

Gross Body Composition of Laboratory-Bred *Pitymys subterraneus*

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Fedyk A., Farin D. & Malzahn E., 1978: Gross body composition of laboratory-bred *Pitymys subterraneus*. Acta theriol., 23, 24: 259—267 [With 4 Figs. & 2 Tables].

Examination was made of the rate of changes in the quantitative composition of fat, water, protein and mineral substances and in the proportions of components of fat-free body (FFB) of laboratory-bred *Pitymys subterraneus* during the course of postnatal development. A high degree of correlation was found between body weight and the amount of fat contained in it. The greatest amount of fat is deposited during the first 20 days of life. Rate of increase in FFB depends on reciprocally correlated increase in its components, the participation of which varies greatly during postnatal development. When kept in captivity, *Pitymys subterraneus* attains chemical maturity, expressed in the quotient of protein and water contents, between the the 50th and 60th day of life.

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1. INTRODUCTION

One of the criteria of postnatal development characterizing the species is the growth rate, the measure of which is increase in body mass per unit of time. Rate of increase in biomass has been examined in all species of mammals bred by humans and many wild species kept in captivity. Rate in increase in gross body composition (GBC) has, however, been examined in greatest detail in animals bred on an industrial scale. In the case of rodents GBC has been examined chiefly in the seasonal aspect (Jameson & Mead, 1964; Górecki, 1965; Hayward, 1965; Evans, 1973; Fleharty *et al.*, 1973; Sawicka-Kapusta, 1974; Schreiber & Johnson, 1975). Dynamics of changes in GBC during the course of postnatal growth has been exhaustively studied only in the laboratory mouse *Mus musculus* (Bailey *et al.*, 1960; Sobel *et al.*, 1968) and among wild species only in the bank vole *Clethrionomys glareolus* (Fedyk, 1974a; 1974b; Sawicka-Kapusta, 1974) and common vole *Microtus agrestis* (Sawicka-Kapusta, 1970; Drożdż *et al.*, 1972).

The purpose of the present study was to measure GBC in European pine voles (*Pitymys subterraneus*) during postnatal development. This

species is bred in the laboratories of the Mammals Research Institute, Polish Academy of Sciences, at Białowieża.

II. MATERIAL AND METHODS

The pine voles taken for the studies constituted the 9—11th brother X sister generation born in captivity during 1972. Laboratory breeding conditions and feeding of the animals were identical with those described earlier (Buchalczyk, 1961). The young animals were taken from their parents on the 20th day of life and each litter reared separately. Analysis was made of 159 pine voles from 1 to 400 days old, examining animals up to the 60th day of life in 1—3 day intervals of time (taking 1—4 individuals in each case), and the older animals in irregular age groups. Animals intended for analysis were anaesthetized with ether, and the following determined in the eviscerated carcass: water content, ether extract (termed fat in the further part of this paper), protein and mineral substances by the methods described earlier (Fedyk, 1974a). The results obtained were elaborated statistically, describing the relation between eviscerated body weight and the amount of fat by means of straight line regression and the percentage of protein, water and mineral substances in the fat-free body (*FFB*) by means of multiple regression. The above regressions were calculated for the whole study of development. In order to show differences in rate of deposit of the different components of *FFB* during postnatal development the above relations were also calculated for four age groups. The *F*-Snedecor test, with $P=0.001$, was used to check the significance of differences in growth rate of fat and *FFB* components in the age groups distinguished. Where there were no significant differences the relations in similar groups were described by a common equation. Statistical calculations were made by the Computer Centre of the Polish Academy of Sciences in Warsaw.

III. RESULTS

During the 400 days of postnatal development there is an almost eightfold increase in the weight of the pine vole, variation in the animals' weight at a given age increasing as development proceeds (Fig. 1). The amount of water in the organism during this period increases on an average from 1.63 g on the first day of life to 8.60 g (over 400%), the amount of protein increases from 0.23 g to 2.25 g (870%) and the amount of mineral substances from about 0.04 g to 0.53 g (over 1200%). The greatest range of variation among the components examined is found for fat, but the relation between body weight and amount of fat it contains — as also among the remaining less variable body components — is statistically significant (Table 1). Most rapid increase in fat takes place during the first 20 days of life (age group I) and is about 3.6 times more intensive than during the subsequent 20 days of life (Fig. 2). Rate of increase in fat similar to that in age group II is characteristic of pine voles between the 41st and 60th

day of life. Pine voles over two months old exhibit the slowest rate of increase in fat. Among the four periods of development distinguished (=age groups) the rate of increase in fat during the II and III period is not significantly different, and therefore these two periods may be described by a common equation (Table 1). Average rate of increase in fat between the 21st and 60th day of life of these animals is then about 73% lower than it is during the first 20 days of life. Rapid increase in fat during the first 20 days of life (while still sucking the mother's milk) affects the average relation for the 400-day period of development between amount of fat and body weight — it is slightly higher than between the 21st and 60th day of life.

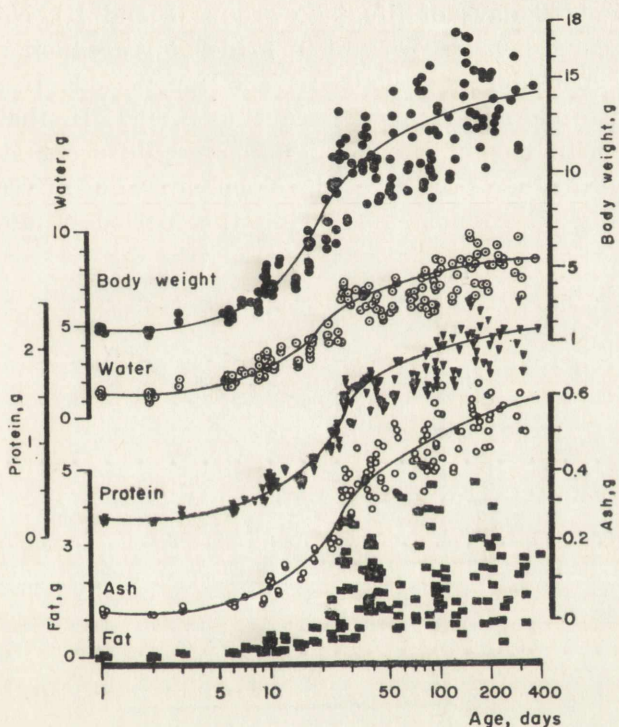


Fig. 1. Quantitative increase of gross body composition and body weight during postnatal development in *P. subterraneus*. Semi-logarithmic scale.

The simultaneous participation of water, protein and mineral substances in the structure of *FFB* is shown in Table 2. During the study development period protein, then water and mineral substances, exert the greatest influence on increase in *FFB*, but the participation of these components varies at different stages of development. Nevertheless pine voles are characterized by a similar rate of increase in *FFB* components

Table 1

Relation between eviscerated body weight (Y) and amount of fat (X) at different stages of development and basic characteristics of regression equations: r —coefficient of correlation, s —standard error of estimate, s_B —standard error of regression coefficient.

Age groups (days)	$Y=A+BX$	r	s	s_B
I (1—20)	$Y=2.080+6.277 X$	.926	.505	.357
II (21—40)	$Y=6.876+1.721 X$	.821	1.167	.215
III (41—60)	$Y=7.582+1.577 X$	.873	.789	.255
IV (61—400)	$Y=9.745+1.435 X$	.809	1.436	.129
I—IV (1—400)	$Y=4.923+2.762 X$	.850	2.322	.136
Together II and III	$Y=6.890+1.687 X$			

during the first 40 days of life (age groups I and II). Non-significant differences occur when comparison is made of regression equations for the I and IV period of development and for periods II and IV. The rate of increase in *FFB* components during period III, that is, between the 41st and 60th day of life, is significantly different statistically in comparison with other periods of development. The different character of increase in *FFB* components during this period of development is

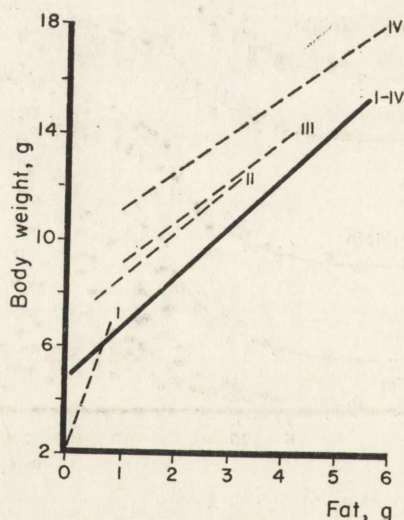


Fig. 2. Relation between body weight and amount of fat contained in it at different stages of development. Mean relation between the parameters examined for 400 days of development is indicated by thick line.

particularly clear when comparing the different components (Fig. 3). The percentage of protein is unusually high, in comparison with other development periods, and the percentage of water and mineral substances particularly low, during the third period.

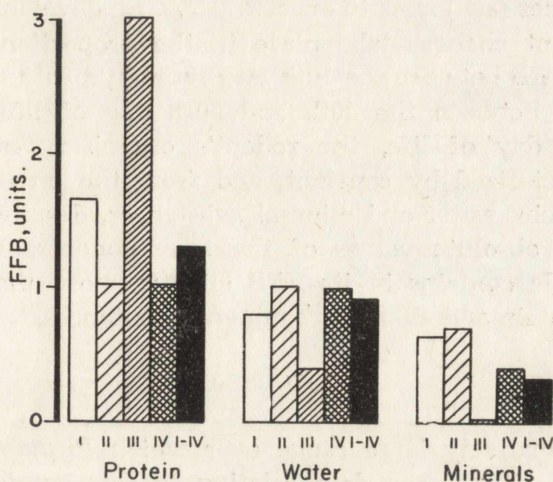


Fig. 3. Gross composition for fat-free body—rate of increase in *FFB* depending on individual increase of different components in successive age groups, and average for the whole study period (I—IV).

The percentage of water, protein and mineral substances in *FFB* varies in a way characteristic of all the mammals examined (Fig. 4). Day-old pine voles have a little more than 85% water in their *FFB*, almost 12% protein and slightly less than 2% mineral substances, whereas by the 10th day of life the amount of water drops to approx. 80%, amount of protein rises to about 17%, while the amount of

Table 2

Growth rate of fat-free body of *Pitymus subterraneus* (X_1) depending on simultaneous influence of water (X_2), mineral substances (X_3) and protein (X_4). In cases in which the multiple regression equation describing this relation did not differ significantly for the different age groups a common equation was used. s —standard error of estimate; s_{B_2} , s_{B_3} , s_{B_4} —standard errors of regression coefficients, r —coefficient of multiple correlation.

Age groups	N	$X_1 = A + B_1 X_1 + B_2 X_2 + B_3 X_3 + B_4 X_4$	S	s_{B_2}	s_{B_3}	s_{B_4}	$r_{1,234}$
I	53	$X_1 = +.012 + .811 X_2 + .643 X_3 + 1.756 X_4$	.075	.091	.837	.380	.998
II	33	$X_1 = -.040 + 1.003 X_2 + .693 X_3 + 1.080 X_4$	.024	.019	.168	.057	.999
III	24	$X_1 = -.060 + .403 X_2 + .095 X_3 + 3.170 X_4$	.081	.180	.544	.507	.997
IV	49	$X_1 = -.32 + 1.026 X_2 + .399 X_3 + 1.074 X_4$	.110	.067	.307	.198	.997
I—IV	159	$X_1 = +.012 + .957 X_2 + .362 X_3 + 1.284 X_4$	.088	.028	.179	.090	.999

Connected groups

I—II	$X_1 = +.007 + .975 X_2 + .669 X_3 + 1.156 X_4$
I—IV	$X_1 = -.021 + .990 X_2 + .464 X_3 + 1.170 X_4$
II—IV	$X_1 = -.056 + .996 X_2 + .538 X_3 + 1.150 X_4$

mineral substances (ash) rises to approx. 2.5%. As development continues further important changes take place in the proportions of the basic components of *FFB* between the 10th and 40th day of life. These changes are less abrupt between the 40th and 50th day of life. Between the 50th and 60th day of life, the rodent's organism reaches chemical maturity, characterized by constant, and from the on unvarying, proportions of protein, water and mineral substances, despite the continued increase in the absolute values of these components. The chemically mature pine vole contains in its *FFB* slightly more than 72% water, about 22.5% protein and almost 5% mineral substances.

IV. DISCUSSION

Despite the relatively large range over which *Pitymys subterraneus* occurs, the majority of the data relating to this species refer to its biology and ecology and reproduction in captivity. There are, however, no data on its postnatal development.

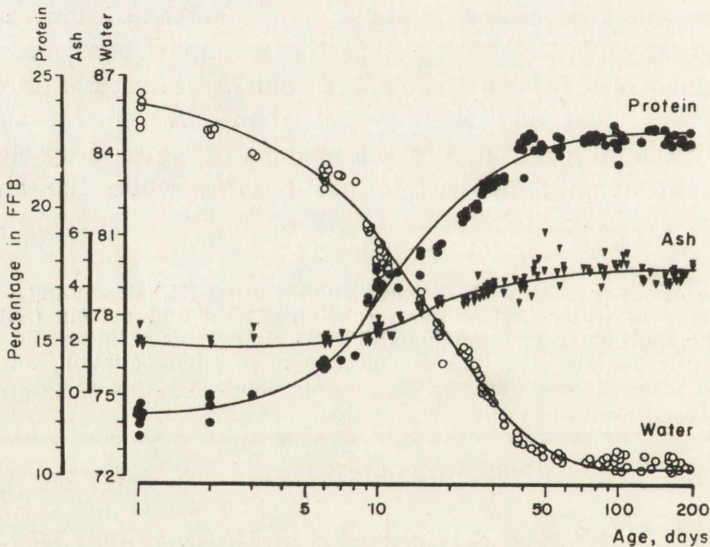


Fig. 4. Sequence of changes in proportions of protein, water and mineral substances in *FFB* which accompany postnatal development of *P. subterraneus*. Semi-logarithmic scale.

The results of the present study showed that during postnatal development the participation of the different components in increase in body mass is not uniform. There are also variations in the participation

of each of the components at different stages of development. In view of the similar methods used for elaborating material, the characteristics of *GBC* development in *Pitymys subterraneus* may be compared with the corresponding data for the bank vole, *Clethrionomys glareolus*, bred in laboratories (cf. Fedyk, 1974a). Both species, despite considerable differences in their biology, have many similar features characteristic of their *GBC* development: (1) Similar body weight on day of birth and similar *GBC* contents in it; (2) Quickest increase in body mass between the 10th and 20th day of life; (3) High degree of correlation between the amount of fat and body weight; (4) Very high rate of fat deposit during the suckling period in comparison with later stages of development; (5) Identical age at which chemical maturity is reached, and consequently similar sequence of changes in the percentage composition of *FFB* during the first two months of life.

In both species the water level in the organisms of mature individuals is chemically identical, but in *P. subterraneus* the protein level is slightly lower and level of mineral substances higher than in *C. glareolus* (protein 22.5% and 23.2%, mineral substances almost 5% and slightly over 4%).

There are distinct differences in the rate of increase of different *FFB* components at different stages of development of the species compared, particularly of increase in protein. In the pine vole protein is most rapidly deposited during the period from the 40th and 60th day of life, while in the bank vole the effect of protein on increase in *FFB* is minimal during this period. The effect of amount of mineral substances on increase in *FFB* is also uneven, and in *P. subterraneus* is minimal between the 40th and 60th day of life, whereas in *C. glareolus* it is greatest between the 20th and 40th day of life, but almost uniform in other periods of development. The rate of water deposit is more varied in different periods of development in *P. subterraneus* than in the bank vole.

The comparison made justifies the conclusion that increase in gross body composition, despite similarity in general trends, is specific to each of these species.

In the light of data from literature on the time, or properly speaking, age at which pine voles enter upon reproduction (Buchalczyk, 1961; Niethammer, 1972) it would seem that chemical maturity is not closely correlated with sexual maturity, but greatly precedes it. This does not apply to *C. glareolus*, in which the age at which the animal attains chemical maturity coincides with the age of attaining sexual maturity.

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PODSTAWOWE SKŁADNIKI CIAŁA *PITYMYS SUBTERRANEUS*
Z HODOWLI LABORATORYJNEJ

Streszczenie

Zbadano podstawowe składniki ciała: tłuszcz, białko, wodę i substancje mineralne w ciągu 400 dni życia darniówek, *Pitymys subterraneus*, ulaboratoryjnia-nych w ciągu 9—11 pokoleń.

Uzyskane wyniki opracowano statystycznie, opisując relacje między ilością tłuszczu a ciężarem ciała równaniami regresji prostej; tempo przyrostu beztłuszczowej masy ciała (*FFB*) w zależności od przyrostu jej składnikóy — równaniami regresji wielokrotnej. Dla wykazania zróżnicowań w tempie przyrostu podstawowych składników ciała (*GBC*) w trakcie rozwoju postnatalnego powyższymi równaniami opisano tendencje przyrostu w czterech etapach rozwoju.

W badanym okresie rozwoju 8-krotnie zwiększa się ciężar ciała darniówek. Na ten przyrost składa się, w stosunku do 1-go dnia życia, przyrost substancji mineralnych o ponad 1200%, białka o 870% a wody o 400% (Fig. 1). Tłuszcz charakteryzuje największy spośród badanych składników zakres zmienności w zależności od wieku (Fig. 1), pomimo to zależność między ciężarem ciała a ilością zawartego w nim tłuszczu jest istotna w każdym okresie rozwoju (Tabela 1). Najszybszy przyrost tłuszczu ma miejsce w okresie oseskowym (Fig. 2).

Szybkość odkładnia pozostałych składników ciała, stanowiących jej beztłuszczową masę jest różna w różnych okresach rozwoju (Tabela 2). Największe różnice w udziale składników *FFB*, w porównaniu z innymi okresami rozwoju zanotowano w okresie od 41 do 60 dnia życia. Procentowy udział wody, białka i substancji mineralnych w *FFB* zmienia się w sposób charakterystyczny dla ssaków (Fig. 4). Dojrzałość chemiczną osiągają darniówki między 50 a 60-tym dniem życia.