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FOOD COMPOSITION AND NUTRITIONAL BALANCE
IN TWO SPECIES OF MONGOLIAN SMALL MAMMALS *

The food composition of Brandt vole (Microtus brandti Radde, 1861) and others rodents occurring in steppes of Central eastern Mongolia was investigated. Brandt voles preferred three monocotyledone species and not lignified shoots of Caragana pygmaea (L.) DC. In feeding experiments it was found that daily consumption rate by Brandt vole amounted to 5.19 g dry weight of Caragana pygmaea and by dahurian pika (Ochotona daurica Pallas, 1776) - 15.5 g. Coefficients of digestibility of energy amounted to 63.3 and 42.9% in the two species examined. The nutritional balance of main nutrients: N, P, K, Ca was also calculated for the two species studied.

1. INTRODUCTION

Some parameters applied in bioenergetic studies show small variation, therefore one can use in present case the data ob-

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tained in other terrain and on quite different populations. There are, however, parameters both populational and bioenergetical ones which have to be estimated in field directly; such are the population numbers or density and the natural food composition of the animals examined. The knowledge of these parameters forms a basis for conducting feeding and food utilization experiments as well as for the possibility of estimation the animal impact on vegetation in the ecosystem in question. That is why in the field studies on the effect of small mammals on steppe ecosystems of Mongolia, the estimates of food consumption in balance feeding experiments were taken into account in chosen species of herbivorous mammals.

2. MATERIAL AND METHOD

2.1. Natural food composition

Studies on natural food composition of Brandt vole (Microtus brandti Radde, 1861) - a dominant species, were carried out in Caragana-Stipa steppe (Weiner and Górecki 1982). Both the food selectivity tests and stomach contents analysis were performed (Zemanek 1972).

The cafeteria tests were performed twice during the vegetation season. In the beginning of July 21 Brandt voles were supplied with 10 species of plants and in the end of summer (end of August) analogous series of experiments was carried out on 7 Brandt voles, each being given 12 species of plants.

On account of short duration of vegetation of plant species, the second series of experiments pertained mostly to different plant species. The plants given to voles (a total of 18 species) were clearly predominant in the environment when the experiments were performed.

At the rodent catchment by the use of different types of snap traps, the animals' stomachs were collected and stored in a dry state. Prior to analysis of their contents they were soaked in water and under binokular lense their contents were sorted into various fractions. Further on, microscopic slides were prepared and from the shape of characteristic epidermal cells and other

morphological diagnostic features, the plant fragments were identified to species. The alcohol preparations of plants collected in this area were used for the sake of comparison.

2.2. Consumption and food utilization

Feeding experiments were carried out on Brandt vole and dahurian pika (Ochotona daurica Pallas, 1776) by the balance method in special metabolic cages, permitting separate collection of faeces and urine (D r o ž d ž 1968). The experiments lasted 3-5 days after animals were caught, in outdoor conditions, average ambient temperature was 294.8 K (21.6°C) in vole experiments and 290.4 K (17.2°C) in dahurian pika experiments. The experimental animals were fed with fresh (this year), non lignified shoots of Caragana pygmaea (L.) DC., which was available during the whole vegetation season and was strongly preferred in the two series of experiments on cafeteria tests. This food allowed for a long rearing these species without any symptoms of animals bad condition. In total, 5 complete experiments on 5 matured Brandt voles and on 4 dahurian pikas were performed. For all feeding experiment series samples of both food and faeces were collected, which after transferring them to laboratory were analysed for energy value and content of main nutrients (N, P, K, Ca).

The energy value was determined in calorimeter of Berthelot's system (G ó r e c k i 1965). The determination of nitrogen was done by the method of potentiometric titration, that of potassium and calcium - by flame emission method, and phosphorus by colorimetric method.

3. RESULTS

3.1. Stomach content analyses

In Brandt vole stomachs that were analysed (N = 12) monocotyledone plants prevailed quantitatively. Carex duriuscula C.A.M., was present in every stomach and at large quantity, the second was Festuca sp. (Table 1) and further were Agropyron cristatum (L.) Gaertn. and Stipa krylovii Roshev., the latter being

Table 1

Food preference and results of stomach content analyses of Brandt vole (Microtus brandti Radde, 1861)

Species	Cafeteria test		Stomach contents analyses (N = 12) frequency in per cent
	July (N = 21)	August (N = 7)	
<u>Caragana pygmaea</u> (L.) DC.	++	++	42
<u>Caragana microphylla</u> (Pall.) Lam.	0	0	
<u>Carex duriuscula</u> C.A.M.	+++		100
<u>Agropyron cristatum</u> (L.) Gaertn.	+++		50
<u>Cymbaria dahurica</u> L.	+++		33
<u>Panceria lanata</u> (L.) Bge.	0		
<u>Chamaerhodos erecta</u> (L.) Bge.	0		
<u>Leymus chinensis</u> (Trin.) Tzvel.	+	+++	25
<u>Stellaria dichotoma</u> (L.) Bge.	0		
<u>Asparagus dahuricus</u> Fisch.	0	0	
<u>Heteropapus hispidus</u> (Thunb.) Less.		++	25
<u>Stipa krylovii</u> Roshev.		+++	42
<u>Oxytropis</u> sp.		+++	
<u>Festuca</u> sp.			100
<u>Lophanthus chinensis</u> Benth.		+	
<u>Thermopsis lanceolata</u> R. Br.		+	25
<u>Salsola collina</u> Pall.		+	25
<u>Artemisia adamsii</u> Bess.		0	
<u>Artemisia frigida</u> Willd.		0	
<u>Allium</u> sp.			17

+++ - food consumed in 80-100%, ++ - food consumed in 30-80%, + - food consumed up to 30%, 0 - food not consumed.

found in several stomachs at very large quantities. Caragana pygmaea showed relatively high frequency. In four stomachs, husks of unidentified seeds were encountered and in other stomachs - starch grains. In Brandt vole stomachs no underground parts of plants were found, nor remnants of invertebrates.

There were few stomachs of other species, thus the data are of tentative character only. In two stomachs of djungarian hamster (Phodopus sungorus Pallas, 1770) seeds dominated; it seems that these were seeds of Cymbaria dahurica L. In two stomachs of siberian jerboa (Allactaga sibirica Forster, 1778) remnants of larvae and insects, mainly grasshoppers, were occurring almost exclusively in large quantities, but fragments were also found which seem to belong to hymenopterans. It was characteristic that no heads or appendages of insects were found in stomach contents. No green remnants of plants were found whatsoever, only very few fragments identified as seeds.

In one stomach of bobac marmot (Marmota bobac Müller, 1776) filled with plant remnants, fragments of Caragana pygmaea and some of Carex sp. were identified. Besides these a few plant fibers, perhaps from root parts of plants.

In the two seasons the voles clearly avoided plant species with strong odour (Artemisia sp., Chamaerhodos sp., Panzeria sp.) and Caragana microphylla (Pall.) Lam. which occurred in masses and during the whole vegetation season.

3.2. Consumption and natural food utilization

From the analysis of stomach contents and food preference experiments carried out on Brandt vole it turned out that the Brandt voles rather clearly prefer green shoots of Caragana pygmaea. This fact together with its mass accessibility during the whole vegetation season have decided that for experiments on consumption and food utilization this species has been chosen. Average body weight in Brandt voles examined amounted to 36.1 g and that of dahurian pika - 98.7 g. Brandt voles consumed daily from 3.8 to 5.8 g dry weight (Table 2). Dahurian pika consumed from 10.2 to 19.1g dry weight per day (Table 2). The digestibility and assimilation coefficients of the same forage in the two species differed considerably (all differences were statistically significant $p < 0.01$). The energy assimilation coefficient in Brandt vole was higher by about 24% than that in dahurian pika (Table 2).

The dependence of consumption (C - expressed in g dry weight per body unit weight) on body weight of these animals (W - in g) for dahurian pika is described by equation:

T a b l e 2

Consumption and utilization of foods
by Brandt vole (Microtus brandti Radde, 1861)
and dahurian pika (Ochotona daurica Pallas, 1776)

	Consumption	Assimilation	Coefficient of digestibility	Coefficient of assimilation
	g d. wt x day ⁻¹ kJ x day ⁻¹ ± SD		per cent ± SD	
	Brandt vole (\bar{x} body weight = 36.1 g, N = 5)			
Dry weight	5.19 ± 0.81	3.2 ± 0.50	66.1 ± 7.7	63.6 ± 4.2
Energy	93.4 ± 25.9	58.2 ± 18.4	63.3 ± 2.8	62.1 ± 3.1
	Dahurian pika (\bar{x} body weight = 98.7 g, N = 4)			
Dry weight	15.5 ± 3.8	6.8 ± 2.6	47.3 ± 5.5	42.6 ± 8.2
Energy	276.5 ± 61.5	102.6 ± 34.3	42.9 ± 3.6	38.1 ± 5.8

$$C = -0.058 + 0.0022 W \quad (r = 0.73)$$

and for Brandt vole:

$$C = 0.242 - 0.0027 W \quad (r = -0.72)$$

Analogous dependence for assimilation of dahurian pika has a form of:

$$A = -0.072 + 0.0014 W \quad (r = 0.58)$$

and for Brandt vole:

$$A = 0.132 - 0.012 W \quad (r = -0.68)$$

4. DISCUSSION

The coefficients of digestibility obtained in the present work both of dry matter and of energy are much higher in Brandt vole than in dahurian pika, similar is true for coefficients of assimilation. D r o ž d ž (1968) studied utilization of natural food by Microtus arvalis (Pallas, 1779). Digestibility of high-caloric forage such as grains of oats amounted to over 92% and assimilation efficiency almost 90%. Corresponding coefficients for green parts of wheat were much lower and amounted to 70 and

65%, respectively. The coefficients obtained for Brandt vole in the present work does not differ much from these listed above as well as from generally known average coefficients for grazing herbivores as reported by G r o d z i ń s k i and W u n d e r (1975) for many groups of animals. According to these authors the average coefficient of digestibility for this ecological group amounts to 67% and assimilation efficiency - 65%. These obtained for Brandt vole amounted to 63 and 62%. Much higher difference was observed in dahurian pika, where coefficient of digestibility equalled 43% and assimilation efficiency 38% in spite of the fact that dahurian pika were fed with the same forage as that used for Brandt voles. These low coefficients of food utilization can be related with coprophagous mode of feeding common for all Lagomorpha. Two types of faeces can be distinguished in this group - nocturnal and diurnal one - the former being only partially digested is reconsumed by the animals. In metabolic cage the animals probably can only to a lesser degree utilize energy bound in faeces which, of course, considerably underestimated their coefficients of digestibility and assimilation. On the other hand one cannot exclude that Caragana pygmaea is not an optimum food for dahurian pika, since its food preference is unknown.

With the animals used for feeding experiments, respirometric measurements were carried out, measuring basal metabolic rate and thermoregulation. Since the experimental animals were adults, they practically did not change their body weights during the measurements. Brandt voles grew only by 0.28 g per 24 hrs and dahurian pika only by 0.12 g per 24 hrs. Thus one can directly compare assimilation of food (metabolizable energy) with respiration.

The feeding experiments were run at ambient temperature at 294.8 K (21.6°C); for this temperature and for animals of the same body weight metabolic rate was calculated according to formula reported by W e i n e r and G ó r e c k i (1981). The energy metabolism calculated from respirometric data amounts to 53.7 kJ per individual per day and it is higher than energy value of assimilated food under the analogous conditions only by 7.8%. Similar comparison was made for dahurian pika. In this case, the daily energy dispersion calculated as resting metabolism rate

T a b l e 3

Balance of some elements in Brandt vole
(Microtus brandti Radde, 1861) and dahurian pika
(Ochotona daurica Pallas, 1776)

Consumption		Faeces	Digested	Assimilated
Brandt vole (x body weight = 36.1 g)				
N	0.1557	0.0559	0.0998	0.0970
P	0.0237	0.0084	0.0153	-
K	0.0288	0.0197	0.0091	-
Ca	0.0477	0.2050	0.0272	-
Dahurian pika (x body weight = 98.7 g)				
N	0.4864	0.2138	0.2726	0.2671
P	0.0466	0.0224	0.0242	-
K	0.1654	0.0851	0.0803	-
Ca	0.1146	0.0649	0.0479	-

All values in g d. wt. per individual per day.

(Weiner and Górecki 1981) amounted to 104.5 kJ per individual and it was higher than those obtained in feeding experiments only by 1.8%. In both cases the differences are inconsiderable and suggest a high congruency of results obtained by the two different methods.

From the results of feeding experiments, knowing the element contents in food and faeces, a trial was made to estimate nutritional element balances for the two species in question. The results are presented in Table 3. For all nutrients, their digestibility was assessed as expressed in g dry weight per individual and day; for nitrogen assimilation was also assessed, since in the urine only nitrogen was determined. As it is evident all balances are clearly positive, and digestibility of dry matter of various elements is rather small (see also Table 4). On the average much more than half of nutritional element quantity consumed with food returns in an easy assimilable form to the ecosystem. The amounts of various elements per hectare are relatively small due to low density of animals. To exemplify this one can say that at an annual average density of 22 Brandt voles per hectare they consume 1.2 kg N per year, out of which almost 0.5 kg per ha re-

T a b l e 4

Coefficient of digestibility of nutrients in food
of Brandt vole (Microtus brandti Radde, 1861)
and dahurian pika (Ochotona daurica Pallas, 1776)

	N	P	K	Ca
Brandt vole	58.1 ± 18.5	59.6 ± 22.6	28.7 ± 16.4	44.9 ± 29.5
Dahurian pika	53.6 ± 14.6	50.6 ± 7.6	45.1 ± 15.4	42.2 ± 8.7

All parameters in per cent ± SD.

turns immediately to the ecosystem. For other elements these values are much lower since annual consumption per ha amounts: P - 190 g, K - 230 g, Ca - 380 g. Out of this more than a half returns to the ecosystem. It seems, therefore, that this positive impact of rodents is very important. Such suggestions were already made by other authors (C h e w 1974, Z i m i n a and Z l o t i n 1980). In a similar steppe similar studies were carried out by A b a t u r o v, R a k o v a and S e r e d n e v a 1975 and Z i m i n a and Z l o t i n 1980 - they reported that rodents, especially ground squirrels (Citellus sp.) had a significant effect on primary production just by enrichment of soil due to burrow digging and by acceleration of organic matter cycling.

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5. STRESZCZENIE

Skład pokarmu i równowaga pokarmowa u dwóch gatunków mongolskich gryzoni

Przeprowadzono badania składu naturalnego pokarmu metodą testu na wybiórczość pokarmową i analiz żołądków u normnika Brandta (Microtus brandti Radde, 1861), dominującego gryzonia na ste-

pach Mongolii. Wyniki obu metod wskazują, że zwierzęta preferują rośliny: Carex duriuscula C.A.M., Caragana pygmaea (L.) DC., Agropyron cristatum (L.) Gaertn. i Stipa krylovii Roshev (tab. 1).

Doświadczenia nad konsumpcją i wykorzystaniem pokarmu przeprowadzono na nornikach Brandta i szczekuszkach (Ochotona daurica Pallas, 1776). Zwierzętom podawano niezdrewniałe pędy Caragana pygmaea. Konsumpcja suchej masy wyniosła dla norników 5,19 g, a dla szczekuszek 15,5 g, co odpowiada 93,4 i 276,7 kJ (tab. 2). Współczynniki strawności energii były znacznie wyższe u norników (63,3%) niż u szczekuszek (42,9%). Odpowiednio współczynniki asymilacji wynosiły 62,1 i 38,1%.

Na podstawie powyższych wyników i współczynników strawności biogenów (N, P, K, Ca) (tab. 4) oceniono bilans tych pierwiastków u obu badanych gatunków (tab. 3).

6. РЕЗЮМЕ

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Состав кормов и кормовой баланс у двух видов монгольских млекопитающих

По методу теста избирательности и анализа желудков исследовали состав естественного корма полёвки брандта (Microtus brandti Radde, 1861), грызуна, доминирующего в степях Монголии. Полученные результаты указывают на то, что исследуемые животные предпочитают следующие растения: Carex duriuscula C.A.M., Caragana pygmaea (L.) Gaertn. Stipa krylovii Roshev (Табл. I.).

Авторы занимались исследованием потребления и использования корма полёвкой Брандта и даурской пищухой (Ochotona daurica) (Pallas, 1776). Животным подавали свежие побеги Caragana pygmaea. Потребление сухой массы для полёвки равнялось 5,19 г., для пищухи 15,5 г., что соответствует 93,4 и 276,7 кДж. (Табл. 2). Коэффициенты перевариваемости энергии были значительно выше у полёвки (63,3%), чем у пищухи (42,9%). Соответственно с этим коэффициенты ассимиляции равнялись 62,1 и 38,1%.

На основании результатов исследований и коэффициентов перевариваемости биогенов (N, P, K, Ca) (Табл. 4), авторы оценили баланс элементов для исследуемых видов животных (Табл. 3).

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