WILL MAMMALIAN PHEROMONES BE USEFUL IN WILDLIFE DAMAGE CONTROL?

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Rodents, lagomorphs and cervids are the most important herbivorous mammals that cause economic damage in North America. Farmers, foresters, trappers and gardeners have since time immemorial used various concoctions to attract wild mammals or repel them from certain sites or crops. The chemical industry has often used food odors in their animal control products. Currently no pheromone is being used in wildlife damage control.

We have only recently begun to understand chemical communication within mammal species well enough to be encouraged to try to apply this knowledge for actual manipulation of free-ranging, wild mammals that cause damage. We are at the threshold of vertebrate pheromone applications, commonplace for insects.

In this paper I will briefly review recent studies that have succeeded in influencing the behavior of mammals in their natural social and physical environment.

RODENTS

A review of the literature on scented trap experiments with various species of small rodents shows that, depending on the odors used, one sex can be attracted more than the other, or breeding animals more than pre- or non-breeders (resulting in seasonal differences of trapping success), and dominants more than subordinates.

RESPONSES TO SCENTED TRAPS

Free-ranging rodents can be attracted to scented traps. However, the responses to these traps vary widely with species, sex, season, or social status. Generally, traps with conspecific odor are entered more often than those with heterospecific odor. This is true for *Clethrionomys* and *Apodemus* (Hansson 1967). Within one species, traps with the odor of the opposite sex are often more attractive than those with the odor of the same sex, as in *Mus musculus* (Rowe 1970), *Peromyscus leucopus* (Mazdzer et al. 1976), and *Microtus brandtii* (Fan 1978). But house mice *(M. musculus)* and *Microtus brandtii* may also enter traps with same sex odor more frequently (Rowe 1970 and Fan 1978, respectively). Muskrats, *Ondatra zibethicus* (Ritter et al. 1982) and *Peromyscus maniculatus* (Daly et al. 1978) also showed same-sex preferences. Males appear to be particularly attracted to the odor of the same sex, as in *Mus musculus* and possibly *Ondatra*.

Trap response also depends on reproductive status. Animals in breeding condition prefer conspecific odor over blanks, while the opposite is true for nonreproductive adults. This has been observed in *Peromyscus maniculatus* (Daly et al. 1978), *Perognathus* and *Dipodomys* (Daly et al. 1980).

Dominant individuals in *Mus musculus* (Wuensch 1982) and *Sigmodon hispidus* (Summerlin and Wolfe 1973) prefer conspecific scent, while subordinates enter blanks. In *Mus*, females entered clean traps and those scented with soiled bedding from subordinate males (Wuensch 1982). There may even be interspecific effects: Male *Peromyscus maniculatus* entered traps that had been scented with odors from dominant and low-ranking male house mice, while females almost always entered clean traps (Wuensch 1982).

Immature individuals or those new to an area or to the traps may prefer conspecific over no odors, as in *Microtus townsendii* (Boonstra and Krebs 1976), or *Peromyscus maniculatus* (Daly et al. 1978).

Some rules can be culled from these experimental results. First, as expected, conspecific odors are more effective in triggering and modulating contact behavior than heterospecific odors. Second, in any practical application one has to keep in mind that the kind and intensity of response depend on sex, age, and condition of the signaler as well as that of the receiver, resulting in diverse possible behaviors. Third, an animal may experience an odor in different spatial or behavioral contexts: it may occupy a territory, be dispersing, immigrating, or migrating. Fourth, reproductive activity and a mate of social dominance appear to heighten sensitivity to conspecific odors and to lead to more intraspecific contact and confrontation.

MUSKRAT

The muskrat, *Ondatra zibethicus*, has been attracted to traps with odor lures by trappers for centuries, but controlled experiments had not been conducted until 3 years ago. We have live-trapped muskrats with scented traps in upstate New York in order to determine what role the muskrats' musk secretion from the preputial gland plays in its behavior. Thus far, the sample size is small, but significant trends emerge. Adults avoid musk-scented traps while young are indifferent or attracted to them (Tables 1 and 2; van den Berk and Müller-Schwarze, in press). Laboratory tests point in the same direction. In a laboratory test with a Y-maze attached to their home cage, muskrats usually visited musk samples and blanks equally often and had similar duration times at both musk samples and blanks. When there was a significant difference in duration (3 out of 16 cases), the muskrats preferred blanks (Fig. 1). This is in contrast to recent findings in the Netherlands where most adult males were caught with muskrat musk (Ritter et al. 1982). It remains to be seen whether this is a geographical difference, or due to the difference between the status of these populations. The New York populations are saturated, with established families in ponds and channels, while the Dutch populations are transitory, with males, and later females immigrating via canals and streams into Holland from protected breeding reservoirs to the East in Germany. Our studies would suggest that musk is a repellent for muskrats, while the Dutch results indicate an attractant function.

Table 1. Responses of muskrats to scented traps, New York State, all seasons.

	Musk	Blank	Total
Adults	1	16	17
Young	13	13	26
Total	14	29	43

$X^2 = 8.89$; $p < 0.005$

Table 2. Responses of muskrats to scented traps, Montezuma National Wildlife Refuge, May-July 1983.

	Blank	Muskrat Musk	Control Odor	Total
Adult	10	1	1	12
Young	11	7	13	31
Total	21	8	14	43

$p < 0.05$

YELLOW VOLE

The yellow vole *(Lagurus luteus)* has been studied in China by Fan (1983). If voles were removed from a field and released again into the field after the burrows had been closed experimentally, the voles dug up the burrows again and used them again. If, however, the closed burrows were treated with anal gland secretion from males, a larger percentage were opened and reoccupied.

BEAVER

Several studies have shown that beaver *(Castor canadensis)* can be stimulated to perform specific and predictable behaviors by experimental scent marks in their family territory (Hodgdon 1978; Butler and Butler 1979; Bollinger 1980; Müller-Schwarze and Heckman 1980; Svendsen 1980). More important for applications in beaver damage control is our finding that beaver can be discouraged from colonizing vacant areas if these have been scented artificially with beaver castor (Müller-Schwarze and Heckman 1980). Data from an earlier study in Maine are lumped with

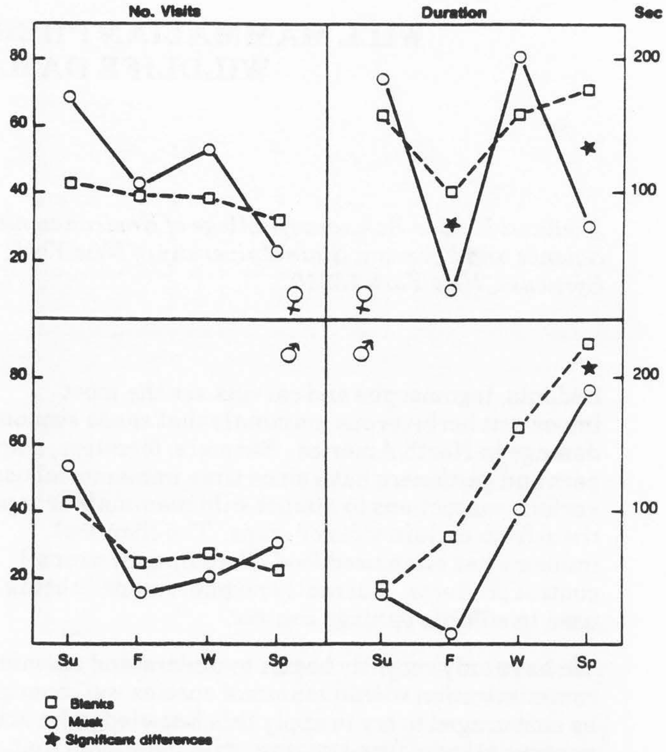

Figure 1. Responses of muskrats to musk samples (dots) and blanks (squares) in a laboratory two-way choice test. On left (with left ordinate): Number of visits; on right (with right ordinate): Duration of visits in seconds. Abscissa: the four seasons. Top: Females; bottom: Males. Asterisks: Significant differences ($p < 0.05$).

those from a 1983 experiment in Fulton County, New York and shown in Table 3. The field work of this 1983 experiment was carried out by R. Gregory Welsh as part of a M.S. degree program.

Table 3. Number of vacant beaver sites that became occupied after artificial scenting with castor.

	Occupied	Not Occupied	Total
Scented	0	31	31
Control	8	27	35
Totals	8	58	66

$x^2 = 7.77$; $df = 1$; $p < 0.01$

CERVIDS

Black-tailed deer *(Odocoileus hemionus)* are alerted when experimentally exposed to metatarsal secreation of conspecifics (Müller-Schwarze 1980). This metatarsal odor is released in situations of alarm or stress, and the odor can now be termed an alert pheromone, belonging into the general class of alarm pheromones. The active components have not been identified chemically. This work is still in progress. Once identified, this odor is a good candidate for application as a deer repellent.

White-tailed deer *(O. virginianus)* showed some response to an interspecific, i.e. predator odor. Extracts from wolf scats reduced the frequency of visits to gardens. The odor was also more effective in spring (May) than in summer (August) (Müller-Schwarze 1983).

CARNIVORES (CANIDS)

The behavior of coyotes and wolves at experimental scent marks has been reviewed repeatedly (Shumake 1977, for instance). In the most successful experiment with canids, urine of red foxes was analysed and a "synthetic urine" made from 8 constituents. Males marked more than females, and the "synthetic urine" received more responses than a control odor (Wilson et al. 1980).

DISCUSSION

The examples reviewed demonstrate that it is possible to influence the behavior of free-ranging mammals predictably with con- and interspecific odors. Thus far the effects are small, limited to a few very special cases and possibly short-lived. Furthermore, studies in different geographical areas may yield apparently contradictory results, as in the muskrat.

Applications of pheromones in wildlife damage control will have to be a part of an integrated management program. Furthermore, such pheromone treatments will have to be limited to brief, crucial time periods, in order to avoid habituation of the animals to the odors.

Now that some effects are known, pheromones should be used in conjunction with other control measures. The additional protection effect afforded by the pheromone can then be demonstrated. Integrated wildlife damage control programs should consider including pheromone techniques wherever feasible and promising.

Nocturnal, crepuscular species and those that dwell in burrows are good candidates for pheromone manipulations, as their visual communication is likely to be underdeveloped, and chemical communication more important, instead.

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