# The Relation between Premolar Wear and Age in Yellow-bellied Marmots, *Marmota flaviventris*

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We evaluated the utility of the premolar gap technique for estimating age of Yellow-bellied Marmots (*Marmota flaviventris*). Premolar wear increased linearly with age through four years, then stabilized. The technique is unsuitable for estimating ages of marmots older than three years, but shows promise for marmots one through three years old.

Key Words: Yellow-bellied Marmot, *Marmota flaviventris*, age estimation, premolar wear, premolar gap.

Ground-dwelling squirrels have provided fruitful opportunities for research on a variety of topics in population biology (Murie and Michener 1984). Knowledge of the age of individual squirrels often is important, but age can be determined reliably only for individuals first captured and marked as young of the year (Erlien and Tester 1984; King and Murie 1985) or when young enough to be aged by body mass (Armitage et al. 1976; Boag and Murie 1981). Even in studies that are of sufficient duration to include known-age adults, previously unmarked adults may immigrate into the population (Schwartz and Armitage 1980; Sherman and Morton 1984).

Few non-destructive techniques are available for estimating age of ground-dwelling squirrels (Sherman et al. 1985; Hoogland and Hutter 1987; Cox and Franklin 1990; Stockrahm and Seabloom 1990), and generality to other species is known for none. One of these techniques, the premolar gap, has proven useful in estimating the ages of Black-tailed Prairie Dogs (*Cynomys ludovicianus*) (Cox and Franklin 1990). Our objective was to evaluate the generality of the premolar gap technique by describing the relationship between premolar wear and age in a second species of ground-dwelling squirrel, the Yellow-bellied Marmot (*Marmota flaviventris*).

## Methods

Yellow-bellied Marmots near Rocky Mountain Biological Laboratory, Gunnison County, Colorado, have been the subjects of a long-term study (Armitage 1991). Each year since 1962, all young of the year in the study area were trapped and permanently marked with numbered ear tags shortly after first emergence from the natal burrow. Thus, the age of most marmots in the study area was known.

During the summer of 1990, we trapped 45 known-age marmots that were one year old or older, chemically restrained them with an injection of ketamine hydrochloride (Frase and Van Vuren 1989), and measured the distance between the paraconid and protoconid cusps of the lower left premolar (Cox and Franklin 1990) using calipers with 0.05 mm precision. Young of the year were excluded from the study because they are easily distinguished from other age classes on the basis of body mass (Armitage et al. 1976).

We grouped marmots into monthly age classes based on the summer active season when tooth wear occurred. Premolar wear presumably results from masticating food; because marmots hibernate from mid-September until early May and greatly reduce their feeding during September (Melcher et al. 1989), almost all mastication occurs May through August. We calculated monthly age classes by summing the active season months (May-August) for each marmot, beginning with May of the yearling summer and ending with the month of capture. Thus, marmots trapped during July of their yearling summer were assigned to monthly age class 3, two-year-olds trapped during May were assigned to monthly age class 5, and so forth. Monthly age classes allowed better resolution of the relationship between tooth wear and the amount of time the teeth were used than did annual age classes.

The relationship between premolar wear and monthly age class of marmots from May at age one year through August at age four years was evaluated with linear regression. We obtained an a posteriori estimate of accuracy by using the empirically derived regression equation to "predict" the annual age class of known-age marmots one to four years old (Sherman et al. 1985). Each annual age class comprises four monthly age classes; thus, prediction was scored as accurate if monthly age class computed from the regression equation fell within two months of the true monthly age class.

## Results

The relationship between premolar wear and age was asymptotic; the premolar gap increased with age until marmots were four years old, then stabilized

(Figure 1). Cox and Franklin (1990) likewise reported a decrease in rate of tooth wear in Black-tailed Prairie Dogs at about four years of age.

Regression analysis of premolar wear from May of the yearling summer through August at age four years indicated a significant relationship between wear and age ($r^2 = 0.85$, $F_{1,35} = 205.11$, $P < 0.001$). Males ($n$=10) and females ($n$=27) were combined because their separate regression equations did not differ (analysis of covariance, $F_{1,33} = 1.149$, $P = 0.29$). The premolar gap widened at a rate of 0.12 mm per month of above-ground activity.

Annual age class was accurately predicted for 54% of 37 marmots. Extending the criterion for accuracy to ±2.5 months improved prediction success to 78%.

## Discussion

The premolar gap technique is unsuitable for estimating the ages of marmots older than three years. The age-related increase in premolar wear, however, does provide a basis for estimating the age of marmots according to four annual age classes: one, two, three, or four and older. The 54% prediction accuracy falls short of the reliability that researchers typically desire, but it is a substantial improvement over classifying first-time captures as age unkown. Moreover, the dramatic increase in accuracy resulting from a modest relaxation of the accuracy criterion suggests that many incorrect predictions were close to being correct. Accuracy of age estimation for marmots might be improved by combining measures of premolar wear with age-specific changes in body mass (Armitage et al. 1976).

We conclude that the premolar gap technique has potential for estimating the ages of Yellow-bellied Marmots. Given the need for such a technique for ground-dwelling squirrels in general, we believe that the approach deserves further consideration.

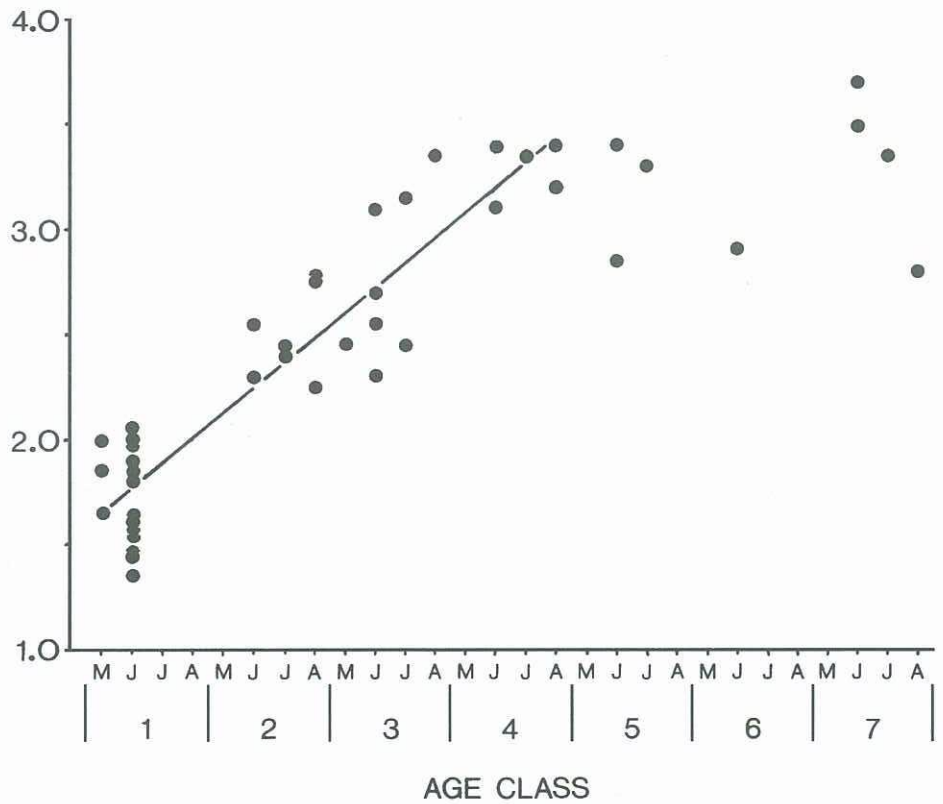


FIGURE 1. Relation between premolar wear and age among Yellow-bellied Marmots in Colorado. Age class is presented in two scales. The upper scale indicates sequential months of above-ground activity (May through August), and the lower scale indicates the grouping of monthly age classes into annual age classes through seven years old. Premolar gap is regressed on monthly age class ($Y = 1.52 + 0.12X$) for marmots one through four years old. See text for further explanation.

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## Literature Cited

**Armitage, K. B.** 1991. Social and population dynamics of yellow-bellied marmots: results from long-term research. Annual Review of Ecology and Systematics 22: 379–407.

**Armitage, K. B., J. F. Downhower,** and **G. E. Svendsen.** 1976. Seasonal changes in weights of marmots. American Midland Naturalist 96: 36–51.

**Boag, D. A.,** and **J. O. Murie.** 1981. Weight in relation to sex, age, and season in Columbian ground squirrels (Sciuridae: Rodentia). Canadian Journal of Zoology 59: 599–1004.

**Cox, M. K.,** and **W. L. Franklin.** 1990. Premolar gap technique for aging live black-tailed prairie dogs. Journal of Wildlife Management 54: 143–146.

**Erlien, D. A.,** and **J. R. Tester.** 1984. Population ecology of sciurids in northwestern Minnesota. Canadian-Field Naturalist 98: 1–6

**Frase, B. A.,** and **D. Van Vuren.** 1989. Techniques for immobilizing and bleeding marmots and woodrats. Journal of Wildlife Diseases 25: 444–445.

**Hoogland, J. L.,** and **J. M. Hutter.** 1987. Using molar attrition to age live prairie dogs. Journal of Wildlife Management 51: 393–394.

**King, W. J.,** and **J. O. Murie.** 1985. Temporal overlap of female kin in Columbian ground squirrels (*Spermophilus columbianus*). Behavioral Ecology and Sociobiology 16: 337–341.

**Melcher, J. C., K. B. Armitage,** and **W. P. Porter.** 1989. Energy allocation by yellow-bellied marmots. Physiological Zoology 62: 429–448.

**Murie, J. O.,** and **G. R. Michener,** *Editors.* 1984. The biology of ground-dwelling squirrels. University of Nebraska Press, Lincoln. 459 pages.

**Schwartz, O. A.,** and **K. B. Armitage.** 1980. Genetic variation in social mammals: the marmot model. Science 207: 665–667.

**Sherman, P. W.,** and **M. L. Morton.** 1984. Demography of Belding's ground squirrels. Ecology 65: 1617–1628.

**Sherman, P. W., M. L. Morton, L. M. Hoopes, J. Bochantin,** and **J. M. Watt.** 1985. The use of tail collagen strength to estimate age in Belding's ground squirrels. Journal of Wildlife Management 49: 874–879.

**Stockrahm, D. M. B.,** and **R. W. Seabloom.** 1990. Tooth eruption in black-tailed prairie dogs from North Dakota. Journal of Mammalogy 71: 105–108.

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