OBSERVATIONS ON FOOD CONSUMPTION AND PREFERENCE IN FOUR ALASKAN MAMMALS

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DURING the summer of 1950 a number of living specimens were collected during studies on temperature regulation in Alaskan mammals.[1] These animals were brought back to Wisconsin and maintained in captivity, a number being still alive more than two years after capture. Since an adequate diet is often essential for successful maintenance, some systematic observations on food preference in terms of kind and amount were carried out. Such studies may be indicative of the requirements and food preferences of the animals in nature.

The animals studied were the Alaskan ground squirrels, *Citellus parryii ablusus* (8) and *C. osgoodi* (2), the Dawson red-backed vole, *Clethrionomys rutilus dawsoni* (8), the Alaskan collared lemming, *Dicrostonyx rubricatus rubricatus* (2), and the pika, *Ochotona collaris* (1). Some details as to habitat, distribution, abundance, and mode of capture of these animals are described elsewhere (Strecker and Morrison, 1952; Strecker *et al.*, 1952).

The following observations were made in Madison during October and November, about two months after capture, during which time the weights of the animals were substantially constant, that is there was no steady gain or loss in body weight. The lemmings and the pika were kept in individual cages in a window well in the laboratory while the ground squirrels and the voles were caged in groups in an animal room. The temperature of the latter was always near 22°C while that of the window well averaged about 17°C but showed considerable diurnal variation with low values of 0°C being recorded on two cold nights. However, all animals were liberally supplied with bedding material so that the effective temperature variation was much less.

The animals were fed at 24-hour intervals (48-hour over Sunday) at which time the residual food was removed, weighed, and discarded. The different foodstuffs were kept in separate glass or porcelain dishes of appropriate size. Food that fell through the mesh floor was screened from the sawdust and weighed with the other residual food. Occasionally it was necessary to shake out cached food from the cotton waste bedding. Contamination with urine or feces presented no great problem since the animals tended to deposit excreta at a definite location in the cage, often in the water dish. Consumption values were calculated by the difference in weight of the residual food from that supplied at the beginning of the period. For wet

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foods it was necessary to correct the residual weights for loss of moisture as indicated in Table 1. In comparing food consumption, values were adjusted for water content and energy content and these factors are shown in Table 1.

Table 1. The water content and estimated caloric equivalents for the several foodstuffs, and the moisture loss from unconsumed foods.

Food	*Dry Weight*[1] %	*Energy content*[2] *in kcal. gm.* *Dry*	*Wet*	*Evaporative loss*[3] % *1 day*
Cabbage	8.5	3.0[4]	0.25	22
Grass	30	3.0[4]	0.9	58
Carrot tops	30	3.0[4]	0.9	(58)
Carrot	13.5	4.0[5]	0.54	15
Apple	11.0	4.0[5]	0.44	24
Sunflower seeds	90	5.0[6]	4.5	
Peanut butter	(90)	5.0[6]	4.5	
Rat chow	88	4.0[5]	3.5	
Rabbit chow	89	3.0[4]	2.7	
Hay	(89)	3.0[4]	2.7	
Corn	84	4.0[5]	3.4	

[1] Residual weight after drying chopped foodstuffs for 48 hours at 105°C.
[2] Estimated *metabolizable energy, i.e.* gross energy minus fecal, urinary, and (fermentation–gas) energy.
[3] Evaporative loss in control samples of wet food held on top of the animal cages for 24 hours. Average values for 3–4 determinations.
[4] Estimated from values for average cattle and rabbit rations (Brody, 1945) and representing *c.* 2/3 of the gross energy.
[5] These carbohydrate-containing "storage" tissues were considered substantially digestible and estimated as 90 per cent of the gross value for corn meal (4.4 kcal./gm.).
[6] These oil-containing "storage" tissues were estimated as 90 per cent of the gross value for soybeans (5.5 kcal./gm.).

Detailed food consumption for the pika and the lemmings is given in Fig. 1. This shows considerable day to day variation in quantity, ranging up to three-fold although usually much less, despite the continuous presence of

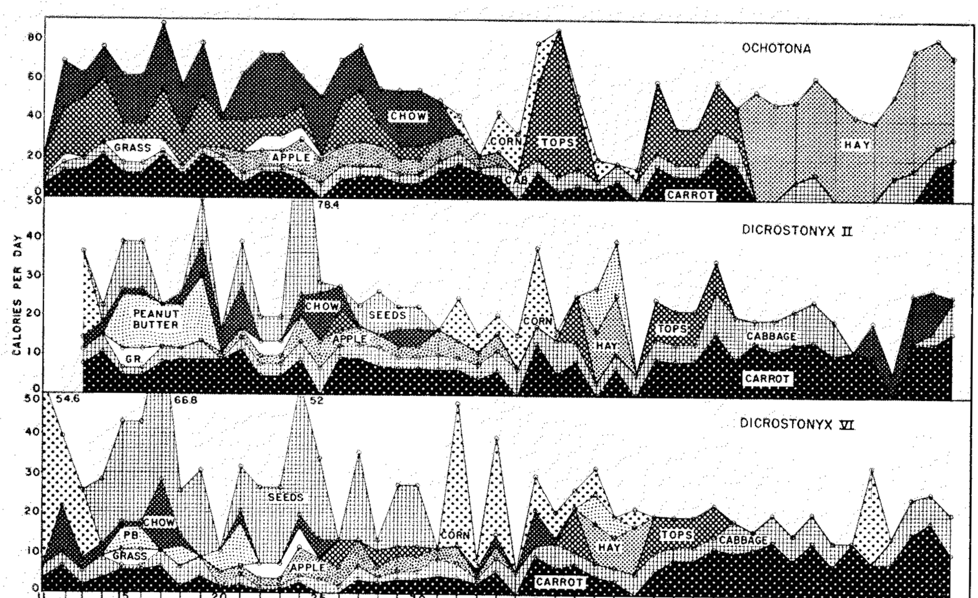

Fig. 1. Daily food consumption records for the pika and lemmings, as calories per animal-day (*cf.* Table 1). Wet foodstuffs below and dry above, represented by symbols. Consumption over the 48-hour Sunday period was allocated equally to the two days.

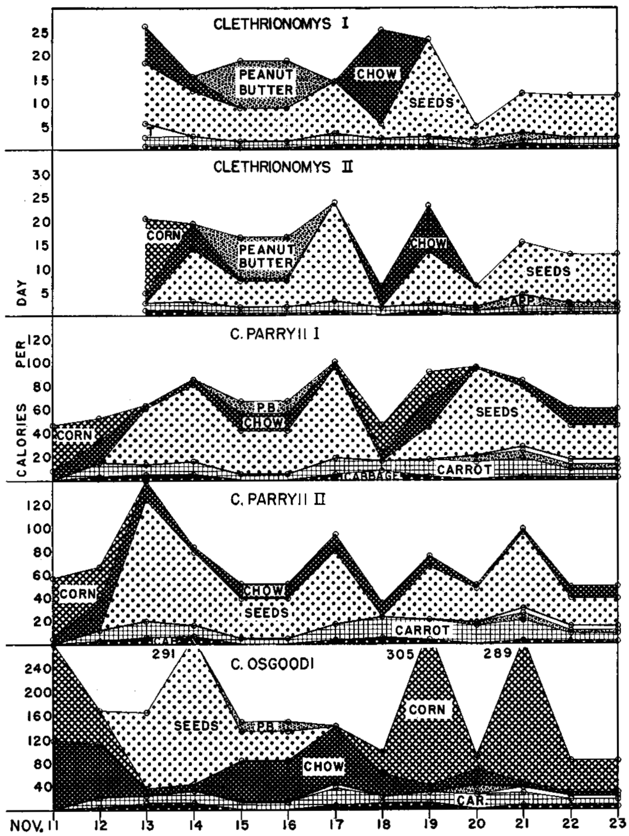

Fig. 2.
Daily food consumption records for ground squirrels and red-backed voles as cal./animal-day. Wet foodstuffs below and dry above, represented by symbols.

food. In almost all cases the excess or deficit from the average consumption rate is promptly made up during the next twenty-four hours. The period of these short cyclic fluctuations in food intake averaged 2.9 days. Possibly this behaviour, particularly marked in the lemmings, reflects a natural tendency to fill up when food is available together with a capacity sufficient to tide the animal over part of the succeeding day.

The daily fluctuations in food intake appear to be independent of the type of food supplied. Thus, in the lemmings the average total caloric consumption when given wet food alone (November 10–20) was the same as in other periods when half to two-thirds of the intake was in dry food. Similarly, the pika took in the same number of calories of hay alone (November 16–17 and 20–22) as it did when five different foods, wet and dry, were being consumed (October 11–30). The gross food intake varied with the type of foodstuff but the metabolizable caloric intake, as based on feeding values from domestic animals, was constant indicating that the caloric contents of all the foodstuffs supplied were equally available to these animals.

Water intake. The fluctuations in food intake were largely confined to the dry portion and when both food types were available the sum of the wet foods consumed was relatively constant. This was particularly evident in the pika and the lemmings which were supplied a greater variety and which consumed larger amounts of wet foods than the squirrels and the voles (Fig. 2), and correlates with the observation that the former animals were never seen to drink nor to deplete their water supply. Such behaviour has previously been noted in the collared lemming by Degerbøl and Møhl-Hansen (1943).[1] The constant intake level of wet foods, then, may simply represent the water requirement of the animal rather than any specific preference or need. The average water intake through this route is summarized in Table 2. The values

Table 2. Food consumption for all groups as gross weight, calories, and water.

Animal or group		*Number*	*Av. Weight in gm.*	*Days*[1]	*Food consumption gm./gm.day wet food*	*gm./gm.day dry food*	*kcal./gm.day wet food*	*kcal./gm.day dry food*	*Ratio wet/dry food gm./gm.*	*Ratio wet/dry food cal./cal.*	*Water with food c.c./gm.day*
Clethrionomys	I	4	25	11	0.24	0.114	0.10	0.46	2.1	0.19	0.30
Clethrionomys	II	4	25	11	0.26	0.121	0.10	0.49	2.2	0.18	0.30
Dicrostonyx	II	1	38	33	0.70	0.128	0.28	0.48	5.4	0.52	1.01
Dicrostonyx	VI	1	47	31	0.71	0.078	0.29	0.29	9.1	0.86	0.90
Ochotona		1	127	33	0.55	0.073	0.25	0.18	7.5	1.3	0.60
C. parryii	I	4	482	13	0.068	0.027	0.031	0.11	2.5	0.25	0.08
C. parryii	II	4	419	12	0.087	0.029	0.042	0.12	3.0	0.32	0.08
C. osgoodi		2	683	12	0.086	0.046	0.038	0.14	1.9	0.24	0.11

[1]Only the days on which both wet and dry foods were given are included here.

for the lemming, 0.90–1.0 c.c./gm. day, are more than adequate to meet their water requirement. In contrast, the squirrels and the voles averaged only one-fifth of this value, 0.08–0.30 c.c./gm. day. They were observed to drink regularly, evidently obtaining their water from this source. The squirrels and the voles consumed only one-fifth of their calories as wet food while the lemmings and the pika took in roughly one-half.

Caloric intake. In general, the caloric food intake per unit of weight was greater in the small animals than in the large ones. This is in agreement with the general laws relating metabolic function and size. However, exceptions were noted in that the lemmings showed almost as high an intake per unit of weight as the voles which were only half their size. The melanistic C. *osgoodi* had a caloric intake roughly one-third higher than the two groups of C. *parryii* although the former were substantially heavier. Accordingly, it is of interest to compare the energy input (food consumption) with the energy output (metabolic rate) in these animals as shown in Table 3. The metabolic levels used here were calculated from the average rates of oxygen consumption at 20°C (Morrison, Ryser, and Morrison).

Both species of ground squirrels showed excellent correspondence between energy input and output with an average ratio of 1.01 (food/oxygen), despite the difference in consumption levels between the two. The agreement was not so close in the other species with the input running from 40 to 50 per cent above the output. This could well result from a higher activity level in the

[1]Collared lemmings kept in captivity in Ottawa have frequently been seen to drink, both from glass feeder tubes and from dishes, although liberally supplied with wet foods. *Ed. Arctic.*

Table 3. Comparison of caloric consumption and expenditure.

Animal or group		*Weight in gm.*	*Food kcal./gm. day*	*Oxygen[1] kcal./gm. day*	*Food/oxygen*
Clethrionomys	I	25	0.56	0.40	1.40
Clethrionomys	II	25	0.59	0.40	1.48
	Av.	*25*	*0.58*	*0.40*	*1.44*
Dicrostonyx	II	38	0.76	0.51	1.49
Dicrostonyx	VI	47	0.58	0.37	1.57
	Av.	*43*	*0.67*	*0.44*	*1.52*
Ochotona		127	0.43	0.31	1.39
C. parryii	I	482	0.141	0.138	1.02
C. parryii	II	419	0.162	0.156	1.04
C. osgoodi		683	0.178	0.185	0.96
	Av.	*497*	*0.157*	*0.155*	*1.01*

[1] Average rate of oxygen consumption at 20° C times 4.8 cal./c.c. The animals were confined in a small chamber which permitted moderate activity.

Table 4. Food preference ratios.

		WET FOODS					*DRY FOODS*				
		Carrot	*Cabbage*	*Grass*	*Carrot top*	*Apple*	*Peanut butter*	*Sunflower seed*	*Corn*	*Rat chow*	*Hay*
Clethrionomys	I	0.67	0.19			1.00		0.61		0.33	
Clethrionomys	II	0.59	0.23		1.0	0.88		0.68		0.47	
	Av.	*0.63*	*0.21*		*1.0*	*0.94*		*0.64*		*0.40*	
Dicrostonyx	II	0.22	1.00	0.25	0.27	0.36	0.39	1.00	0.44	0.17	0.55
Dicrostonyx	VI	1.00	0.67	0.77	0.67	0.42	1.00	0.67		0.45	0.83
	Av.	*0.61*	*0.84*	*0.51*	*0.47*	*0.39*	*0.70*	*0.84*	*0.44*	*0.31*	*0.69*
Ochotona		0.59	0.44	0.44	1.00	0.48	0.0		0.44	(0.5)	(1.0)
C. parryii	I							1.00	0.41	0.13	
C. parryii	II	1.00	0.22					1.00	0.45	0.19	
C. osgoodi								0.50	1.00	0.22	
	Av.							*0.90*	*0.55*	*0.19*	

cages than in the more restricted metabolic chambers. Indeed, the ground squirrels, which showed the closest agreement, also showed strikingly little activity in both cage and chamber, so that the excess in the other animals may reasonably be considered as the metabolic cost of activity. However, other factors, such as a loss of finely divided foodstuffs during feeding or a lower physiological availability (metabolizable energy), of the foodstuffs may have contributed to the discrepancy. In view of these several factors, all of which act in the direction of the observed discrepancy, the degree of correspondence is not unreasonable and shows that simple food consumption values can give a fairly reliable measure of metabolic requirements and output in wild animals.

Food preference. Discrimination in favour of one or another foodstuff was estimated separately for wet and dry foods in terms of a "preference ratio". For any given day the food consumed in greatest amount was given an arbitrary value of 1.0 and the other foods were referred to this value in proportion to the number of calories consumed. Ratios for foods given separately on two days were estimated on the basis of a third common food.

These preferences, calculated separately for the wet and dry foods, are summarized in Table 4. The two groups of voles agreed closely with each other, and showed a definite preference for apple and for carrot tops of the wet foods and for peanut butter of the dry foods.

The two lemmings had entirely different preference values for all foods. This might perhaps be due to the fact that one was an adult and the other a growing young mammal, but it more probably reflects simply a lack of any preference in this species. This lack of preference is clearly seen since the average preference ratios range from 0.31 to 0.84 for the ten foods given, that is a fair amount of every food was consumed. Foods entirely unlike any they might encounter in nature were equally favoured as compared with more natural types. Such a catholic taste in foods would appear well adapted for survival in their rigorous natural environment.

The pika showed a similar diversity of taste in terms of the five wet foods, although carrot tops, which are probably most like the small plants which form their natural food, were preferred. Among the dry foods, hay, again the most similar to their natural food, was strongly preferred. Peanut butter was untouched and corn was eaten only sparingly.

The three groups of ground squirrels all agreed in their dislike for rat chow, one of the few common tastes shared by the four species. They differed in that the dark *C. osgoodi* had a decided preference for corn while the *C. parryii* preferred sunflower seeds.

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