Present evidence does not strongly support the hypothesis that pseudo-urinations by coyotes are separate behavioral displays that were derived secondarily from normal urinations for their long distance visual effectiveness.

This study was supported by a Killam Foundation postdoctoral fellowship and research grants from Dalhousie and Mount Saint Vincent Universities. Additional support was provided by J. C. Fentress through NSERC grant A9787. J. Ryon assisted throughout the study and, with N. Bennett and L. White, helped with the observations. M. Bekoff and L. D. Mech reviewed the manuscript and provided helpful suggestions.

Literature Cited

Bekoff, M. 1979. Scent-marking by free-ranging domestic dogs: olfactory and visual components. Biol. Behav., 4:123–139.

Bowen, W. D., and Cowan, I. M. 1980. Scent marking in coyotes. Canadian J. Zool., 58:473–480.

Brod, J. 1973. The kidney. Butterworth and Co., London, 740 pp.

Dunbar, I. 1978. Olfactory preferences in dogs: the response of male and female beagles to conspecific urine. Biol. Behav., 3:273–286.

Hart, B. L. 1974. Environmental and hormonal influences on urine marking behavior in the adult male dog. Behav. Biol., 11:167–176.

Lockwood, R. 1976. An ethological analysis of social structure and affiliation in captive wolves (*Canis lupus*). Unpubl. Ph.D. dissert., Washington Univ., St. Louis, Missouri, 374 pp.

Schmidt-Nielsen, B. 1964. Organ systems in adaptation: the excretory system. Pp. 215–243, *in* Handbook of physiology, 4: adaptation to the environment (D. B. Hill and E. F. Adolph, eds.). Amer. Physiol. Soc., Washington, D.C., 1056 pp.

Sprague, R. H., and J. J. Anisko. 1973. Elimination patterns in the laboratory beagle. Behaviour, 47:257–267.

Timm, R. M. 1977. Responses of coyotes *Canis latrans* to urine odors. Unpubl. Ph.D. dissert., Univ. California, Davis, 106 pp.

Fred H. Harrington, *Department of Psychology, Mount Saint Vincent University, Halifax, Nova Scotia B3M 2J6, Canada.* *Submitted 4 June 1981. Accepted 15 October 1981.*

J. Mamm., 63(3):503–505, 1982

MARMOTS AND COYOTES: BEHAVIOR OF PREY AND PREDATOR

Where the two species overlap, the yellow-bellied marmot (*Marmota flaviventris*) composed about 4.0% of the diet of the coyote (*Canis latrans*) (Craighead, 1951). Although coyotes use the mouse-jump on smaller prey (Ewer, 1973:160), little is known about their predatory habits on larger prey (Bekoff, 1977). There are no reported accounts of marmot reaction to coyote predation. Herein, I report two instances of coyote predation on yearling yellow-bellied marmots. These are the only observations by my coworkers or me of predation on yellow-bellied marmots in more than 5,000 h of field observations conducted during 20 years.

The first instance occurred at Marmot Meadow (locality 4, Armitage, 1974) on 6 July 1977. The main burrow area located in a rocky outcrop was occupied by 6-year-old female 1065 and her four yearling daughters. By 1700 h (MDT), all five animals had emerged from their burrows and were sitting on the rocks prior to afternoon foraging. By 1745 h, females 911 and 918 were feeding west of the rocky outcrop (A on Fig. 1) in a grass-forb meadow (primarily *Bromus richardsonii* and *Potentilla gracilis*) interspersed with shrubby cinquefoil (*Pentaphylloides floribunda*), which locally forms dense clumps. At 1747 h, female 918 ran to a rock, sat up, and looked north. One minute later, female 909 left the rocky outcrop and moved across the open meadow toward area A. Suddenly a coyote dashed out of a clump of shrubby cinquefoil toward female 909. A burst of alarm calls came from at least three marmots; female 909 turned back toward the rocky outcrop but was caught easily by the rapidly moving coyote, whose angle of approach cut off retreat. Females 1065 and 957 remained up on the rocks, female 918 entered a burrow in area A, female 911 ran to a rock, stood up, looked, and then returned to the main burrow area; no marmot moved toward the

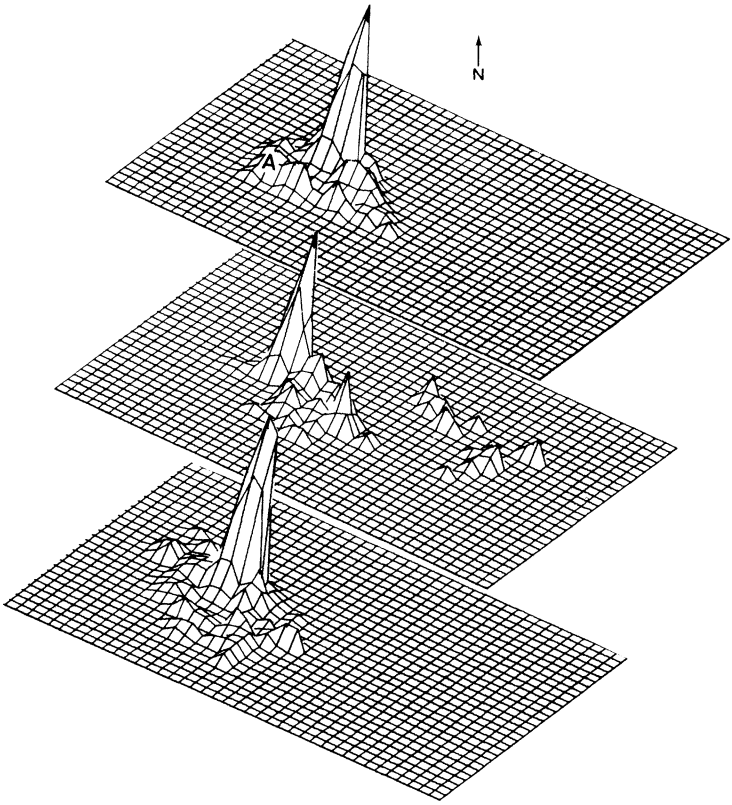

FIG. 1.—Perspective block diagram (Sampson, 1975) of space use by five yellow-bellied marmots at Marmot Meadow. Upper—5 days prior to predation; middle—first 5 days following predation; lower—second 5 days following predation. Amount of use is indicated by the height of the peak. A = feeding area. Each side of each grid block is 3 m long. The location of each animal was determined every 10 min during a total of 29 h of observation.

coyote. The coyote, carrying female 909 by the middle of the back, moved off to the north while female 1065 continued chirping. The coyote paused twice and looked back before disappearing into the trees. Female 1065 ran out into the meadow toward the site of the predation and then returned to the rocks, she continued chirping for 44 minutes. During this time she frequently looked in the direction in which the coyote had gone. Females 957 and 911 remained on the rocks. Twenty-five minutes after the coyote departed, female 918 returned to the main burrow area from area A. During the last 15 min of female 1065's chirping, the three yearlings did some feeding near the rocks, but primarily remained among the rocks and appeared to be "nervous." One hour after the incident, all marmots were feeding. None went into the meadow west of the rocky outcrop where the coyote had been. They all seemed more cautious, proceeding more slowly, and looking around more often.

Behavior seemed normal on the following days, except for a marked shift in foraging areas. For the next 5 days, marmots avoided foraging in area A where the predation had occurred (Fig. 1). On the sixth day, the marmots returned to area A and the general pattern of space use was similar to that of the period before predation.

The second instance occurred at North Picnic (locality 7, Armitage, 1974) on 6 July 1980. The central part of the locality was occupied by 3-year-old female 88, her three yearling daughters and yearling son, and adult male 411. They were using two burrow systems. Male 411 and female yearlings 497 and 381 lived at Burrow 1; female 88, yearling female 490, and yearling male 383 lived at Burrow 2, which was upslope and to the right (when facing the slope) 40 m distant. Burrow 2 was located on a steep slope that was heavily vegetated with several tall forbs (e.g., *Delphinium barbeyi*, *Epilobium angustifolium*) and

shrubs (primarily gooseberry, *Ribes inerme*). Marmots had made a path from the burrow beneath a gooseberry shrub to a small rocky outcrop, which was used as a perch, about 12 m upslope. A band of willows extended about 100 m across the slope to the left of the rocky perch. A well-used trail ran along the upper edge of the willows. Marmots always moved slowly and cautiously from the burrow to the perch and spent several minutes looking upward before moving off into the high vegetation to feed.

At 0827 h (MDT), several marmots chirped. Both yearling female 381 and male 411 appeared at a rocky outcrop below Burrow 1 where they sat alertly and watched downslope. Female 381 continued chirping as a coyote passed in full view from right to left about 70 m downslope and disappeared in the trees to the south. By 1005 h, only two animals were active: female 597 at Burrow 1 and female 490 on the slope between the perch and Burrow 2. At 1015 h, a coyote, with part of its back, head, and ears visible above the vegetation, appeared at the rocky perch. The coyote sank from sight behind the shrubs. At the same time, I could detect a marmot moving about downslope near the burrow entrance. Eleven minutes later, the coyote bounded down the slope, leaping from left to right, and pounced on female 490, which had wandered about 9 m downslope from the burrow. Three minutes later, the coyote headed south carrying the marmot by the middle of the back. No alarm call was heard. Female 497 stood and looked in the direction of the band of willows as the coyote presumably moved along the trail. There were no alternate burrows near Burrow 2; the coyote's charge cut off retreat. The coyote easily crashed through the dense vegetation which seemed to impede the marmot's movements. Subsequent space-use by the surviving marmots was not modified.

These two predations shared several features. Each occurred at a burrow site near tall vegetation, which provided concealment for the coyote. Generally, home burrows of marmots are located distant from high vegetation and marmots rarely frequent it (Travis and Armitage, 1972). The avoidance of high vegetation apparently is an anti-predator strategy. However, high vegetation also provides concealment for the marmot and its burrow; there may be some trade-off between concealment for the prey and the predator.

In each instance the coyote seized the yearling marmot in the middle of the back. I did not observe the coyote shake the marmot; the manner in which the marmot dangled from the coyote's jaws suggested that its back had been broken.

Each predation occurred during a period of transition between surface activity and burrow occupancy. At Marmot Meadow, the coyote was not seen until it charged; presumably, it achieved its close approach before the marmots emerged. At North Picnic, most marmots had immerged and the coyote was undetected. Frequently, I have seen marmots, which were fully active, detect coyotes that were 100 m or more distant. Successful predation during the transition period suggests that the cautious behavior of marmots as they emerge from their burrows, and the time they spend on rocks looking around before moving out to feeding areas, are also part of an anti-predator strategy. Predation by coyotes is more likely to be successful on marmots when they are active alone, as seen at North Picnic. Marmot activity is concentrated in morning and afternoon bouts (Armitage, 1962). This synchronization of activity, which increases the number of pairs of eyes available to detect prey, is probably selected for in the development of an anti-predator strategy (Bertram, 1978:67).

In both instances, at least one marmot apparently saw the coyote without giving an alarm cry. Frequently, a marmot, when alerted, runs to a perch or to a burrow and looks in the direction of the disturbance without calling. What determines whether a marmot will emit the alarm-call is unknown. Research conducted at the Rocky Mountain Biological Laboratory and supported by National Science Foundation Grant DEB 78-07327.

Literature Cited

Armitage, K. B. 1962. Social behaviour of a colony of the yellow-bellied marmot (*Marmota flaviventris*). Anim. Behav., 10:319–331.

———. 1974. Male behaviour and territoriality in the yellow-bellied marmot. J. Zool., London, 172:233–265.

Bekoff, M. 1977. *Canis latrans*. Mamm. Species, 79:1–9.

Bertram, B. C. 1978. Living in groups: predators and prey. Pp. 64–96, *in* Behavioural ecology: an evolutionary approach (J. R. Krebs and N. B. Davies, eds.). Blackwell Sci. Publ., London, 494 pp.

Craighead, F. C., Jr. 1951. A biological and economic evaluation of coyote predation. New York Zool. Soc., 23 pp.

Ewer, R. F. 1973. The carnivores. Cornell Univ. Press, Ithaca, New York, 494 pp.

Sampson, R. J. 1975. Surface II graphics system. Kansas Geol. Survey, Lawrence, 240 pp.

Travis, S., and K. B. Armitage. 1972. Some quantitative aspects of the behavior of marmots. Trans. Kansas Acad. Sci., 75:308–321.

Kenneth B. Armitage, *Division of Biological Sciences, University of Kansas, Lawrence, KS 66045.*
Submitted 12 June 1981. Accepted 19 October 1981.