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Original investigation

Feeding ecology and postural behaviour of the three-toed sloth (*Bradypus variegatus flaccidus*) in northern Venezuela

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Abstract

We studied the diet, activity budget, vertical ranging, and postural behaviour in relation to weather of the three-toed sloth (*Bradypus variegatus flaccidus*) in disturbed montane forest remnants (1150 m asl) in northern Venezuela. Sloths spent most (72.9%) of their time resting and had a nearly exclusive (99.4%) leaf diet. While resting they assumed a sitting – not hanging – posture mostly (90.2% of observations). Species of three families, Clethraceae, Cecropiaceae, and Clusiaceae accounted for 77% of feeding records. Young leaves (67.2%) accounted for most of the leaf diet. Activity and posture were dependent on weather conditions. Sloths fed more often during mid-day hours and tended to rest more at dawn and dusk. In northern Venezuela sloths tended to use more frequently the upper strata of the canopy, while in warmer lowland sites they use intermediate levels more often. They adopted postures that maximized exposure of ventral surfaces to incident solar radiation when sunny, but minimized their surface area by huddling when cloudy, foggy or rainy. We propose that sunning behaviour of sloths may speed up their fermentation rate, and ultimately, might have been an important selective factor in the evolution of derived upside-down posture of sloths.

Key words: *Bradypus variegatus*, sloth, behaviour, folivory, Venezuela

Introduction

Sloths (*Bradypus* and *Choloepus*; order Xenarthra) have received particular attention because of their low metabolic rate and their strictly folivorous habits; an unusual feeding mode among Neotropical arboreal mammals (Bauchop 1978; Beebe 1926; Jouffroy et al. 1961; Goffart 1971; Chiarello 1998a, b; Nagy and Montgomery 1980). Three-toed sloths (*Bradypus variegatus*; 4.5–5.0 kg), are common inhabitants of primary and secondary evergreen and semi-deciduous forests from southern Honduras to northern Argentina (Eisenberg 1989; Emmons 1997), and is the best-known of sloth species in terms of behaviour and ecology. However, most information on this species comes from studies conducted at lowland sites such as Barro Colorado Island in Panamá (Montgomery and Sunquist 1975, 1978; Sunquist and Montgomery 1973), and Mamirauá in the

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Brazilian Amazonia (Queiroz 1995). In contrast, this research took place in a montane area of northern Venezuela. Such an elevational comparison is of interest because sloths have a low and labile body temperature (28–35 °C, Silva et al. 1996 cited in Gilmore et al. 2000) compared to other mammals and have poor thermoregulatory ability; their body temperature closely correlated with changes in ambient temperature (McNab 1978; Gilmore et al. 2000). Hence, their low body temperature, and concomitantly low metabolic rate, is considered a major factor restricting their altitudinal-and likely latitudinal-range, because they do not tolerate cool temperatures.

In northern Venezuela three-toed sloths are distributed in the Central Coastal Range (Linares 1998), and were the focus of a single study on life history and growth by Herbig-Sandreuter (1964) in semi-free conditions. Our study site at 1150 m asl lies towards the upper end of their reported altitudinal range, approximately 1100 m asl, according to Emmons (1997). Nonetheless, in northern Venezuela three-toed sloths are common at cloud forest sites as high as 1700 m asl (Bosque, pers. obs.), and have been reported up to 2300 m asl (Linares 1998). The aim of the present study was to determine the diet, time budget, vertical ranging and postural behaviour in relation to thermal and radiant environment of individuals of *B. variegatus flaccidus* in a disturbed forest in the metropolitan outskirts of Caracas. Despite it being common in northern Venezuela, there are no previous studies of wild *flaccidus* populations.

Material and methods

Field research was carried out in the surroundings of Universidad Simón Bolívar (10°24′25″N; 66°52′51″W; elevation 1150 m asl), southeast of Caracas, northern Venezuela. The site is a disturbed and fragmented forest with a highly broken canopy (~20 m height), remnant of the original montane forest. The weather of the area is "relatively cool", with an average rainfall of 946 mm – most of which falls between May and October – and a mean annual temperature of 19.9 °C (Baruch and Gómez 1996). This temperature is below the lower limit of thermoneutrality for this species (approximately 24 °C, Gilmore et al. 2000) or close to it (18 °C), according to McNab (1978). The study was conducted from January to April 2002, during the dry season. Minimum and maximum were 15 and 23 °C, respectively, and average temperature was 19 °C. Temperature of rainfall water was approximately 4 °C cooler than air temperature.

Eigth sloths, three adult females, four adult males and one young of unknown-sex, were the focus of this study. Although individuals were not marked, we became familiar enough with movements and whereabouts of members of this small population. Adult males have a large dark brown spot surrounded by a yellowish aril on their backs, and are larger than females (Linares 1998). We recorded sloths' behaviour for a total of 204 h and 50 min of observation time. Instantaneous-focal samples (Martin and Bateson 2000) were made every 10 min; during each sampling we recorded posture, weather conditions, location within the tree, kind of activity and type of food when appropriate. We distinguished between "young" and "mature" leaves by their relative sizes, differences in colour and apparent tenderness; if uncertain, we considered them of "undetermined age". Table 1 presents the description of behavioural, postural, locomotor and weather categories used in this study. These categories were defined after a 2 week preliminary observation period, and following Queiroz (1995). On any one day normally only one sloth was observed from ~08:00 to 18:00 h. We tested for independence in contingency tables by *G*-tests.

Results

Sloths spent an average of 72.9% of their time resting, 14.2% feeding, 7.3% moving and 5.6% self-grooming. We examined the possible effect of "time of day" on the activity of the sloths by testing the null hypothesis that behavioural activities ($N = 1227$) were uniformly distributed across all hours of the day. Sloths performed their activities differentially throughout the day (G-value = 146.75, df = 27; $P = 0.01$); they fed mostly during midday hours and tended to rest more at dawn and dusk (Fig. 1). Self-grooming and moving, which together accounted for an average of 12.9% of their time, remained nearly constant throughout the day.

Overall, 99.4% of food items were leaves; of these, 67.2% were young leaves, 27% mature