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GENERAL NOTES

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OFFSPRING RECOGNITION BY MALE *PEROMYSCUS MANICULATUS*

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The mating system of *Peromyscus maniculatus* is promiscuous (Eisenberg, 1968), with females engaging in multiple matings (Dewsbury, 1981) and litters having multiple paternity (Birdsall and Nash, 1973; Wolff, 1985). Paternal care (Dewsbury, 1985; Hartung and Dewsbury, 1979; Horner, 1947) and maternal aggression as a deterrent to infanticide by males (Wolff, 1985) also have been recorded. If promiscuity implies uncertain paternity, then it is difficult to understand why males should provide paternal care or be infanticidal. Paternal care and infanticide would not confer a selective advantage to males unless they performed these behavioral patterns selectively, i.e., unless they exhibited paternal behavior toward their own offspring and infanticidal behavior toward strange offspring. Recognition of offspring through familiarity with the female, the nest environment, or the young themselves is known in *Mus musculus* (Bowers and Alexander, 1967; Brooks and Schwarzkopf, 1983; Huck et al., 1982; vom Saal, 1984) but not in *Peromyscus*.

We tested the hypothesis that males *P. maniculatus* can distinguish between their own young and those sired by other males. Given the promiscuous nature of females, it may be advantageous for males to be able to discriminate between their own young and unrelated young even in the presence of familiar females.

Mice were housed in standard (28 by 16 by 12 cm) laboratory cages, provided with Purina Rat Chow and tap water ad lib., and maintained on 18L:6D photoperiod at 21°C. Young were weaned at approximately 21 days of age and housed individually until 2 months of age. Males and females then were paired in 48- by 28- by 14-cm plastic cages for 3 days, after which males were separated from females until parturition. On day 1 postpartum, all young from 22 unrelated females were exchanged, providing 22 fostered litters. An additional 21 litters remained with their mothers. Here, females that gave birth to a male's offspring are termed "familiar," and those never in contact with the male are termed "unfamiliar." Offspring sired by a particular male are termed "related" and those sired by other males are termed "unrelated."

Preliminary observations indicated that only young <6 days of age were highly susceptible to infanticide (Wolff, 1985). Our experiment thus was conducted on day 1 postpartum for 24 h. Each male was introduced to one of four conditions for 24 h: a familiar female with related young (nine males), a familiar female with unrelated young (eight males), an unfamiliar female with related young (eight males), or an unfamiliar female with unrelated young (eight males). Four females with their own young and six females with foster young were not exposed to males. Whole litters rather than single young were exposed to males in these experiments because, under natural conditions, males are not likely to encounter solitary young. At the end of the testing period, the number of litters in which infanticide occurred and the number of young killed were recorded.

Three adult males were killed by adult females; one by a familiar female with related young and two by unfamiliar females with unrelated young. No infanticide occurred when the males were killed, or when females and their young or foster young were not exposed to males (Table 1). Therefore, all infanticide was attributed directly or indirectly to the presence of males.

Our analyses were based on the number of infanticidal males in each of the four experimental categories (Table 1). The number of young killed in each category is included in Table 1 for reference, but was not used in our statistical analyses (Labov et al., 1985; McCarthy and vom Saal, 1986; vom Saal, 1984). Because our predictions were directional, e.g., males should be more infanticidal toward unrelated young than toward their own young, one-tailed tests with phi-coefficient as the test statistic (Iman and Conover, 1983) were used.

Males appeared to discriminate between their own and unrelated offspring in the presence of familiar females. Six of eight males were infanticidal when young were unrelated, but only two of eight males were infanticidal toward their own young (Table 1). Thus, relatedness of young to a male appeared to influence infanticidal behavior ($\phi = 0.5$, $P < 0.01$) and our prediction that males can recognize their own young is supported. However, males did not appear to discriminate between their own and unrelated young in the

TABLE 1.—*Infanticide by Peromyscus maniculatus under different experimental conditions.*

Condition	Litters n	Infanti- cidal males n	Young n	Dead young	
				n	%
Female and own young, no male	4	—	19	0	0
Female and foster young, no male	6	—	31	0	0
Familiar female and related young, male both mate and sire of young	8	2	33	6	18
Familiar female and unrelated young, male not sire of young	8	6	42	16	38
Unfamiliar female and related young, male sire of young	8	7	42	25	56
Unfamiliar female and unrelated young, male neither mate nor sire of young	6	5	25	22	88

presence of unfamiliar females. When young were with an unfamiliar female, seven of eight males were infanticidal toward their own young and five of six males were infanticidal toward unrelated young (Table 1). These levels of infanticide were similar to those found when males encountered familiar females with unrelated young (χ^2 -test of homogeneity, $P > 0.80$). Males were highly infanticidal in all three of these situations. Thus, we conclude that female familiarity alone, or young relatedness alone, cannot inhibit infanticide.

Hrdy (1979) suggested that sex-biased infanticidal tendencies should operate in situations in which competition between members of one sex (usually males in rodents) for reproductive investment by the other sex makes destruction of a competitor's offspring advantageous. Infanticide should be directed toward offspring unrelated to the killer, and mechanisms that inhibit killing one's own offspring should be favored.

Several investigators have found that a male's recognition of its own young is based primarily on past sexual association with the mother (Huck et al., 1982; Labov, 1980; Mallory and Brooks, 1978; Webster et al., 1981). Bowers and Alexander (1967) found house mice (*Mus musculus*) to be capable of individual recognition based on olfactory cues. In monogamous and polygynous species, recognition of mates alone may be sufficient to prevent males from misdirecting paternal care or infanticide. However, in promiscuous species such as *P. maniculatus*, recognition of mates alone would not always permit discrimination of related and unrelated young, and our results indicate that males do not rely solely on female familiarity to identify their young. Infanticide was invoked when either the female or the young were unfamiliar or unrelated, and was inhibited only in the presence of familiar females with related young. The features of the females and young used in this recognition remain unclear. It seems likely that males respond to odors when identifying familiar and unfamiliar females. It also is likely that neonates carry odors from their mothers. If this is true, males that killed unrelated young may have responded to "unfamiliar" female odors on these young. Alternatively, they may have responded to some characteristic of the young themselves. Although the specific cues used by males remain unknown, it is clear that the presence of any novel individual (either female or young) triggers infanticidal behavior.

Finally, although these data clearly indicate that males can discriminate between familiar and unfamiliar females, the application of these results to natural conditions is uncertain. In the wild, males are unlikely to encounter familiar females with foster young. More likely, they encounter familiar females with both related and unrelated young in the same litter. The ability of males to discriminate among these young remains unknown.

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ADOPTION IN GREATER ONE-HORNED RHINOCEROS (*RHINOCEROS UNICORNIS*)

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Reports of adoption in free-ranging mammals include several primate species (Clarke and Glander, 1981; Hrdy, 1976), mountain zebras (*Equus zebra zebra*; Lloyd and Harper, 1980), elephant seals (*Mitrounga angustirostris*; Riedman, 1982; Riedman and LeBoeuf, 1982) and a number of species in the Artiodactyla. Aside from the reference to zebra, however, adoption apparently is rare in the Perissodactyla. Here, we document an instance of adoption in *Rhinoceros unicornis* in Royal Chitwan National Park, Nepal.

Rhinoceros unicornis (hereafter referred to as *Rhinoceros*) has among the lowest reproductive rates known for mammals. Gestation averages 16 months, intercalving interval is about 4 years, and females first give birth as early as about 6.5 years. Females nurse calves to the age of 2 years, but by the age of 2 months the calves begin supplementing milk intake with grass shoots, and by 10 months they graze and browse freely.

As part of a larger study on population and foraging ecology of *Rhinoceros*, we photographed and identified 167 animals in the eastern sector of Chitwan National Park and radio-collared 15 individuals for intensive study. The adoption incident occurred in this sector on Icharni Island, an area of 1.1 km² of riverine forest surrounded by 2.2 km² of 3-m-tall *Saccharum spontaneum* grassland. Icharni Island supports the highest density of *Rhinoceros* within the park; numbers vary monthly but include a minimum of 15 adult females with calves, 1-2 barren adult females, 2 subadult females, 3 subadult males, and 2 dominant males. The island also attracts a few transient, reproductive females that give birth or nurse young calves there then move off.

Although *Rhinoceros* cows guard young calves closely, calves become separated from their mothers when