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Biogen Contents in the Bodies of Two Species of Rodents

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Nitrogen, phosphorus, potassium and calcium contents were determined in *Clethrionomys glareolus* (Schreber, 1780) and *Apodemus flavicollis* (Melchior, 1834), the average values in bank voles being 9.9% dry mass N, 2.3% P, 1.0% K and 2.9% Ca, and in mice 10.2% N, 2.4% P, 1.1% K and 3.0% Ca. Calculation was made of relations between body weight, and in the case of the mice, also between age, and the contents of all these elements, since this makes it possible to use these data in various types of calculations relating to biogen flow. As an example the biogen balance was calculated for the rodent population in tree stands of the Niepołomice Forest near Kraków.

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1. INTRODUCTION

When estimating the flow of matter through populations or trophic levels it is essential to determine the contents of different biogenic elements in animals' bodies. There is a considerable amount of information on the bioenergetic parameters of rodents, but as regards the body composition of this group practically only data on *Peromyscus polionotus* are available (Kaufman & Kaufman, 1975a, b).

The purpose of the present study was to define the contents of the basic biogens N, P, K and Ca in two common rodent species, *Clethrionomys glareolus* and *Apodemus flavicollis*.

2. MATERIAL AND METHODS

The rodents were caught in snap-traps and after removing stomach contents were individually dried to a constant mass, then finely minced. A total of 58 voles and 18 mice were examined, all the animals originating from the Niepołomice Forest. Approximately 20—30 mg samples were weighed from the homogeneous mass and placed in a Kjeldahl flask, making two repeats for each individual. The material was treated in H_2SO_4. After cooling, 30% H_2O_2 was added and the sample treated further until a completely colourless clear solution was obtained.

The potentiometric tritration method was used to identify nitrogen. Phosphorus was identified in a spectrophotometer, with wave length = 685 nm and aparature width 0.05 nm. Potassium was identified by means of a FLAPHO flame photometer. Standard solutions and samples were pulverised in burning propane flame. Identification of calcium was also made in the flame photometer, using acetylene instead of propane.

3. RESULTS

All data on percentage contents of the biogens examined in dry body mass for voles and mice are given in Tables 1 to 3.

In order to facilitate use of the results obtained for different kinds of calculations on flow of matter, calculation was made for all the elements of the relation to body weight (Table 2, 3). In the case of voles for which age was determined, calculation was also made of the relation to the age of the animals examined (Table 2). Since the calculations often apply only to a given season or group of animals, all the voles and mice were divided into those caught in spring or autumn, and into males and females, regardless of the statistical significance of differences between them (Table 2, 3). In the case of voles the group of young animals less then 3 months old was distinguished (Table 2).

Table 1

Nitrogen, phosphorus, potassium and calcium contents expressed in percentages of dry mass of body for *Clethrionomys glareolus* and *Apodemus flavicollis*. Coefficient of variation (%) given below average value.

Item	Age in months±SD	Body wt. in g±SD	Nutrients in % of dry weight ± SD			
			N	P	K	Ca
			Clethrionomys glareolus			
Autumn	4.1±1.7	17.6±1.5	9.96±0.69	2.33±0.35	1.00±0.21	3.02±0.49
(N=43)	41.5	8.7	6.9	14.8	21.4	16.2
Spring	10.5±2.9	24.9±3.2	9.73±1.07	2.26±0.29	1.08±0.13	2.70±0.67
(N=15)	27.9	12.7	10.9	12.9	12.2	24.6
Males	7.6±3.6	21.4±3.4	9.63±0.99	2.17±0.26	1.05±0.23	2.82±0.49
(N=21)	47.1	15.8	10.2	12.1	21.6	17.3
Females	7.3±2.9	21.3±4.1	9.69±0.47	2.27±0.14	1.07±0.13	2.91±0.49
(N=22)	40.9	19.4	4.8	6.1	11.8	16.9
Youngs	2.9±1.1	16.4±0.6	10.30±0.63	2.47±0.41	0.96±0.19	3.08±0.63
(N=15)	38.6	3.9	6.1	16.6	20.4	20.6
All anim.	5.7±3.5	19.4±3.8	9.90±0.01	2.31±0.33	1.02±0.20	2.94±0.56
(N=58)	61.2	19.6	8.2	14.4	19.5	19.0
			Apodemus flavicollis			
Autumn		22.8±6.6	10.40±0.70	2.37±0.45	1.04±0.09	3.16±0.45
(N=11)		29.2	6.8	10.6	0.9	14.4
Spring		22.7±8.9	10.25±0.47	2.55±0.58	1.16±0.06	2.77±0.21
(N=7)		39.6	4.6	22.7	6.5	7.5
Males		25.5±8.0	10.62±0.53	2.39±0.29	1.09±0.09	3.12±0.47
(N=10)		31.4	4.9	12.1	8.3	15.2
Females		19.4±5.5	9.99±0.57	2.51±0.53	1.09±0.11	2.87±0.29
(N=8)		28.5	5.7	21.2	10.2	10.0
All anim.		22.8±7.6	10.34±0.63	2.44±0.42	1.09±0.10	3.01±0.42
(N=18)		33.6	6.1	17.2	9.2	14.0

Table 2

Relation between phosphorus, nitrogen, potassium and calcium contents expressed in percentages of dry mass and body weight (BW) and age (A) in *Clethrionomys glareolus*. Correlation coefficient given below equations.

Animal groups	Age (A)	Body weight (BW)	Age (A)	Body weight (BW)
	Nitrogen (N)		Phosphorus (P)	
Autumn	N=−0,178A+10.68 0.435 [3]	N=−0.225BW+13.93 0.497 [3]	P=−0.061A+2.58 0.300 [1]	P=−0.840BW+3.81 0.371 [2]
Spring	N=−0.162A+11.43 0.446 [3]	N=−0.106BW+12.36 0.314 [1]	P= 0.059A+1.63 0.599 [2]	P=−0.001BW+2.28 0.072
Males	N=−0.109A+10.45 0.396 [2]	N=−0.068BW+11.09 0.234	P= 0.030A+1.93 0.414 [1]	P= 0.009BW+0.20 0.111
Females	N= 0.079A+ 9.11 0.507 [3]	N= 0.012BW+ 9.42 0.110	P= 0.019A+2.13 0.410 [1]	P= 0.011BW+2.03 0.346
Youngs	N= 0.011A+10.27 0.020	N= 0.027BW+ 9.87 0.027	P= 0.036A+2.37 0.098	P=−0.156BW+5.03 0.247
All animals	N=−0.083A+10.38 0,359 [2]	N=−0.068BW+11.22 0.319 [2]	P=−0.007A+2.35 0.070	P=−0.017BW+2.64 0.191
	Potassium (K)		Calcium (Ca)	
Autumn	K= 0.024A+ 0.90 0.192	K= 0.030BW+ 0.46 0.216	Ca= 0.017A+2.95 0.059	Ca=−0.024BW+3.44 0.074
Spring	K=−0.012A+ 1.21 0.217	K= 0.003BW+ 1.00 0.079	Ca= 0.010A+2.95 0.043	Ca=−0.024BW+3.31 0.482 [1]
Males	K=−0.017A+ 1.18 0.270	K=−0.012BW+ 1.31 0.178	Ca=−0.056A+3.25 0.415	Ca=−0.070BW+4.31 0.482 [1]
Females	K= 0.032A+ 0.83 0.759 [3]	K= 0.020BW+ 0.64 0.654 [3]	Ca= 0.034A+2.66 0.205	Ca=−0.003BW+2.97 0.022
Youngs	K= 0.055A+ 0.80 0.318	K= 0.128BW+ 0.80 0.450 [1]	Ca= 0.169A+2.58 0.299	Ca=−0.017BW+3.35 0.017
All animals	K= 0.010A+ 0.96 0.181	K= 0.012BW+ 0.78 0.234 [1]	Ca=−0.028A+3.10 0.175	Ca=−0.038BW+3.69 0.262 [1]

Significance levels: [1] 0.05; [2] 0.01; [3] 0.001.

Table 3

Relation between nitrogen, phosphorus, potassium and calcium contents expressed in percentages of dry mass and body weight (BW) in *Apodemus flavicollis*. Correlation coefficient given below equations, significant levels as in Table 2.

Animal groups	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Calcium (Ca)
Autum	N= 0.067BW+ 8.86 0.638 [2]	P= 0.013BW+2.07 0.354	K=0.007BW+0.88 0.524 [1]	Ca=−0.003BW+3.24 0.052
Spring	N= 0.008BW+10.06 0.158	P=−0.044BW+3.55 0.686 [1]	K= 0.003BW+1.09 0.158	Ca=−0.014BW+3.09 0.606
Males	N= 0.035BW+ 9.73 0.530	P=−0.006BW+2.55 0.173	K= 0.006BW+0.94 0.505	Ca=−0.030BW+3.45 0.271
Females	N=−0.007BW+10.13 0.066	P=−0.046BW+3.40 0.482	K= 0.005BW+0.99 0.258	Ca=−0.033BW+3.52 0.643 [1]
All animals	N= 0.036BW+ 9.53 0.435 [1]	P=−0.017BW+2.84 0.321	K= 0.005BW+0.98 0.354	Ca=−0.009BW+3.21 0.164

Table 4
Biogen contents in bodies and excrement of voles and mice.

Item	N	P	K	Ca
Nutrients in bodies, in % of dry weight				
Clethrionomys glareolus	9.9	2.3	1.0	2.9
Apodemus flavicollis	10.3	2.4	1.1	3.0
"Mean animal"	9.9	2.3	1.0	2.9
Faeces	7.5	1.1	1.4	0.6
Nutrients in excrements, in g/ha				
Pine forest, 10.3 animal/ha	580	21	27	11
Oak-hornbeam forest, 13.2 animal/ha	740	27	34	14

4. DISCUSSION

Kaufman & Kaufman (1975a, b) estimated calcium, phosphorus and potassium contents in growing and adult *Peromyscus*. These authors also gave equations making it possible to calculate the contents of some elements in the body of the rodents examined. Ca contents — 2.0%, P — 1.7% and K — 0.8% in 42-day old *Peromyscus* are values lower than those determined for voles and mice (Table 1), whereas the values calculated from equations included in the paper by these authors (1975b) are almost identical with the values obtained in the present study for *Apodemus*. This would seem to indicate that it is not essential, for less exact calculations, to use only values determined for a definite species of rodent.

As an example, calculation is given below of the balance of biogen flow through populations of voles and mice in the Niepołomice Forest near Kraków (Górecki, 1980). The average N, P, K and Ca contents in the bodies of these voles, set out in Table 4, were calculated, taking into consideration the species and age composition of the population and the body weights of the different groups of rodents (Górecki, 1980). Variations in numbers of voles and forest mice were evaluated over a period of several years in the tree stands of the Niepołomice Forest. The average long-term numbers in coniferous stands was 10.3 rodents/ha. Numbers were higher in deciduous stands, where the average figure was 13.0 rodents/ha. This amount of estimated biogens was almost 9 g/ha in the coniferous woods of the Niepołomice Forest, over half of which was nitrogen. After allowing for turnover (Petrusewicz, 1966; Bobek, 1973) the annual percentage of these biogens in production was 32.4 g/ha, this including 19.8 g nitrogen, 4.5 g phosphorus, 2.1 g potassium and almost 6 g calcium. In deciduous woods these amounts are slightly higher and jointly constitute 41.2 g biogens/ha (nitrogen — 25.2; phosphorus — 5.7 g; potassium — 2.7 g; calcium — 7.6 g).

Knowing the biogen contents in the excrement of voles and mice (Górecki, 1980) calculation was made of the annual amount of biogens in their excrement. Data after Drożdż (1968) on the amount of excrement dropped during the course of 24 hours were used for this purpose. Annually almost 200 g of biogens/ha is deposited together with the rodents' excrement in coniferous woods, and almost 140 g of this is nitrogen. In deciduous woods these amounts are even higher — over 250 g biogens, with 180 g of nitrogen/ha.

Nitrogen content in urine is far higher than in excrement (from 40 to over 60% of dry mass), and depends on the kind of food consumed. Voles fed on concentrated and bulk food excreted from 0.090 to 1.120 g nitrogen/24 hours (Górecki, 1980) with their urine, and thus during the course of a year one rodent excretes almost 43 g of nitrogen. When converted to one hectare of forest this is almost 440 g in coniferous stands and 360 g of nitrogen in deciduous stands. These values greatly exceed the total amount of nitrogen contained in excrement. Jointly with excrement the rodents in coniferous stands excrete almost 580 g nitrogen/ha per year, and in deciduous stands almost 740 g (Table 4).

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ZAWARTOŚĆ NIEKTÓRYCH BIOGENÓW W CIAŁACH DWÓCH GATUNKÓW GRYZONI

Streszczenie

Zawartość azotu, fosforu, potasu i wapnia oznaczono w ciele dwóch gatunków gryzoni — *Clethrionomys glareolus* (Schreber. 1780) i *Apodemus flavicollis* (Melchior, 1834). Zawartość azotu wynosi u różnych grup nornic od 9.6 do 10.3% suchej masy (Tabela 1), fosforu wynosi średnio 2.47%, a wapnia 3.08%. Najmniej z badanych pierwiastków jest w ciele nornic potasu — tylko od 0.96 do 1.08%. U myszy leśnych zawartość azotu wynosi 10.3% suchej masy, fosforu 2.4%, wapnia 3.0%, a potasu 1.1% (Tabela 1).

Przykładowo wyliczono dla populacji gryzoni w lasach Puszczy Niepołomickiej stan i bilans biogenów. Łącznie cała populacja (licząca średnio w roku 10.3 do 13.0 gryzoni/ha) wydala rocznie na hektar w ekskrementach 580 g azotu, 21 g fosforu, 27 g potasu i 11 g wapnia w borach, a w grądach nieco więcej (Tabela 4).