EXPERIMENTAL TESTS OF LATRINE USE AND COMMUNICATION BY RIVER OTTERS

ALANA R OLDHAM AND JEFFREY M BLACK

Department of Wildlife, Humboldt State University, Arcata, CA, 95521; otters@humboldt.edu

ABSTRACT—Nearctic River Otters (*Lontra canadensis*) deposit scat (feces), scat-jellies (mucous deposits), urine, and dark colored anal gland secretions at latrine sites. We tested responses of River Otters to removal and addition of scat to assess the role of marks. We found a 9-fold increase in River Otter urine marking along with a 5-fold increase in scat-jellies following removal of all marks from latrines, but scat deposition frequency remained constant. River Otters investigated foreign more than local scat when added to latrines. This result supports the notion that River Otters are capable of distinguishing foreign from local scent marks. The ability to recognize an unfamiliar signaler is necessary if marks function in social recognition and spacing. Our findings illustrate the potential role of olfactory signaling in the social lives of River Otters and highlight a previously un-established importance of urine and scat-jellies in intra-group communication.

Key words: communication, Humboldt County, latrine use, *Lontra canadensis*, northern California, River Otters, scent-marking

Nearctic River Otters (*Lontra canadensis*) deposit scat (feces, or spraints), urine, and anal gland secretions at discrete sites, called latrines. Substances involved in carnivore scent-marking behavior are limited in quantity, potentially energetically expensive, and time consuming to distribute (MacDonald 1980; Gosling and Roberts 2001a). Scat presentation has induced behavioral responses in captive male otters, suggesting a communicative function for these marks (Rostain and others 2004). We tested whether free-living River Otters adjust scent marking behavior after experimental removal and addition of scat. If scent marking has a function in territorial communication or recognition of social partners, then the sudden removal of marks from latrines should elicit a change in behavior in River Otters using a site. Likewise, River Otters should respond differently to the introduction of foreign compared to familiar scat.

METHODS

Study Area

We tested our predictions (see above) for River Otters inhabiting the Arcata Marsh and Wildlife Sanctuary (UTM: Zone 10, E 407634, N 4523226, NAD 27), a 124-ha created wetland that serves as a waste treatment facility for the City of Arcata (Gearheart 1992) which is adjacent Humboldt Bay, CA. A social group of at least 6 individuals (4 adults, and 2 pups born in April 2005) used multiple latrines at the site, which was characterized by fresh and brackish ponds, tidal sloughs and mudflats (Barnhart and others 1992). The otters' diet at this site consists primarily of fish, then crustaceans, birds, and aquatic insects (Penland and Black 2009). Cattail (*Typha* spp.), blackberry (*Rubus* spp.), Wild Celery (*Vallisneria americana*), and bulrush (*Scirpus* spp.) dominated bank and island vegetation, with willows (*Salix* spp.) and Shore Pines (*Pinus contorta contorta*) providing cover at most latrine sites.

The Arcata Marsh is a busy recreational area for walkers and joggers, so the River Otters were habituated to human activity as shown by their daily use of latrines next to trails and roads through the marsh. This allowed us to repeatedly visit latrine sites with negligible confounding experimenter effect. We intended to replicate experiments among other River Otter groups in the area (Black 2009), but all were located in secluded areas where otters were not used to human presence and we suspected they would avoid or abandon those latrines.

Experiments

A layer of sand was placed on 10 latrines and adjacent slides to determine visitation by

recording fresh tracks, scat, scat-jellies, and urine (identified by a wet mark). Whereas scat deposits contain prey remains in them, scat-jellies are mucous deposits without prey remains. The mucus, produced in the lower intestine, acts to protect the intestinal tract from sharp indigestible food item fragments (R Grove, USGS FRESC, pers. comm.). Scat-jellies are usually opaque and light in color, compared to the dark paste-like and stronger-smelling deposits produced by the anal gland. These differences are confirmed by observations of over 300 necropsied River Otters caught by trappers from Oregon and Washington, where thick mucus was found in the intestines (more in animals that had not eaten) above the area of the anus where the anal glands reside (R Grove, USGS FRESC, pers. comm.). In our study, we report on the occurrence of light colored, opaque mucous deposits (scat-jellies) rather than the darker, paste-like deposits (anal gland secretions).

Five latrines with signs showing the most otter activity were chosen for experiments, and additional sand was placed at these latrines after removing older marks; we used 8 L of sand taken from a nearby beach, and spread it over the latrine, creating a sand layer approximately 5 cm deep. Removal of old marks and adding sand served to cover urine and mask odor. In the scat-addition experiment, we placed familiar and foreign scat on opposite ends of the fresh layer of sand 0.5 to 1 m apart, switching sides when the treatment was repeated. Fresh scat was collected and refrigerated no more than 5 d before use. Local 'familiar' scat was taken from other latrines at the Arcata Marsh, and foreign scat was collected from River Otters living on another portion of Humboldt Bay (Black 2009).

Treatment days were preceded by 3 d of monitoring baseline visitation and scat, scat-jellies, and urine deposition frequencies. Treatments were established in late afternoons and sand beds were checked on 3 subsequent mornings. Latency, frequency, and duration of River Otter responses were quantified by recording fresh signs left in the sand layer. We recorded whether experimental scat were 'investigated' by recording tracks that approached within 5 cm of the scat, and movement of experimental scat (in cm) from their original locations.

We alternated 9 removal and 8 scat-addition experiments between 18 July and 22 October 2005, ensuring a 5-d rest period between treatments; to reduce order effects, treatments were interchanged. We applied each treatment at 2 of the 5 latrines during each experiment; latrines were used in an average of 3.4 experiments (range 1 to 7).

Data Analysis

Co-deposition of mark types was assessed using a χ^2 test. We assessed changes in daily deposition frequency and distribution of signs by comparing post-experiment records with the sum of pre-removal records (referred to as baseline marking frequencies) using Mann-Whitney *U* tests. Frequency of approach to within 5 cm or investigation of experimental scat was compared using Fisher's exact tests. Tests were two-tailed, $\alpha = 0.05$.

RESULTS

During the 70-d study, we recorded 187 instances of slide-latrine use and 413 scent marks ($n = 133$ scat, 151 scat-jellies, and 129 urine marks). During baseline monitoring periods, River Otters left 1 or more scat on 51% of their 81 visits and urine marks accompanied scat on 49% of these occasions. Urine marks were found together with scat-jellies ($n = 31$) more often than with scat ($n = 19$; $\chi^2_1 = 8.29$, $P = 0.004$). Scat-jellies were co-deposited with scat only 17% ($n = 8$) of the time, usually when urine was also present. We made direct observations of River Otters on 26 occasions; 85% were of 2 or more individuals, with a median group size of 3.5. In most instances, therefore, more than 1 individual apparently passed through the experimental treatments.

Remarking of Latrines

On 6 of the 9 occasions after removal of marks and placement of fresh sand, latrines were marked with urine and scat-jellies. Sand was also trodden over and apparently rolled on as opposed to the typical orderly trails that crossed latrines. There was a 9-fold increase in urine marking frequency by the following morning (day 1: Mann-Whitney *U* test: $Z = 4.29$, $n_1 = 26$, $n_2 = 9$, $P < 0.0001$) and a 5-fold increase in the number of scat-jellies (day 1: Mann-Whitney *U*

test: $Z = 4.07$, $n_1 = 26$, $n_2 = 9$, $P < 0.0001$). Response to the removal treatment was somewhat reduced by the 2nd day (day 2: Mann-Whitney U tests: urine: $Z = 1.79$, $n_1 = 26$, $n_2 = 8$, $P = 0.002$; scat-jellies: $Z = 1.77$, $n_1 = 26$, $n_2 = 9$, $P = 0.024$), and no longer significantly different from baseline values by the 3rd day (Fig. 1). The mean number of scat did not change following the removal treatment (2.5 scat/night in both baseline and outcome periods), nor did the frequency at which latrines were visited (2.6 and 2.7 visits/night in baseline and outcome periods, respectively).

Investigation of Experimental Scat

When presented with experimental foreign and local scat at latrines, River Otters investigated foreign scat in 7 of 8 trials and a local scat only once (Fisher's exact test: $P = 0.01$; Fig. 2). On all 7 occasions the foreign scat had moved 5 to 30 cm from its original location, apparently being knocked about. Tracks indicated that foreign scat were more heavily investigated than local scat; they were walked up to and around on all 7 occasions while local scat were generally passed by without obvious approach. On the single occasion in which a local scat was investigated, the foreign scat at that latrine also was investigated. Foreign scat were investigated on the 1st ($n = 3$), 2nd ($n = 3$), and 3rd ($n = 1$) nights. Otter visitation frequency to experimental latrines was similar during 3-d before and after experimental scat were added (2.6 and 2.5 otter visits/night in baseline and outcome periods, respectively). Frequency of marking did not change following experimental scat presentation. Over-marking behavior did not occur.

DISCUSSION

Suggested motivations of the signaler and social functions of carnivore scent posts include communication of territory ownership, confrontation potential, reproductive status, group identity, orientation, and mutualistic signaling of resource depletion (Eisenburg and Kleiman 1972; Melquist and Hornocker 1983; Gorman and Trowbridge 1989; Kruuk 1992; Melquist and others 2003). To a receiver, scent marks may convey information about species identity, gender, reproductive status, age, health, time since marking, individual identity, and possibly

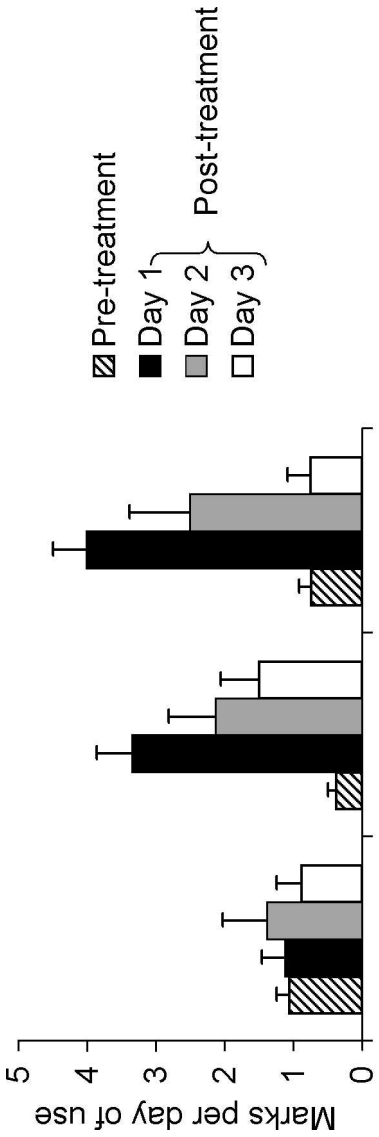

FIGURE 1. Mean ±SE number of marks/d of use before and after removal of all odorous substances from latrines. Treatments were conducted July through October 2005 at the Arcata Marsh, Arcata, CA.

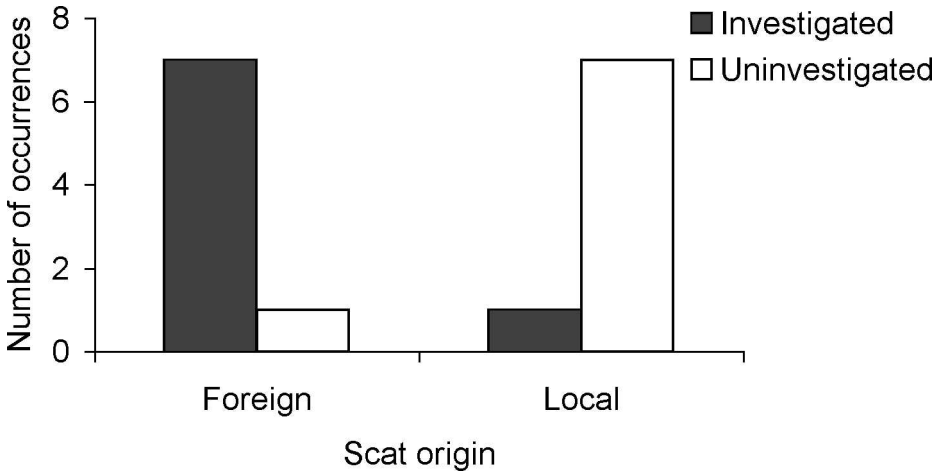

FIGURE 2. River Otter frequency of investigation of foreign and familiar scat that were placed at latrines at the Arcata Marsh, from July through October 2005.

mood of the signaler (Eisenburg and Kleiman 1972; Melquist and Hornocker 1983; Gorman and Trowbridge 1989; Gosling and Roberts 2001b; Rostain and others 2004). River Otters in our study responded to experimental removal and addition of scat at latrines. Urine marks and scat-jellies increased on cleared latrines while the number of scat remained constant. Scat-jelly reportedly contains more accessible DNA from shed intestinal cells for use in studies of individual genetic identity of River Otters because it provides workers with a cleaner sample not mixed with prey remains (Hájkova and others 2006). A study quantifying the potential information content of scat-jellies compared to other deposit types (such as regular scat, urine, and anal gland secretions) would be instructive.

River Otters were apparently able to distinguish between foreign and familiar scat, which is necessary if marking signals individual or group identity. Manipulation and movement of the majority of foreign experimental scat seems to signify thorough investigation. Experiments involving scent mark additions in other carnivore systems have typically resulted in marking on top or over-marking by territorial species (Gorman and Trowbridge 1989; Sliwa and Richardson 1998). In our study, response of River Otters to the addition of foreign scat was investigative behavior, not over-marking. This is best explained by an individuals' interest in obtaining information about a potentially new social contact rather than territoriality (*sensu* Gosling and Roberts 2001b). While investigation of foreign scat does not rule out a territorial function, it does not support the idea in the way observations of over-marking or increased marking would have. Investigation of marks in the absence of these responses has been associated with a 'scent-matching' function where information about the signaler is acquired for purposes of conflict and competition avoidance or, in more social species, for reference during future contact (Gosling and McKay 1990; Begg and others 2003). An initial suspiciousness of unfamiliar individuals increases the evolutionary stability of cooperation among highly mobile animals (Enquist and Leimar 1993). This suspiciousness toward unfamiliar individuals could be important in the River Otter social system, comprised of overlapping linear home ranges by females and helpers attending young-of-the-year, and transient male groups (Melquist and others 2003; Gorman and others 2006). Potentially important in interpreting our results, dominant individuals spent more time investigating scat than subordinates in a study of 15 captive male River Otters (Rostain and others 2004). However, otter response was the same after presentation of foreign and familiar scat in that study. Differences between our findings suggest that River Otter response to olfactory signals may be dependent on the social and ecological context in which they occur.

Our study of free-ranging River Otters contributes to the idea that olfactory signaling is an

important part of the social lives of these carnivores. We show that urine and scat-jelly marks are quickly deposited at cleared latrines in addition to normal levels of scat. The strong investigative response of River Otters to foreign scat may imply an important social recognition or territoriality function to marking behavior.

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