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Oxygen Consumption and Heat Production in Chinchillas

[With 2 Tables and 1 Fig.]

The oxygen consumption of chinchillas (average body weight=402.5 g) was studied in a closed-circuit system respirometer in ambient temperatures from 5 to 35°C. The thermoneutral zone of these rodents is between 20 and 30°C where the minimal resting metabolism rate averages 0.6812 ccm O_2/g/h. With the decrease of ambient temperature from 30 to 5°C the oxygen consumption increases by 85%. Both the metabolism rate and the heat production are lower in the chinchilla than in other rodent species with similar body weight.

The chinchillas (*Chinchilla lanigera* Molina, 1782) have been thoroughly studied because of their great importance in fur industry. Recently they are often used in comparative physiological studies (White, 1964) but there are almost no data on the metabolism rate of chinchilla. Therefore it seemed appropriate to study the oxygen consumption and the chemical thermoregulation in this interesting rodent.

MATERIAL AND METHODS

Male chinchillas (*Chinchilla lanigera* Molina, 1782) were used for the experiments. These animals were raised at a farm in the temperature of 15°C (± 5°C) and in natural illumination.

The chemical thermoregulation was determined by the oxygen consumption in a modified Kalabukhov-Skvartzov respirometer (Grodziński, 1961). In this apparatus the resting metabolism rate (*RMR*) was measured. The animals were not fasted before runs. For measurements the animals were placed in 9 liter chambers slightly limiting their movements. The oxygen consumption was determined in six ambient temperatures, every 5° from +5 to +35°C. The total of 63 thirty minute runs was done on six individuals. The rectal temperature was measured before and after each run with a tele-thermistor thermometer. All experiments were done during the winter. The mean body weight of animals used was 402.5 g (from 330.0 to 498.0 g).

The oxygen consumption was measured in ccm/g/h. From this the following values were computed: heat production in cal/g/h, intensity of chemical thermoregulation in per cent and the body insulation index from the formula of Hart & Héroux (1955).

RESULTS AND DISCUSSION

In the studied range of ambient temperatures the chinchillas had the lowest oxygen consumption at 30°C (Table 1). In temperatures 20 and 25°C it was only very slightly higher. Assuming the oxygen consumption at 30°C as 100% it was 101.5 and 103.0% at 20 and 25°C, respectively. Most likely this broad range of temperatures (20—30°C) corresponds to

Table 1.

The oxygen consumption and the heat production of chinchilla in different ambient temperatures.

°C	No of runs	ccm O_2/g/h ± S.D.	Coeff. Variat. /%/	Kcal/g/24^h ± S.D.	Coeff. Variat. /%/	Kcal/animal/24^h ± S.D.	Coeff. Variat. /%/
5	10	1.2579 ± 0.290	23.0	0.1461 ± 0.033	20.5	58.19 ± 11.16	20.0
10	10	1.0377 ± 0.232	22.1	0.1194 ± 0.027	22.6	47.23 ± 7.58	16.1
15	9	0.7933 ± 0.081	10.2	0.0906 ± 0.010	11.0	36.49 ± 4.70	12.9
20	12	0.6938 ± 0.097	13.7	0.0799 ± 0.011	12.5	31.91 ± 4.40	13.8
25	12	0.7075 ± 0.095	13.5	0.0805 ± 0.022	25.0	32.33 ± 6.19	19.1
30	10	0.6812 ± 0.073	10.7	0.0785 ± 0.022	28.0	31.45 ± 6.61	20.9

the thermoneutral zone of chinchilla (Fig. 1). The temperature of 35°C borders the upper lethal zone. After attempts to do a run in this temperature the animals appeared strongly overheated. The increase of oxygen consumption from 20 to 15°C was slight and amounted only to 14.5%. In the lowest studied temperatures the increase of oxygen consumption was rather abrupt, 150.2% at 10°C and 185.0% at 5°C (Table 1).

The absolute increase of heat production from the thermoneutral zone to +5°C was 0.0676 kcal/g/24^h, or 26.74 kcal/24^h/ animal of average body weight (402.5 g). This body weight is slightly lower than the mean value based on a large sample — 476.6 g (Kidwell, 1955). The heat production calculated in cal/g/h/°C differed considerably in five degrees temperature intervals. It was 0.223 cal/g/h/°C in the range 5 to 15°C and 0.0955 cal/g/h/°C in the range from 15 to 20°C. In the thermoneutral zone (20 to 30°C) it was, of course, the lowest namely 0.006 cal/g/h/°C.

The insulation index of the chinchilla body was computed from the formula of H a r t & H é r o u x (1955):

$$Ii = \frac{\text{Body temp.} - \text{Ambient temp.}}{\text{Oxygen consumption}}$$

In different ambient temperatures the chinchillas were somewhat poikilothermic. The rectal temperature was the highest at ambient temperatures from 20 to 30°C averaging 35.4°C. It was considerably lower at 5 and 10° averaging 31.5 and 32.4°C, respectively. These temperatures were used in computing the body insulation index for the chinchilla. The insulation curve is given in Fig. 1. The values of insulation index are highest between 15 and 20°C. This is most likely related to the acclimatization of chinchillas to these temperatures aquired during long breeding

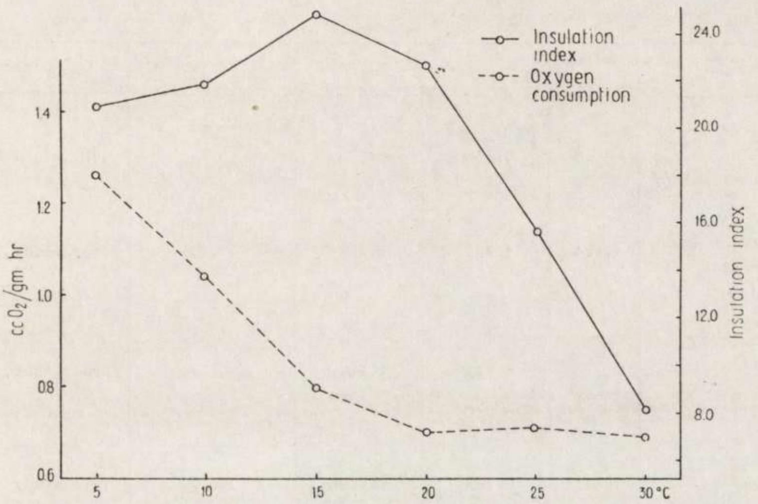

Fig. 1. The metabolism-temperature curve and the curve of body insulation of the chinchilla.

Resting metabolism rate (*RMR*) of the chinchilla at 30°C is 50% lower than basal metabolism rate (*BMR*) of the hamster, *Cricetus cricetus* (L i n n a e u s, 1758) (body weight 309 g) and 28% lower than *BMR* of the guinea pig (body weight 439 g) (K a y s e r & H e u s n e r, 1964). From the general dependence of basal metabolism (*M*) on the animal body weight (*W*), $M = 70\ W^{3/4}$ (K l e i b e r, 1961) it is possible to compute so called "predicted" *BMR*. For the animal weighing 402.5 g it is 0.7638 ccm O_2/g/h. This "predicted" value of *BMR* exceeds by 11% the minimal *RMR* of chinchilla determined in the thermoneutral zone. Moreover, the value of *RMR* certainly exceeds slightly that of *BMR* due to some movements of animals and specific-dynamic action of food (*SDA*). Consequently, one can assume that the basal metabolism rate of chinchilla is below the mouse-elephant line at least by 15 to 20%.

The oxgen consumption of different rodent species at 15°C is given in Table 2. Corresponding values of energy requirement (in kcal/g/24^h) were computed. The energy requirement of the chinchilla is lower than one would expect from its body weight.

Similarly, the intensity of chemical thermoregulation (expressed in %%/°C) is much lower in the chinchilla than in other "domesticated" rodent species. In the range from 30 to 5°C it amounted to only 3.4%.

Table 2.

Comparison of the oxygen consumption and daily energy requirement of some rodent species. All values of oxygen consumption measured at 15°C, as resting metabolism rate or the average daily metabolism rate.

Species	Weight in g	ccm O_2/g/h	Kcal/g/24^h	Kcal/anim./24^h	Author
Clethrionomys glareolus /Schreber, 1780/	20.9	6.280	0.7239	15.14	Górecki, 1966
Glaucomys sabrinus yukonensis /Osgood, 1900/	174.4	1.753	0.2019	35.23	Grodziński, 1966
Tamiasciurus hudsonicus preblei /Howell, 1936/	252.3	1.745	0.2010	50.72	Grodziński, 1966
Chinchilla lanigera /Molina, 1782/	402.5	0.793	0.0906	36.49	This study
Lepus americanus /Erxleben, 1777/	1550.0	0.810	0.0892	138.24	Hart et al., 1965

During long breeding practice the chinchillas were acclimatized to the temperature about 15 to 20°C. However, even below this temperature zone (at 5 to 10°C), the heat production of chinchillas is quite low.

Most probably the wild chinchillas in their high mountain habitat are much better acclimatized to low temperatures. Consequently the intensity of their thermoregulation can very well be even lower than 3.4%. It seems very interesting that, with respect to the chemical thermoregulation, the high mountain chinchilla is very similar to the subarctic red squirrel (*Tamiasciurus hudsonicus preblei* Howell). Although these squirrels are almost two times smaller than the chinchillas, they increase the heat production from 30 to 0°C only by roughly 4.5%/°C (I r v i n g, *et al.*, 1955).

The low level of metabolism and not very intensive chemical thermoregulation of chinchillas is most likely related to the exceptionally good physical thermoregulation of their body. The chinchillas have very good insulation because of their coat which is quite unique both morphologically and histologically and compares very favourably with that of other rodents (W i l c o x, 1950; K a ź m i e r c z a k, 1962).

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ZUŻYCIE TLENU I PRODUKCJA CIEPŁA U SZYNSZYLI

Streszczenie

W respirometrze Kalabukhov'a — Skvartzov'a określano zużycie tlenu szynszyli w temperaturach od +5 do +35°C. Strefa termoneutralna tych gryzoni leży w zakresie 20—30°C, minimalny metabolizm spoczynkowy w tej strefie osiąga średnio 0,6812 ccm O_2/g/h (Tab. 1, Fig. 1). Intensywność zużycia tlenu od 30 do 5°C wzrasta o 85%. Zarówno poziom metabolizmu, jak także produkcji ciepła są u szynszyli niższe, niż u innych gryzoni o podobnym ciężarze ciała (Tab. 2). Szynszyle zawdzięczają to wyjątkowej izolacyjności swego futra.