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Short communication

Comparative food preference of *Microtus brandti* and *Ochotona daurica* in grasslands of Inner Mongolia, China

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Brandt's voles (*Microtus brandti*) and dahurian pikas (*Ochotona daurica*) are two common small mammal species in typical steppes of Inner Mongolia, China. The burrowing and foraging activities of the voles can impose strong impact on the composition, physiognomy, and productivity of typical steppes (Zhong et al. 1985 a). In Inner Mongolian grasslands, the density of burrow entrances of *M. brandti* reached 5,616/ha in a high density year, and average above ground plant biomass in the area inhabited by voles was only 47% compared to areas without voles (Zhong et al. 1985 b). The voles and pikas are sympatric in this region. Trophic relationships are important to understand the interspecific interactions between these two coexisting species. However, none of previous studies covered seasonal changes in the food habits of *M. brandti* and *O. daurica* and their trophic relationships. The objectives of this study were twofold: (1) to report species composition of natural diets of *M. brandti* during spring, summer and autumn in typical steppes of Inner Mongolia, China, and natural diet composition of *O. daurica* in summer and autumn; (2) to determine the interspecific trophic relationship between *M. brandti* and *O. daurica*.

The study was conducted in Hexiten Banner, Inner Mongolia, China. The study site (43°24′ N, 116°46′ E) was located in a grassland of flat topography. The vegetation is characterized as a *Stipa krylovii, Artemisia frigida, Aneurolepidium chinense* community. The average annual temperature is about –0.1 °C. The average annual rainfall is about 350 mm, and is concentrated in June, July, and August. Snow cover is present from November to March. Plant growth occurs from April to August (Jiang 1985).

We trapped *M. brandti* and *O. daurica* in a 10-ha plot. Snap traps were set at burrow entrances of voles and pikas. Stomachs of captured voles and pikas were removed and preserved in 5% formalin solution. We analysed 22 stomachs of voles in April 1989, 23 in July 1989, and 20 in September 1990. Sample sizes for the pikas were 10 stomachs in July 1989, and 11 in September 1990. All sample sizes were greater than or equal to the minimum sample size for this kind of analysis (Batzli 1985). Stomach contents were analysed following the procedures described by Williams (1962). Reference slides of epidermal layers were made for about 40 plant species of the study site. Epidermal fragments in stomach contents were identified to species whenever possi-

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ble. Percent of each plant species in diet dry weight was estimated following the procedure of Sparks and Malechek (1968). We only listed main food items contributing >1% of diets (Batzli 1985).

Within plot, above ground biomass was sampled with a 100×100 cm square frame in July, 1989. Ten random frames were chosen. Green plants were cut to the ground. Vegetation samples were sorted to species, and were dried in an oven at 60 °C for 48 consecutive hours. Dried samples were weighed to the nearest 0.1 g. The total biomass of plants in a quadrat (g/m^2) and percent biomass of each plant species in the total biomass were recorded.

We used the proportional similarity index (Feinsinger et al. 1981), $SI = \sum_i \min(D_j, D_k)$, to calculate the trophic niche overlap between the two mammal species, where $\min(D_j, D_k)$ is the minimum value between D_j and D_k, D_j the proportion of plant species i in diet dry weight of species j, and D_k the proportion of the same plant species in the diet of species k. We computed the jackknife means and variances (Zahl 1977) of SI for summer and fall, and then followed the t-test procedure of Hutcheson (1970) to test for differences in the trophic niche overlaps between the voles and pikas. We also used the proportional similiarity index to determine the similarity between the composition of summer diets of the voles and pikas and vegetation. Similarity between diet and vegetation composition measures diet selectivity of voles and pikas. Trophic niche width was determined by Shannon-Wiener diversity index, $H = -\sum D_i \ln(D_i)$, where D_i is the proportion of plant species i in a herbivore's diet. We followed the t-test procedure of

Table 1. Natural diets (diet dry weight percent %) of *Microtus brandti* in spring, summer, and autumn and *Ochotona daurica* in summer and autumn. Blank cells indicate either not used by the voles and pikas or < 1% of diets.

Food items	voles			Pikas	
	spring	summer	autumn	summer	autumn
Monocotyledons					
Aneurolepidium chinense	55.4	40.3	27.4	56.4	21.0
Agropyron cristatum	27.6	4.7	2.8	2.3	4.0
Stipa krylovii	5.1	2.1	1.3	2.3	1.3
Carex duriuscula	2.6				
Keoleria cristata			1.9		
Cleistogenes squarrosa		2.2			
Other monocotyledons	0.7		3.8	0.5	3.1
Dicotyledons					
Astragalus galactites				2.0	
Scutellaria scordifolia				2.0	
Artemisia frigida	1.4	6.5	32.4		30.0
Potentilla acaulis	2.0		1.3		
Ixeris chinensis	1.3		2.3	3.4	
Saussurea amara			1.1		
Melissitus ruthenica		28.9	11.6	3.6	1.5
Potentilla tanacetifolia		2.7	5.8	14.1	16.4
Salsola collina			1.1		
Heteropappus altaicus		7.6		7.2	8.2
Potentilla bifurca		1.5		3.2	
Astragalus adsurgens				1.8	7.0
Other dicotyledons	1.8	3.5	7.2	1.2	7.5
Plant roots	2.0				
Unknown	0.1				

HUTCHESON (1970) to detect differences in the niche width between two species as well as between the seasons for the same species. We used preference index (PI = proportion of diet/proportion of forage) to assess if a herbivore responds to availability of a food item, e. g. PI > 1 if consistently preferred, PI < 1 if consistently avoided (BATZLI 1985).

In spring, the voles consumed seven main plant species, including four species of monocotyledons and three species of dicotyledons. Monocotyledons made up 91.4% of diet dry weight, and dicotyledons 6.5%. The voles consumed nine main plant species in summer, four species of monocotyledons (49.3%), and five species of dicotyledons (47.2%) (Tab. 1). In summer, vole diet composition was different from plant species composition of the vegetation as the similarity index between the diet composition and vegetation composition was 0.39. Of all available food items, the voles strongly preferred certain dicotyledons in summer (PI $\geqslant$ 1.0), such as *Potentilla tanacetifolia*, *Heteropappus altaicus*, and *Melissitus ruthenica* (Tab. 2). Although *Artemisia frigida* contributed 6.5% of the summer diet, the voles did not prefer this plant (PI < 1.0). Autumn diets of voles consisted of 11 main plant species, four species of monocotyledons (33.4%) and seven species of dicotyledons (55.6%). *A. chinense* was the favorite food of voles in spring, summer, and autumn in terms of percentage. *A. cristatum* was less important during summer (4.7%) and autumn (2.8%) compared with spring (27.6%). However, *Melissitus ruthenica* and *A. frigida* became more important during summer and autumn.

In summer, the pikas selected 11 main plant species, three species of monocotyledons (61%) and eight species of dicotyledons (37.8%). The pikas also showed preference for certain plants in summer, as the similarity index between the diet and the vegetation composition was 0.33. The pikas preferred *Potentilla tanacetifolia*, *Astragalus galactites*, *Heteropappus altaicus*, *Melissitus ruthenica*, and *Ixeris chinensis* (PI $\geqslant$ 1, Tab. 2). The pikas selected eight main plant species in autumn, including three species of monocotyledons (26.3%) and five species of dicotyledons (63.1%, Tab. 1). The diet dry weight percent of *A. frigida* increased from 0.5% in summer to 30% in autumn, while the percent of *A. chinense* declined from 56.4% in summer to 21% in autumn. Therefore, diets of the pikas had apparent seasonal changes.

The overlap index of trophic niche between the voles and pikas was 0.54 in summer, and 0.64 in autumn, but did not differ between

Table 2. Percent of main food items of the voles and pikas in the summer above ground biomass of vegetation and preference index (PI). PI > 1.0 indicates consistent preference, PI < 1.0 consistent avoidance.

Food items	% of vegetation biomass	PI of voles	PI of pikas	Food items	% of vegetation biomass	PI of voles	PI of pikas
Aneurolepidium chinense	15.32	2.6	3.7	*Melissitus ruthenica*	4.23	6.8	0.8
Agropyron cristatum	4.47	1.1	0.5	*Astragalus adsurgens*	1.61	0	1.1
Stipa krylovii	7.03	0.3	0.3	*Artemisia frigida*	26.29	0.3	0
Potentilla tanacetifolia	0.03	91	470	*Ixeris chinesis*	0.29	0	11.8
Heteropappus altaicus	0.23	32.9	31.2	*Potentilla bifurca*	1.25	0	2.6
Astragalus galactites	0.03	0	65.3	*Scutellaria scordifolia*	2.48	0	1.2

the two seasons (P > 0.05). The trophic niche width of voles was 1.32 in spring, 1.69 in summer, and 1.92 in autumn. Likewise the trophic niche width of pikas increased from summer (1.61) to autumn (1.93). The trophic niche width of the voles differed between spring and autumn (P < 0.05), but neither voles nor pikas had significantly different trophic niche widths between summer and autumn (P > 0.05). The voles selected more main food items in autumn than in spring, and the voles consumed more monocotyledons in spring (91.4%) than in autumn (37.2%) (Tab. 1). Selection for more food plant species and more even contributions of dicotyledons and monocotyledons in the autumn diet resulted in broader trophic niche of the voles in autumn than in spring. Although the standing crop biomass of the steppes of Inner Mongolia reaches its highest in autumn (Li et al. 1988), the food quality of plants in autumn may be low. Mature plants in grasslands generally have higher fiber content, decreased protein, and increased phenolic content that voles tend to avoid (Lindroth et al. 1986; Marquis and Batzli 1989). The reduction of food quality could lower the availability of food plants in autumn. Consequently, the voles expanded their trophic niche in autumn to respond to the low availability of food. The trophic niche width was not different between the voles and pikas either in summer or in autumn (P > 0.05).

Bergman and Krebs (1993) found that the overlap of the diets of collared lemming (*Dicrostonyx kilangmiutak*) and tundra voles (*Microtus oeconomus*) increased when both species foraged in the same habitat. Overlap index of food utilization of voles and pikas under the food selection trial was 0.45 (computed from data of Zhong et al. 1982 and Zhou et al. 1992), while the overlap of trophic niche in the free-ranging conditions was 0.54 in summer. The voles and pikas had overlapping habitat use on our study site. The greater overlap under the free-ranging conditions might result from the lower availability of preferred food plants of pikas in natural vegetation and higher percent of *A. chinense* in the pika's natural summer diet. *A. chinense* made up 6% of daily food consumption in the food selection trial (Zhong et al. 1982), but 56.4% of the natural diet of pikas in summer. The lower availability of preferred *P. bifurca*, *A. bidentatum*, and *A. commutata* might force the pikas to use the more abundant *A. chinense*, one of the dominant plant species in the plant community on the study site. The limited availability of preferred food items in natural vegetation may cause the voles and pikas to share more common and abundant plant species and may result in greater trophic niche overlap under the free-ranging condition.

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