

## Nest Building Activity as Thermoprotective Maternal Behaviour in Rats<sup>1</sup>

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Every other day from the 4th to the 11th day postpartum mother rats and their litters were exposed to a lowering of the ambient temperature by 5° C for 2 hours (Experiment I), while on the 12th day the temperature was lowered by 10° C (Experiment II). These drops in temperature resulted in a considerable increase in the total duration of nest-building activities by mother rats. This increase was easily perceptible within the first 30 minutes of cooling. Moreover, a longer nest-building bout was observed. On the 12th day both the experimental (Ex) and the control (C) groups were cooled. Then the C group mothers, which had not been cooled before, devoted more time to nest-building than the Ex group females. This may indicate that thermal experiences of dams influence their later thermoprotective reactions. There was no increase in the total duration of mother-pups tactile contact during cooling. The frequency of occurrence of an area without bedding at the bottom of a rat nest was observed. It was found that in the lowered temperature dams filled such areas with bedding or reduced their diameters considerably.

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### 1. INTRODUCTION

Studies on early weaning in rats have shown that the mortality rate among rat pups separated from their mothers is high even if the pups are carefully nourished, and even if the separation takes place on the 12th or 13th day postpartum. The mortality rate is not high, however, when the separated pups are housed with another non-lactating adult female (Oswald & Koch, 1975) or when they are provided with an artificial heat source enabling some tactile contact (Plant & Davis, 1972). These facts indicate that pups' survival at the age of 12—13 days still depends upon the possibility to maintain an adequately high and constant

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body temperature. The need for a constant source of heating is probably even greater in younger pups. During the first weeks of life the thermoregulatory mechanisms of rats are inefficient (Kleitman & Sati-noff, 1982; Melanie *et al.*, 1986). The lack of hair cover and subcutaneous fat tissue, as well as a small thermal storage (capacity) resulting from small body weights (5–6 g at birth), are responsible for the fact that when pups are deprived of parental protection, their body temperatures undergo sharp changes. These changes are parallel to ambient temperature variations. The low thermal stability of rat pups during the first days of life is well illustrated by drops in their body temperatures following short periods of separation from mothers. With constant ambient temperatures of 21.5 to 22.5° C, the drops were 2–3.5° C after 30- and 60-minute separations, respectively (Chaber & Korda, 1984; Chaber, 1983).

Norway rats can reproduce throughout almost the whole year, including winter (Gambarjan & Dukielskaja, 1955). Despite low resistance of rat pups to ambient temperature changes, wild populations of *Rattus norvegicus* (Berkenhout, 1769) have been found in Alaska, Iceland, Lapland north of the Arctic Circle), and in many areas of Siberia (Brooks & Rowe, 1987; Gambarjan & Dukelskaja, 1955). Instances of rat reproduction in a cold storage plant containing meat frozen to –13° C (Gambarjan & Dukelskaja, 1955) have also been noted. In such circumstances mother rats built nests using rope, paper, film shreds, and animal tendon scraps. In areas endangered by flood rat nests are built of leaves and twigs, and located on trees or bushes. All this suggests that the wide geographic location of rats should be, except for sinantropic abilities, best facilitated by the ability to adapt parental care patterns to different habitat requirements. Especially the thermoprotective behavior of mother rats is subject to such adaptations (Strózik & Korda, 1977). There are many ways in which females try to reduce body temperature variations of their litters. The most important ways are to locate the nest suitably (Silverman, 1978; Jans & Leon, 1983), to manipulate the thermoprotective properties of the nest (Korda & Komorowska, 1987; Jans & Leon, 1983), to retrieve the pups (Grotta & Ader, 1969), and to warm them by tactile contact (Alberts, 1978; Leon *et al.*, 1978). It was noted earlier (Korda & Komorowska, 1987) that mother rats subjected to the lowering of the ambient temperature by 4° C for 7 hours every other day intensified some caregiving activities. Intensified care was cyclic and synchronized with the cooling periods. It was found, for example, that during such coolings both the total duration of nest-building activities and the total duration



of mother-pups tactile contact grew visibly. But on the following day (day without cooling) the females usually abandoned the extra care that they had given to the pups previously (on the cooling day).

Since the thermal stability of the pups is low, their survival seems to be frequently determined by the immediacy of the mother's response to the ambient temperature changes. The aim of this work was to find the time needed to make a female initiate its thermoprotective behavior in the nest. The purpose of experiment I was to collect data about the latency with which mother rats reacted to temperature drops within the immediate environment of their nests. Nest-building activities and tactile contact with the litters served as the main indicators of the females' thermoprotective behavior. The direct purpose of experiment II was to investigate whether thermal experiences of mother rats influence their later thermoprotective behavior, and if so, in what way.

## 2. METHODS AND MATERIAL

Sixteen mother rats with their own litters, 4 pups per female, were used in the experiments. The adult females were 12 outbred Wistar and 4 outbred hooded rats about 150 days old. The majority of these females had previously bred one litter. All the females were mated with Wistar males. Four or five days before the expected birth the pregnant females were separated and put singly in standard plastic cages. The cages were provided with a certain amount of shavings and sisal fibre shreds (this bedding was not changed during the 12 experimental days). Each cage had one of its corners covered with a cardboard roof in order to make the females feel more comfortable and so then could locate their nests under the roofs. The rats were given *ad libitum* standard food (Murigran) for laboratory rodents and water.

The animals were subject to both successive experiments. Before experiment I started, the rats were kept at  $21 \pm 1^\circ \text{C}$ . The thermic conditions preceding experiment II were different, depending on the procedure in experiment I. In both experiments the circadian cycle of 12 light hours and 12 darkness hours was adopted. The light phase lasted from 8:15 a.m. to 8:15 p.m.

Two experiments were carried out: experiment I lasted from the 3rd to the 11th day of the pups' lives; experiment II took place on the 12th day. Out of the 8-10 females that had been mated to males at the same time, 2 females which gave birth on the same day ( $\pm 18$  hours) were chosen. They formed a pair. One of the mother rats was regarded as experimental, the other as control. On the 2nd day postpartum both the litters were reduced to 4 pups, *i.e.* to 2 males and 2 females per female.

After finishing tests on one pair of mother-pups families, another pair was chosen for observation. During the entire study, the successive and observed, simultaneously pairs of families built 2 groups: control (C group) and experimental (Ex group). Each of these groups was compound of 8 families.

All female activities connected with building, reconstructing and reshaping the nest were assigned the name of "nest-building activities". They consisted of carrying or moving the nest building stuff to or towards the nest, treating

the nest building material with the fore-feet and mouth, and finally, placing it within the nest. "Tactile contact" was understood as any direct adjunction of the mother body to at least one pup. The data analysed below deal with all nest-building activities which lasted longer than 5 seconds, and all tactile-contact lasting more than 10 seconds.

From the 4th to the 12th day postpartum the following were recorded:

- (1) the total duration of nest-building activities,
- (2) the duration of particular nest-building bouts,
- (3) the total duration of mother-pups tactile contact.

### 2.1. Procedure of Experiment I

The observations started when the pups were 3 days old and ended when they were 11 days old. On the 3rd day neither the nest-building activities nor mother-pups tactile contact were recorded. Only changes in the bedding arrangement were noted then. On the cooling days, *i.e.* on the 3rd, 5th, 7th, 9th and 11th days of the experiment, the temperature inside the Ex group cage was lowered by 5° C, *i.e.* from 21±1° C to 16±1° C. This was achieved by dipping the cage walls and bottom in cool water. Each time the 16±1° C temperature was maintained for 2 hours, but it took one more hour to make the temperature go down to 16° C and then rise back to 21° C. During the whole experiment the temperature of the C group cage remained constant at 21±1° C. All observations were carried out simultaneously in a pair of families, and the distance between their cages was 30 cm. Observations were facilitated by the use of a mirror hanging over the cages. Both females of a given pair were tested simultaneously for 3 hours a day: from 4:30 till 5:30 p.m. and then between 6:00 and 8:00 p.m. An half-an-hour break from 5:30 until 6:00 p.m. was needed every other day to cool the Ex group cage.

### 2.2. Procedure of Experiment II

On the 12th day postpartum the same pairs of families were subjected to the second test. The same aspects of rat maternal behavior as in experiment I were taken into consideration. The time arrangement of the observations remained the same too. What changed on the 12th day was that the temperature in both cages was lowered by 10° C. After experiment I the Ex group mothers had a different thermal experience than the C group mothers, *viz.* the former had already been subject to a rapid ambient cooling by 5° C five times postpartum, whereas the latter had not. In experiment II the Ex females encountered a familiar stimulus but of a higher intensity. The C group females, on the contrary, were confronted with a completely new stimulus.

### 2.3. Procedure of Observing an Area Without Bedding at the Bottom of a Rat Nest ("Clearing")

Four Ex group mothers and the corresponding four C group females were tested simultaneously between the 3rd and the 11th day of the pups' lives. The data collected concerned 5 cooling days and 4 days without cooling. The frequency of the "clearing" occurrence and the "clearing" diameter were registered during the daily 3-hour observation sessions. The breaks between particular acts of



measuring were at least half an hour long. Nevertheless, many times it was impossible to estimate the size of the area without bedding, or even to ascertain its presence, because the position of the animals in the nest prevented us from doing so. That is why the data are not comparable in numbers.

The "clearing" frequency of occurrence is the relation of the number of all the situations when any lack of bedding at the bottom of a nest was ascertained to the total number of observations made in a given group. This proportion has a percentage representation (the number of "clearing" appearances/total number of observations  $\times 100\%$ ). The "clearing" diameters were measured from outside the cage not to upset the rats. The precision of those measurements was  $\pm 1$  cm. When no "clearing" was ascertained, the "clearing" diameter was considered to equal 0 cm, and this number was used in calculations.

In analysing statistical differences between the cooling days and the days without cooling, the following pairs of days were formed: the 4th & 5th, 6th & 7th, 8th & 9th, 10th & 11th, 10th & 12th, and 11th & 12th. In turn, the analysis of differences between the Ex group and the C group became available due to comparison of results obtained for the groups on each day postpartum (the pups' age in both groups was the same). Mann-Whitney U-test and Wilcoxon two-sample test were used throughout. In additional observations the data on "clearing" were compared using Replicated Goodness of Fit Test (G-Statistic) (Sokal & Rohlf, 1981).

### 3. RESULTS

The results of both experiments are presented in the same figures (see Figs 1, 2, 3 and 4) but separated by a vertical dashed line. The figures show the duration of the examined aspects of mother rats' thermoprotective behavior on particular days as the mean time counted for all the 8 females of each group. The 2nd and 3rd hours of each observation session have one joint representation in the figures. This simplification is justified by the fact that there were no statistically significant differences between the data collected during the 2nd and 3rd observation hours (Wilcoxon two-sample test).

#### 3.1. Experiment I

##### 3.1.1. The Total Duration of Nest-Building Activities

The results of experiment I, presented in Fig. 1 and 2 (left of the vertical dashed lines), allow one to state that:

(a) In the Ex group the total duration of nest-building activities during the 2nd & 3rd observation hours was 1.1 to 1.9 percent of time per hour. During the low temperature hours on all the cooling days the total duration of nest-building activities in the same families grew considerably (see Fig. 1, solid line). On particular cooling days this duration varied from 6.3 to 10.9% of time per hour. The differences

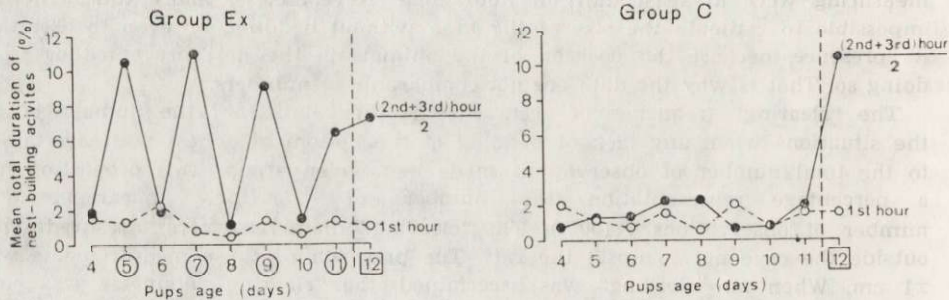


Fig. 1. Mean daily duration of nest-building activities in both groups during 3 hours of observation. The data are presented in percents where 100% = 60 min. "Dashed line — 1st hour" — mean percent of time for each of the groups during the 1st observation hour. "Solid line —  $\frac{(2nd+3rd)hour}{2}$ " — mean percent of time for each of the groups during the 2nd and the 3rd hours (the two hours have one mean representation). The vertical dashed line separates the results of experiment I from those of experiment II. Abscissa: successive days postpartum; numbers in circles stand for days when the Ex group families were subject to cooling by 5° C for hours. The number in the squares stands for the day when both groups were cooled by 10° C for 2 hours.

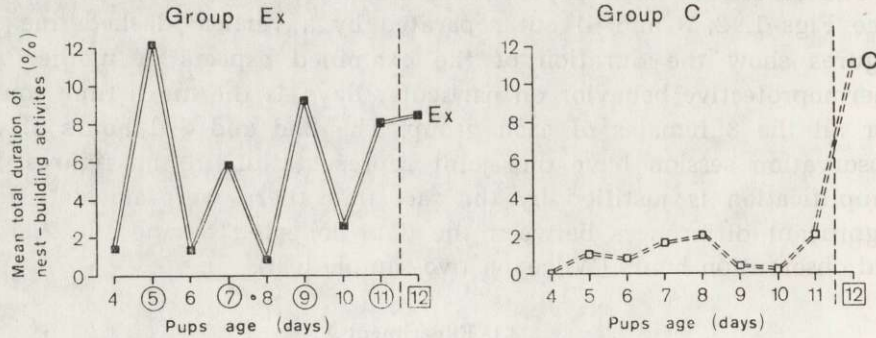


Fig. 2. Mean daily duration of nest-building activities in both groups during the first 30 minutes of the 2nd hour of observation. The data are presented in percents where 100% = 30 minutes. Denotations as in Fig. 1.

were statistically significant for all compared pairs of days ( $p < 0.01$  or  $p < 0.001$ ; Mann-Whitney U-test).

(b) On all the cooling days the total duration of nest-building activities of Ex group females was much longer during the two hours of low temperature than during the hour without cooling ( $p < 0.01$  or  $p < 0.001$ ; Mann-Whitney U-test). The coefficient for the  $21 \pm 1^\circ$  C temperature



hour differed from day to day and was 0.8 to 1.3 percent of time (see Fig. 1, dashed line).

(c) In the C group the mean total duration of nest-building activities did not grow to the level of statistical significance on any day or hour of observation (see Fig. 1, both curves).

(d) A comparison of data collected on particular days and hours of cooling show that the Ex group females always devoted more time to nest-building activities than the C group females. When the groups were compared (*i.e.* the mean total duration of nest-building activities of the Ex group with that of the C group on the 5th day, then on the 7th day and so on), the differences between them turned out to be statistically significant ( $p < 0.01$  or  $p < 0.001$ ; Mann-Whitney U-test). On other days and hours when the temperature in cages did not drop, there were no significant differences between the groups.

The results obtained indicate that when a mother rat and its litter were exposed to a lowering of the ambient temperature by  $5^{\circ}\text{C}$  for 2 hours on every other day, the total duration of nest-building activities by the mother on the cooling days extended considerably. Nevertheless, no visible change in this aspect of the females' thermoprotective behavior were noted on the days following the cooling days.

In order to collect more precise data on the latency with which mother rats reacted to ambient temperature drops, the total duration of nest-building activities for the first 30 minutes of the 2nd observation hour was recorded for each of the groups and for each of the experimental days. On every other day these 30 minutes constituted the period of time when the temperature in the Ex group cage had just settled to  $16 \pm 1^{\circ}\text{C}$ . In the figures drawn, the curves representing the nest-building activities in both groups during these 30 minutes turned out to be very similar to the curves characterizing the same activities during 2-hour periods of time, *i.e.* during the 2nd and 3rd hours of daily observations (see Fig. 1 and 2). This indicates that soon within the first minutes of cooling the females adopted a level of nest-building activity similar to that responding to longer, *i.e.* 2-hour, periods of low temperature.

### 3.1.2. The Duration of One Nest-Building Bout

For all the observation days and hours of experiment I the mean duration of one nest-building bout was found. The results for each of the two groups remained separate (see Fig. 3). In the Ex group the mean duration of one nest-building bout calculated for the cooling hours

of one day was always compared with the mean duration of one nest-building bout found for the previous day (day without cooling). The "mean bout" during the cooling hours lasted longer ( $p < 0.01$ ; Mann-

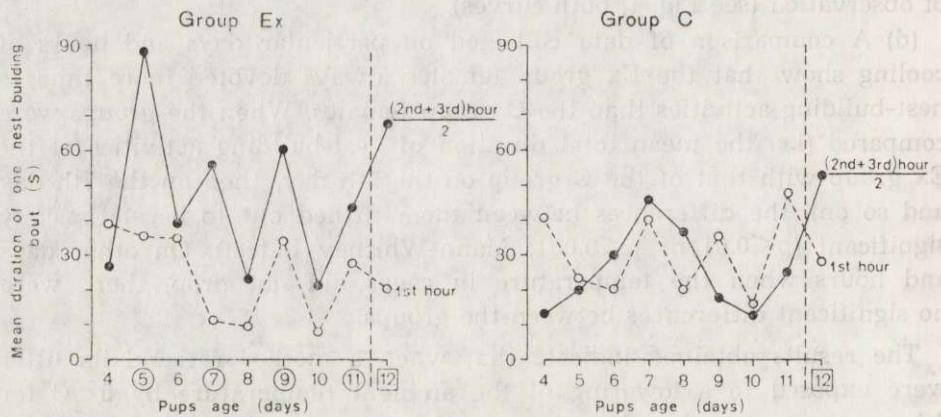


Fig. 3. Mean daily duration of one nest-building bout in both groups during 3 hours of observation. The data are presented in seconds. Denotations as in Fig. 1.

-Whitney U-test). Moreover, on the cooling days there were visible differences between the data collected during the cooling hours (see group Ex in Fig. 3; black dots on the solid line), and those of the hours without cooling (see group Ex in Fig. 3; white circles on the dashed line). Also these differences were statistically significant ( $p < 0.05$ ,  $p < 0.01$  or  $p < 0.001$  for various pairs of days; Mann-Whitney U-test). In the C group the mean duration of one nest-building bout found during the same observation sessions varied from day to day and from hour to hour. In spite of the fact that these differences were easily perceptible, they usually were statistically insignificant. There was only one exception when the 2nd and 3rd observation hours of the 11th day were compared with the corresponding period of the 10th day. Then the differences were statistically significant. It may be presumed that the variations observed in the C group remained within the boundaries of the natural fluctuation of the duration of one nest-building bout. But it is also possible that the variations resulted from other causes not connected with the ambient temperature changes.

On each of the cooling days the mean duration of one nest-building bout in the Ex group was considerably longer than in the C group, and all the daily differences, apart from that of the 7th day, were statistically



significant ( $p < 0.05$  or  $p < 0.001$ ). On the 7th day the difference was statistically insignificant but perceptible (see Fig. 3). No statistical differences between groups appeared in data concerning  $21 \pm 1^\circ \text{C}$  temperature sessions ( $p > 0.05$ ; Mann-Whitney U-test).

To sum up the results obtained in experiment I on the nest-building activities of female rats, it can be stated that regular drops in the ambient temperature by  $5^\circ \text{C}$  for 2 hours every other day made the mother rats intensify their nest-building activities. Both the duration of one nest-building bout and the total duration of nest-building activities were extended. In the latter case the changes were visible and significant within the first 30 minutes of cooling.

### 3.1.3. The Total Duration of Mother-Pups Tactile Contact

In spite of the fact that only the Ex group families were subjected to cooling, the mean total duration of mother-pups tactile contact in both groups turned out to be similar (see Fig. 4) with no statistically significant differences. Moreover, the results obtained in the Ex group during the 2nd and 3rd observation hours on all experimental days, *i.e.* those with cooling and those without it, did not show differences, either. All this suggests that regular drops in the ambient temperature by  $5^\circ \text{C}$  for 2 hours per day did not influence noticeably the total duration of mother-pups tactile contact.

It was found, however, that the total duration of mother-pups tactile

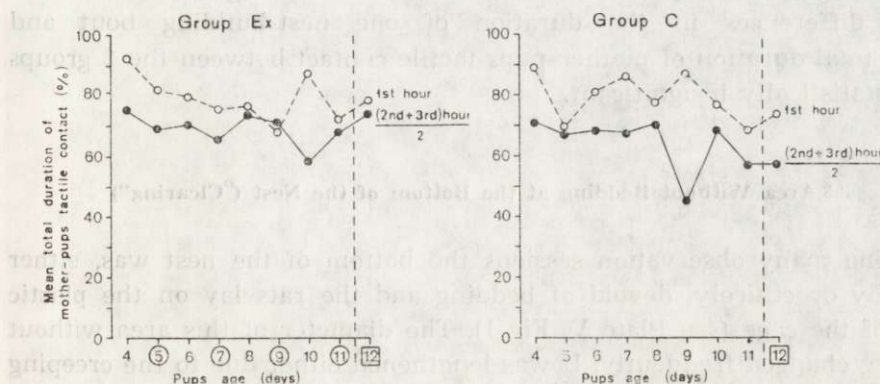


Fig. 4. Mean daily duration of mother-pups tactile contact in both groups during 3 hours of observation. The data are presented in percents where 100% = 60 minutes. Denotations as in Fig. 1.

contact in both groups was much longer ( $p < 0.01$ ; Wilcoxon two-sample test) during the 1st than the 2nd and 3rd observation hours (see Fig. 4).

### 3.2. Experiment II

The very essence of experiment II was the difference between the C and Ex group females in their behavioral responses to cooling. By the 12th postpartum the Ex group females had been cooled by 5° C several times, whereas the C group females had never been cooled. On the 12th day both cages of observed pairs were each time cooled by 10° C for 2 hours and the intensity of behavioral responses to the temperature drop by the C group mothers turned out to be different than that by the Ex group ones. The results of experiment II are presented in Figures 1 to 4, right of the vertical dashed lines.

The total duration of nest-building activities during the 2 hours of redoubled cooling was distinctly longer in the C group than in the Ex group ( $p < 0.05$ ; Mann-Whitney U-test). The mother rats that had not been cooled before reacted to the drops in the ambient temperature to  $11 \pm 1^\circ$  C much stronger than the females that had experienced some coolings in the same maternal cycle. This difference was visible both after the 2-hour exposure to the  $11 \pm 1^\circ$  C temperature and after the first 30 minutes of cooling (see Fig. 1 and 2). The results were 10.3% of time per hour for the C group, 7.2% for the Ex group in the 2-hour cooling, and 11.0% for the C group, 8.4% for the Ex group in the 30-minute cooling. The difference between the groups after the 30 minutes was only slightly below the level of statistical significance.

The differences in the duration of one nest-building bout and in the total duration of mother-pups tactile contact between the 2 groups were statistically insignificant.

### 3.3. Area Without Bedding at the Bottom of the Nest ("Clearing")

During many observation sessions the bottom of the nest was, either partially or entirely, devoid of bedding and the rats lay on the plastic floor of the cage (see Plate V, Fig 1). The diameter of this area without bedding changed frequently. It was lengthened either due to the creeping of the pups or due to the mother's activity.

During the cooling hours the "clearing" often shrank or disappeared, and this almost always happened owing to the female's nest-building activities (see Plate V, Fig. 2).



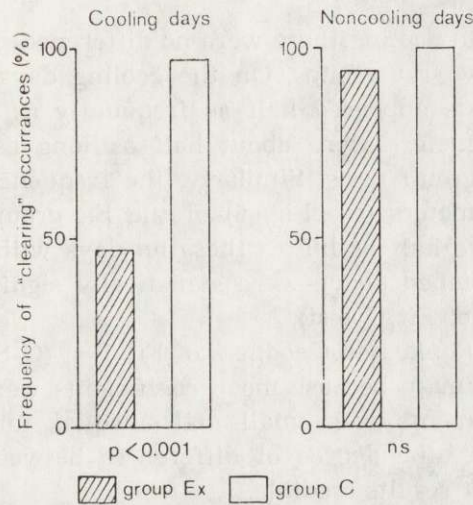


Fig. 5. Mean total frequency of occurrence of the area without bedding at the bottom of a rat nest ("clearing") in both groups during 3 hours of observation on all experimental days. The data concern 4 families from the Ex group and 4 from the C group. 100% stands for the situation when "clearing" occurrence was constant.

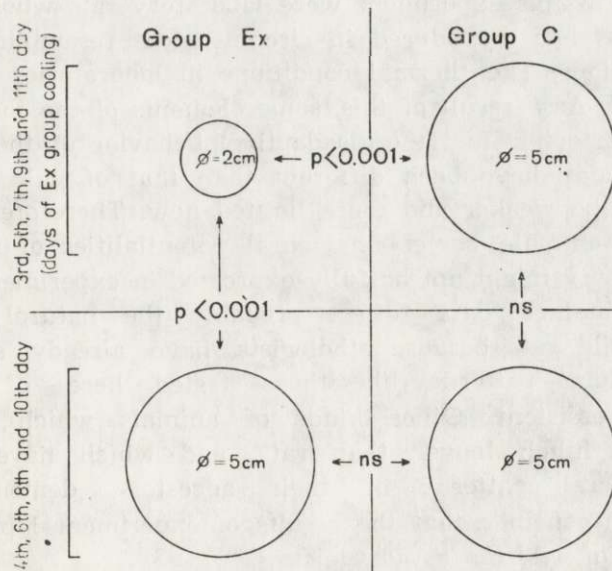


Fig. 6. Mean "clearing" diameter in both groups. The results concern four pairs of families chosen at random (4 families chosen from the Ex group and the corresponding 4 families from the C group). The mean "clearing" diameter of the days without cooling (in the Ex group only) was compared with that of the cooling days (vertical arrows). The mean "clearing" diameters of the C group were compared with those of the Ex group (horizontal arrows).

On the days without cooling there were no differences in the "clearing" sizes between the two rat groups. On the cooling days the "clearings" in the Ex group nests appeared half as frequently as in the C group nests, and their diameters were about half as long as the "clearing" diameters in the C group nests. Similarly, the frequency of occurrence (see Fig. 5) and diameters (see Fig. 6) of the Ex group "clearings" on the cooling days were half as big as those on days without cooling. All the differences mentioned above were statistically significant ( $p < 0.001$ , Replicated Goodness of Fit G-test).

The results of the Replicated Goodness of Fit Test (G-Statistics) should be treated as approximate because mean coefficients were used, and the number of measurements was small and unequal for particular rat families. Nevertheless, the degree of differences between the 2 groups seem to make the test results credible.

#### 4. DISCUSSION

##### 4.1. Experiment I

The subject of this experiment were laboratory rats whose ancestors for generations had reproduced in circumstances resembling optimum natural conditions. The thermal conditions in laboratories had always been favorable. As a result of this, some elements of the thermoregulative (thermoprotective and thermoadaptive) behavior of the laboratory Norway rats may have been different than that of wild rats. These elements may be weaker and more limited now. Therefore, in comparison to wild animals, some behavioural potentialities of rat thermoprotective activity might not be fully expressed in experiment I. Nevertheless, the obtained data reflect probably the natural behavioral patterns of wild rats because ethologists have already shown that inborn behavioral patterns, like those tested here, of particular species are persistent. Other kinds of animals which have been bred by man much longer than rats, and which have preserved many behavioral patterns of their ancestors, demonstrate the point. One can conclude that the results of experiment I probably are representative of wild *Rattus norvegicus*.

The results show that after a rapid drop in the ambient temperature the nest-building activities of a mother rats are considerably intensified. The intensity increases soon after the thermal stimulus appears. The latency does not exceed 60 minutes from the very beginning of the cooling process on a given day, and 30 minutes after the temperature has settled at  $16 \pm 1^\circ \text{C}$ . A short-term latency in nest-building activities is



important since when there are rapid drops in the ambient temperature because the preservation of the litter's body temperature by the mother-pups tactile contact exclusively makes the female lose the warmth of her body. Moreover, such tactile contact is effective only as long as it is maintained. When the pups are separated from the mother, their body temperatures decrease noticeably. On the contrary, when the female reacts to the temperature drop by improving the thermoinsulative properties of the nest, the pups are protected for a longer period of time, and when the mother is outside the nest. By nest-reconstructing the female maintains also its own body temperature and thus saves the warmth of her body which can be used to heat the pups later (Alberts, 1978; Leon *et al.*, 1983). Of the thermoprotective responses of a rat female to the ambient temperature drop tested here, the intensification of nest-building activities is that of the shortest latency.

Lowering the temperature by 5° C for 2 hours every other day did not lengthen the total duration of mother-pups tactile contact. Two-hour exposure to cooling is probably too short to evoke any visible changes in this aspect of rat thermoprotective behavior. A smaller drop in temperature (by 4° C) but lasting for 7 hours caused significant changes (Korda & Komorowska, 1987).

No matter which group was tested, and on what day, the duration of mother-pups tactile contact during the first hour of observation was almost always longer than during the remaining two observation hours ( $p < 0.01$ ; Wilcoxon two-sample) (see Fig. 4). These apparently surprising results are perhaps explained by the rat circadian activity cycle varieties. Contrary to the 1st observation hour (lasting from 4:30 until 5:30 p.m.), the 2nd and 3rd hours (falling between 6:00 and 8:00 p.m.) immediately preceded the phase of darkness. Mother rats activity at dark increases substantially (Miles, 1962; Silverman, 1978). Therefore, the duration of mother-pups tactile contact was longer in the 1st hour because later the females were probably subject to the intensified motor activity stage and spent more time outside the nests. The cyclic character of circadian care-giving activities in rats has been described by Groskerry *et al.* (1978), Leon *et al.* (1984), and others.

#### 4.2. Experiment II

The results concerning the total duration of nest-building activities, obtained in experiment II showed that the reaction of Ex group mothers to a rapid drop in temperature was much weaker than that of the C group mothers. This indicates that the Ex group females may have

developed habituation towards the definite kind of thermal stimuli, or that they may have introduced, under the influence of their experience, some thermoregulative or compensatory physiological mechanisms. The experiment showed that the intensity of care-giving activities is likely to depend upon the females previous thermal experiences. But it is possible that the influence of those experiences does not go beyond the weaning.

Another interpretation of the phenomena in question should be taken into consideration, too. It is possible to recognize the substantial increase in the total duration of nest-building activities in the C group families not as the effect of the 10° C temperature drop but as the result of the very first cooling of the group in the whole cycle. Maybe if the C group had been cooled only by 5° C on the 12th day, the results would have been quite similar. To solve the problem decisively, however, complementary experiments are necessary.

In this work changes observed at the bottom of a rat nest were described temporarily: In no other available literature have studies about this matter been found. The frequency of occurrence and diameters of the area without bedding ("clearing") were related to the ambient temperature changes. When temperatures are optimal, "clearing" almost always occurs, and its diameter is long. When the nest is subjected to cooling, the female makes the "clearing" disappear or at least reduces its diameter visibly (see Fig. 5 and 6). It seems that "clearing" contributes to the regulation of the inner temperature in the nest. It is possible to assume that when the nest is underheated, the reduction of the "clearing" size decreases the rate of heat loss. On the other hand, when the nest is overheated, "clearing" constitutes the channel through which the heat can be emitted effectively.

According to Jans & Leon (1983) the durations of the female's stays in the nest are regulated by the rate at which the nest-pups-mother system overheats. It seems that "clearing" allows the rat mother to remain in the nest for longer periods of time when the ambient temperature is favorable. This can be beneficial for both the mother and the litter since the adult female can remain in the nest during the inactive phase of its circadian activity cycle. Also pups can have longer access to the mothers' feed and care.

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CZYNNOŚCI BUDOWANIA GNIAZDA JAKO PRZEJAW  
TERMOPROTEKCYJNEGO BEHAVIORU MACIERZYŃSKIEGO SZCZURÓW

## Streszczenie

Założono, że możliwość ekspansji dzikich populacji szczura wędrownego *Rattus norvegicus* (Berkenhout, 1769) do chłodnych środowisk może wynikać między innymi ze skutecznej opieki macierzyńskiej nad oseskami w niskich temperaturach otoczenia. Zamierzano zbadać czy krótkotrwałe obniżenie temperatury otoczenia wywoła dostrzegalne zmiany w opiekuńczym zachowaniu się matek wobec osesków, a jeżeli tak, to uzyskać informacje o latencji reakcji intensyfikującej opiekę po obniżeniu temperatury otoczenia (dośw. I). Ponadto starano się uzyskać dane o tym, jak poprzednie doznania termiczne wpływają na termoprotekcyjny behavior samicy — matki (dośw. II). Jako model termoregulacyjnego zachowania się samic posłużyły czynności budowania gniazda i przebywanie ich w kontakcie dotykowym z potomstwem. Stopień intensyfikacji tych przejawów mierzono czasem ich trwania.

Użyto 16 rodzin (matka + 4 oseski) szczura laboratoryjnego. Utworzono dwie grupy, doświadczalną i kontrolną, po 8 rodzin. W okresie od 4-go do 11-go dnia po porodzie kolejne rodziny grupy doświadczalnej poddawano co drugi dzień dwugodzinnemu oddziaływaniu obniżonej temperatury otoczenia o 5°C, a badane równocześnie rodziny grupy kontrolnej nie były ochładzane (dośw. I). Stwierdzono, że obniżenie temperatury powoduje w czasie jego trwania (2 godz.) znaczny wzrost czasu poświęcanego przez samice grupy doświadczalnej na manipulacje przy gnieździe (Ryc. 1), a także wydłużenie czasu trwania pojedynczych aktów budowania gniazda (Ryc. 3). Wzrost łącznego czasu trwania budowania gniazda dostrzegalny był także już w ciągu pierwszych 30 minut chłodzenia (Ryc. 2). W 12-tym dniu życia osesków (dośw. II) stosowano chłodzenie otoczenia o 10°C tym razem zarówno wobec samic grupy doświadczalnej, jak i grupy kontrolnej. Wykazano przy tym, że u samic uprzednio nie ochładzanych (uprzednia grupa kontrolna) wzrost łącznego czasu trwania budowania gniazda był w tym dniu większy (Ryc. 1 i 2) niż u samic uprzednio chłodzonych. W odniesieniu do czasu trwania kontaktu dotykowego między matką a potomstwem żadnej z opisanych w dośw. I i II zależności nie stwierdzono (Ryc. 4).

Opisano też zjawisko występowania na dnie szczurzego gniazda, obszaru pozbawionego ściółki (Fot. 1). Stwierdzono, że w obniżonej temperaturze samica wypełnia go ściółką lub znacznie zmniejsza jego średnicę (Ryc. 5 i 6. Fot. 2).

Nasuwa się przypuszczenie, że przy szybkim spadku temperatury otoczenia, skuteczność behavioru termoprotekcyjnego matek wpływa z natychmiastowego niemal podnoszenia właściwości termoizolacyjnych gniazda, w którym znajdują się oseski. Pozwala to prawdopodobnie w istotnym stopniu ograniczyć straty energetyczne matki i szczurząt oraz zwiększyć przeżywalność młodych w chłodnych środowiskach, zwłaszcza w pierwszych dniach życia.



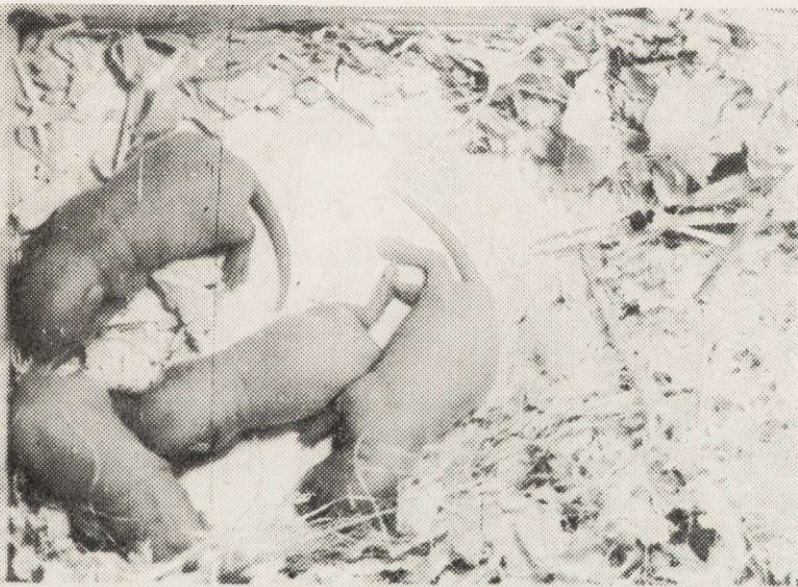
1

EXPLANATION OF PLATE V

Photo 1. Rat nest with "clearing" and the pups on the 7th day postpartum.  
Ambient temp. 21°C.

Photo 2. Rat nest without "clearing". The pups, at the age of 7 days, were  
removed from the cage in order not to cover the nest bottom. Ambient temp.  
16°C.

1



2



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*auctores phot.*