Free-ranging Eurasian Beavers, *Castor fiber*, Deposit Anal Gland Secretion when Scent Marking

FRANK ROSELL and FRODE BERGAN

Telemark College, Department of Environmental Sciences, N-3800 Bø, Norway

Rosell, Frank, and Frode Bergan. 1998. Free-ranging Eurasian Beavers, *Castor fiber*, deposit anal gland secretion when scent marking. Canadian Field-Naturalist 112(3): 532–535.

Two adult free-ranging Eurasian Beavers (*Castor fiber*) were observed depositing anal gland secretion at the border of their territory by everting the "cloaca", protruding the anal gland openings and rubbing them against the surface as the animal walked over the scent mound. We suggest that anal gland secretion applied to scent marks on land has some as yet unknown function in territory defense of the Eurasian Beaver.

Key Words: Eurasian Beaver, *Castor fiber*, scent marking, anal gland secretion, Norway.

Scent marking apparently plays an important role in territory defense of both the Eurasian Beaver (*Castor fiber*) (Nolet and Rosell 1994; Rosell and Nolet 1997; Rosell et al. 1998) and the North American Beaver (*C. canadensis*) (Houlihan 1989; Welsh and Müller-Schwarze 1989). Scent is usually secreted onto small piles of mud and debris close to the water's edge (Wilsson 1971; Rosell and Nolet 1997). All age classes and both sexes mark within the territory (Wilsson 1971; Buech 1995). Scent marks are assumed to signal occupancy to potential intruders, notably dispersing subadults (Svendsen 1980; Rosell and Nolet 1997; Rosell et al. 1998), and are deposited in greatest concentrations at territorial borders during the entire year (Rosell et al. 1998).

Both Eurasian and North American beavers possess a pair of anal glands and a pair of castor sacs located in two cavities between the pelvis and the base of the tail (Walro and Svendsen 1982; Valeu 1988). Both seem to be involved in chemical signaling. The anal gland is a holocrine secretory gland but the castor sac is only a pocket lined with a layer of nonsecretory epithelium. Both open into the urogenital pouch (cloaca). Anal glands are under seemingly more muscular control than are castor sac (Svendsen 1978). Beavers deposit copious amounts of castoreum on scent mounds apparently by flushing castoreum out with the urine (Svendsen 1978). Castoreum is deposited on the scent mound without the animal actually making contact between the body and the substrate. In contrast, anal gland papilla must be "rubbed" on the substrate in order to deposit exudate from the anal gland (Wilsson 1971; Svendsen 1978).

It is at present uncertain whether or not anal gland secretion (AGS) is used in scent marking by beavers

Sun and Müller-Schwarze (1997) report that North American Beavers actively deposit castoreum while marking, but how the AGS is deposited needs to be clarified. Schulte et al. (1994) report that beaver mounds are marked with urine and castoreum from castor sacs, and possibly with AGS. Tang et al. (1995) report that beavers deposit castoreum and AGS, and Tang et al. (1993) report that beavers apply castoreum to scent mounds, but mention nothing about AGS. On the other hand, Wilsson (1971) and Owesen (1979) observed captive Eurasian Beavers depositing AGS when scent marking. Hodgdon (1978) also noted that free-ranging North American beavers deposited AGS on scent mounds. Recently, several authors have studied the response of beavers to artificial scent mounds (Müller-Schwarze and Houlihan 1991; Schulte 1993; Sun 1996), but none observed that resident beavers responded by depositing AGS (L. Sun, personal communication; D. Müller-Schwarze, personal communication). The aim of this study was to monitor Eurasian Beavers depositing AGS at their territory border where marking activity was known to be intense.

On 21 July 1997, we were stationed at the border between two territories with high scent marking activity in the Bø River (59°25′N, 09°03′E), Telemark County, Norway. At this northerly latitude, light conditions during summer allow filming throughout most of the night. The animal living downstream belonged to territory 4 (hereafter animal 4) and the animal upstream to territory 3 (hereafter animal 3). The animals were of unknown sex and estimated age for both was ≥ 2 years. We videotaped the movements of the beavers from the opposite bank (30 m) from 2145 to 2225 hours and later analyzed behavior from the tape.

Both animals were observed depositing AGS at their common border by everting the "cloaca", protruding the anal gland openings and rubbing them against the surface as the animals walked over their scent mounds. When scent marking, the beavers held their tails rigid and almost horizontal just above the ground, afterwards dragging the tail over the scent mound. Once, a beaver sat on the mound during marking, after first having protruded the anal gland. The beavers were never in a hurry to leave the marking site following the deposition of AGS.

Beaver 4 scent marked five times with AGS at four different sites. It was also seen scent-marking on seven other occasions but we were not able to determine if AGS was deposited. Beaver 3 was observed scent marking once with AGS, at the same site marked a few minutes earlier with AGS by the first beaver. On two other occasions, it was impossible to determine if beaver 3 scent marked with AGS. After beaver 3 had over-marked the mound previously marked by its neighbor, the first beaver promptly returned to mark the same site two more times. Both times it sniffed intensely at the mound before over-marking. Once, after the first over-marking, both beavers tail-slapped while only 15 m apart.

Our observations are apparently the first of free-ranging Eurasian Beavers depositing AGS when scent marking. Hodgdon (1978) never observed North American Beavers sitting on the mound during marking. He reported that animals characteristically galloped or rushed to water and entered as soon as the body was away from the mound, though occasionally they would move away and feed. However, Eurasian Beavers never rapidly departured from the scent marking site (Wilsson 1971; this study). Hodgdon (1978) observed that North American Beavers held the tail rigid, horizontal and elevated above the ground, without dragging over the mound following scent marking as we observed.

Other field observations (Rosell et al., unpublished) indicate that the beaver under certain circumstances use castoreum or AGS, or both. The odor of scent marks, as detected by humans, varies greatly within a site (Rosell et al. unpublished; B. Schulte, personal communication). Whether this is due to different beavers or different scents (castoreum and AGS differ in smell), or a change in the nature of the site over a short-time period, is uncertain (B. Schulte, personal communication). On the basis of both visual and olfactory cues, Bergan (1996) suggested that castoreum was secreted far more frequently than AGS, particularly in winter.

The AGS of the Eurasian and the North American Beaver is sexually dimorphic (Grønneberg and Lie 1984; Sun 1996; Rosell et al. 1997), and the color and viscosity of AGS can be used for sexing both beaver species (Grønneberg and Lie 1984; Owesen 1979; Valeur 1988; Schulte et al. 1995). We assume that in areas where the two species occur together (see Nolet and Rosell 1998), AGS deposited on scent mounds is very important for species recognition.

The North American Beaver has also recently been shown to use the AGS to discriminate between unfamiliar sibling and unfamiliar non-relatives (Sun and Müller-Schwarze 1997), and Schulte (1998) found that North American Beavers discriminated among castor-fluid scents from family, neighbour, and nonneighbour adult males. Therefore, information about kinship is probably contained both in AGS and castoreum. However, field tests including both AGS and castoreum still need to be carried out to determine if the Eurasian Beaver also can discriminate among scents from family, neighbour, and nonneighbour individuals. However, our observations may suggest they do. Both AGS and castoreum from a strange conspecific can elicit territorial responses (Hodgdon 1978; Walro 1980; Welsh and Müller-Schwarze 1989).

One major difference between the two marking organs of beaver may be important for the function of scent marking behavior. Castoreum has a low molecular weight (volatile) and AGS has a higher molecular weight (Grønneberg 1978; Grønneberg and Lie 1984; Tang et al. 1993, 1995; Sun 1996). This may indicate that castoreum informs intruders about territory occupancy at a distance, while AGS works at close range. Indeed, most of the lipids in the AGS are of molecular weight above 300 and will thus normally not be volatile enough to act as "chemical messenger" through the air (Grønneberg and Lie 1984).

AGS seems to have many different functions. Information about kinship is coded in the AGS, and scent from anal glands differ between the sexes and also between the two species. So far, most researchers have given castoreum most attention when studying scent marking behavior. However, our findings indicate that the function of AGS in territory defense should be examined more closely. We suggest that AGS applied to scent marks on land has some as yet unknown function in territory defense of the Eurasian Beaver.

Acknowledgments

We thank H. Parker and L. Sun for reviewing our manuscript.

Literature Cited

Bergan, F. 1996. Duftmarkering hos europeisk bever (*Castor fiber* Linnaeus, 1758) i Bøelva, Telemark. Fordeling i tid og rom gjennom et år. Hovedoppgave Høgskolen i Telemark, institutt for natur- og miljøforvaltning. Bø i Telemark. [In Norwegian with English summary]

Buech, R. R. 1995. Sex difference in behaviour of beavers living in near-boreal lake habitat. Canadian Journal of Zoology 73: 2133–2143.

Grønneberg, T. Ø. 1978. Analysis of a wax ester fraction from anal gland secretion of beaver (*Castor fiber*) by chemical ionization mass spectrometry. Chemica Scripta 13: 56–58.

Grønneberg, T. Ø., and **T. Lie.** 1984. Lipids of the anal gland secretion of beaver (*Castor fiber*). Chemica Scripta 24: 100–103.

Hodgdon, H. E. 1978. Social dynamics and behavior within an unexploited beaver (*Castor canadensis*) population. Ph.D. thesis, University of Massachusetts, Amherst. 292 pages.

Houlihan, P. W. 1989. Scent mounding by beaver (*Castor canadensis*): Functional and semiochemical aspects. M.S. thesis, State University of New York College of Environmental Science and Forestry, Syracuse, New York. 184 pages.

Müller-Schwarze, D., and **P. W. Houlihan.** 1991. Pheromonal activity of single castoreum constituents in beaver, (*Castor canadensis*). Journal of Chemical Ecology 17: 715–734.

Nolet, B. A., and **F. Rosell.** 1994. Territoriality and time budgets in beaver during sequential settlement. Canadian Journal of Zoology 72: 1227–1237.

Nolet, B. A., and **F. Rosell.** 1998. Comeback of the beaver *Castor fiber*: an overview of old and new conservation problems. Biological Conservation 83: 165–173.

Owesen, A. 1979. I beverskog. Gyldendal Norsk Forlag Oslo. [In Norwegian]

Rosell, F., F. Bergan, and **H. Parker.** 1998. Scent-marking in the Eurasian beaver (*Castor fiber*) as a means of territory defense. Journal of Chemical Ecology 24: 207–219.

Rosell, F., and **B. A. Nolet.** 1997. Factors affecting scent-marking behaviour in the Eurasian beaver (*Castor fiber*). Journal of Chemical Ecology 23: 673–689.

Rosell, F., L. Sun, and **F. Bergan.** 1997. Use the color of the anal gland secretion to differentiate between the two beaver species. Abstract, page 19 *in* Proceedings of the 1. European beaver symposium, Bratislava, Slovakia, September 15 to 19, 1997. *Edited by* K. Pachinger. Institute of Ecology, Faculty of Natural Sciences Comenius University. Bratislava, Slovakia.

Schulte, B. A. 1993. Chemical communication and ecology of the North American beaver (*Castor canadensis*). Ph.D. thesis, State University of New York, College of Environmental Science and Forestry. Syracuse, New York. 194 pages.

Schulte, B. A. 1998. Scent marking and responses to male castor fluid by beavers. Journal of Mammalogy 79: 191–203.

Schulte, B. A., D. Müller-Schwarze, and **L. Sun.** 1995. Using anal gland secretion to determine sex in beaver. Journal of Wildlife Management 59: 614–618.

Schulte, B. A., D. Müller-Schwarze, R. Tang, and **F. X. Webster.** 1994. Beaver (*Castor canadensis*) responses to major phenolic and neutral compounds in castoreum. Journal of Chemical Ecology 20: 3063–3081.

Sun, L. 1996. Chemical Kin Recognition in the Beaver (*Castor canadensis*): Behavior, relatedness and information coding. Ph.D. thesis. State University of New York, College of Environmental Science and Forestry, Syracuse. New York 184 pages.

Sun, L., and **D. Müller-Schwarze.** 1997. Sibling recognition in the beaver: a field test for phenotype matching. Animal Behavior 54: 493–502.

Svendsen, G. E. 1978. Castor and anal glands of the beaver (*Castor canadensis*). Journal of Mammalogy 59: 618–620.

Svendsen, G. E. 1980. Population parameters and colony composition of beaver (*Castor canadensis*) in Southeast Ohio. American Midland Naturalist 104: 47–56.

Tang, R., F. X. Webster, and **D. Müller-Schwarze.** 1993. Phenolic compounds from male castoreum of the North American beaver (*Castor canadensis*). Journal of Chemical Ecology 19: 1491–1500.

Tang, R., F. X. Webster, and **D. Müller-Schwarze.** 1995. Neutral compounds from male castoreum of North American beaver, *Castor canadensis*. Journal of Chemical Ecology 21: 1745–1762.

Valeur, P. 1988. Territorial behavior as factor in regulation of populations in beaver. Fauna 41: 20–34. [In Norwegian with English summary]

Walro, J. M. 1980. Castor and anal glands of North American beaver (*Castor canadensis*): histology and communicatory functions of secretions. Ph.D. thesis, Ohio University, Athens. 98 pages.

Walro, J. M., and **G. E. Svendsen.** 1982. Castor sacs and anal glands of the North American beaver (*Castor*

canadensis): their histology, development, and relationship to scent communication. Journal of Chemical Ecology 5: 809–819.

Welsh, R. G., and **D. Müller-Schwarze.** 1989. Experimental habitat scenting inhibits colonization by beaver, *Castor canadensis*. Journal of Chemical Ecology 3: 887–893.

Wilsson, L. 1971. Observations and experiments on the ethology of the European Beaver (*Castor fiber* L.). Viltrevy 8: 115–266.

Received 14 December 1997
Accepted 16 March 1998