Use of Boat Surveys to Provide Complementary Data on the Ecology of Bradypus Tridactylus (Pilosa: Bradypodidae) from Northern Amazonia

Authors: Laufer, Juliana, Amador, Joyce A., Conceição, Paula C., Norris, Darren, and Michalski, Fernanda

Source: Edentata, 13(1) : 56-60

Published By: IUCN/SSC Anteater, Sloth and Armadillo Specialist Group

URL: https://doi.org/10.5537/020.013.0115

Edentata 13 (2012): **56–60**
Electronic version: ISSN 1852-9208
Print version: ISSN 1413-4411
http://www.xenarthrans.org

SHORT COMMUNICATION

Use of boat surveys to provide complementary data on the ecology of *Bradypus tridactylus* (Pilosa: Bradypodidae) from northern Amazonia

Juliana Laufer[A,B], Joyce A. Amador[A], Paula C. Conceição[A], Darren Norris[A,C] and Fernanda Michalski[A,B,D,1]

[A]Laboratório de Ecologia e Conservação de Vertebrados, Universidade Federal do Amapá, Rod. Juscelino Kubitscheck, km 02, 68902-280, Macapá, AP, Brazil. E-mail: lauferjuliana@gmail.com
[B]Programa de Pós-Graduação em Biodiversidade Tropical, Universidade Federal do Amapá, Rod. Juscelino Kubitscheck, Km 02, 68902-280, Macapá, AP, Brazil.
[C]Laboratório de Biologia da Conservação, Departamento de Ecologia, Universidade Estadual Paulista, C.P. 199, 13506-900, Rio Claro, SP, Brazil. E-mail: dnorris75@gmail.com
[D]Instituto Pró-Carnívoros, C.P. 10, 12940-970, Atibaia, SP, Brazil. E-mail: fmichalski@procarnivoros.org.br
[1]Corresponding author

Abstract Here we present new data on relative abundance and diet of *Bradypus tridactylus* Linnaeus, 1758 resulting from 2,505 km of river based surveys conducted in northern Amazonia. Our sampling effort using a motorized boat provided a low number of *B. tridactylus* detections (n = 4, relative abundance of 0.02 individuals/10 km surveyed). Our observations provide the first record of *Parkia velutina* Benoist (Leguminosae – Mimosoideae) consumption for *B. tridactylus*. We contribute with recommendations of standardized complementary survey techniques that can be used to provide data on relative abundance of arboreal mammals such as sloths in tropical forests.

Keywords: Amazonia, *Bradypus tridactylus*, diet, relative abundance, sloths

Uso de levantamentos em barcos motorizados para fornecer dados complementares sobre a ecologia de *Bradypus tridactylus* (Pilosa: Bradypodidae) na Amazônia Oriental

Resumo Neste estudo apresentamos novos dados sobre a abundância relativa de *Bradypus tridactylus* Linnaeus, 1758 e de sua dieta, obtidos a partir de observações realizadas em 2505 km ao longo de rios no norte da Amazônia. O esforço amostral utilizando um barco motorizado resultou em um baixo número de detecções de *B. tridactylus* (n = 4, abundância relativa de 0,02 indivíduos/10 km percorridos). As observações forneceram o primeiro registro do consumo de *Parkia velutina* Benoist (Leguminosae – Mimosoideae) para *B. tridactylus*. Nós apresentamos informações de técnicas de amostragem padronizadas e complementares que podem fornecer dados sobre abundância de mamíferos arbóreos em florestas tropicais, como as preguiças.

Palavras-chave: abundância relativa, Amazônia, *Bradypus tridactylus*, dieta, preguiças

Sloths are folivorous, arboreal mammals that are currently classified in the order Pilosa and suborder Folivora (Wilson & Reeder, 2005). Despite their wide distribution across Neotropical forests, few studies describe the ecology and behavior of sloths (but see Carvalho, 1960; Montgomery & Sunquist, 1975; Queiroz, 1995; Chiarello, 1998; Taube *et al.*, 1999; Taube *et al.*, 2001; Bezerra *et al.*, 2008; Cassano *et al.*, 2011). One reason for this relative scarcity of information is the difficulty human observers experience in detecting sloths that often remain stationary and obscured from vision in the forest canopy (Brattstrom, 1966).

Bradypus tridactylus, the pale-throated three-toed sloth, occurs in the northern Neotropics in Venezuela, Guyana, Suriname, French Guiana, and northeastern Brazil from the delta of the Orinoco River to north of the Amazon River and east of Negro River (Hayssen, 2009; Moraes-Barros *et al.*, 2010; Chiarello & Moraes-Barros, 2011). Due to the camouflage provided by the pelage color of *B. tridactylus* (Hayssen, 2009) and the general behavior of moving very slowly in trees, thus avoiding predation largely by preventing detection (Brattstrom, 1966) it is difficult to discern *B. tridactylus* during terrestrial field surveys (*e.g.*, line-transect census). Thus, the majority of studies available for *B. tridactylus* come from captivity and museum specimens and have focused on physiology, metabolism, morphology, and molecular phylogeny (Foley *et al.*, 1995; Gilmore *et al.*, 2000; Green, 2009; Moraes-Barros *et al.*, 2011).

Studies reporting abundance and density estimates of *B. tridactylus* are scarce. For example, in a total line transect census effort of 1,739.6 km in the southern Amazonia, sloths were not detected (Michalski & Peres, 2007) and only three observations of *B. tridactylus* were made during 2,192 km of census in Varzea and *Terra Firme* forests in central-western Amazonia (Haugaasen & Peres, 2005). Density estimates were reported from Guyana (31 individuals/km^2) (Beebe, 1926) and from a rescue operation in French Guiana (Taube *et al.*, 1999). From this rescue operation Taube *et al.* (1999) provide a density estimate considering the entire study area (1.7 individuals/km^2) and a corrected estimate considering only the area surveyed (9.0 individuals/km^2).

Additionally, behavioral data are also lacking for this species. For example, there is only one study with observations on the diet of this species that was conducted in an urban park in Pará, Brazil (Carvalho, 1960). Currently, most of the knowledge on the behavior of *B. tridactylus* is inferred from its Amazonian congener *B. variegatus* (Emmons & Feer, 1997), which is considered to have similar biology and behavior (Eisenberg & Redford, 1999).

In this study, we present new information on the relative abundance and diet of *B. tridactylus* observed along waterways in a continuous forest area in northern Amazonia. We also contribute with discussion of standardized survey techniques that can be used to complement ecological studies of sloths.

The study was conducted around the Floresta Nacional do Amapá (FLONA), a protected area of 412,000 ha designated for sustainable use, located in northern Amazonia (0°55'29''N, 51°35'45''W; **Fig. 1**). FLONA is adjacent to continuous undisturbed forests and maintains the complete community of medium and large bodied vertebrates. This protected area experiences low levels of anthropogenic perturbations (*e.g.* subsistence hunting), in part because only thirteen families live on the reserve border, and the nearest city is located 46 km away by river (Brandão & Silva, 2008).

From March 2011 to February 2012 we conducted surveys of mid to large bodied vertebrates along waterways (Araguari and Falsino Rivers) in a motorized boat using a standardized boat census protocol (Pitman *et al.*, 2011). To optimize detections the boat was piloted along the center of the rivers at a low speed (mean velocity±SD = 11.9±3.3 km/h, range = 3–20). At least three observers (range = 3–5) searched for vertebrates in the river (aquatic species), on the border of the river (terrestrial species), and along the tree line / canopy (arboreal species), with the help of binoculars. To avoid detection bias due to differences in observer experience, all field surveys were conducted with a local field assistant who had lived for more than 30 years in the study area and was trained to identify vertebrates, and one researcher with a minimum of 6 years experience with Neotropical vertebrate censuses. All censuses took place in rainless weather during the morning (08:00–11:59 hr) or afternoon (13:00–18:00 hr).

Here we present a subset of the data that provides information on the abundance and behavior of *B. tridactylus.* We analyzed boat census data in terms of individuals detected per 10 km travelled, which enables our data to be compared with other surveys in the Amazon (Haugaasen & Peres, 2005; Michalski & Peres, 2007; Pitman *et al.*, 2011).

In total, our census effort covered 2,505 km, including 1,677 km along the Araguari and 828 km along the Falsino rivers. Our sampling effort resulted in a low number of detections of *B. tridactylus* (n=4), and a relative abundance of 0.02 individuals/10 km surveyed. Two *B. tridactylus* individuals were observed on 10 July 2011, at the end of the rainy season, when the river water levels in the study area were still high. The other two *B. tridactylus* were observed during the dry season (02 and 15 November 2011), when the river water levels were lower.

The first observation of a solitary *B. tridactylus* occurred at 10:13 hr on 10 July 2011 along the Araguari River. The individual was observed eating leaves (**Fig. 2**) in the upper stratum of a low canopy tree at a height of 24 m (estimated visually from the boat at a perpendicular distance of 20 m). During the 12 min of observation the sloth was first seen at the upper stratum of the tree canopy, eating leaves, but after 3 min it descended and disappeared into the dense under canopy vegetation at a height of *ca.* 15 m. This individual was identified as a male by the characteristic dorsal orange-yellow patch with a broad, tapering, black central streak and a black spot (Hayssen, 2009) (**Fig. 2**). The tree was identified as *Parkia velutina* (Leguminosae - Mimosoideae) (voucher deposited at the Instituto de Pesquisas

Científicas e Tecnológicas do Amapá – IEPA, Herbarium number: HAMAB-18234).

The second observation occurred at 14:56 hr on 10 July 2011. We observed another *B. tridactylus* individual at the edge of the Araguari River supported between vines at a height of 0.5 m above the water line. We remained in the boat at a distance of approximately 15 m from the individual, which did not alter its behavior as a result of our presence. We observed this individual for a total of 7 min during which the animal climbed slowly through the vines until it disappeared into the forest.

The third observation occurred at 14:11 hr on 02 November 2011, when we observed a male *B. tridactylus* swimming across the Araguari River in the direction of the protected area. We observed this individual for a total of 13 min during which the animal reached the river bank and climbed a canopy tree.

The fourth observation occurred at 12:23 hr on 15 November 2011 along the Falsino River. We observed another *B. tridactylus* male along the border of FLONA at a height of 20 m above the water line (estimated visually from the boat at a perpendicular distance of 12 m). This individual was climbing a canopy tree and after 8 min of observation disappeared into the dense canopy vegetation.

As far as we are aware this study is the first to provide information on the relative abundance and diet of *B. tridactylus* in a continuous forest area in the northern Amazonia. In general, density estimates for sloths vary greatly between studies, depending on forest type and census method, and it appears to be difficult to obtain reliable estimates of sloth densities (Taube *et al*., 1999).

The relative abundance of *B. tridactylus* detected in our study area was similar to those reported in unflooded (*Terra Firme* – 0.02 individuals/10 km transect), and slightly higher than the abundance in flooded forests (Varzea – 0.01 individuals/10 km transect) in central-western Amazonia (Haugaasen & Peres, 2005). However, these figures are likely underestimates due to limited visibility along transects. Our abundance estimate for the study area is also probably an underestimate.

Wildlife rescue operations such as the one conducted by Taube *et al*. (1999) will always provide a better estimate of sloth densities as the majority of animals are seen and rescued. Thus, animal records obtained from rescue operations will tend to be higher (Taube *et al*., 1999) than those observed on census surveys with no capture (Haugaasen & Peres, 2005; Michalski & Peres, 2007; Pitman *et al*., 2011). However, due to their sporadic nature estimates from rescue operations are unlikely to provide sufficient data for comparative analysis across Neotropical forests.

Obtaining reliable abundance estimates for sloths is challenging and there is currently no single technique that can provide cost effective data for comparative studies. Line transect census is widely used to study arboreal species such as primates in the Neotropics (Peres, 1999). However, issues of detectability mean that this technique is less effective for sloths. The majority of Amazon forests are accessible by boat (Peres & Terborgh, 1995), and we suggest that boat surveys should be used to complement more focused line transect and behavioral studies. Yet caution needs to be taken as results obtained by

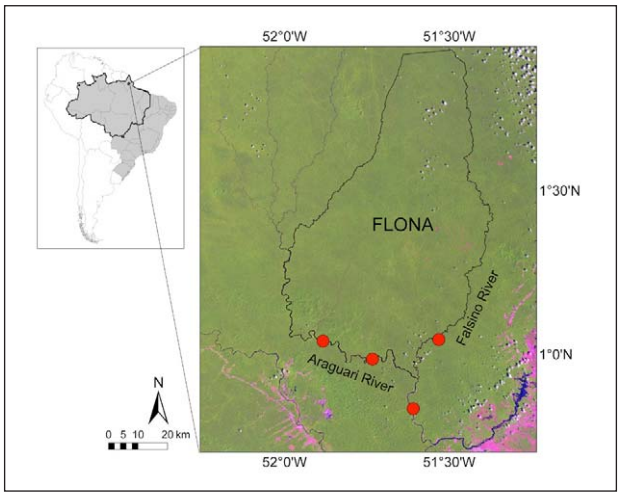

Figure 1. Location of the study region around the Floresta Nacional do Amapá (FLONA), state of Amapá, eastern Brazilian Amazon. Inset shows Legal Amazon (bold black line), and the polygon within the main figure shows the limits of FLONA. A Landsat TM image (226/59, 25 October 2009) shows locations of *Bradypus tridactylus* (red circles) detected via motorized boat surveys. Green, pink, and blue areas represent forest, non-forest, and open-water cover, respectively.

Figure 2. Male *Bradypus tridactylus* eating leaves of a *Parkia velutina tree* (Leguminosae: Mimosoideae) observed during boat surveys along the Araguari River on the border of the Floresta Nacional do Amapá (FLONA), state of Amapá, eastern Brazilian Amazon.

boat surveys may tend to underestimate sloth abundances and should therefore be used to complement other techniques.

Although boat surveys can cause potential biases by failing to detect species that avoid rivers, are difficult to observe due to cryptic behavior, and that are spooked by the noise of boats, the method has a high data-to-cost ratio and a high potential for long-term monitoring. Additionally, this technique is capable of detecting a broad range of species, ranging from small cryptic (*e.g.*, *Saimiri boliviensis*) to large bodied vertebrates (*e.g.*, *Panthera onca*) (Pitman *et al.*, 2011). A particular advantage of boat surveys compared with terrestrial forest survey techniques such as line transect census is that the canopy is visible. Such advantages combined with the fact that researchers often use boats to access Amazonian study areas means that standardized boat surveys have the potential to provide a cost effective source of complementary data on sloth ecology.

As well as abundance estimates, our results show that boat surveys can also contribute with data on species natural history and behavior. We provided data on displacement (swimming) across rivers, which is a rarely documented behavior. We also provided the first observation on the consumption of leaves of the genus *Parkia* and the species *P. velutina* (Leguminosae – Mimosoideae) for *B. tridactylus*. The only previous description of the diet of wild *B. tridactylus* comes from an urban park in Belém (Pará State, Brazil) where this species was recorded eating leaves of *Hevea viridis* Huber. (Euphorbiaceae), *Elizabetha paraense* Ducke. (Leguminosae – Mimosoideae), and *Ceiba sumauma* Schum. (Bombacaceae) (Carvalho, 1960). In our study area, Leguminosae is the dominant family accounting for 23.9% of the species surveyed in a 1.9 ha forest plot (Pereira *et al.*, 2007). Yet there are no studies available to enable insights into the relative generality or selectivity of *B. tridactylus* feeding patterns.

Considering the lack of knowledge of this species and other sloths there is clearly a need to implement complementary field techniques that can be incorporated into current studies with a minimal increase in time and costs to improve the quantity and quality of existing data. This is especially true in remote Amazonian areas where access for researchers is provided by boat travel and terrestrial census and trap studies are more expensive (Pitman *et al.*, 2011).

We suggest that by integrating boat surveys with existing survey techniques it may be possible to cost-effectively generate broad scale comparative data on the distribution and abundance of sloths across Amazonia. Boat surveys can be conducted by people from the local community trained to identify sloths and other vertebrate species (Danielsen *et al.*, 2009). These people could combine the census technique with other activities (*e.g.*, displacement to fish), thereby ameliorating the logistical constraints of time and money. This strategy could increase the number of sloths observed, sampling effort, and the data-to-cost ratio in long-term projects (Pitman *et al.*, 2011) as well as provide data on natural history of poorly studied sloth species.

Acknowledgements

This research was supported by Conservation International – Brazil and the Walmart Institute – Brazil through the project "Support to the implementation of the Amapá National Forest", and The Rufford Small Grants for Nature Conservation. Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) and the Universidade Federal do Amapá provided logistical support. JL was funded by a Brazilian Ministry of Education (CAPES) PhD studentship, JAA and PCC were funded by a National Council for Scientific and Technological Development (CNPq) PIBIC studentships, and DN was funded by a CNPq PhD scholarship. We thank IBAMA for authorization to conduct research in FLONA (IBAMA/SISBIO permit n° 26653-1). We are deeply indebted to Alvino Pantoja for field assistance and to Ivone Nishi, Nigel Pitman, and Fabiano Cesarino for botanic identification.

References

Beebe, W. 1926. The three-toed sloth (*Bradypus cucculliger cucculliger* Wagler). Zoologica 7: 1–67.

Bezerra, B. M., A. S. Souto, L. G. Halsey & N. Schiel. 2008. Observation of brown-throated three-toed sloths: mating behaviour and the simultaneous nurturing of two young. Journal of Ethology 26: 175–178.

Brandão, F. C. & L. M. A. Silva. 2008. Conhecimento ecológico tradicional dos pescadores da Floresta Nacional do Amapá. Uakari 4: 55–66.

Brattstrom, B. H. 1966. Sloth behavior. Journal of Mammalogy 47: 348.

Carvalho, C. T. 1960. Notes on the three-toed sloth, *Bradypus tridactylus*. Mammalia 24: 155–156.

Cassano, C. R., M. C. M. Kierulff & A. G. Chiarello. 2011. The cacao agroforests of the Brazilian Atlantic forest as habitat for the endangered maned sloth *Bradypus torquatus*. Mammalian Biology 76: 243–250.

Chiarello, A. G. 1998. Activity budgets and ranging patterns of the Atlantic forest maned sloth *Bradypus torquatus* (Xenarthra : Bradypodidae). Journal of Zoology 246: 1–10.

Chiarello, A. & N. Moraes-Barros. 2011. *Bradypus tridactylus*. in: IUCN 2011. IUCN Red List of

Threatened Species 2011.2. <www.iucnredlist.org/>. Downloaded on 28 July 2011.

Danielsen, F., N. D. Burgess, A. Balmford, P. F. Donald, M. Funder, J. P. G. Jones, P. Alviola, D. S. Balete, T. Blomley, J. Brashares, B. Child, M. Enghoff, J. Fjeldsa, S. Holt, H. Hubertz, A. E. Jensen, P. M. Jensen, J. Massao, M. M. Mendoza, Y. Ngaga, M. K. Poulsen, R. Rueda, M. Sam, T. Skielboe, G. Stuart-Hill, E. Topp-Jorgensen & D. Yonten. 2009. Local participation in natural resource monitoring: a characterization of approaches. Conservation Biology 23: 31–42.

Eisenberg, J. F. & K. H. Redford. 1999. Mammals of the Neotropics. Volume 3. The Central Neotropics: Ecuador, Peru, Bolivia, Brazil. The University of Chicago Press, Chicago. 609 pp.

Emmons, L. H. & F. Feer. 1997. Neotropical rainforest mammals: a field guide. The University of Chicago Press, Chicago. 307 pp.

Foley, W. J., W. V. Engelhardt & P. Charles-Dominique. 1995. The passage of digesta, particle-size, and in-vitro fermentation rate in the 3-toed sloth *Bradypus tridactylus* (Edentata, Bradypodidae). Journal of Zoology 236: 681–696.

Gilmore, D. P., C. P. Da-Costa & D. P. F. Duarte. 2000. An update on the physiology of two- and three-toed sloths. Brazilian Journal of Medical and Biological Research 33: 129–146.

Green, J. L. 2009. Intertooth variation of orthodentine microwear in armadillos (Cingulata) and tree sloths (Pilosa). Journal of Mammalogy 90: 768–778.

Haugaasen, T. & C. A. Peres. 2005. Mammal assemblage structure in Amazonian flooded and unflooded forests. Journal of Tropical Ecology 21: 133–145.

Hayssen, V. 2009. *Bradypus tridactylus* (Pilosa: Bradypodidae). Mammalian Species 839: 1–9.

Michalski, F. & C. A. Peres. 2007. Disturbance-mediated mammal persistence and abundance-area relationships in Amazonian forest fragments. Conservation Biology 21: 1626–1640.

Montgomery, G. G. & M. E. Sunquist. 1975. Impact of sloths on neotropical forest energy flow and nutrient cycling. Pp. 69-98 in: Tropical ecology systems: trends in terrestrial and aquatic research (F. B. Golley & E. Medina, eds). Springer-Verlag, Berlin.

Moraes-Barros, N., A. P. Giorgi, S. Silva & J. S. Morgante. 2010. Reevaluation of the geographical distribution of *Bradypus tridactylus* Linnaeus, 1758 and *B. variegatus* Schinz, 1825. Edentata 11: 53–61.

Moraes-Barros, N., J. A. B. Silva & J. S. Morgante. 2011. Morphology, molecular phylogeny, and taxonomic inconsistencies in the study of *Bradypus* sloths (Pilosa: Bradypodidae). Journal of Mammalogy 92: 86–100.

Pereira, L. A., K. S. Sena, M. R. Santos & S. V. C. Neto. 2007. Aspectos florísticos da FLONA do Amapá e sua importância na conservação da biodiversidade. Revista Brasileira de Biociências 5: 693–695.

Peres, C. A. 1999. General guidelines for standardizing line-transect surveys of tropical forest primates. Neotropical Primates 7: 11–16.

Peres, C. A. & J. W. Terborgh. 1995. Amazonian nature reserves: An analysis of the defensibility status of existing conservation units and design criteria for the future. Conservation Biology 9: 34–46.

Pitman, N. C. A., D. Norris, J. M. Gonzalez, E. Torres, F. Pinto, H. Collado, W. Concha, R. Thupa, E. Quispe, J. Pérez & J. C. F. del Castillo. 2011. Four years of vertebrate monitoring on an upper Amazonian river. Biodiversity and Conservation 20: 827–849.

Queiroz, H. L. 1995. Preguiças e guaribas, os mamíferos folívoros arborícolas do Mamirauá. CNPq e Sociedade Civil Mamirauá. Brasília – DF, Tefé - AM. 176 pp.

Taube, E., J. C. Vié, P. Fournier, C. Genty & J. M. Duplantier. 1999. Distribution of two sympatric species of sloths (*Choloepus didactylus* and *Bradypus tridactylus*) along the Sinnamary River, French Guiana. Biotropica 31: 686–691.

Taube, E., J. Keravec, J. C. Vié & J. M. Duplantier. 2001. Reproductive biology and postnatal development in sloths, *Bradypus* and *Choloepus*: review with original data from the field (French Guiana) and from captivity. Mammal Review 31: 173–188.

Wilson, D. E. & D. M. Reeder. 2005. Mammal species of the world: a taxonomic and geographic reference. Johns Hopkins University Press, Baltimore. 2142 pp.

Received: 15 March 2012; Accepted: 1 June 2012