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NEST-BUILDING BEHAVIOR OF THE BRAZILIAN BARE-TAILED OPOSSUM, *MONODELPHIS DOMESTICA*

This report describes nest-building behavior of the Brazilian bare-tailed opossum, *Monodelphis domestica*. In our laboratory, paper strips were used by the opossum to weave a trilayered nest that resembled in shape nests constructed of leaves by other species (Enders, 1935; Marshall, 1978). I have found no descriptions of nest construction by *M. domestica* in the wild.

Three adult female one-year-old opossums obtained from the Office of Zoological Research, National Zoological Park, progeny of animals livetrapped in Venezuela and all approximately 12 cm in body length, were housed in clear plastic cages 40 by 15 by 12 cm. Wood chips served as bedding and water was available *ad libitum*. Each afternoon the opossums were fed a diet of meal worms, fresh orange and banana slices, evaporated milk, and a meat mixture containing ground beef, egg white, wheat germ, "Marmoset Diet" (Health Science Co.), and a vitamin supplement. Room temperature was maintained at 24°C, but humidity was not controlled. Cages were located on racks near windows having a northern exposure to the natural light cycle of winter and spring in central New York. The opossums were observed for two hours each morning from 20 January to 7 May 1979. Observation periods were 0600 h to 0800 h and 0800 h to 1000 h; during the former time period observations and video-tapes were made of nest-building behavior and during the latter time period woven nests were examined.

Nest examinations were performed between 9 March and 25 March. The opossums were found in one of four sleeping states each morning: on the bedding five times, in an unwoven nest 14 times, in a partially woven nest eight times, and in a woven nest 24 times. Completely woven nests were globularly shaped with an expanded base and were characterized by three discernible levels. The "A" level consisted of strips lining the nest floor. The paper strips of "B" level formed a wall above level "A," creating an interior sleeping chamber. Level "C" constituted the upper two-thirds of the nest and included the roof.

The possibility that *M. domestica* would use paper strips of various lengths for different parts of the nest was explored by presenting the opossums daily with a total of 80 paper strips (3 cm wide), 20 each of four lengths: 3, 6, 12, and 24 cm. Each morning cages were inspected for evidence of nest building. Woven nests were dismantled and the number of each of the four strip lengths present in each level was recorded (Table 1). Dismantled nests were replaced with fresh paper strips, though rarely would the somnolent opossums attempt to weave another nest before the following dawn. There was significant interaction between the nest levels and the strip lengths in woven nests as revealed by analysis of variance ($F = 41.3$, d.f. $= 6,22$, $P < 0.01$).

Each level exhibited an unique distribution of strip lengths. The "A" level was characterized by 3 cm strips apparently because their short length made them difficult to interweave among other strips, and therefore were primarily found lining the nest floor. Longer strips in this level provided a firm, interwoven connection between levels "A" and "B."

The "B" level was the thickest and most heterogeneous in regard to strip length. Long and short strips were interwoven to form a wall that created an interior chamber. The nest wall at level "B" typically was twice as thick as the nest roof in level "C." The strips in level "C" formed a dome-like roof over the interior chamber. Although the thinnest level, it effectively shielded the opossum from view.

TABLE 1.—*Summary of observations of strip length versus nest level for 24 woven nests of* Monodelphis domestica. *Percentages are in parentheses.*

Strip length (cm)	Nest level: Floor (A)	Wall (B)	Roof (C)	Strips not used
24	83 (14)	128 (23)	270 (52)	80 (14)
12	113 (19)	201 (35)	152 (30)	94 (17)
6	190 (32)	133 (23)	72 (14)	163 (29)
3	212 (36)	107 (19)	22 (04)	234 (41)

There are at least two possible explanations for the significant differences in strip length frequencies in relation to nest level: 1) shorter strips simply fall to the bottom and longer strips remain in place; 2) the observed frequencies result from a choice of appropriate lengths by the opossum. If differences reflect the former, the same strip length variances between levels found in woven nests should also characterize unwoven nests. An unwoven nest was defined as a pile of strips that were brought to the nest area by the opossum but did not exhibit the distinctive layers and cohesiveness characteristic of woven nests. Table 2 describes the strip length distribution in one unwoven nest. No particular strip length was prominent in any of the levels, whereas in the woven nests strip length distribution varied significantly between levels. Of the 24 woven nests, none exhibited the strip length frequencies found in the unwoven nest. Table 3 contrasts the raw data obtained from one woven nest (randomly chosen) in regard to strip length distribution between levels.

It is no longer believed that marsupials are poorer thermoregulators than placentals although marsupial body temperature can vary greatly within a short amount of time (the body temperature in *Marmosa robinsoni* has been observed to vary 5°C in 3 min). These same marsupials exhibit a behavioral thermoregulatory response by crawling under paper when their body temperatures increase due to an increase in the ambient temperature (Hunsaker, 1977). Possibly these tightly woven nests protect *M. domestica* from the daytime tropical heat. If nests function, at least in part, to protect opossums from the daytime heat, possibly the animals use sunshine as the cue for anticipating particular temperatures. In our laboratory, we noted that on 10 sunny mornings 19 nests were woven and 11 nests were unwoven whereas on 16 cloudy mornings 10 nests were woven compared to 38 unwoven nests. Opossums built significantly more woven nests when it was sunny and were more likely to sleep in unwoven nests when it was cloudy ($\chi^2 = 12.4$, d.f. = 1, $P = 0.01$). To test this hypothesis thoroughly would require measurements of temperatures within the nest as ambient temperatures varied.

Monodelphis domestica exhibited a stereotypic behavior while gathering paper strips. With a strip held in its mouth, the opossum brought its rostrum beneath its body where the forepaws grasped the strip and pushed it along under the body toward the base of the tail. While the forepaws were bringing the paper strip to the base of the tail, the opossum was supported by its hind feet. The tail tip was brought forward to a point beneath the tail base, thus creating a tail loop into which the paper was deposited. Paper strips were released in the nest area by uncurling the tail. Enders (1935) noted that the pectoral gland of *Didelphis* secretes a liquid that is rubbed off when in contact with other objects while climbing. Possibly, *M. domestica* is odor marking by pushing the paper strip along its ventral surface.

Tail curling has been observed in *D. virginiana*, *M. domestica*, *Caluromys derbianus*, and *M. robinsoni* (Hunsaker and Shupe, 1977). The first reported observation of a Virginia opossum using its tail to carry material was in 1872, according to Hartman (1952), who also reported that two Australian marsupials, the

TABLE 2.—*Summary of strip length versus nest level for one unwoven nest constructed by* Monodelphis domestica. *Percentage are in parentheses.*

Strip length (cm)	Nest level: Floor (A)	Wall (B)	Roof (C)	Strips not used
24	6 (38)	4 (17)	10 (25)	0 (0)
12	2 (13)	8 (35)	10 (25)	0 (0)
6	3 (19)	5 (22)	12 (30)	0 (0)
3	5 (31)	6 (26)	8 (20)	1 (100)

TABLE 3.—*Stripe length distribution versus nest levels from an unwoven nest and a woven nest constructed by* Monodelphis domestica.

Strip length (cm)	Nest level: Floor (A)		Wall (B)		Roof (C)		Strips not used	
24	6	2	4	7	10	10	0	1
12	2	4	8	5	10	5	0	2
6	3	8	5	3	12	5	0	4
3	5	6	6	1	8	0	1	13

rat kangaroo and the sugar glider, transport material with the tail. Layne (1951) described the method by which *D. virginiana* placed material in its tail; the method is similar in most respects to that exhibited by *M. domestica.*

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VARIABILITY OF INCISOR ENAMEL MICROSTRUCTURE WITHIN *GERBILLUS*

Enamel microstructure on the incisors can be used with other anatomical characters to interpret systematic relationships among rodents. Korvenkontio (1934) observed and measured three kinds of crystalline organization in rodent incisor enamel: uniserial, pauciserial, and multiserial. Flynn (1977) examined incisors of uniserial rodents, especially the myomorphs Cricetidae and Heteromyidae, showing that different rodent families with uniserial enamel may be distinguished by quantified microstructural characters and that extinct taxa exhibit similar variability. Escala and Gallego (1977) differentiated muroids by details of enamel architecture and demonstrated that distantly related species acquired different enamel microstructure while closely related species retained very similar structures. In this paper, I use incisor enamel as new data bearing on interpretation of gerbil systematics.

Sagittal sections along the midlines of gerbil incisors were prepared for viewing through a scanning electron microscope (SEM) after the techniques of Flynn and Wahlert (1978). Incisors were glued medial side down on aluminum SEM stubs and ground by hand on a glass plate in a carbide grit slurry. The ground surface was etched in 5% HCl to bring out relief and then coated with gold. A SEM photomicrograph (Fig. 1) reveals uniserial organization of microscopic hydroxyapatite prisms in gerbils. Two superposed layers of enamel are evident (Fig. 2). Prisms in the outer layer are oriented nearly parallel to the incisor surface, while prisms of the inner layer interlock to form inclined bands. The following characters can be measured