

BRIEF REPORT

Seasonally Variable Effects of Conspecific Odors upon Capture of Deer Mice (*Peromyscus maniculatus gambelii*)

MARTIN DALY, MARGO I. WILSON, AND STEVEN F. FAUX¹

Department of Psychology, University of California, Riverside, California 92521

Traps were set in triplets of one male-scented (M), one female-scented (F), and one neutral (N) trap. Bedding from laboratory-caged, adult deer mice (*Peromyscus maniculatus gambelii*) was the source of M and F odors. In winter, outside the breeding season, deer mice, pocket mice, and kangaroo rats all avoided deer mouse odors and preferentially entered N traps. In spring, when breeding had commenced, deer mice preferentially entered scented traps, and avoidance of deer mouse odors by other species was reduced. These changes are interpreted as reflecting seasonally variable strategies of social confrontation.

Biological odors can serve a variety of communicative functions. Conspecific odors are often attractive, particularly to members of the opposite sex. Conversely, these odors may function territorially, repelling conspecifics (and perhaps other animals too), but such repulsive effects have rarely been demonstrated (Johnson, 1973).

Recent studies have indicated that conspecific odors can sometimes increase (Boonstra and Krebs, 1976; Mazdzer *et al.*, 1976) and sometimes decrease (Summerlin and Wolfe, 1973) the probability that rodents will enter traps. Here, we present the first field evidence that rodents of a single species selectively approach or avoid conspecific odors according to the season and that unrelated sympatric rodents are also responsive to such odors.

The study was performed by livetrapping with odorized traps in semiarid coastal sage scrub in the western foothills of Box Springs Mountain, Riverside County, California, during three periods: (I) January 29–February 22, 1977, 384 trap nights; (II) April 3–14, 1977, 333 trap nights; (III) May 3–29, 471 trap nights. At each trapping station, three folding

¹ Present address: Department of Psychology, Brigham Young University, Provo, Utah 84601.

aluminum Sherman traps, $8 \times 9 \times 23$ cm, were placed at 1-m intervals. Stations were situated at least 10 m apart. No previously trapped area was used on any experimental trapping night, so that all captured rodents were without prior trap experience.

Traps were baited with about 2 g of wheat or rolled oats, a piece of clean cotton, and about 5 g of San-i-cel bedding material. The three traps at each station differed in the sources of the San-i-cel: One contained clean, unscented material (designated N); one, female-scented material (F); and one, male-scented material (M). The F and M materials were obtained on the day of trapping from the home cages of donor adult *Peromyscus maniculatus gambelii* housed individually in the laboratory. Donors' cages had not been cleaned for 1 week prior to use.

During periods I and II, donors were unmanipulated. For period III, in an effort to standardize their hormonal state and hence their odors, donors were gonadectomized and injected with hormones in a sesame oil medium: Males received 10 mg of testosterone cypionate three times weekly, and females received 15 ng of estradiol benzoate daily.

Two-hundred and fifteen rodents were trapped in 1188 trap nights, viz., 84 deer mice (*P. maniculatus gambelii*), 6 cactus mice (*P. eremicus*), 59 pocket mice (*Perognathus* spp.), 43 kangaroo rats (*Dipodomys agilis*), and 23 woodrats (*Neotoma lepida*). These captures are broken down in Table 1, and significant departures from a random pattern of entry into available traps are indicated.

All three species captured during period I exhibited significant preference for the N traps. This was not true subsequently. After period I, deer mice preferentially entered scented traps. The change in preference between periods I and III is highly significant ($\chi^2(2) = 15.4$, $P < 0.005$) and occurred in both sexes (females: $\chi^2(2) = 8.0$, $P < 0.05$; males: $\chi^2(2) = 6.0$, $P < 0.05$).

This change in trap response accompanied a change in breeding activity in the deer mouse population. Breeding was suspended during period I, when deer mice avoided conspecific odors, and resumed in periods II and III, when deer mice preferentially approached them. Ten of seventeen adult females captured near the experimental area in October–November 1976 proved to be pregnant; none of twelve in December–February (which includes period I); and four of five in April–May (periods II and III). Only 7 of 15 adult males on or near the experimental area had conspicuous descended testes in January–February, compared to 23 of 24 in April–May.

Two of four adult males without descended testes entered N traps, whereas 4 of 30 with descended testes entered N traps. This difference is not significant (Fisher exact test, $P = 0.13$), but the possibility of differential trap response as a function of reproductive condition warrants further testing (Summerlin and Wolfe, 1973).

TABLE 1
Rodent Captures by Species, Trap Odor, and Period

Trap odors	Period I (January 29–February 22)				Period II (April 3–14)				Period III (May 3–29)				Sum for Periods I–III			
	M	F	N	χ^2_a	M	F	N	χ^2_a	M	F	N	χ^2_a	M	F	N	χ^2_a
<i>Peromyscus maniculatus gambelii</i>																
Females	3	6	11	6.91*	0	2	0	0	11	7	4	0	14	15	15	0
Males	3	3	4		2	1	0	0	16	9	2	10.85**	21	13	6	7.88*
Total	6	9	15	6.42*	2	3	0	0	27	16	6	12.93**	35	28	21	
<i>P. eremicus</i>																
Females	0	0	0		0	1	0	0	1	2	0	0	1	3	0	0
Males	0	0	0		0	1	0	0	0	1	0	0	0	2	0	0
Total	0	0	0		0	2	0	0	1	3	0	0	1	5	0	0
<i>Perognathus</i> spp.	10	2	16	13.48**	9	5	4	0	2	7	4	0	21	14	24	0
<i>Dipodomys agilis</i>	2	2	8	8.12*	6	2	7	0	2	5	9	0	10	9	24	10.13**
<i>Neotoma lepida</i>	0	0	0		0	2	0	0	5	5	11	0	5	7	11	0
Sum of non- <i>Peromyscus</i>	12	4	24	18.88***	15	9	11	0	9	17	24	0	36	30	59	11.35**
Occupied traps	18	13	39	19.95***	17	14	11	0	37	36	30	0	72	63	80	0
Empty traps	110	115	89		94	97	100	0	120	121	127	0	324	333	316	0

^a Two degrees of freedom.

* $P < 0.05$.

** $P < 0.01$.

*** $P < 0.001$.

Variability in total captures over the three periods and, in particular, the increase in deer mice from period II to period III apparently resulted in part from population fluctuations. All five deer mice caught in April were adults, whereas 11 of 49 caught in May exhibited juvenile pelage and were probably conceived in March. Precise comparisons of capture totals are unwarranted, however, since the exact locales varied, and variables such as moonlight and cloud cover were not equated over the three periods.

In period I, 10 male and 20 female deer mice were captured; in periods II and III, 30 males and 24 females. The increased proportion of males is significant ($\chi^2(1) = 3.0$; $P < 0.05$) on the directional hypothesis of increased male ranging activity during breeding seasons (Daly and Daly, 1975).

Five of six cactus mouse (*P. eremicus*) captures were in female-scented traps. This degree of departure from random choice approaches significance (Fisher exact test, $P = 0.06$). If this preference is real, its meaning is unclear. Laboratory tests of *Peromyscus* odor preferences have yielded varied results, but generally indicate that specific discrimination by olfactory cues occurs (Moore, 1965; Doty, 1972, 1973).

Kangaroo rats and pocket mice avoided deer mouse odors, at least seasonally, and the few captures of woodrats indicated that even this much larger rodent may do the same. The distribution of non-*Peromyscus* captures varied significantly over periods ($\chi^2(4) = 13.5$, $P < 0.01$), because the overall tendency to prefer N traps was absent in period II.

In winter, outside the breeding season, both deer mice and heteromyids (kangaroo rats and pocket mice) avoided deer mouse odors. In spring, when breeding had commenced, deer mice were attracted to conspecific odors, and avoidance by heteromyids, the reproductive season of which evidently coincided with that of the deer mice, was less marked or absent. Apparently these rodents adopt a nonconfrontational, inconspicuous mode of behavior outside the breeding season and become attracted to stimuli of potential social significance when breeding commences. Conspecific attraction is not confined to opposite-sexed animals; in fact, male deer mice in reproductive condition entered M traps most of all.

Only one previous study has found rodents to avoid conspecific trap doors. Summerlin and Wolfe (1973) found that cotton rats (*Sigmodon hispidus*) that were not in reproductive condition entered clean traps in preference to traps scented with bedding from captive cotton rats. Among animals in reproductive condition, there was a nonsignificant tendency to reverse that preference. Like the present study, Summerlin and Wolfe's thus suggest that conspecific odors may be avoided by nonreproductive individuals and approached by reproductives. They did not trap in different seasons, nor did they separate odor donors according to sex, but instead pooled the odorous bedding.

Hansson (1967), using odors of mice (*Apodemus flavicollis*) or voles (*Clethrionomys glareolus*), found a tendency to approach conspecific and avoid heterospecific odors. Neither conspecific nor heterospecific respondents alone differed significantly from a random trap entry pattern, but they differed significantly from one another. Donors were not differentiated by sex.

Mazdzer *et al.* (1976) found male and female *Peromyscus leucopus noveboracensis* to prefer conspecific trap odors to weasel odors or clean traps. Their white-footed mice especially approached odors of opposite-sexed conspecifics, a trend not found in our data. They found no evidence that white-footed mouse odors are ever avoided, but responses were not broken down according to season or reproductive condition, and few heterospecific rodents were captured.

Finally, Boonstra and Krebs (1976) found voles (*Microtus townsendii*) to be significantly more likely to enter dirty traps than clean ones. The "dirt" was primarily vole excreta accumulated over weeks of trapping, and odor sources were not discriminated.

The nature of the stimulus odors is problematic in all studies to date. In the studies of Hansson (1967), Mazdzer *et al.* (1976), and Boonstra and Krebs (1976), traps were odorized by confining donors within them. The donors may therefore have been stressed, and stress can alter the attractive or aversive properties of rodent odors (e.g., Carr *et al.*, 1970). Furthermore, no study has yet standardized the odor donors. Hormonal manipulations in period III of the present study were designed to achieve that end, but regular handling and injection of the odor donors may have been stressful. In continuing studies of trap odor effects, we are now using gonadectomized donors with implanted capsules providing steady secretion of testosterone or estrogen.

REFERENCES

- Boonstra, R., and Krebs, C. J. (1976). The effect of odour on trap response in *Microtus townsendii*. *J. Zool.* **180**, 467-476.
- Carr, W. J., Martorano, R. D., and Krames, L. (1970). Responses of mice to odors associated with stress. *J. Comp. Physiol. Psychol.* **72**, 51-59.
- Daly, M., and Daly, S. (1975). Socio-ecology of Saharan gerbils, especially *Meriones libycus*. *Mammalia* **39**, 289-311.
- Doty, R. L. (1972). Odor preferences of female *Peromyscus maniculatus bairdi* for male mouse odors of *P. m. bairdi* and *P. leucopus noveboracensis* as a function of estrous state. *J. Comp. Physiol. Psychol.* **81**, 191-197.
- Doty, R. L. (1973). Reactions of deer mice (*Peromyscus maniculatus*) and white footed mice (*Peromyscus leucopus*) to homospecific and heterospecific urine odors. *J. Comp. Physiol. Psychol.* **84**, 296-303.
- Johnson, R. P. (1973). Scent marking in mammals. *Anim. Behav.* **21**, 521-535.
- Hansson, L. (1967). Index line catches as a basis for population studies on small mammals. *Oikos* **18**, 261-276.

- Mazder, E., Capone, M. R., and Drickamer, L. C. (1976). Conspecific odors and trappability of deer mice (*Peromyscus leucopus noveboracensis*). *J. Mammal.* **57**, 607-609.
- Moore, R. E. (1965). Olfactory discrimination as an isolating mechanism between *Peromyscus maniculatus* and *Peromyscus polionotus*. *Amer. Midl. Natur.* **73**, 85-100.
- Summerlin, C. T., and Wolfe, J. L. (1973). Social influences on trap response of the cotton rat, *Sigmodon hispidus*. *Ecology* **54**, 1156-1159.