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NOTES

Arboreal and Terrestrial Mammal Trapping on Gigante Peninsula, Barro Colorado Nature Monument, Panama[1]

Key words: *Barro Colorado Nature Monument; Gigante Peninsula; live trapping; Neotropical mammals; vertical stratification.*

BIOLOGISTS ARE INCREASINGLY AWARE OF THE IMPORTANCE OF CANOPY FLORA and fauna in tropical ecosystems (Perry 1986, Wilson 1987, Farrell & Erwin 1988, May 1988, Nadkarni 1988, Stork 1988, Lowman & Moffett 1993), and concerted efforts are being made to explore this forest zone. In New World tropical forests the majority of mammals are arboreal to some extent (that is, they spend some portion of their time in trees), both by number of species (Janson & Emmons 1990) and by biomass (Eisenberg & Thorington 1973). Although there is sufficient information available to indicate whether most of these mammals are canopy-dwellers, subcanopy residents, or denizens of secondary forests, *etc.* (Eisenberg 1989, Emmons 1990), few trapping surveys of arboreal mammals have been published. Recent reports on live-trapping projects in forests near Manaus, Brazil demonstrate that a different mammal assemblage is captured in the canopy than at either 2–3 m above ground, or at ground level (Malcolm 1990, 1991). We report here trapping data from different forest levels from 1991–92 on Gigante Peninsula in the Barro Colorado Nature Monument (**BCNM**), Panama.

We trapped on a mainland peninsula in Gatun Lake, Panama that recently became part of the BCNM (established in 1977) and is administered by the Smithsonian Tropical Research Institute (STRI) (Leigh & Wright 1990). We set traps for 27 consecutive wet season days (3 July–29 July 1991) along the first 400 m of the Robin B. Foster Trail (**RBF**) and the first 50 m of the Paca Trial on Gigante Peninsula and for 35 dry season days between 12 January and 27 February 1992 along the first 400 m of RBF. The forest here is younger than the forest deeper into the peninsula and the canopy is 20–25 m above ground. During the wet season, traps were set at two heights: ground level and midlevel (1–4 m above ground). During the dry season we trapped at three heights: ground, midlevel, and 4–20 m above ground. Traps of different sizes were evenly distributed among different levels. During the wet season there were 25 trap stations with two traps each (one ground, one midlevel) at approximately 15 m intervals (50 traps total). During the dry season trapping, 12 trap stations were set at approximately 20 m intervals; 10 of these stations had three traps (one at each level) and two stations had only a ground and midlevel trap (34 traps total). Table 1 summarizes the details of trapping methods. All traps were baited with banana and/or apple slices as well as a peanut butter and oatmeal mixture or a peanut butter and cracked corn mixture; the traps were rebaited every day or two because of loss of bait to ants. Checks were run between 0900 and 1300 hr, animals were processed, and traps were reopened or left open 24 hr per day. Mammals caught in the wet season were filmed and released, whereas dry season captures were weighed and marked with hair dye before being filmed and released.

Overall trap success was calculated as the number of captures per trapnight according to standard mammalogical practice for calculating relative abundances (*cf.* Davis 1982, Kirkland 1982). For all other statistics a trap history for each trap was determined independently because of potential variation in trap success at each location along the traplines. The individual trap is therefore the unit of analysis, and each successive day of trapping at that trap is considered a replicate event. Tests of statistical significance were ANOVAs and pairwise multiple comparison tests (Wilkinson 1990).

Overall trap success (mean number of captures per trapnight for all vertebrates) was 4.2 percent for the 1991 early wet season (6.0% for ground traps, 2.7% for midlevel traps) with 1174 trapnights. Trap success was 7.3 percent during the 1992 dry season (10.7% for ground traps, 5.7% for midlevel traps, and 3.7% for high traps) with 1038 trapnights. Overall trap success during the dry season was significantly higher than during early wet season ($G = 10.771$, $P < 0.01$). Most of the increase in number of animals caught during the dry season was due to the higher capture rate of common opossums (*Didelphis marsupialis*).

Not all traps were equally likely to catch a vertebrate; half the traps were never successful (27 of 53 traps in the wet season, 16 of 34 traps in the dry season). The mean capture rate standardized to 100 nights (excluding the traps that never caught an animal) was 8.7 in the wet season and 13.0 in the dry

TABLE 1. *Comparison of wet and dry season trapping methods and overall trap success.*

	Wet season July 1991	Dry season January–February 1992
Trapping area	Gigante Peninsula/Robin B. Foster Trail within 400 m of clearing and Paca Run first 50 m	Gigante Peninsula/Robin B. Foster Trail within 400 m of clearing
Number of nights	27	35
Maximum number of traps	50	34
Number of trapnights	1174[a]	1038[a]
Trap intervals	~15 m	~20 m
Number of trap stations	25 (two traps each)	12 (ten stations with three traps each, two stations with two traps each)
Trap levels	ground 1–4 m above ground	ground 1–4 m above ground >4 m above ground
Trap types	small (23 × 7.5 × 7.5 cm) medium (61 × 17 × 17 cm) large (81 × 32 × 26 cm)	small (25.5 × 8 × 7.5 cm) medium (61 × 17 × 17 cm) large (81 × 32 × 26 cm)
Trap success	4.2	7.3%
Number of vertebrate captures	49	76
Number of mammal captures	41	74

[a] Number of trapnights does not equal nights × traps because some traps could not be run every night. All capture data were standardized to 100 nights per trap to compensate.

season (t = 2.448, df = 42, P = 0.02). Trap height had some effect on trap success. Ground level traps were more successful than high traps (F = 8.381, P = 0.008), but ground level trap success was not significantly different from trap success at midlevel in either the wet season (F = 2.573, P = 0.115) or the dry season (F = 3.321, P = 0.08). There was no significant trap size by height interaction (F = 0.774, P = .55).

During both early wet and dry seasons, most of our mammal captures were spiny rats (*Proechimys semispinosus*) (57% of wet season mammals, 35% of dry season mammals), or common opossums (20% of wet season mammal captures, 53% of dry season mammal captures). Considered by trap height, the dominant species caught were spiny rats (68% of ground mammal captures in the wet season, 52% in the dry season), common opossums (45% of all midlevel mammal captures in the wet season, 79% in the dry season), and woolly opossums (*Caluromys derbianus*) (75% of all high captures in the dry season) (Table 2). Common opossums were equally likely to be caught in ground or midlevel traps during wet season (F = 0.237, P = 0.63) and dry season (F = 0.010, P = 0.92), but they were less likely to be caught in high traps than in either ground traps (F = 4.825, P > 0.04) or midlevel traps (F = 4.507, P = 0.04). *Proechimys semispinosus* usually were caught on the ground (26 of 28 captures in the wet season; 23 of 25 captures in the dry season); all captures not at ground level were in traps 1–4 m above ground positioned along an obliquely oriented branch that had one end on the ground.

During the dry season trapping period, ten individual *D. marsupialis,* ten *P. semispinosus,* and five *C. derbianus* were marked. Nine of the ten *D. marsupialis* were recaptured at least once; mean capture rate for an individual was 4.1. Of the ten marked *P. semispinosus,* six were recaptured at least once; the mean capture rate for an individual was 2.1. Only two of the five marked *C. derbianus* were recaptured.

Seasonal differences in trap success could be due to many factors, including fluctuations in population densities of key species (*e.g., Didelphis marsupialis*) or increased tendency to enter traps for bait. Fleming (1972) reported catching more unmarked *Didelphis marsupialis* in dry season than in early wet season at two Canal Zone sites but was unable to determine whether the cause was a change in population numbers or just an increase in trapability. No such seasonal difference was seen for *Proechimys* captures (Fleming 1971; our data). However, pronounced dry season (January) food shortages have been documented (Foster 1982) on **Barro Colorado Island (BCI)**, and overall mammal trap success on BCI is higher during dry season and late wet season than during early wet season (Marcus 1984) when many fruits are available in the forest.

Despite seasonal differences in trap success, the mammal species assemblages for the two periods were equivalent; most frequently captured were spiny rats, common opossums, and woolly opossums. These three mammals were distinctly different in the forest stratum they occupied, however. Spiny rats were almost exclusively confined to the ground level. Common opossums were equally likely to be caught at ground and midlevels, but less likely to be above 4 m. Woolly opossums were captured at the high level, occasionally at the midlevel, and never on the ground. It is instructive to compare our trapping data to those published by Malcolm (1990, 1991) for his arboreal mammal survey in Brazil, to the trapping data of Charles-Dominique and colleagues in French Guiana (Charles-Dominique *et al.* 1981), and also to census data from Barro Colorado Nature Monument (Glanz 1982, 1990, 1991). On the one hand, there are striking similarities between our Gigante results and the Brazilian and French Guianan data (in terms of dominant genera and their vertical stratification), and on the other hand there are apparent differences between the adjacent Gigante and BCI mammal communities. In Brazil, spiny rats (*Proechimys* sp.) were the most common ground-trapped animal and the wooly opossum (*Caluromys philander*) was the most frequently captured animal in the canopy (~15 m). In addition, *Didelphis marsupialis* was caught in traps at all levels. In French Guiana, *Caluromys philander* was trapped at all levels of the forest, including the ground; however, 79 percent of the *Caluromys* captures occurred at 5 m above ground or higher whereas only 41 percent of *Didelphis marsupialis* captures occurred at 5 m or higher. The finding that *Caluromys* sp. are active higher in the trees than are *Didelphis* opossums is consistent with our findings on Gigante Peninsula. We also confirm the assertion (Malcolm 1991) that *Caluromys* abundances are likely to be underestimated unless high traps are used.

On BCI, only a few hundred meters away from Gigante Peninsula, agoutis (*Dasyprocta punctata*) and red-tailed squirrels (*Sciurus granatensis*) are more frequently trapped and censused than are spiny rats (Glanz 1982, 1991). In two months of trapping on Gigante Peninsula, however, we caught no red-tailed squirrels and only one agouti. We also caught no coatis on Gigante during a period when coati

TABLE 2. *Vertebrate species caught at ground, midlevel, and high traps in decreasing order of frequency captured*[a]*: Numbers of captures and percentage of total captures for each trap height by season (wet/dry).*

Ground	(Wet/Dry)	Midlevel (1–4 m)	(Wet/Dry)	High (>4 m)	(Wet/Dry)
Proechimys semispinosus (spiny rat)	(26 = 68%/23 = 52%)	*Didelphis marsupialis*	(5 = 45%/19 = 79%)	*Caluromys derbianus*	(—/6 = 75%)
Didelphis marsupialis (common opossum)	(5 = 13%/20 = 45%)	*Proechimys semispinosus*	(2 = 18%/2 = 8%)	*Didelphis marsupialis*	(—/2 = 25%)
Leptotila verreauxi (white-tipped dove)	(3 = 8%/1 = 3%)	*Tamandua mexicana* (vested anteater)	(0 = 0%/1 = 4%)		
Basiliscus basiliscus (basilisk lizard)	(1 = 3%/0 = 0%)	*Caluromys derbianus* (woolly opossum)	(2 = 18%/1 = 4%)		
Dasyprocta punctata (agouti)	(1 = 3%/0 = 0%)	*Leptotila verreauxi*	(0 = 0%/1 = 4%)		
Crocodilian sp.	(1 = 3%/0 = 0%)	*Basiliscus basiliscus*	(2 = 18%/0 = 0%)		
Unidentified anuran	(1 = 3%/0 = 0%)				

[a] Mammals seen in study site during daylight trap checks but not captured during the trapping periods: three-toed sloth (*Bradypus variegatus*), Geoffroy's tamarin (*Saguinus geofforyi*), white-faced monkey (*Cebus capucinus*), howler monkey (*Alouatta palliata*), red-tailed squirrel (*Sciurus granatensis*), agouti (*Dasyprocta punctata*), peccary (*Tayasso tajacu*), coati (*Nasua narica*).

trap success was ~30 percent on BCI (Matt Gompper, pers. comm.). These discrepancies between nearby sites could be due to several factors or combinations of factors such as lower densities caused by predation (Terborgh 1988) or heightened wariness of agoutis and coatis on the less-protected peninsular site (Glanz 1991), habitat differences (our trap line went through disturbed second growth forest, which is no longer a common habitat on BCI) (Leigh & Wright 1990), bait differences (Marcus 1984), or inadvertent disturbance of diurnal agoutis during their morning activity period (Smythe 1978). No systematic mammal canopy trapping has yet been done on BCI, so the arboreal mammal communities on BCI and Gigante cannot be compared directly. The reader should consult Glanz (1991) for a discussion of the differences in mammal communities in the BCNM based on trail censuses.

The most common nonmammal vertebrates caught were white-tipped doves and basilisk lizards (Table 2). Our trapline ran close to the lake shore, near the forest edge, which is appropriate habitat for both the lizards (Rand & Myers 1990) and doves (Ridgely & Gwynne 1989). We would anticipate catching fewer doves and no basilisk lizards in the central areas of Gigante Peninsula.

The data reported here represent an assessment of the mammals present at different levels in a Central American moist forest. Our study, considered with the work of Malcolm (1990, 1991) and Charles-Dominique *et al.* (1981), supports decades of naturalists' observations indicating certain general patterns in the vertical stratification of small mammals throughout neotropical forests. Our intention in this note is to add a small piece to the puzzle of the organization of neotropical mammal communities and to recommend the use of long-term canopy trapping surveys to help answer some of the outstanding questions regarding the lives of the lesser known arboreal mammals.

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