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## Body Temperature and Resistance to Cooling in Growing Pine Voles

TEMPERATURA CIAŁA I OPORNOŚĆ NA OCHŁADZANIE U ROSNĄCYCH DARNIÓWEK

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Gębczyński M., 1981: Body temperature and resistance to cooling in growing pine voles. Acta theriol., 26, 34: 495—499 [With 1 Table].

Body temperature in the pine vole *Pitymys subterraneus* (de Selys-Longchamps, 1836) is about 33°C at birth, but reaches 38° by the fourth week of life. Increase in body temperature is most rapid during the first week of life. Its value does not vary between the 7th and 12th day of life. Reaction to cooling is formed during the first nine days after birth.

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### 1. INTRODUCTION

Pine voles, *Pitymys subterraneus* (de Selys-Longchamps, 1835) are not capable after birth, like many other mammal species, of maintaining constant body temperature. This does not mean, however, that the body temperature ($T_B$) during the postnatal development period of young pine voles still living in the nest is subject to considerable and random fluctuations. Data on poikilothermy during the postnatal period do not in any way contradict the above statement, but each of these conclusions applies to a different situation. The opinion as to relatively constant body temperature refers to individuals under natural conditions, in the nest, under maternal (parental) care. The second opinion as to complete poikilothermy of newborn mammals is based on measurements made under laboratory conditions, frequently on animal's kept singly and outside the nest. Such research makes it possible to supplement our knowledge on the development of thermoregulation during the postnatal period, but does not state the temperature of the growing rodents. Only measurements made on individuals in the nest can provide information as to the value and range of variations in this index. Collection of data in the field is, however, limited with the present technical facilities available. Another solution is to use animals kept under semi-natural conditions (enclosures) (Gębczyński, 1975). Measurements made under laboratory conditions at different ambient temperatures nevertheless give some guide as to the body temperature of growing animals.

The rate at which poikilothermy is formed can be evaluated by means of the capacity for maintaining constant body temperature under conditions of physiological cold. In this way it is possible to estimate the animal's resistance to cooling, which may be expressed by an index estimating the rate of changes in body temperature in a unit of time.

The purpose of the study was to determine body temperature and resistance to cooling in growing pine voles during the first four weeks of life.

## 2. MATERIAL AND METHODS

Measurements were made in a laboratory for 28 days of the offspring's life. The females, together with the males and the litter, were kept in cages measuring 40×25×15 cm. A partition at one end created a nesting area of 10×25×15 cm and a run of 30×25×15 cm. Entrances into the nest area were through two small holes at the lower left and right hand corners of the partition. The bottom of the cage was covered with moss and the nest was made of hay.

A total of 132 litters (271 voles) were examined, 114 of which were kept at an ambient temperature of 16—19°C, and 18 litters were born and kept at a temperature of 5—8°C. The animals' body temperature was measured immediately after removal from the nest, using an electric thermometer (Type TE3, Electrolaboratiet, Copenhagen) with H1 and F6 probes. Resistance to cooling was determined in a separate series of measurements on pine voles kept single for 30 min. outside the nest at a temperature of 16—17°C. Details of the technique used for $T_B$ measurements and treatment of the animals have been described earlier (Gębczyński, 1975). The measurements were made on a given individual not more often than every 5 days.

## 3. RESULTS AND DISCUSSIONS

### 3.1. Body Temperature in Growing Individuals

On the first day after birth the body temperature of pine voles living in the nest was 33°C. During the fourth week of life $T_B$ is the same as in adult individuals, since it reaches 38°C. The rate of variations during the first three weeks of life is not even; it is greatest during the first seven days of life, when increase in this value is 3°C. During the second and third week of life increase in $T_B$ slows down and it becomes stabilized (Table 1).

The level and rate of increase in $T_B$ do not differ to a statisically significant degree ($P<0.05$) between pine voles born and growing at ambient temperatures of 5—8° and 16—19°C, and therefore the values obtained have been treated jointly.

Increase in $T_B$ after birth is also observed in a large number of other species of homoiothermic animals, and this increase may undergo transitional stabilization. Thus in the pine vole $T_B$ does not vary between the 7th and 12th day after birth (Table 1). In laboratory mice transitional stabilization of $T_B$ takes place between the second and fourth, or fifth, day of life (Pichotka, 1971). In the bank vole interruption of increase in $T_B$ is extended from the first to the ninth day after birth (Gębczyński, 1975). In the rabbit, however, $T_B$ increases by 3° during the first 27 hours after birth, then is maintained up to the 9th day of life on a similar level, after which it again increases by 1° between the 12th and 25th day of life, then reaches the value proper to an adult individual (Poczopko, 1969). In the birch mouse (*Sicista betulina)*, that is, a rodent capable of hibernation, the period of the $T_B$ plateau during the postnatal increase also occurs on the 10th—16th day of life (Pucek, 1958).

Periods of stabilization in body temp. during its postembryonic increase are also observed in some species of birds, *e.g.* in the thrush

Table 1
Body temperature level and cooling rate index in *P. subterraneus* during the first month of its life.
Cooling rate index was calculated according to the formula: $C=(Ts\text{-}Tf)\times100/t$, where $Ts$ and $Tf$ are body temperature at the beginning and at the end of experiments, respectively; $t$ is time in minutes. Body weight of *P. subterraneus* is about 2 g at birth and 12 g at age of 28 days.

| Age, days | Body temperature, °C n | x̄ | ± SD | Cooling rate, C n | x̄ | ± SD |
|---|---|---|---|---|---|---|
| 0 | 6 | 32.4 | 1.9 | 23 | 31.6 | 14.8 |
| 1 | 63 | 33.4 | 1.9 | 32 | 38.2 | 21.5 |
| 2 | 52 | 34.2 | 1.7 | 20 | 41.4 | 12.2 |
| 3 | 61 | 34.8 | 1.2 | 23 | 39.2 | 10.1 |
| 4 | 52 | 34.8 | 2.0 | 17 | 36.9 | 12.6 |
| 5 | 42 | 35.3 | 0.9 | 23 | 36.3 | 12.1 |
| 6 | 51 | 35.1 | 1.7 | 23 | 28.0 | 9.0 |
| 7 | 37 | 36.3 | 1.2 | 18 | 26.0 | 6.1 |
| 8 | 27 | 35.7 | 1.3 | 18 | 21.0 | 7.8 |
| 9 | 28 | 36.1 | 0.8 | 22 | 14.5 | 4.4 |
| 10 | 17 | 35.9 | 1.0 | 25 | 0.4 | 6.6 |
| 11 | 32 | 36.0 | 0.8 | 20 | –5.2 | 4.2 |
| 12 | 27 | 36.1 | 0.9 | 26 | 1.4 | 3.7 |
| 13 | 33 | 36.5 | 0.3 | 27 | 0.5 | 0.5 |
| 14 | 16 | 37.2 | 0.4 | 23 | 2.0 | 3.7 |
| 15 | 18 | 37.1 | 1.0 | 20 | 3.6 | 2.5 |
| 16 | 26 | 37.5 | 0.5 | 26 | –3.7 | 4.1 |
| 17 | 15 | 37.1 | 0.5 | 18 | –8.0 | 1.3 |
| 18 | 13 | 37.6 | 0.4 | 18 | –4.5 | 7.7 |
| 19 | 18 | 37.9 | 0.3 | 22 | –2.7 | 2.3 |
| 20 | 16 | 37.9 | 0.5 | | | |
| 21 | 6 | 37.5 | 0.5 | | | |
| 22 | 12 | 37.7 | 0.5 | | | |
| 23 | 17 | 37.9 | 0.4 | | | |
| 24 | 14 | 37.9 | 0.4 | | | |
| 25 | 6 | 38.0 | 0.2 | | | |
| 26 | 10 | 38.0 | 0.2 | | | |
| 27 | 6 | 37.8 | 0.4 | | | |
| 28 | 4 | 38.1 | — | | | |
| Ad | 47 | 37.2 | 0.7 | | | |

*Turdus philomelos,* the body temperature of which is maintained on a constant level up to the fifth day after hatching (Keskpaik, 1967). A similarly varying rate of development has also been found in several other species of small passerines (Shilov, 1968).

A regular increase in $T_B$, without a temporary plateau, has been found in piglets (Newland *et al.*, 1952), chickens (Šimkova, 1960), goslings (Poczopko, 1967) and the fat dormouse (Gębczyński, 1970).

This is proof that $T_B$ development can take place without transitional stabilization.

The transitional plateau in $T_B$ lasts for different periods, from 2—3 days (laboratory mice) to 9 days (bank vole, rabbit) or even 12 (rabbit, second plateau). This period may consist of one (birch mouse, laboratory mouse, bank vole, pine vole) or two interruptions of increase in $T_B$ (rabbit). The $T_B$ plateau may begin during the second 24-hour period of life (rabbit, bank vole) or later (birch mouse, laboratory mouse, pine vole).

The phenomenon of periodical stabilization of $T_B$ cannot be connected with increase in body mass, which for instance in the pine vole increases regularly during the first month of life (Schröpfer, 1977), neither can it be explained by the formation of the fur coat, which in such closely related species as miece, pine voles and bank voles forms at the same period of life, *i.e.* between the second and ninth day of life. It would seem that it can be connected with the non-linear relation between *BMR* and body weight in growing homeotherms (Poczopko, 1979). There are no irrefutable data, but results obtained on the bank vole (Gębczyński, 1975) and rabbit (Piekarzewska, 1977) suggest that this relation exists. It may therefore be assumed that the development of vasculomotor reactions participates in the uneven increase in $T_B$.

### 3.2. Resistance to Cooling

Reaction to moderate cooling is formed relatively quickly in the pine vole, and it is only during the first five days of life that there is a very marked drop in body temperature after removing the animals from the nest, and is in fact independent of age. Between the sixth and ninth day there is an abrupt decrease in the calculated index (Table 1). In older individuals cooling causes only a slight decrease, or even an increase, in $T_B$, as is shown by index *C* oscillating round the zero value.

The formation of resistance to cooling in the pine vole takes place differently than in the bank vole (Gębczyński, 1975). In the latter the cooling rate index decreases in successive days of life, without forming a balanced initial level. Data for the rabbit show that 8-day old individuals are already capable of maintaining constant $T_B$ at an ambient temperature of 16°C (Poczopko, 1969). In the fat dormouse also (Gębczyński, 1970) resistance to cooling in 10-day old individuals is significantly higher than in 5-day old dormice. Pichotka (1970) found that resistance to cooling in mice increases between the 1st and the 4th-5th day of life. All these data indicate that resistance to cooling is formed in the above mentioned species of mammals during the period of nest life, long before the animals leave the nest. The young animals nevertheless, during the period of life in the nest, have a fairly constant body temperature increase on successive days of life, since its level in newborn rodents is approx. 5°C lower than in adult individuals.

## REFERENCES

Gębczyński M., 1970: Development of temperature regulation in the fat dormouse. Acta theriol., *15*: 357—372. — Gębczyński M., 1975: Heat economy and the energy cost of growth in the bank vole during the first month of postnatal life. Acta theriol., *20*: 379—434. — Keskpaik J., 1967: Razvitie postojanstva temperatury tela u ptencov *Turdus p. philomelos* Brehm. Ežegodnik Obšč. Estestvoisp. Pri. AN Est. SSR, *58*: 203—215. — Newland H. W., McMillen W. N. & Reinecke E. P., 1952: Temperature adaptation in the baby pig. J. Anim. Sci., *11*: 118—133. — Pichotka J. P., 1970: Chemical thermoregulation in poikilothermic new-born mice. J. Physiol., *63*: 376—379. Paris. — Piekarzewska A. B., 1977: Changes in thermogenesis and its hormonal regulators during the postnatal development of rabbits and guinea pigs. Acta theriol., *22*: 159—180. — Poczopko P., 1967: Badania nad wpływem warunków termicznych środowiska na gęsi. II. Temperatura ciała gęsiąt w pierwszych trzech tygodniach po wylęgu. Acta physiol. pol., *18*: 425—434. — Poczopko P., 1969: The development of resistance to cooling in baby rabbits. Acta theriol., *14*: 449—462. — Poczopko P., 1979: Metabolic rate and body size relationships in adult and growing homeotherms. Acta theriol., *24*: 125—136. — Pucek Z., 1958: Untersuchungen über Nestentwicklung und Thermoregulation bei einem Wurf von *Sicista betulina* Pallas. Acta theriol., *2*: 11—54. — Schröpfer R., 1977: Die postnatale Entwicklung der Kleinwühlmaus, *Pitymys subterraneus* de Selys-Longchamps, 1836 (*Rodentia, Cricetidae*). Bonn. zool. Beitr., *28*: 249—268. — Shilov I. A., 1968: Reguljacija teploobmena u ptic (ékologo-fizjologičeskij očerk). Izd. Moskov. Univ.: 1—251. Moskva. — Šimková A., 1960: Vývoj tělesné teploty kuřat ve vztahu k ruznému tepelnému režimu při odchovu. Sb. Českoslov. Akad. zemed. Věd, Živočišna Vyroba 5 (*33*): 449—460.

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# Body Temperature Relations in Suckling Hedgehogs

TEMPERATURA CIAŁA U ROSNĄCYCH JEŻY

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Walhovd H., 1981: Body temperature relations in suckling hedgehogs. Acta theriol., 26, 34: 499—503 [With 2 Tables].

Young hedgehogs, (n=136) *Erinaceus europaeus* Linnaeus, 1758 (body weight 20—240 g), were discovered while astray from their breeding nests. The state and the behaviour of the young indicated that they had been accidently separated from maternal care. During the subsequent period of human care 88 survived while 48 succumbed, some due to blowfly myiasis. When first found, the young hedgehogs were described as "unconscious and cold" or "not willing to take offered food". The oral temperature in 11 cases was within the normothermic range between 31.5—34.0°C. In 14 others the body temperature ranged between 17.5—21.0°C, a clearly hypothermic state. It is discussed how animals in this situation may enter a state of summer torpor.

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## 1. INTRODUCTION

The postnatal development of temperature regulation has been studied in some species of mammals. Eisentraut (1935) investigated the thermolability in a litter of 7 young hedgehogs during their first month of life. The present paper deals with observations and measu-