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Author(s): Kenneth B. Armitage

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FOOD SELECTIVITY BY YELLOW-BELLIED MARMOTS

Yellow-bellied marmots (*Marmota flaviventris*) consumed only 2.0 to 6.4% of the available net primary production (Kilgore and Armitage, 1978), suggesting that marmot populations were not food limited. However, if marmots feed selectively, such a conclusion might be false.

To determine if marmots feed selectively, I provided them twice daily with a ration consisting of dandelions (*Taraxacum officinale*) and one of eight experimental plant species (Table 1). Prior to the experiments, the marmots gained weight on a daily diet of 640 g of dandelions, cinquefoil (*Potentilla gracilis*), and grass (*Bromus richardsonii*). Because free-ranging marmots were observed to feed selectively on flowers of some plants, flowers were presented separately from shoots. Plants were weighed before and after the marmots fed; the difference between the two weights, corrected for dehydration, was the amount consumed. Because marmots did not eat equal amounts at each feeding, the weight data were converted to percentage of the amount presented which was eaten (Table 1).

Four plant species were accepted readily; four essentially were rejected (Table 1). *Heracleum lanatum*, cow parsnip, was the preferred experimental plant. Marmots were observed to extend their home ranges into areas where cow parsnip was abundant. Although only 49% of *Mertensia ciliata* (bluebells) was consumed, nearly all leaves were eaten and mainly thick stems remained. With the weight of the stems deducted, 96% was eaten. Only 46% of *P. gracilis* was eaten; mostly old leaves, probably of low palatability, remained.

Of the four rejected species, marmots consumed mainly flowers; 38 of 47 g of *Aquilegia caerulea* (columbine), 17 of 23 g of *Lupinus floribundus* (lupine), and 55 of 117 g of *Delphinium barbeyi* (larkspur) eaten were flowers. Free-ranging marmots frequently ate flowers of these species. I never observed marmots to feed on shoots of *Aquilegia* or *Delphinium*; I once saw a marmot feed on *Lupinus* shoots.

Lupinus, *Aquilegia*, and *Delphinium* contain alkaloids (Winek et al., 1964; Raffauf, 1970). Although *H. dissectum* contains alkaloids (Nikogosyan and Stakhorskaya, 1965), *H. lanatum* is "sweet" and readily eaten by domestic animals and big game (Craighead et al., 1963:126). Alkaloids of *Vicia* (vetches) are concentrated in the seeds (Gmelin and Hasenmaier, 1958; Deshmukh and Sohonie, 1961a). The concentration decreases with germination, and alkaloids are absent in the shoots of the growing plant (Deshmukh and Sohonie, 1961b). Fireweed, *Epilobium*, which I never saw marmots eat, contains tannins (Nierenstein, 1934). Thus, all four rejected species contain plant secondary compounds. Although other nutritional factors may influence the observed selectivity, the secondary compounds probably are most important. Food selectivity by marmots was similar to that of a polyphagous grasshopper, *Valanga irregularis*, which rejected plant species known to contain secondary compounds (Freeland, 1975). The similar food choices observed in the laboratory and in the field suggest that marmots conform to the prediction that generalist herbivores should select foods containing only minor amounts of toxic compounds (Freeland and Janzen, 1974).

Populations of generalist herbivores could be limited by the chemical defenses of their food plants (Freeland and Winter, 1975). Although my observations indicate that the rejected species are common in some marmot habitats, none was sufficiently abundant in the localities where marmot energetics were analyzed to affect estimates of available net primary production (Kilgore,

TABLE 1.—The percentages and amounts (wet weight) of leafy shoots eaten by captive yearling *Marmota flaviventris*. The values in parentheses are for the control plant, *Taraxacum officinale*. The values for *H. lanatum* are means of three consecutive feedings; all other plants were presented only once.

Animal	<i>Heracleum lanatum</i>	<i>Vicia americana</i>	<i>Mertensia ciliata</i>	<i>Potentilla gracilis</i>	<i>Delphinium barbeyi</i>	<i>Aquilegia caerulea</i>	<i>Lupinus floribundus</i>	<i>Epilobium angustifolium</i>
927	93 (94)	68 (100)	46 (100)	30 (95)	25 (100)	11 (100)	12 (84)	0 (98)
929	100 (100)	55 (92)	36 (92)	32 (91)	8 (92)	12 (100)	0 (86)	7 (91)
933	63 (90)	68 (100)	59 (100)	94 (92)	38 (100)	14 (100)	0 (93)	0 (95)
935	73 (93)	81 (100)	55 (100)	29 (95)	25 (100)	12 (100)	1 (69)	2 (99)
Means	82 (94)	68 (98)	49 (98)	46 (93)	24 (98)	12 (100)	3 (83)	2 (96)
Mean g per animal:								
Offered	254* (175)	156 (244)	213 (308)	142 (206)	358* (281)	110* (265)	268* (239)	291* (494)
Eaten	199* (164)	105 (239)	106 (301)	59 (192)	117* (275)	47* (265)	23* (198)	8* (472)

* Includes flowers.

1972). Where plants containing secondary compounds were abundant, marmot numbers could be limited, or patterns of space use and social dynamics (Armitage, 1977) could be affected. Because plant species composition varies, effects of plant chemical defenses on generalist herbivores probably differ among communities. Thus, plant-herbivore interactions should be studied in several communities.

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KENNETH B. ARMITAGE, *Rocky Mountain Biological Laboratory and Division of Biological Sciences, The University of Kansas, Lawrence, KS 66045. Submitted 23 May 1978. Accepted 21 December 1978.*

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SUN-COMPASS ORIENTATION IN THE THIRTEEN-LINED GROUND SQUIRREL, *SPERMOPHILUS TRIDECIMLINEATUS*

Homing behavior has been shown by Robinson and Falls (1965) for *Microtus*, and by Murie (1963), Gentry (1964), and Bovet (1971) for *Peromyscus*. Joslin (1977) recently reviewed the literature on rodent orientation. From these studies and others have come three general hypotheses to explain homing by mammals. The first proposes that animals home by random wandering (Murie, 1963). The second invokes the use of memory of the terrain or of familiar objects in the area (Robinson and Falls, 1965). This requires that the animals have previous experience in the displacement area and use the positions of objects to determine their relative position to home. The third hypothesis assumes the use of a "map and compass" enabling the animal to determine the relative geographic locations of its homesite and the release point (Bovet, 1971).

The "map and compass" system can be separated into two components. The first is the compass, which enables the animal to determine direction. Several cues have been proposed for use in compass orientation: celestial cues (Fluharty et al., 1976), inertial navigation (Barlow, 1964), and magnetism (Keeton, 1969). The map component enables the animal to determine relative geographic locations. The mechanism for this system is still unknown (Brown, 1975). Two studies