George W. Cox, Department of Biology,
San Diego State University, San Diego, California 92182-0057

Early Summer Diet and Food Preferences of Northern Pocket Gophers in North Central Oregon

Abstract

Studies of food habits and food plant preferences of the northern pocket gopher, *Thomomys talpoides,* were conducted in a Mima-mound habitat at the Lawrence Memorial Grassland Preserve, north-central Oregon, in early June, 1987. Stomach contents of 15 pocket gophers trapped in early June showed a predominance of forb shoots, particularly those of *Lupinus,* although roots dominated in two individuals, and were present in small amounts in most individuals. Preferences were determined by in-tunnel, cafeteria-style tests. Pocket gophers showed strong preferences for several plant species that were limited to the intermound scabland or stone bed habitats. Strong preference was also shown for certain mound species, such as *Lupinus caudatus.* These observations, together with those of other workers, indicate that members of the genus *Thomomys* feed primarily on herbaceous shoots, especially in summer, and that forb shoots are often much more heavily used than the shoots of grasses.

Introduction

Large areas of the Columbia Plateau are covered by Mima-mounded scabland where the mounds commonly attain heights of 2 m, diameters of 20 m, and densities of 25 ha^{-1}. Thin lithosols cover the basaltic bedrock of the intervening scablands. The mounds and neighboring scablands differ markedly in vegetation. Deeper silt loam soils of the mounds are dominated by grassland species such as *Agropyron spicatum* and *Festuca idahoensis,* whereas the shallow scabland soils are dominated by an *Artemisia rigida-Poa secunda* association (Daubenmire 1970, Winward and Youtie 1978).

Investigations of Mima mounds at the Lawrence Memorial Grassland Preserve, near Shaniko, north-central Oregon, support the hypothesis that the mounds are formed by gradual translocation of soil by the northern pocket gopher, *Thomomys talpoides,* toward the deep, well-drained microsites where these animals center their activity (Cox *et al.* 1987). Translocation results from the backward displacement that accompanies outward tunneling from centers of activity. By mining soil from intermound areas, this translocation also contributes to the formation and maintenance of the intermound scablands.

It has been hypothesized that mining of soil by pocket gophers creates the sharply defined beds of sorted stones that encircle many mounds and form polygonal nets in intermound areas at many locations on the Columbia Plateau (Cox and Allen 1987). Formation of these beds may result from the collapse of tunnels dug beneath them by animals in search of certain highly preferred food plants. These beds possess a distinctive flora of geophytic perennials (Daubenmire 1970, Winward and Youtie 1978) that may be restricted to this microhabitat by intense pocket gopher herbivory.

These observations suggest that the pocket gopher has a significant effect on the grassland ecosystems of the Columbia Plateau through control of the composition of vegetation. The present study was undertaken to obtain information on food plant preferences and use patterns, and on how these patterns relate to the distribution of plants in the mound-intermound habitat mosaic.

Methods

Studies were conducted at the Lawrence Memorial Grassland Preserve (LMGP) and on adjacent ranch land of the Priday Brothers Corporation, Wasco County, Oregon (44°57'N, 120°48'W), in June, 1987. The LMGP is a Registered National Landmark owned by the Nature Conservancy. It lies at an elevation of 1036-1060 m on the Shaniko Plateau (formed of Columbia River basalts) and includes within it several ravines that fall steeply northward into the valley of Ward Creek, 122 m below. The preserve has a cold semi-desert climate, with an average annual precipitation of 280 mm. The surface of the plateau is mounded "biscuit scabland" with Mima mounds that range up to about 1 m in height and 20 m in diameter. Mound soils are Condon eolian silt loams, whereas the intermound soils are residual

Bakeoven loams. The vegetation of mounds and deeper upland soils is dominated by Idaho fescue (*Festuca idahoensis*), and bluebunch wheatgrass (*Agropyron spicatum*). The shallow intermound soils are dominated by scabland sagebrush (*Artemisia rigida*), Sandberg bluegrass (*Poa scabrella*), several species of biscuitroot (*Lomatium* spp.), and bitterroot (*Lewisia rediviva*). The northern pocket gopher is abundant throughout the preserve. A comprehensive physical and biotic inventory of the LMGP is given by Copeland (1980).

Pocket gophers were trapped on ranch land adjacent to the southern and western boundaries of the LMGP to obtain material for stomach contents analysis. Sex, age, reproductive status, and weight were recorded for all animals captured. Stomachs were removed and preserved in 70% ethanol for dietary analysis.

Stomach contents were analyzed at the Composition Analysis Laboratory, Colorado State University, using the microhistological analysis techniques outlined by Sparks and Malechek (1968) and Dearden *et al.* (1975). The analyses were based on examination of 20 fields on each of the three slides made from each stomach sample.

Data on preferences for leaves, stems, and belowground parts of 14 predominant plant species of the mound-and-scabland habitat were obtained by a series of in-tunnel, cafeteria-type preference tests. Species recognized as dominants of mounds and intermound scabland by Winward and Youtie (1978) were chosen for testing. Tunnels of pocket gophers were located with a metal probe. On one side of the tunnel, an alcove about 6 cm wide and 12 cm long was dug. Three food items, each cut or bundled to form a 10-g unit, were positioned in this alcove so that they did not impede passage of an animal through the tunnel. The tuber of biscuitroot, *Lomatium cous,* a preferred food, was used in each test to serve as a standard against which to compare preferences for other species. *L. cous* is almost completely restricted to intermound stone beds that pocket gophers penetrate only with difficulty (Cox and Allen 1987). The sequence of the three items was varied systematically from one tunnel to another in test replicates. An effort was made to obtain at least 10 positive preference tests (tests in which one or more items was removed) for each combination of items. Preferences were evaluated using Fisher's Exact Test (Zar 1974). Plant names follow Hitchcock and Cronquist (1973).

Results

The stomach contents of 15 animals consisted primarily of plant root and shoot material, with seeds and arthropod fragments also present in minute amounts (Table 1). Root material averaged 20.7 percent and shoot material 79.1 percent of the stomach contents. Root material ranged from 0 to 100 percent of individual stomach contents, but in only two cases did roots constitute over 50 percent of the material present.

Grasses constituted 2.4 percent, and forbs constituted 97.0 percent of the shoot matter eaten. Lupine, probably all *Lupinus caudatus,* averaged 70.9 percent of the shoot matter consumed. In six of the ten stomachs of adult animals more than 70 percent of the material present was lupine. Buckwheat, probably all *Eriogonum heracleoides,* and yarrow, *Achillea millefolium,* were other mound dominants that were taken in significant amounts.

Evidence of plant harvesting was also obtained incidental to the preference tests. Sections of cut petioles and stems of *Lupinus caudatus,* 2-5 cm long, were encountered frequently in the loose soil on tunnel floors and in the soil used by animals to plug tunnel sections. *Lupinus caudatus* leaves were also occasionally found in tunnels, as well as small quantities of fine grass roots, seeds of cheat grass, *Bromus tectorum,* and leaves of *Trifolium macrocephalum.*

Fourteen plant species were used in the in-tunnel preference tests (Table 2). For plant species dominant on the mounds, high preferences (not significantly different from those for *L. cous*) were noted for roots of *Lomatium triternatum* and *Achillea millefolium,* and for leaves of *Lupinus caudatus.* For the remaining seven items, preferences were weaker. Among species dominant in the intermound zone, which included the beds of sorted stones, high preferences were noted for rootstocks of *Lomatium minus,* leaves of *Trifolium macrocephalum,* and bulbs of *Allium tolmiei.*

Intermound food items were taken more often than mound items. This difference is strongly significant, even when the total number taken for *L. cous* is considered to be 10 (the integer nearest

TABLE 1. Diets of 15 northern pocket gophers collected at the Lawrence Memorial Grassland Preserve, north-central Oregon, 3-6 June 1987, expressed as percent composition of stomach contents by dry weight (see text for details).

Component	Number of Stomachs	Mean Percent Composition	Range in Occupied Stomachs (Percent)
ROOTS/CORMS			
Roots	12	20.6	0.5-100.0
Corms	1	0.1	1.2
SHOOTS			
Grasses			
Agropyron	1	0.7	10.1
Aristida	1	0.1	1.0
Bromus	2	0.2	1.2-1.3
Festuca	6	1.2	0.5-11.2
Poa	2	0.2	1.2-1.6
Forbs			
Achillea	6	4.6	1.6-43.6
Calochortus	1	0.2	2.3
Compositae	1	1.3	19.6
Eriogonum	2	12.5	92.2-95.0
Erodium	1	0.1	2.1
Lupinus	11	56.1	10.0-100.0
Penstemon	1	0.1	1.1
Ranunculus	1	1.0	15.5
Flowers	5	0.8	0.6-4.8
Seeds	3	0.2	0.5-1.7
ARTHROPODS	1	0.2	1.4
TOTAL		100.2	

the mean value for this species in the eight series of tests) (Contingency $\chi^2 = 8.30$, DF = 1, $P < 0.01$). Segregating items as aboveground or belowground parts showed no significant preference by pocket gophers (Contingency $\chi^2 = 3.28$, DF = 1, $P > 0.05$).

Discussion

Stomach contents data from LMGP indicate that the early summer diet of pocket gophers consists mostly of forb shoots. Data from studies of *Thomomys* pocket gophers in the western United States show a strong tendency for shoot material to constitute most of the annual diet. In south-central Oregon, Burton and Black (1978) found that shoot material made up most of the diet of *T. mazama* in every month except March. On Black Mesa, Colorado, Ward and Keith (1962) found that the consumption of shoot material by *T. talpoides* was 69.4-79.4 percent from June to September, with root consumption rising to 61.8 percent in October. Ward (1960) observed a strong seasonal cycle in the representation of root and shoot material in the diet of *T. talpoides* living in mixed grass and alfalfa fields near Livermore, Colorado; there over 90 percent of the diet consisted of shoots in June, and over 90 percent of roots from December through March. Vaughan (1967) likewise noted that shoots constituted 76 percent of the summer diet of *T. talpoides* in Weld County, Colorado but only 61 percent of the winter diet. In Grand County, Colorado, Vaughan (1974) found that shoot material constituted 90 percent of the summer diet of *T. talpoides*. Criddle (1930) noted that green foods, especially legumes and *Artemisia*, were preferred by *T. talpoides* during summer in Manitoba. Ingles (1952), however, concluded that the summer diet of *T. monticola* in the Sierra Nevada Mountains of California consisted mostly of roots, and the winter diet mostly of shoots, which were harvested in snow tunnels on the ground surface.

Foods of *Thomomys*, especially in fall and winter, are often stored as caches in underground

TABLE 2. Results of preference tests conducted in tunnels of the northern pocket gopher at the Lawrence Memorial Grassland Preserve, north-central Oregon, with plant materials of dominant mound and intermound species.

	Number of Tests	Taken	Partially Taken	Not Taken	Fisher's Exact Test
Mound Species					
Lomatium triternatum taproot	9	9	0	0	ns
Lupinus caudatus stems	13	6	1	6	$P < 0.01$
Lupinus caudatus leaves	9	9	0	0	ns
Festuca idahoensis roots	12	3	0	9	$P < 0.001$
Agropyron spicatum roots	10	1	0	9	$P < 0.001$
Bromus tectorum seed heads	9	1	1	7	$P < 0.001$
Eriogonum heracleoides leaves	9	2	0	7	$P < 0.01$
Chrysothamnus viscidiflorus leaves	10	4	0	6	$P < 0.01$
Achillea millefolium stems + leaves	12	8	1	3	$P < 0.05$
Achillea millefolium roots	10	7	0	3	ns
Total	103	50	3	50	
Intermound Species					
Lomatium cous tuber	82	82	0	0	—
Lomatium minus rootstalk	9	9	0	0	ns
Allium tolmiei bulbs	10	9	0	1	ns
Trifolium macrocephalum leaves	10	9	0	1	ns
Sitanion histrix shoots, seed heads	10	3	0	7	$P < 0.01$
Artemisia rigida leaves	13	9	1	3	$P < 0.05$
Total	134	121		12	
GRAND TOTAL	237	171	4	62	

chambers or chambers in snowbanks (Criddle 1930, Aldous 1945, Tryon 1947, Ingles 1952, Ward 1977, Stuebe and Andersen 1985). Roots, corms, and bulbs predominate in most of these caches, although seeds (Criddle 1930, Aldous 1945) or leaves of shrubs (Ingles 1952) or herbs (Ward 1977) are sometimes the primary materials. *Thomomys* species also tend to feed more heavily on woody plants during winter (Burton and Black 1978, Gettinger 1984). Stuebe and Andersen (1985) noted that the items stored in greatest amounts tended to be those low in nitrogen content, such as the roots of *Orogenia linearifolia* and *Claytonia lanceolata.*

The representation of grasses in the LMGP sample is much lower than that observed in most other studies of *Thomomys* diets. Large quantities of grasses are consumed by *Thomomys* pocket gophers in some areas, but different species are often utilized in a highly seasonal manner. Vaughan (1967), for example, noted that *Stipa comata* was used heavily from December through May, whereas *Agropyron smithii* was used heavily from May through September, and *Bouteloua gracilis* was consumed in substantial amounts only in June. Aldous (1951), who estimated summer shoot harvest from evidence of plant cutting near tunnel openings, found that *T. talpoides* in mountain meadows in Utah harvested only 18.2 percent grasses, as opposed to 81.8 percent forbs. Vaughan (1974) noted that 91.7 percent of the shoot material consumed by *T. talpoides* in Colorado mountain meadows consisted of forbs.

In most cases, grasses alone do not seem to provide an adequate diet for *Thomomys* species. On Grand Mesa, Colorado, where 2,4-D treatments were used to reduce the abundance of weedy forbs and favor grasses, Keith *et al.* (1959) noted a strong shift by *T. talpoides* from a predominance of forbs to one of grasses in the diet. However, the pocket gopher population showed a decline of 87 percent on the sprayed areas. Studies by Tietjen *et al.* (1967) on Black Mesa, Colorado, showed that after 2,4-D spraying pocket gopher populations were reduced 80-90 percent, roughly proportional to the decrease

in forb abundance. In addition, they showed through feeding experiments that only use of certain succulent, rhizomatous or cormose grasses enabled animals to maintain body weight. The dominant grasses of mound habitats at the LMGP (*Agropyron spicatum* and *Festuca idahoensis*) lack these characteristics. Nevertheless, at certain times of the year, roots of these grasses may be important foods. In September 1985, for example, plants of *Agropyron spicatum* were observed at LMGP with the entire root systems consumed by pocket gophers (D. B. Lawrence, pers. comm.)

The heavy feeding on *Lupinus* noted in the LMGP sample has been observed by other workers. Vaughan (1974) noted that 48.9 percent of the summer diet of *T. talpoides* in Colorado mountain meadows was *Lupinus argenteus.* Ward and Keith (1962) found that on Black Mesa, Colorado, *Lupinus* spp. made up about 15.2 percent of the diet of *T. talpoides* and that plants of this genus were among the most highly preferred food items, based on their representation in the diet relative to that in the vegetation. Keith *et al.* (1959) also noted that *Lupinus* was a main food item of *T. talpoides* on Grand Mesa, Colorado, and Aldous (1951) found it a common food in central Utah. *Lupinus* is consumed by *T. talpoides* in both Utah and Washington (D.C. Andersen pers. comm.). Gettinger (1984) found *Lupinus* a small, but consistent, component of the diet of *T. bottae* in southern California.

Preferences, as revealed by in-tunnel tests, may indicate only patterns of differential acceptability of items encountered. At the LMGP, pocket gophers showed strong preference for the roots or tubers of *Lomatium* species. Strong preference was noted for *Achillea* shoots and moderately strong preferences for *Achillea* roots. *Achillea* plant tops killed by pocket gopher harvesting of root systems were also noted by D. B. Lawrence (pers. comm.) at LMGP. Thus, some of the unidentified root material in stomach contents was likely *Achillea* roots, since this species grows abundantly on many mounds at LMGP. Andersen and MacMahon (1981), in contrast, found roots of *A. millefolium* to be consistently avoided. The high preference for roots of *Lomatium* spp. suggests that another component of the unidentified root material in the stomachs consisted of *L. triternatum* taproots. Although preference for these roots was strong, only 2 of 15 animals showed a preponderance of root material in their stomach contents.

Strong differences in root form exist among the three species of *Lomatium* used in preference studies. *Lomatium cous,* which is largely restricted to the intermound stone bed habitat, has a large, compact tuber that is rooted on the surface of the soil at the base of the zone of bare stones. *L. minus,* almost completely restricted to the stone bed habitat, has a thick, branched rootstock that is typically more massive than that of *L. cous,* and it, too, is rooted at the surface of the soil zone in the stone beds. *L. triternatum,* which is restricted to the mounds, possesses a slender, elongate tap root. The nature of the root systems of *L. cous* and *L. minus* is probably essential to their ability to occupy the stone bed microhabitat, but should not prevent their occupation of the mounds. I hypothesize that pocket gopher herbivory is the cause of this restriction. The slender taproot of *L. triternatum* is probably incompatible with growth in the stone bed habitat, thus restricting it to mound soils. The high preference of pocket gophers for this species, however, suggests that it enjoys some form of protection. Many of the *L. triternatum* plants were rooted in large clumps of *Agropyron spicatum* or *Festuca idahoensis;* the dense root masses of these grasses may protect the *L. triternatum* roots embedded in these clumps.

Strong preferences of pocket gophers for *Allium tolmei* bulbs and *Trifolium macrocephalum* leaves may also limit these species to the intermound scabland soils that are less accessible to pocket gophers. These species are largely confined to areas of scabland at a considerable distance from mound edges. Thus, these species may escape herbivory only by growing far from centers of pocket gopher activity.

The leaves of *Lupinus caudatus* were highly preferred by pocket gophers. This preference was unsuspected until testing. The short stem sections of lupine that were commonly found in the soil of plugged tunnel openings and scattered along the interior of tunnels during our studies suggested that the stems of lupine were being harvested. The tests, however, showed a relatively weak preference for stems. It appears that the stems of lupine are clipped at the base, pulled into the tunnel, and the leaves eaten or cached. The stems are then cut into short sections, perhaps simply to facilitate disposal. This

suggests that material found casually along tunnels may not be used as food. Aldous (1951), noting similar behavior by *T. talpoides* in Utah, concluded that animals were probably consuming the leaves and tender ends of lupine stems and discarding the tougher stem sections.

These observations suggest that knowledge of the diet of animals may be inadequate to reveal the full impact of the feeding activity of these animals on vegetational composition in a heterogeneous habitat such as Columbia Plateau mounded scabland. Some plants that were abundant on mounds were nevertheless major items in the pocket gopher diet. Strong preferences for intermound species, evident only in preference tests, suggested that several species of corm, bulb, or fleshy-rooted perennials that are rare on mounds are limited to intermound areas by intense herbivory.

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