

Negative relationship between body mass and home range size in three-toed sloths of the Amazon rainforest

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The spatial use of habitat is key to understanding the ecology of animals and their area requirements. In the current study, the locations of 11 wild pale-throated three-toed sloths (*Bradypus tridactylus*) were tracked using GPS loggers across 92 days in a 776 ha forest fragment in the central Amazon. Although male home ranges were slightly smaller than those of females, there were no significant differences in size or its expansion patterns. For nine of 11 individuals, home range size reached a plateau within 45 days of study start, indicating that 45 days can be the basal minimum days to establish the home range size of *B. tridactylus*. There was a negative relationship between body mass and home range size in our study. This counterintuitive result may be caused by disparities in the food-exploring abilities between individuals. Smaller and presumably younger individuals, who have less experience, may require more time and a larger area in which to search for food, while older and more experienced individuals may be able to find food efficiently in a smaller area. Further work on the distribution of food plants and the food-exploring pattern of each animal in relation to age and/or size is thus encouraged.

KEY WORDS: bio-logging, GPS, body size effect, neotropical folivore, *Bradypus tridactylus*, movement ecology, home range.

INTRODUCTION

The spatial use of habitat is a key component of foraging behavior that reflect how animals interact with the environment (van Moorter et al. 2009; Herfindal et al. 2005; Seidel & Boyce 2015; Ofstad et al. 2016; Jacobson et al. 2023). Understanding the home range of animals contributes to studying the feeding ecology (Seidel & Boyce 2015), territoriality (Wronski 2005; Marin 2016; Tao et al. 2016), and microhabitat selection (Matson et al. 2007). Also, estimating the amount of space required by animals helps us to develop effective conservation and management policies (Herfindal et al. 2005; Ofstad et al. 2016; Carmo 2002; Jacobson et al. 2023).

In mammals, the size of the home range is largely determined by energy requirements; therefore, larger mammals should require a larger area in which to find food (McNab 1963; Harestad & Bunnell 1979; Grant et al. 1992; Burness et al. 2001). A positive correlation between body size and home range size has been observed in mammals (McNab 1963; Gompper & Gittleman 1991; Clutton-Brock 2009; Ofstad et al. 2016), birds (Schoener 1968), and reptiles (Turner 1969); accordingly, such positive relationships can reasonably expected to be widespread in vertebrates.

The size of an animal's home range is closely related to its metabolic needs (McNab 1963, 1983). These metabolic needs, in turn, have been demonstrated to vary according to the animal's body mass, following a well-established allometric relationship (Mace & Harvey 1983; Peters 1983; Calder 1984). These relationships between allometry, metabolism, and home range size are widely recognized across various groups of animals, including mammals (Mace et al. 1983), birds (Schoener 1968), and ectotherms (Turner et al. 1969), encompassing different ecological groups as well, such as herbivores, omnivores, and carnivores (Harestad & Bunnell 1979; Damuth 1981).

In mammals, males generally have larger home range sizes than females (Greenwood 1980; Ostfeld 1990), a trend that has been supported by studies across a range of sizes and taxa (Gentile et al. 1997; Powell et al. 1997; Herfindal et al. 1997, 2005). The home range of males often overlaps with those of multiple females, especially when males are polygamous (Ostfeld 1990). Conversely, for rodents, food availability appears to be a significant factor in territorial behavior, as it is associated with improved reproductive success (Ostfeld 1990). However, it should be noted that food availability cannot be considered as the sole factor explaining all the observed variations in the extent of female mammal spatial use (Ostfeld, 1990). Both males and females can have the size of their home range influenced by the availability and distribution of mates and potential mates in space and time. In the case of *B. variegatus*, no difference in home range size between sexes has been recorded (Vaughan et al. 2007). However, it appears that females occupy larger areas than males, and furthermore, the extent of female home ranges may exceed initial estimates, as the observation curve for female areas did not reach a point of stability (Castro-Sá et al. 2021). Nevertheless, in general, male sloths commonly have larger home ranges than females (Kaup et al. 2021). In this sense, the difference in home ranges between male and female sloths is still a topic for academic debate.

On average, sloths are active for 10.1 hours per day, which implies that they are inactive for approximately 57.9% of the time (Sunkist & Montgomery 1973), while a recent study found that *Bradypus variegatus* are inactive for 85.5% of the time (Cliffe et al. 2023). Here we explore the effect of body size and sex on the home range sizes for 11 individuals of a highly sedentary species, *Bradypus tridactylus*.

MATERIALS AND METHODS

Study site

The research was carried out from May 2017 to October 2018 in a forest fragment of approximately 776 ha surrounding the Federal University of Amazonas (UFAM), Amazonas, Brazil (03°04'34" S, 59°57'30" W) (Fig.1). It is considered to be an extensive urban forest fragment of a major metropolis in the central Amazon region (Borges & Guilherme 2000; Calixto et al. 2019). The area consists of plateaus, slopes and valleys and is covered by 'terra firme' rainforest (rich forest composed of diverse tree and liana species that form relatively complex underground and above-ground structures), secondary forests, *campinaranas* (open forests growing on white sand soil) and deforested and anthropized areas (Carmo 2002). At the study site, study species density is around 2.2 individuals/ha (Carmo 2002).

Study species

The pale-throated three-toed sloth, *B. tridactylus*, is endemic to northern South America, occurring in Venezuela, Guyana, Suriname, French Guiana, and northern Brazil (Wetzel 1985; Hayssen 2009). The proportion of leaves in the diet of sloths of the genus *Bradypus* can range from 94.4% to 100% (Chiarello 1998; Queiroz 1995; Taube et al. 2001; Carmo 2002; Urbani & Bosque, 2007). Similar to other *Bradypus* species, *B. tridactylus* predominantly feeds on leaves (>97%), mainly young leaves, but also exhibits opportunistic consumption of fruits, shoots, and flowers (Carmo 2002).

Sloths of the *Bradypus* genus are solitary and have a non-cohesive social structure, being found together only during the mating period and during the period when the female cares for the cub during the initial stages of its development (Taube et al. 1999; Lara-Ruiz & Chiarello 2005). Information regarding interbirth intervals and gestation length in sloths of this genus is still limited, with ongoing debates as to whether these animals follow a specific breeding season or have the ability to reproduce throughout the year (Gilmore et al. 2000). However, a study conducted with female *B. tridactylus* provided valuable insights. In the Petit-Saut region of French Guiana, found evidence of seasonality, with most conceptions occurring between April and September and gestations occurring from March to September and in January (Richard-Hansen & Tauber 1997). The months from January to April are part of the rainy season, and September is part of the dry season. Studies of *B. tridactylus*, using heart-rate monitoring and 24 hours direct observations, found the same individuals displaying both diurnal and nocturnal activities (Muramatsu et al. 2022). Castro-Sa et al. (2021) also found that the same individuals of *B. variegatus* are active both day and night.

Devices and harness preparation

We used TechnoSmArt GiPSy-5 GPS loggers with Saft LS17500 thionyl batteries to record the geographic locations of animals at intervals of 15 min. For waterproofing, the logger was coated with a layer of humidity-resistant insulator, and the logger and battery were wrapped with polyvinylidene chloride film, and sealed with water-resistant tape. Each time a sloth was captured, it was fitted with a custom-made harness with 10 mm-wide, 1.3 mm-thick polypropylene webbing and plastic snapping buckles sewn together with cotton or nylon thread. A GPS logger and VHF transmitter (Holohil RI-2D) were attached to the chest belt of the harness with heat-shrink tubes. The GPS logger and VHF transmitter were located on the

right and left sides of the animal's back, respectively, a location which impedes neither the sloths' tree-climbing motions nor the typical curled-up resting posture (Fig. 2).

Animal capturing and device deployment

We sought wild three-toed sloths (*B. tridactylus*) at the study site; after a sloth was found, one of the authors or a field assistant climbed the tree with tree-climbing equipment and captured the animal by hand. Captured sloths were put into a thin nylon bag and lowered to the forest floor by rope, then brought to our laboratory on the university campus. The body mass of each sloth was measured to the nearest 5 g; sloths were sexed by assessing the presence/absence of the speculum, a large orange patch on the back, a secondary sexual trait of male *B. tridactylus* (Hayssen 2009). We then attached a harness with a GPS logger and VHF transmitter to the sloth and released the animal back onto the same tree where it had been found. The mass of the equipment was at most 70 g, and so did not exceed the limit of 5% of the individual's body mass considered the maximum permissible percentage for tracking equipment (Sikes 2016; Wilson et al. 1996). After leaving the sloths free in their habitat for several months, we searched for the animals by using the signals from the VHF transmitters and recaptured them in a similar manner. Captured sloths were brought to the laboratory, and the coordinate data were downloaded from the GPS logger via GiPSy-5 Utility version 1.7.

Data collection and statistical analysis

As GPS loggers occasionally recorded irrational dates and/or coordinates, we removed such data using the gap-based dichotomization technique (Hirakawa et al. 2022) by applying TimelineAnalyser7-08Sloth (<https://wildlife-science-studio.com/timelineanalyser>) prior to analysis. We discarded all data recorded in the first 24 hours after each animal was released, because they required some time to resume normal activity. To exclude seasonal effects, we used coordinate data obtained from 6 males and 5 females over the same 92-day time period in 2018: 18 January 13:00 to 19 April 17:15 (Table 1). We recognize that the home range of sloths may vary seasonally. However, the choice of this specific period allowed us to mitigate this influence and focus on other aspects of the study. The selection of this specific period also allowed us to directly compare the data from different individuals without significant interference from seasonal variations, making it easier to detect real differences in the sloths' home ranges within our sample. To assess the accuracy of GPS loggers, we placed a logger on three trees where we used to spot sloths, over a period of 15 days (5 days on each tree). After data collection, we used a histogram to analyze the distances between points (Fig. 3). The results revealed that 87% ($n = 1,247$) of the points showed distances smaller than 50 m, indicating a potential GPS error at greater distances (Vidal 2018). Therefore, for distances less than 50 m, we could not determine whether the individual was stationary or in motion.

The definition of home range was introduced by Burt (1943), where he described it as the area traversed by an individual during its regular activities, such as food gathering, mating, and caring for the young. After the redefinition or critiques by several authors, (Mohr 1947, Jewell 1966, Baker 1978, Hansteen et al. 1997), Kernohan et al. (2001) concluded that home range can be considered as the extent of territory where an animal is likely to be present during a specific time interval. In the present study, we used biased random bridge (BRB; Benhamou 2011) analysis to calculate home range size. Different from the conventional location-based methods, the BRB is a movement-based method that estimates the utilization distribution from serially correlated relocations and raw activity information (Benhamou 2011). The maximum drifting time ($T_{\max}$) was set at 60 min, the minimum uncertainty of

relocation ($h_{\min}$) at 5 m and the interpolation time (τ) at 5 min, all based on the ecology and behavior of the animals and the accuracy of the GPS logger in the geographic and environmental conditions of the study site. Additionally, we calculated home range size by using conventional location-based methods: 95% minimum convex polygon (MCP; Mohr 1947) and kernel (Worton 1989) analyses, which have been widely used in earlier studies (Sunquist & Montgomery 1973; Queiroz 1995; Chiarello 1998b; Chiarello et al. 2004; Vaughan et al. 2007; Cassano et al. 2011; Pauli & Peery 2012; Falconi et al. 2015). We applied the bivariate normal kernel (*bivnorm*) method and an *ad hoc* smoothing parameter (*href*) for the kernel analysis. All analyses for home range size calculation were conducted using the *adehabitatHR* package (Calenge 2015), implemented in the statistical software R (R Core Team 2017).

Pearson's correlation coefficient test ('cor.test' function in the 'stats' package) was used to test the relationship between body mass and any one of the BRB, MCP, or kernel home range sizes when the body mass and home range size were normally distributed. If the body mass and/or home range size were significantly different from normal distribution, Spearman's rank correlation coefficient test ('cor.test' function in the 'stats' package) was applied. The home range sizes of males and females were compared by a two-sample t-test (the 't.test' function in the 'stats' package) when the body mass and home range size were normally distributed. If the body mass and/or home range size were significantly different from normal distribution, a Wilcoxon rank sum exact test ('wilcox.test' function in the 'stats' package) was used.

To test the effects of body size and sex on home range size simultaneously, we analyzed the data using general linear models (GLMs) with the 'glm' function in the 'stats' package implemented in the statistical software R (R Core Team 2017). The BRB home range was used as the response variable, while the body mass, sex of each individual, and the interaction between them were fitted as explanatory variables. The number of relocations for each individual were applied as the weighting variable. The Gaussian distribution and an identity link function were used to analyze the data after confirming the distribution normality of the response variable. We calculated Akaike information criterion (AIC) values for all possible combinations of explanatory variables, with the model that yielded the smallest AIC value being selected as the best model. The home range sizes calculated by BRB, MCP, and kernel analyses were compared using the Friedman rank sum test after confirming any of the BRB, MCP, and kernel home range sizes were significantly different from normal distribution.

RESULTS

Body mass

A total of 32 individuals were captured and measured. The body mass of the smallest individual exhibiting secondary sexual characteristics (the male orange patch) was 1.50 kg, and the body mass of the largest male that did not exhibit the secondary sexual characteristics was 1.20 kg; thus, the sex of the individuals lighter than 1.50 kg were classified as 'unknown'.

Home range

During the sampling period, a total of 82,150 location points were recorded for the 11

three-toed sloths (Table 1).

There was no significant difference in the home range sizes between males (mean $\pm$ SE: 1.90 ± 0.20 ha) and females (1.84 ± 0.20 ha) based on the BRB method (t-test: $t = 0.99$, $df = 9$, $p = 0.35$; see Table 1). The same was true for the MCP home range sizes between males (2.98 ± 0.77 ha) and females (3.97 ± 1.53 ha) (Wilcoxon rank sum exact test: $W = 14$, $p = 0.93$), and the kernel home range sizes between males (2.23 ± 0.46 ha) and females (4.26 ± 2.14 ha) (Wilcoxon rank sum exact test: $W = 15$, $p = 1.00$). The rank order of home range size given by the three methods was similar between individuals (Table 1). However, it is important to note that the MCP and kernel methods estimated significantly larger home range sizes for the individual BT-4534 compared to the BRB method. MCP and kernel analyses tended to return larger home ranges than BRB analysis when an animal showed the signs of dispersal behavior, but BRB and kernel analyses showed similar results when an animal moved within a small area (Fig. 4). MCP home range did not correctly reflect the distribution of the relocations because MCP analyses cannot encompass shapes with pronounced spatial invaginations (concave shapes). The estimated home range sizes were significantly different among the three methods (Friedman test; Friedman $\chi^2 = 18.18$, $df = 2$, $p < 0.01$), suggesting that the three methods return non-negligible differences from the same dataset.

The effects of body mass and sex on home range size

There was a strong negative correlation between body mass and BRB home range size (Pearson's correlation coefficient test: $r = -0.78$, $n = 11$, $p < 0.01$; Fig. 5); however, MCP (Spearman's rank correlation coefficient test: $r_s = -0.49$, $n = 11$, $p = 0.13$) and kernel ($r_s = -0.57$, $n = 11$, $p = 0.07$) home range sizes did not correlate significantly with their body mass.

The GLM analysis showed similar results. The model containing only body mass as the explanatory variable was ranked as the best model by AIC, and all five models that ranked higher than the null model predicted negative relationships between home range size and body mass (Table 2).

Cumulative daily home range sizes

There was no apparent difference in the expansion pattern (a pattern in which values increase sequentially) between male and female home ranges (Fig. 6). The home range sizes of nine out of 11 individuals reached a plateau within 45 days from the start of the observation period, but the smallest male, BT-5342, expanded his home range almost constantly across the entire observation period.

DISCUSSION

To the best of our knowledge, this study is the first to conduct continuous monitoring of 11 individuals of pale-throated three-toed sloths (*Bradypus tridactylus*) across a 92-day period at 15 min intervals, within an extensive forest fragment within a major metropolis in the Amazon. Contrary to the prediction that larger individuals would have larger home ranges (Burness et al. 2001), the present study found a negative relationship between home range size and body mass. The explanation may lie in the presence of factors that limit the availability of food to smaller individuals, thus forcing them to travel further, even though they need less food per individual than larger individuals. One possibility is that disparities in

exploring capacity arising from age-related differences in individual foraging experience (Galbraith et al. 1999; Daunt et al. 2007). Smaller, and apparently younger and less experienced individuals that lack full awareness of the spatio-temporal variation in food resource distribution possibly needed to search a larger area to find adequate food. By contrast, older and more experienced individuals may have been able to collect food more efficiently and so ranged over a smaller area.

Bradypus tridactylus has a restricted diet, mainly consisting of specific tree species such as *Clitoria fairchildiana* (39.78%), *Cecropia concolor* (17.20%), and *Ficus maxima* (10.75%), which account for 67.73% of their total food intake (Carmo 2002). Moreover, 59.72% of their diet consists of young leaves (Carmo 2002). Therefore, it would be important for foraging individuals to be aware of location of the feeding trees and/or the timing of leaf flushing so as to collect food efficiently. Indeed, many sloths return to the same place or even the same tree after several months (personal observation). The diet of three-toed sloths consists largely of young leaves (Montgomery & Sunquist 1975; Chiarello 1998; Carmo 2002), so they need to discern the distribution of their diet trees and estimate when and to what extent these produce new leaves. Predictability of abundance can be a key factor in food selection (Itoh & Muramatsu 2015). Supposing that experienced sloths remember the location and the timing of leaf flushing more than inexperienced sloths, they would not need to explore large areas of their overall habitat. Further work correlating the relationship between leaf-flushing phenology and the food-exploring pattern of each animal should, therefore, be encouraged.

The quality of their habitat and the territorial behavior of animals may also influence home range size. Tao et al. (2016) predicted that home range size shrinks over an individual's lifetime when there is a positive correlation between age and territory quality. Such tendencies are found in roe deer (Pettorelli et al. 2003) and flying lizards (Mori & Hikida 1993). However, our study species may not be territorial because the home ranges of two males, BT-4858 and BT-4907, were largely overlapped and the males did not appear to avoid each other (Electronic supplementary material 1).

Larger home range sizes for males than for females are commonly found in mammals (e.g. Greenwood 1980; Ostfeld 1990; Gentile et al. 1997; Powell et al. 1997; Herfindal, et al. 2005). However, the present study's results showed no significant difference between male and female home range sizes. Moreover, both the second- and third-rank models in the GLM analyses suggested smaller home range size for males (i.e., the regression line for males had the lowest intercept). Again, this tendency differs from many other mammals.

The home ranges calculated using the MPC method varied from 1.33 to 10.56 ha, with a mean of 3.38 ha. For the kernel method, the variation was from 1.16 to 13.58 ha, with a mean of 3.09 ha. For *B. variegatus*, the home ranges estimated by the MPC method were smaller, ranging from 0.15 to 3.7 hectares (Sunquist & Montgomery, 1973; Queiroz, 1995).

The home range size of *B. torquatus* is varying from 0.44 to 29.33 ha by MPC method (Chiarello 1998b, Chiarello et al. 2004, Cassano et al. 2011, Falconi et al. 2015, Sunquist and & Montgomery 1973). With the kernel method, we noticed that *Bradypus variegatus* sloths had larger home ranges, ranging from 5.2 to 19.9 ha in previous studies (Vaughan et al. 2007; Pauli & Peery 2012). *B. torquatus* sloths also had slightly larger home ranges compared to the results of our study, varying from 0.39 to 21.52 ha (Cassano et al. 2011; Falconi et al. 2015). The differences in sloth home ranges result from a complex interplay of factors. When comparing our results with previous studies involving *B. variegatus* and *B. torquatus*, we

observed significant variations in home ranges, regardless of the method used, whether MPC or Kernel. Variation in food availability may be an important factor in explaining such differences because ranging strategies within species can vary depending on resource availability (Judson et al. 2024). In different populations, variations in home ranges often correlate with the presence and distribution of food resources (Schoepf et al. 2015; Bengsen et al. 2016). In environments rich in high-quality food, sloths may have smaller home ranges since they do not need to travel long distances in search of food. Furthermore, variations in the home ranges of populations may be related to differences in individual behavior, which, in turn, are influenced by factors such as time, space, and specific individual characteristics (Sálek et al. 2015). Therefore, individual behavior may have contributed to the variation in sloth home ranges between studies. Seasonality also plays an important role, as sloth home ranges can vary throughout the year due to changes in food availability and environmental conditions. This means that sloths can adapt their home ranges according to the seasons and fluctuations in resource availability. In summary, the differences in sloth home ranges result from a complex interplay of factors, including food availability, individual behavior, and seasonality, which can vary in different contexts and regions. There is, however, a significant possibility that sloths will expand their home range during their lifetimes, because they occasionally move long distances in search of new habitats, feeding areas and/or mates. In our data, a small male (BT-5342) constantly increased its home range size, showing a consistent exploration pattern to new areas throughout the observation period.

To conclude, our pioneering research on three-toed sloths in an urban environment revealed a negative relationship between body size and home range size. This suggests that factors beyond size, such as food availability and individual foraging experience, can influence the sloth home range sizes. While the difference between the sexes were expected, our analysis did not show a significant difference in the home range sizes between males and females. Further work correlating the distribution of their food plants, leaf-flushing phenology, and the food-exploring pattern of each animal throughout a year is thus encouraged.

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DISCLOSURE STATEMENT

The authors declare no potential conflict of interest related to this study.

ETHICAL STANDARDS

All the research procedures were approved by the biodiversity authorization and information system (SISBIO - 60116-1) and the Ethics Committee of the Federal University of Amazonas (006/2018-CEUA / UFAM).

AUTHOR CONTRIBUTIONS

LVV found the phenomenon and designed this study with DM. DM, AS, TY and MG conceived of the project. LVV, DM and AS conducted fieldwork and collected data. DM and LVV analyzed data and wrote the manuscript, and MG, TY and AS revised it.

DATA AVAILABILITY STATEMENT

The relocation data are available at Mendeley Data:
<https://dx.doi.org/10.17632/4pw5hp9r7w.1>.

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Table 1.

Biometric data and estimated home range size of each individual						
Sloth ID	Sex	Body mass (kg)	Number of coordinates	BRB (ha)	MCP (ha)	Kernel (ha)
BT-4858	Male	2.32	7732	1.88	2.12	1.89
BT-4907	Male	3.42	7556	2.09	3.36	2.27
BT-5144	Male	3.29	7528	1.32	1.67	1.30
BT-5342	Male	1.50	7536	2.71	6.60	4.44
BT-5583	Male	2.47	7572	1.93	2.38	1.99
BT-5447	Male	3.90	6864	1.49	1.75	1.51
BT-4532	Female	3.79	7022	1.41	2.16	1.75
BT-4534	Female	2.80	7222	1.97	10.56	13.58
BT-4732	Female	4.58	7548	1.15	1.33	1.16
BT-5247	Female	2.84	7846	1.61	2.14	1.67
BT-5297	Female	3.50	7724	2.05	3.12	2.40

Note: BRB, MPC, and Kernel indicate home range size estimations based on biased random bridge, minimum convex polygon, and bivariate normal kernel methods, respectively.

Table 2.

Values of Akaike information criterion (AIC), ranked in increasing order, calculated using general linear models for predicting biased random bridge (BRB) home range size.

AIC	Intercept	Body mass	Body mass $\times$ Sex (male)	Sex (male)
8.05	3.04 ± 0.35	-0.40 ± 0.11	-	-
10.04	3.06 ± 0.47	-0.41 ± 0.13	-	-0.01 ± 0.21
11.95	2.91 ± 0.80	-0.36 ± 0.22	-0.07 ± 0.28	0.21 ± 0.94
16.29	1.79 ± 0.13	-	-	-
17.11	1.64 ± 0.20	-	-	0.27 ± 0.27

Note: Values for intercept and model term(s) are shown as parameter estimates $\pm$ SE.

Fig. 1. A - Location of the city of Manaus in relation to Brazil, B - location of the study area in the city of Manaus, central Amazon. Figure was created using QGIS version 3.24.2 (QGIS Association 2022).

Fig. 2. (A) Sloths carrying transmitters (blue arrow) and GPS devices - GiPSy-5 (red arrow) in their characteristic curled-up posture. (B) Sloths climbing trees with devices (red arrow).

Fig. 3. - Potential error in the accuracy of Gipsy 5 GPS devices when recording the coordinates of three known points.

Fig. 4. — Difference in shape of biased random bridge (BRB), minimum convex polygon (MCP), and bivariate normal kernel (Kernel) home ranges. MCP and Kernel methods estimated considerably larger home ranges than BRB for BT-4534, but BRB and Kernel methods returned similar home ranges for BT-4858.

Fig. 5. — Relationship between body mass and home range size calculated using the (a) biased random bridge (BRB), (b) minimum convex polygon (MCP), and (c) bivariate normal kernel (Kernel) methods. There was a strong negative correlation between body mass and BRB home range size (Pearson's correlation coefficient test: $r = -0.78$, $n = 11$, $p < 0.01$); however, MCP (Spearman's rank correlation coefficient test: $r_s = -0.49$, $n = 11$, $p = 0.13$) and Kernel ($W = 0.53$, $p < 0.01$; $r_s = -0.57$, $n = 11$, $p = 0.07$) home range sizes did not correlate significantly with their body mass. All individuals were large enough to have a secondary sexual trait.

Fig. 6. — Cumulative daily home range calculated by using biased random bridge (BRB) analysis.

Electronic supplementary material 1 — The relocation data of 11 individuals of the three-toed sloth, *Bradypus tridactylus*. Access via:

<https://data.mendeley.com/datasets/4pw5hp9r7w/draft?a=6a5b1e49-2441-48c8-82ec-05cd579d5eb4> [This URL will be replaced with DOI link after acceptance]. The relocation data of each individual are recorded as Keyhole Markup Language (*.kml) files, developed for use with Google Earth (<https://earth.google.com>) or Google Maps (<https://google.com/maps>). The filenames indicate the ID of each individual. “All.png” file represents the relocation data of all individuals in a single figure.

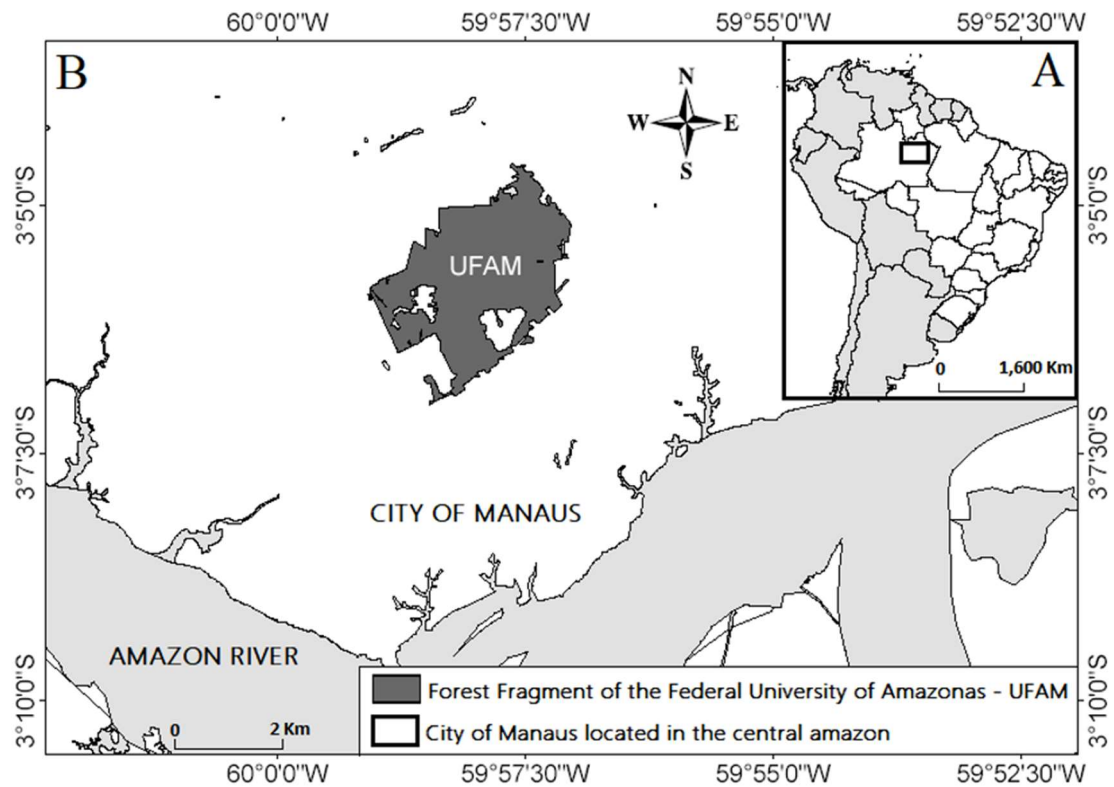


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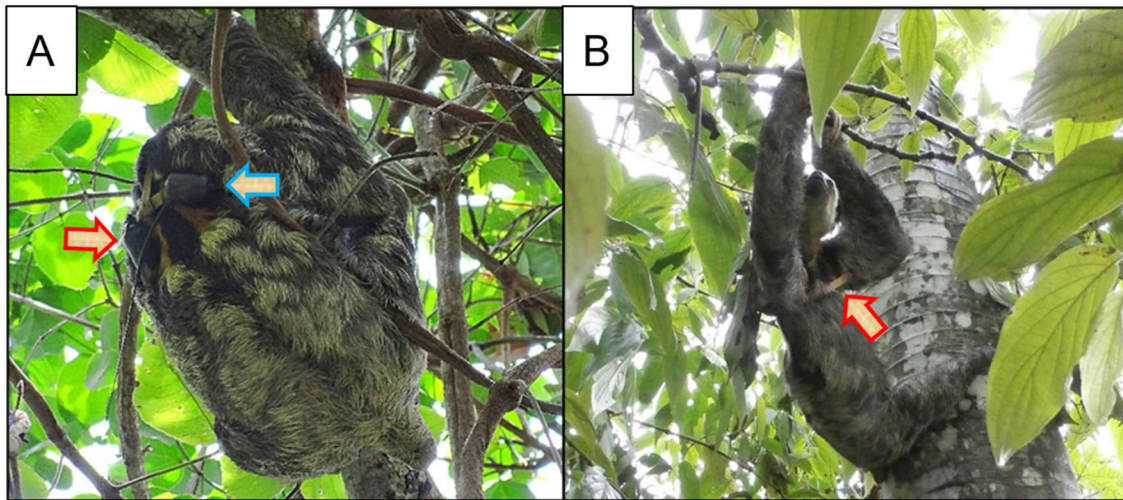


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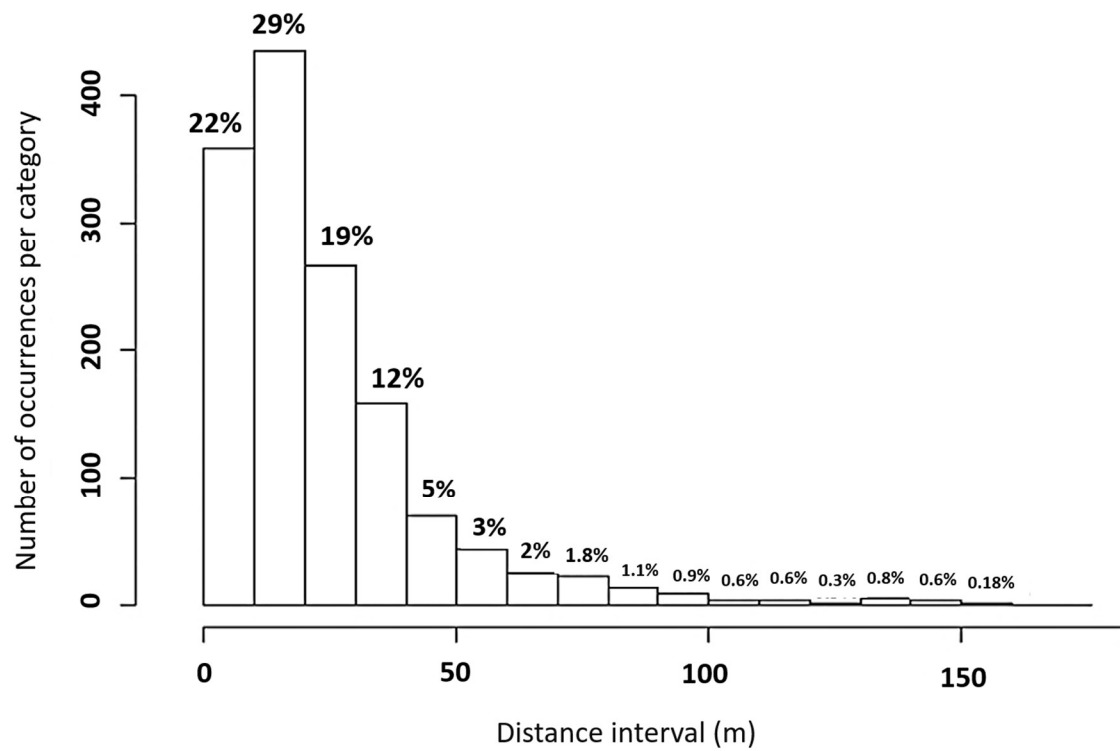


Fig. 3. — Potential error in the accuracy of Gipsy 5 GPS devices when recording the coordinates of three known points.

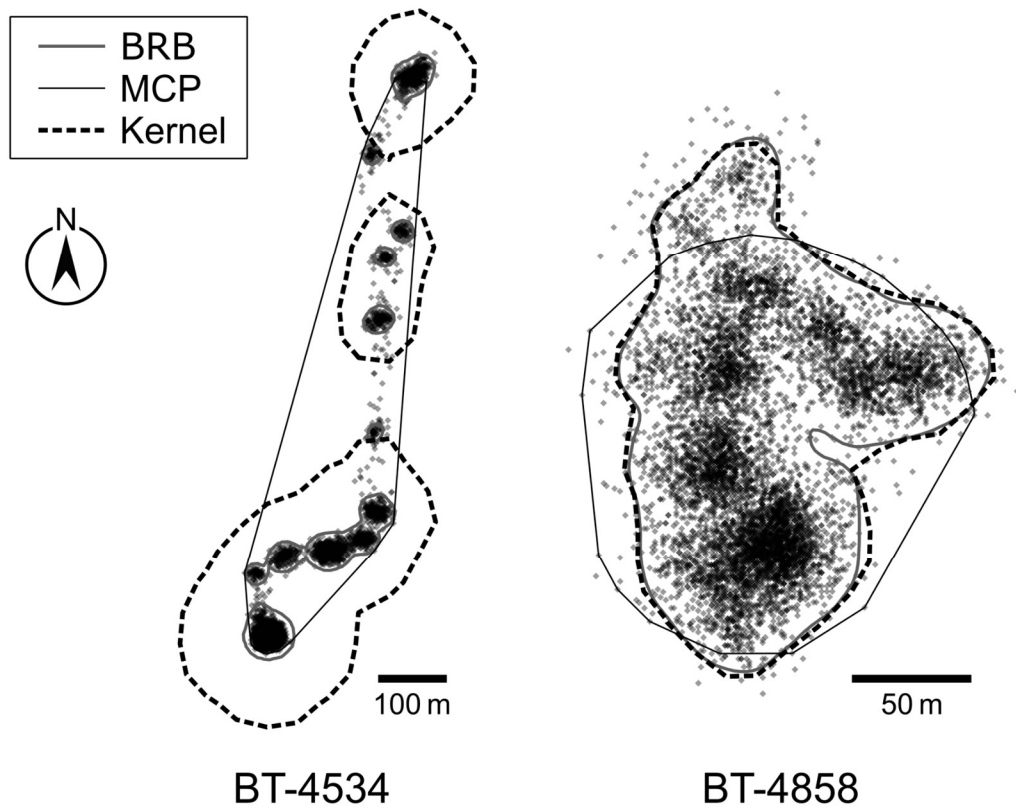


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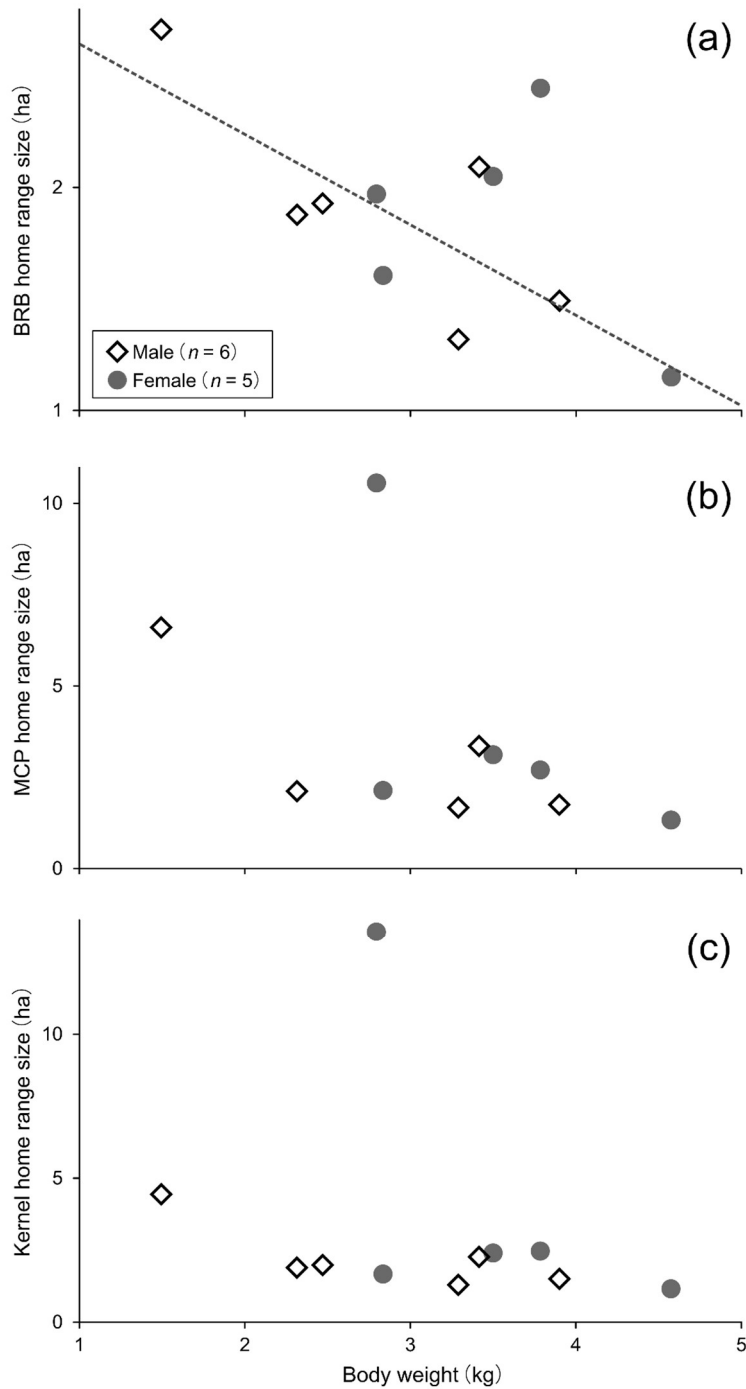


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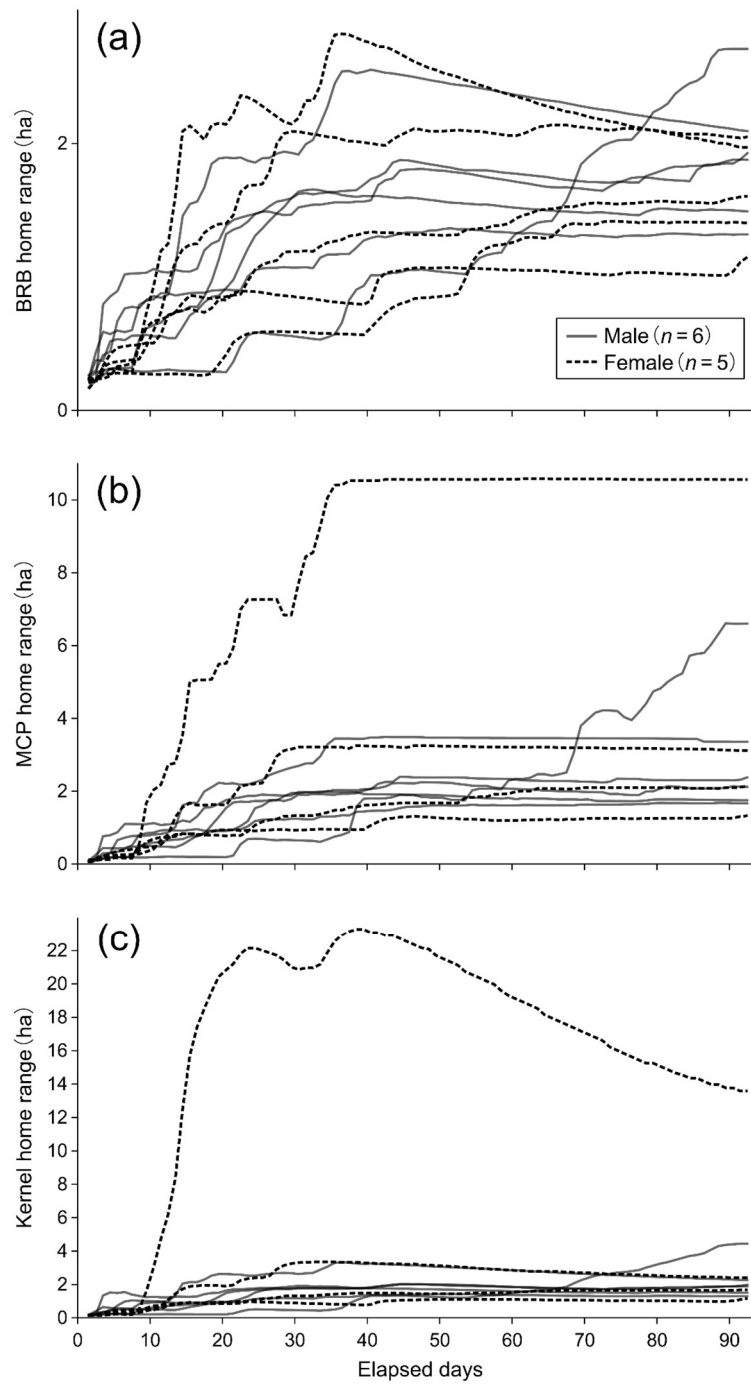


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