

BODY TEMPERATURE IN THE NEWBORN COTTONTAIL RABBIT *(Sylvilagus floridanus)*¹

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ABSTRACT

Body temperature measurements were obtained for neonatal cottontail rabbits (*Sylvilagus floridanus*) exposed to ambient temperatures of 5, 18 and 30 C. The cottontails ontogenetic progression towards a homeothermic state has been documented. The ecological implications of this critical developmental period are described.

INTRODUCTION

From past studies, it is apparent that a relationship exists between the state of maturity of a newborn homeotherm and its capacity to regulate body temperature. The altricial hamster, for example, possesses poor thermoregulation at birth and requires a thermally protected existence while heat production and heat conservation mechanisms develop (Rink, 1969). The precocial lamb, on the other hand, is able to maintain a near adult level body temperature at birth, even at very low ambient temperatures (Alexander and McCance, 1958; Smith, 1961).

To date, most studies on the development of thermoregulation have focused on laboratory and domesticated mammals with little attention being paid to wild species. Among the leporids, only the domesticated European rabbit (*Oryctolagus cuniculus*) has been studied. The purpose of the present investigation was to determine the pattern of early body temperature development in wild cottontail rabbits and to assess its ecological implications.

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MATERIAL AND METHODS

Test animals were healthy newborn cottontails of either sex. The neonates were obtained by capturing wild, pregnant rabbits and holding them in an environmentally controlled animal room until parturition occurred. Normal growth was achieved by a method of force-maternal-feeding using oxytocin. The details of this procedure have been described by Gates and Pederson (1986).

With the exception of those animals retested on days 15 and 30, rabbits were tested for body temperature each day for 10 days at three different ambient temperatures (T_a): 5, 18 and 30 C, and in that order. Testing began no sooner than 2 hours after the morning feeding, about 10:00 AM, and continued for the next 8-10 hours.

The T_a was regulated in conjunction with metabolic experiments on the species. Thus, the test subject was contained within a closed-system respiration chamber submersed in a water bath. By adding small amounts of ice or hot water, the bath temperature was adjusted to provide a chamber T_a within ± 0.5 C of the desired reading. The need for modifying the T_a was determined using a thermistor probe inserted into the chamber. The probe reading was monitored using a *Yellow Springs* tele-thermometer, series 46TUC (*Yellow Springs Instrument Co.*, Yellow Springs, Ohio). The animals received pure oxygen, as needed, during the testing period. Soda-lime was used to absorb carbon dioxide. A cylindrical wire cage was used to reduce the animal's activity.

Body temperature was measured as rectal temperature (T_r) using a thermistor probe and the *Yellow Springs* tele-thermometer. For reasons of safety, the thermistor probe was tipped with size 50 polyethylene tubing for animals aged 0-15 days, and was completely encased with the terminal portion of an infant feeding tube for 30 day-old animals. When used, the probe was lubricated with petroleum jelly and inserted as deeply into the rectum as the size of the animal would permit. After a 50-60 minute exposure to a given T_a , the animal was removed from the test chamber, and its T_r was taken as quickly as possible (within 30 sec). Each animal was given at least one hour to recover between test runs. During this period it was allowed to huddle with litter mates in a warm location.

RESULTS

Data for the mean T_r of animals aged 0-10, 15 and 30 days exposed for 50-60 min to T_a of 5, 18 and 30 C is presented in Figure 1. An average of 19 animals per day were tested between days 0-10; exactly 9 animals on day 15 and 4 on day 30. These animals were obtained from 9 different litters.

Figure 1 shows the change in T_r at various T_a during early postnatal development. At the T_a of 5 C, T_r rose steadily at an average rate of 1.5 C/day during the first 15 days, and changed only slightly (0.5 C) during the next 15 days. The thermal gradient ($T_r - T_a$) at this same T_a increased from 10 C on the day of birth to 24.5 C by day 10, to 32 C by day 15, and to 32.5 C by day 30. Changes were less dramatic at the T_a of 18 C. Rectal temperature rose at an average rate of 0.8 C/day during the first 15 days and again only slightly (0.6 C) during the next 15 days. The thermal gradient increased from 7.6 C on the day of birth to 15.7 C by day 10, to 19.4 C by day 15 and to 20 C by day 30. At a T_a of 30 C, T_r rose at the rate of 0.4 C/day

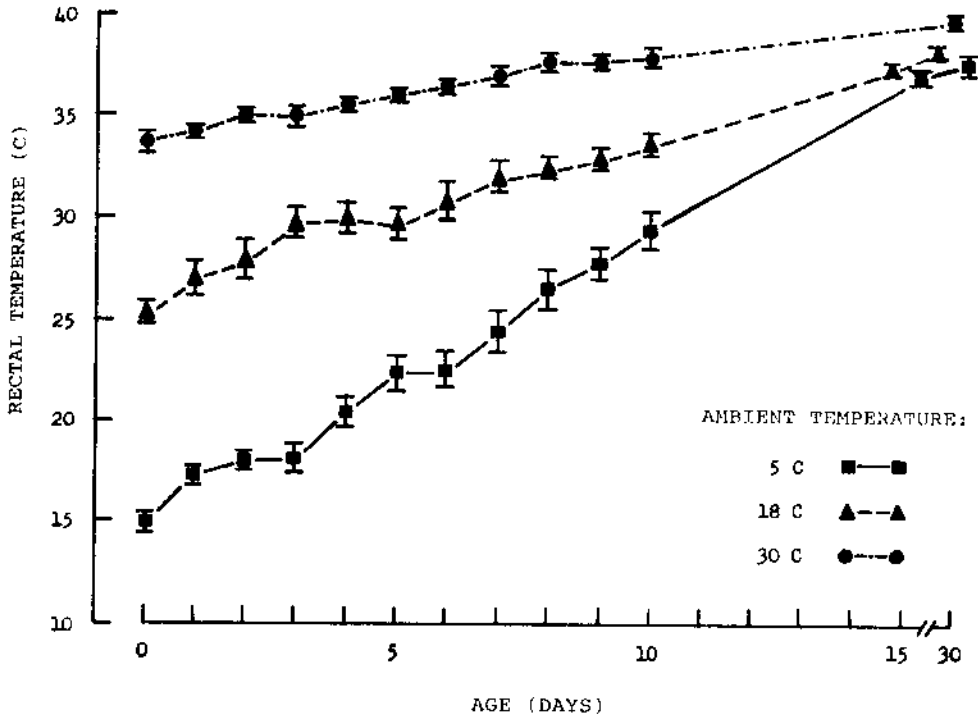


Fig. 1. Rectal temperature (Mean \pm S.E.) plotted against age for ambient temperatures of 5, 18 and 30 C. The means are indicated by solid symbols and the S.E. by vertical lines.

during the first 10 days, and only an additional 2 C by day 30. The thermal gradient changed from 3.7 C on the day of birth to 7.8 C by day 10, and to 9.8 C by day 30.

The percent variation ($SD/MX \times 100$) was determined to facilitate a comparison of the relative variability in thermoregulatory capacity at various T_a and ages. During the first 10 days, there appeared to be no consistent variation with respect to age; however, there was variation with respect to T_a . The average percent variation at 5, 18 and 30 C was 14, 10 and 5 percent respectively. This shows that not all the animals had a similar capacity for thermoregulation, particularly at colder temperatures. By days 15 and 30 the situation had altered. The magnitude of the variability had changed with age (about 2 percent) but not the T_a . This shows that the animals had a similar capacity for thermoregulation irrespective of T_a .

DISCUSSION

Thermoregulation in Newborn Rabbits.—As in other altricial species, the newborn cottontail experiences a decrease in T_r when exposed to a decreasing T_a . During subsequent postnatal development the drop in T_r decreases, and finally T_r becomes independent of T_a . If the curves of Figure 1 are considered linear up to day 10 and are extrapolated from day 10 to 40 C (adult T_r ; Janes, 1957), an estimate of the time of homeothermy can be obtained. On this basis, homeothermy over the T_a range 5-30 C, should occur between days 15 and 18. The fact that day 30 data differs little from day 15 data lends support to this conclusion.

If the data for T_r in the study by Hull (1965) is representative of the European rabbit, then by interpolation, at a T_a of 18 C the domesticated species is able to maintain a T_r about 6 C higher than the cottontail on the day of birth. By day 9, the European rabbit appears to be essentially homeothermic at 18 C, a state the cottontail does not reach until much later.

Ecological Implications.—The results of the present study demonstrate the newborn cottontails' poorly developed capacity for thermoregulation at birth and shortly thereafter. Hypothermia was a potentially detrimental effect to the animal observed during experimentation. Bernard and Hull (1964) have observed the effects of rearing newborn European rabbits at reduced T_a . Long-term exposure at 25 C resulted in hypothermia and death for many rabbits before the age of 7 days, while a reduced milk intake and increased metabolism resulted in a slow growth rate for survivors.

Ambient temperatures as severe as those used in testing do occur during the nesting season. Indeed, the average minimum T_a for the Illinois region during March is about -1 C, and for May, the peak nesting month it is about 10 C (Conway, 1963).

Obviously, there must be some supplemental source of thermal protection available to the young cottontail until it reaches homeothermy. The nest is a superb candidate. Its construction has been described by a number of authors (Beule, 1940; Hendrickson, 1940; Casteel, 1966). It consists of a small ground cavity in which is arranged an outer layer of plant debris and an inner layer of rabbit fur. Hendrickson indicated that, on the average, fur comprises 38 percent of the nesting material. The fact that the nest is in the ground may be of thermal significance. A Nebraska study has revealed that surface soil has a temperature above that of the air for every season of the year, but the deviation is the greatest during the spring and summer seasons, the nesting period for the cottontail (Buckman and Brady, 1960).

Another source of protection is afforded by huddling. Mount (1960) found that in newborn pigs exposed to cold, T_r is maintained more economically in terms of energy expenditure when the pigs are tested in a group rather than individually, and that the savings becomes proportionately greater with decreasing T_a . In addition, he noted that the energy expenditure decreases as the number of individuals and the total weight of the huddling mass increases. Cottontails also huddle, and this behavior could be a very important mechanism for heat conservation.

Any factor adversely influencing the thermal state of this thermally vulnerable young animal is a potential mortality factor. Such factors might include severe weather, poor maternal care, small litter size and nest exposure due to farming operations, predators and the like.

SUMMARY

The rectal temperature of the newborn cottontail rabbit showed a precipitous drop in response to decreasing ambient temperature, thus revealing the animals' poorly developed capacity for thermoregulation. The magnitude of the drop decreased significantly with age, and by day fifteen the animal was essentially homeothermic.

The suggestion is made that under certain circumstances the poor thermoregulatory capacity of the young rabbit might be a source of mortality for the cottontail population.

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