1990) Amazon Forest, a higher proportion of fruits constitute the diet of *T. terrestris*. Local variation in the diet can also be found as a result of the selective use of some plant species, which are more frequent in the diet of the individuals than would be expected according to their relative abundances in the habitat (BODMER 1990, FRAGOSO 1997, SALAS & FULLER 1996).

Tapirus terrestris has a strong capacity to modify its environment according to its food habits and habitat use (HENRY *et al.* 2000), especially due to its seed dispersal capacities (FRAGOSO 1997, FRAGOSO & HUFFMAN 2000, SALAS & FULLER 1996). The use of large-sized seeds (> 25 mm) and the dispersal of these seeds over long distances are unique characteristics of *T. terrestris*

among Neotropical frugivores (GALETTI *et al.* 2001). According to GALETTI *et al.* (2001), the removal of *T. terrestris* from its habitat would be deleterious for 50 out of 1,380 Atlantic forest plant species, especially those with large seeds. However, despite its wide distribution along the Atlantic Forest and Cerrado biomes, the knowledge about *T. terrestris* diet is scarce in Brazil (FRAGOSO 1997, OLMOS 1997, GALETTI *et al.* 2001). In this work, we characterized the seasonal pattern of the feeding habit of *T. terrestris* living in a nature reserve in south-eastern Brazil. The reserve is located in a region considered a transition zone between the Cerrado and the Atlantic Forest biomes.

MATERIAL AND METHODS

The study was carried out at the Serra do Caraça Private Reserve (20°05'S, 43°29'W), state of Minas Gerais, Brazil. The reserve has an area of 10,187 ha and is located in the slopes of a mountainous chain known as Serra do Espinhaço. The climate of the region is subtropical (ANTUNES 1986), with a mean annual temperature of ca. 19°C (maximum temperatures usually below 30°C and minimum temperatures rarely below 0°C). Annual rainfall is ca. 1,236 mm (CEMIG/UHE Peti station), with a well-defined rainy season from October to March. The reserve vegetation is a mosaic of different physiognomies that include semideciduous forests and cerrado (savannah-like grass-

land), with the latter being found mainly between 820 and 1,600 m of altitude. There are also open areas such as high-altitude fields and "rupestris" fields that consist of rocky and sandy soils interspersed with grasslands, shrubs, and small trees, which are mainly found above 1,000 m of altitude (EITEN 1992, HARLEY 1995).

There is no estimate of the number of tapirs in the reserve, but four adult individuals and a young individual were registered in the sampled area using camera traps. From September 2002 to October 2003, a total of 147 fresh fecal samples were collected monthly along six sampling areas for a total sampling area of 242.22 ha. The selection of these areas was based on evidences of their use by tapirs. Two transects of 250 x 20 m were established in each area. Transects were defined along tracks used by the tapirs in the forest interior and at the margins of different water bodies (Tanque Grande, Belchior, and Tabões streams). The "Tanque Grande" is an artificial dam that constitutes the largest water body available for the tapirs in the area. For each fecal sample collected the deposition place (position in or out of water) was recorded. Another 41 miscellaneous samples collected in the same area from September 2001 to February 2002, which did not have their deposition date known, were also analyzed. Samples collected in latrines, i.e., sites with many faeces of different ages (according to FRAGOSO & HUFFMAN 2000), were not analyzed.

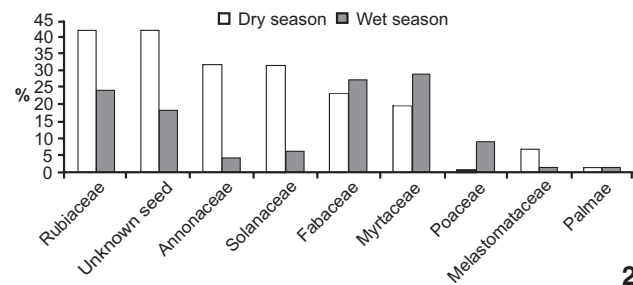
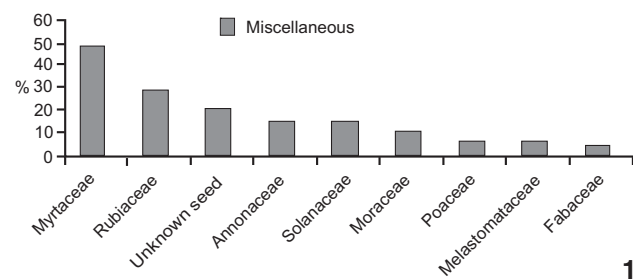
At the laboratory the samples were washed and all food items were separated according to the following categories: fruit seeds and vegetative parts (leaves, petioles, bark). All seeds were identified to the family level, and chi-square tests were utilized to test for differences between frequencies of each plant family between the samples from the dry and wet seasons (SIEGEL & CASTELLAN 1988, ZAR 1999). Frequency data are derived from the number of samples in which a particular family occurred (SIEGEL & CASTELLAN 1988).

RESULTS

Of the total of the fresh samples analyzed, 77 were found during the dry season and 70 during the wet season; 105 (71.5%) were found inside water bodies and only 42 (28.5%) were found on the ground. The diet of *T. terrestris* in the reserve was composed mainly of fibrous and foliar materials. The samples presented a small quantity of fruits, which were not quantified. The seeds most frequently found in the fresh samples belonged to the family Rubiaceae (*Psychotria* sp. and two unidentified species), followed by Fabaceae (*Senna* sp. and two unidentified species), Myrtaceae (specifically *Psidium myrtilodes* O. Berg.), Solanaceae (one unidentified species), and Annonaceae (*Rollinia* sp. and *Annona* sp.). Figure 1 shows the percentage of occurrence of the plant families in the miscellaneous sample, and the figure 2 shows the percentage of occurrence of the plant families in the fresh samples collected during the wet and dry season. Seasonality of consumption was pronounced for the families Rubiaceae ($\chi^2 = 4.6$, $df = 1$, $p < 0.05$), Annonaceae

($\chi^2 = 14.8$, $df = 1$, $p < 0.001$), and Solanaceae ($\chi^2 = 12.8$, $df = 1$, $p < 0.001$). For Leguminosae, Myrtaceae, and Poaceae families, the seasonal variation was not significant ($p > 0.05$). The palm fruit of *Syagrus romanzoffiana* (Cham.) Glassman, which was rarely consumed in either seasons, and the Melastomataceae fruits were not included in the chi-square analysis due to their low frequency counts.

Most of the seeds found in the samples presented small mean diameter (mean \pm SD mm: Rubiaceae = 3.7 ± 0.3 ; Fabaceae = 8.46 ± 0.86 ; Solanaceae = 4.45 ± 0.33). Only Annonaceae (*Rollinia* sp.) presented large seeds, with a mean diameter of 14.7 mm (SD = 1.04 mm). Most of the fruits were of the capsule type (Poaceae and Melastomataceae, mean diameter \pm SD = 4.06 ± 0.32 mm) or seeds of dry fruits (Fabaceae). From the miscellaneous sample (Figs 1 and 2), the fruit *P. myrtilodes* (Myrtaceae, mean diameter \pm SD = 5.4 mm \pm 0.48 mm), was found in 50% of the samples. *Ficus* sp. (Moraceae) was found in 10.8% of the samples.



Figures 1-2. Frequency of occurrence of plant fragment and seeds in the diet of *Tapirus terrestris* at the Caraça Reserve: (1) data obtained from fecal samples with undetermined deposition date (N = 41); (2) data from fecal samples obtained during dry (white bars, N = 77) and wet seasons (black bars, N = 70).

DISCUSSION

The diet of *T. terrestris* in the study area is characterized mainly by leaves and stems. The presence of seeds of small fruits, especially Rubiaceae and Melastomataceae, which are families frequently found in the lower stratum of tropical forests (e.g., GENTRY & EMMONS 1987, LASKA 1997, MARTIN-GAJARDO &

MORELLATO 2003), suggests the consumption of these fruits while the tapirs are browsing for leaves in the lower stratum of the forest. It is known that the majority of the species found at the lower stratum of the forest produce small fruits, with edible parts that attract animals (HOWE & SMALLWOOD 1982, RENNER 1987). Several studies indicate the importance of the lower stratum of the forest for the maintenance of the local fauna due to its continued fruit production. This phenology pattern of fruit production favors interactions between plants and their dispersal and pollinating agents during all the year. Usually the understory fruits are small (10-20 mm), produced in large quantities, and are the ones preferred by several fruit eaters (FRANKIE *et al.* 1974, HILTY 1980, MARTIN-GAJARDO & MORELLATO 2003, GAYOT *et al.* 2004, MOURA & WEBER 2007). In our study site, *Psidium myrtooides* occurs in shrubby formations ("capoeiras") and "rupestre" fields (MORAIS & LOMBARDI 2006). The distribution of this species in the lower stratum and its morphological traits, such as its globe-like (globose) shape, fleshy consistency, and small mean diameter of 13 mm, could benefit its high consumption by the tapirs. Similar morphological traits were identified for many genera of Myrtaceae fruits eaten by mammals in the Brazilian Atlantic forest (PIZO 2002).

Usually the feeding habits of *T. terrestris* are similar to that of other ruminant herbivores in their consumption of large quantities of low quality browse (BODMER & WARD 2006). The use of abundant forage, as observed for *T. terrestris* (HENRY *et al.* 2000) and *T. bairdii* (NARANJO 1995), has the advantage of reducing the search effort since it is improbable that non-ruminant ungulates can satisfy their needs if they concentrate in the search for high quality forage (DEMMENT & VAN SOEST 1985). The high fruit consumption in some sites has been attributed to the grouped distribution of some types of fruits (BODMER 1990, FRAGOSO 1997), which allows a large-bodied tropical forest ungulate to maintain a higher rate of fruit consumption exploring nutritionally rich sources (BODMER & WARD 2006). CODRON *et al.* (2007), however, determined that some fruits cannot be considered high quality resources since several fruits, especially those from savanna formations like the cerrado, have a high proportion of structural cell wall, especially the neutral detergent fiber, implying poorer nutritional value than is commonly assumed. Accordingly, a research on the availability of different fruits and their nutritional content in forest and cerrado areas could explain the high frequency of small fruits in *T. terrestris* diet at the studied area, especially considering the high consumption of Solanaceae and Annonaceae fruits during the dry season.

The consumption of high quantities of seeds of some species either depletes seedling abundance or promotes seed dispersal (GILL 2006). The capacity of *T. terrestris* to act as a dispersal agent in the studied area is suggested by the consumption of *P. myrtooides*. It is known that dispersal quality depends in part of the places where seeds are deposited by the disperser (HOWE & SMALLWOOD 1982). As the tapirs defecate mainly in the

water bodies, as observed during this study, any plant species potentially dispersed by them has to grow nearby these water bodies (SALAS & FULLER 1996). Several dense clumps of *P. myrtooides* located next to rivers were observed in the reserve. These clumps suggest that *T. terrestris* can be acting as a dispersal agent for the species even though other frugivorous vertebrates may consume and disperse it. According to PIZO (2002), the key feature of *Psidium* that permits such a varied assemblage of seed-disperser is the presence of small seeds scattered through the pulp; any animal feeding on its fruits will ingest and disperse its seeds. There are no reports in the literature about the consumption of *Psidium* species by any tapir species, except a report of guava (*P. guajava* L.), a non-native species, consumed by *T. terrestris* (GALETTI *et al.* 2001). The data obtained here indicate the need to preserve as good as possible the habitats where tapirs live, taking into account the scarce knowledge about the real meaning of their interaction with the vegetation.

ACKNOWLEDGMENTS

We thank the reviewers plus Robert J. Young, Gilmar B. Santos and to Adriano G. Chiarello for suggestions, to Eduardo de Paula Pupo Nogueira for their help with data collection, to the staff at the Caraça Reserve, especially to father Célio Dell'Amore, for their help with logistics, to J. A. Lombardi and to M. Sobral (UFMG), for fruit identification. FIP PUC Minas provided financial support. EPPN and MAC had scholarships from PIBIC/CNPq.

LITERATURE CITED

- ANTUNES, F.Z. 1986. Caracterização Climática do Estado de Minas Gerais. **Informativo Agropecuário** 12: 9-13.
- BODMER, R.E. 1990. Fruit patch size and frugivory in the lowland tapir (*Tapirus terrestris*). **Journal of Zoology** 22: 121-128.
- BODMER, R.E. & D. WARD. 2006. Frugivory in large mammalian herbivores, p. 232-260. *In*: K. DANELL; P. DUNCAN; R. BERGSTROM & J. PASTOR (Eds). **Large Herbivore ecology, ecosystem dynamics and conservation**. Cambridge, Cambridge University Press, 506p.
- CODRON, D.; J.A. LEE-THORP & M. SPONHEIMER. 2007. Nutritional content of savanna plant foods: implications for browser/grazer models of ungulate diversification. **European Journal of Wildlife Research** 53: 100-111.
- DEMMENT, M.W. & P.J. VAN SOEST. 1985. A nutritional explanation for body-size patterns of ruminant and nonruminant herbivores. **American Naturalist** 125: 641-672.
- EITEN, G. 1992. Natural Brazilian vegetation types and their causes. **Anais da Academia Brasileira de Ciências** 64: 35-65.
- FRAGOSO, J.M.V. 1997. Tapir-generated seed shadows: scale-dependent patchiness in the Amazon rain forest. **Journal of Ecology** 85: 519-529.
- FRAGOSO, J.M.V. & J.M. HUFFMAN. 2000. Seed-dispersal and seedling recruitment patterns by the last Neotropical megafaunal

- element in Amazonia, the tapir. **Journal of Tropical Ecology** 16: 369-385.
- FRANKIE, G.W.; H.G. BAKER & P.A. OPPLER. 1974. Comparative phenological studies of trees in tropical wet and dry forest in the lowland of Costa Rica. **Journal of Ecology** 6: 881-919.
- GALETTI, M.; A. KEUROGHLIAN; L. HANADA & M.I. MORATO. 2001. Frugivory and seed dispersal by the lowland tapir (*Tapirus terrestris*) in Southeast Brazil. **Biotropica** 33: 723-726.
- GAYOT, M.; O. HENRY; G. DUBOST & D. SABATIER. 2004. Comparative diet of the two forest cervids of the genus *Mazama* in French Guiana. **Journal of Tropical Ecology** 20: 31-43.
- GENTRY, A.H. & L.H. EMMONS. 1987. Geographical variation in fertility, phenology and composition of the understory of Neotropical forest. **Biotropica** 19: 216-227.
- GILL, R. 2006. The influence of large herbivores on tree recruitment and forest dynamics, p. 170-202. *In*: K. DANELL; P. DUNCAN; R. BERGSTROM & J. PASTOR (Eds). **Large herbivore ecology, ecosystem dynamics and conservation**. Cambridge, Cambridge University Press, 506p.
- HARLEY, R.M. 1995. Introduction, p. 1-42. *In*: B.L. STANNARD; Y.B. HARVEY & R.M. HARLEY (Eds). **Flora of the Pico das Almas, Chapada Diamantina – Bahia, Brazil**. Kew, Royal Botanic Gardens, 853p.
- HENRY, O.; F. FEER & D. SABATIER. 2000. Diet of the Lowland Tapir (*Tapirus terrestris* L.) in French Guiana. **Biotropica** 32: 364-368.
- HILTY, S.L. 1980. Flowering and fruiting periodicity in a premontane rain forest in Pacific Colombia. **Biotropica** 12: 298-306.
- HOWE, H.F. & J. SMALLWOOD. 1982. Ecology of seed dispersal. **Annual Review of Ecology and Systematics** 13: 201-228.
- LASKA, M.S. 1997. Structure of understory shrub assemblages in adjacent secondary and old growth tropical wet forests, Costa Rica. **Biotropica** 29: 29-37.
- MARTIN-GAJARDO, I.S. & P.C. MORELLATO. 2003. Fenologia de espécies Rubiaceae no sub-bosque em floresta Atlântica no sudeste do Brasil. **Revista Brasileira de Botânica** 23: 299-309.
- MORAIS, P.L.O. & J.A. LOMBARDI. 2006. A Família Myrtaceae na Reserva Particular do Patrimônio Natural da Serra do Caraça, Catas Altas, Minas Gerais. **Lundiana** 7: 3-32.
- MOURA, T.N. & A.C. WEBER. 2007. Padrões de frutificação em plantas do sub-bosque na Amazônia Central: implicações ecológicas. **Revista Brasileira de Biociências** 5: 306-308.
- NARANJO, E. 1995. Abundancia, uso do hábitat y dieta del tapir (*Tapirus bairdii*) em um bosque tropical húmedo de Costa Rica. **Vida Silvestre Neotropical** 4: 20-31.
- OLMOS, F. 1997. Tapirs as seed dispersers and predators, p. 3-9. *In*: D.M. BROOKS; R.E. BODMER & S. MATOLA (Eds). **Tapirs: status survey and conservation action plan**. Gland, Switzerland, IUCN/SSC Tapir Specialist Group, 164p.
- PIZO, M.A. 2002. The seed-dispersers and fruit syndromes of Myrtaceae in Brazilian Atlantic Forest, p. 129-144. *In*: D.J. LEVEY; W.R. SILVA & M. GALETTI (Eds). **Seed dispersal and frugivory: ecology, evolution and conservation**. Wallingford, CAB International, 508p.
- RENNER, S. 1987. Seed dispersal. **Progress in Botany** 49: 113-131.
- SALAS, L. & T.K. FULLER. 1996. Diet of the lowland tapir (*Tapirus terrestris* L.) in the Tabaro River Valley, Southern Venezuela. **Canadian Journal of Zoology** 74: 1444-1451.
- SIEGEL, S. & N.J. CASTELLAN JR. 1988. Nonparametric statistics for the behavioral sciences. New York, McGraw-Hill, 399p.
- ZAR, J.H. 1999. **Biostatistical analysis**. New Jersey, Prentice hall, IV+718p.

Submitted: 03.VIII.2008; Accepted: 08.VI.2009.

Editorial responsibility: Glauco Machado