Laboratory Rearing of a Hibernating Animal, Pocket Mouse (Perognathus flavus)

Tetsuya MATSUZAKI, Yasushi YOKOHATA*, Masao KAMIYA*, and Terry L. YATES**

Section of Laboratory Animal Resources, National Institute of Neuroscience, National Center of Neurology and Psychiatry, 4-1-1 Ogawa-Higashi-cho, Kodaira-shi, Tokyo 187, *Department of Parasitology, Faculty of Veterinary Medicine, Hokkaido University, 9 Nishi, 18 Jo, Kita-ku, Sapporo-shi, Hokkaido 060, and **Department of Biological Sciences, University of New Mexico, Albuquerque, New Mexico 87131, U. S. A.

(Received 21 December 1993 /Accepted 9 February 1994)

Hibernating pocket mice (Perognathus flavus) were obtained from the Department of Veterinary Medicine, Hokkaido University, in September 1990, and attempted to rear them in National Institute of Neuroscience, NCNP. Rearing of pocket mice was possible under the general conditions used for rearing mice. As a result of random mating of 4 females to 2 males for breeding, gestation was achieved in only one pair of animals, and parturition under artificial rearing conditions was observed for the first time. The animal gave birth to 3 offspring that had no body hair. Their eyes were closed. Each of the offspring weighed about 1.0g. The mean body weight of the females was 6.5g and that of males 5.6g at 3 weeks. Weaning was possible at this age. Subsequently the animals grew rapidly; the body weight was almost equal to that of an adult animal (8.0g) at 5 weeks of age for the females and 7 weeks for the males. The gestation period was estimated to be 26 days. These findings indicate that pocket mice can be bred and reared under general laboratory conditions.

KEY WORDS: hibernationg animal, laboratory rearing, Perognathus flavus, pocket mouse

The pocket mouse (Perognathus flavus), which belongs to Rodentia, Sciuromorpha, Heteromyidae, inhabits the US southwest and arid parts of Mexico. The animal is nocturnal and lives in holes. Its principal foods are seeds and grain. The body weight of the adult animal is 8g, making it one of the smaller mammals. The animal undergoes seasonal diapause, and has a pair of cheek pouches in the oral cavity [5,7]. In August 1990, one of the authors (MK) visited New Mexico to research Echinococcosis [2-4] and brought back a pocket mouse (Fig. 1) to Japan.

We attempted to rear the pocket mouse in our laboratory in order to use it as an animal model of infection with Echinococcosis and in studies on circadian rhythm or organ transplantation by taking advantage of its characteristics as a hibernating animal.

In September 1990, 5 female and 3 male pocket mice were transported from the Department of Veterinary Science of Hokkaido University to National Institute of Neuroscience, NCNP, and used for rearing and breeding. Temperature and humidity in the rearing room were 22±2°C and 55±5%, respectively. The frequency of ventilation was 10~15 times per hour. The room was illuminated between 8:00 am and 20:00 pm. Stainless-steel clean racks and plastic mouse cages (215mm×320mm×130mm)
were used for rearing. Wood shavings were used for the floor covering and a small quantity of absorbent cotton was added to the cages for nests. The diet consisted of mixed seeds of Italian millet, barnyard grass and canary seed. No water was provided because the animals seldom drink water. Cages were changed twice a month, but the nest materials were maintained. One female was mated with one male, and after compatibility of the pair was confirmed, they were housed together in a cage. Both male and female animals were housed in individual cages at all times except mating. Body weight was measured twice a week.

Body weight: Each pocket mouse (4 females and 2 males) was weighed for about 2 months (Fig. 2). The animals that were being housed together were also weighed. The mean body weight for the females was 8.8 g and that for the males 9.3 g. The mean body weight for both the females and males was 9.1 ± 1.0 g. The maximum body weight was 10.75 g in females and 11.5 g in males. None of the animals weighed 12.0 g or more. The variation in these individuals was 10.9% according to the coefficient of variation, indicating that the body weight of adult pocket mice ranges from 8 to 10 g. Among individual animals, female #66 showed an (2.0 g) increase in body weight indicating gestation on day 13 after the start of determination, but thereafter the body weight remained at 10.5 g. Female #77 showed a gradual decrease in body weight from 9.0 g to 7.5 g. The animal's movements became slower as the body weight decreased, but nesting behavior continued. The body temperature felt low when the animal was touched, suggesting that the mouse was drowsy.

Mating: When a randomly selected female and male were housed together, one-sided attack behavior was observed in 15 pairs of 5 females and 3 males; the females or males which were dominant bit the inferiority's tails. This strong attack behavior ended in a few hours, but thereafter conflicts occasionally occurred between them and either the female or male attacked the other in a one-sided manner. Eventually, the animal being attacked died. In a female (#74) and male (#72) pair, for example, the male, which had copulated with the female, died on the second day after they were
housed together. In a female (#2) and male (#62) pair, death of the female was confirmed 6 days after housing. In both cases blood spots were observed on the tail of the animal that died. In a female (#63) and male (#72) pair in which gestation was established by mating, the male had an advantage over the female similar to that described above at the beginning of housing, and the male attacked the female, but soon mounted her. Two hours later, both the male and female had accommodated themselves to each other and were using the same hole.

Body weight at gestation: Changes in the body weight of a female (#63) with gestation were measured after mating (Fig. 2). The body weight on mating, 9.0g, had decreased to 8.0g on day 5 of housing. The body weight started to improve (8.5g) 2 days after she was separated from the male. Twenty-one days after mating the body weight was increased to 9.25g, slightly more than that at mating, and on day 24 the body weight was increased to 10.5g. Parturition occurred on day 26. The body weight of the mother was 7.5g immediately after parturition. As described above, the body weight increased rapidly around 1 week before parturition, but the amount of increase was within the range of individual variation.

Gestation period: One female each was mated with one male each. Housing of each pair was begun on October 3, and they were separated from each other on October 8, and maintained in individual cages. On October 29 parturition was observed. Since mounting was frequently observed on the day each pair was housed together, the day was regarded as the day of successful mating. Based on this, the gestation period for the pocket mouse was estimated to be between 21 to 26 days.

Growth of offspring: Three offspring were produced from one pocket mouse. Immediately after parturition the offspring had no body hair. The eyes were closed. One week after birth the dorsal skin became black and thin hairs were observed on it. Two weeks after birth the eyes opened and the animals freely went in and out of holes. Feeding was also observed. At the age of 3 weeks, seeds were ingested. Changes in the body weight of the offspring are shown in Fig. 3. The body weight at birth, 1.0g, was increased to 2.5g one week after birth, and during this period each offspring showed a 0.25g increase per day. From about 2 weeks of age onwards, there was a male–female difference in body weight, and at the age of 3 weeks the body weight was 6.5g in the female, and 6.0g and 5.25g in the males. Weaning was possible in these three offspring. After weaning, their growth was rapid: the female's body weight increased to 8.0g, approximately the same as that of an adult pocket mouse, at age of 5 weeks, and the males, body weights reached 7.0g to 8.0g at the age of 7 weeks, showing slower growth than in the female.

Maternal behavior: The mother always piled up nest materials on one half of the cage to make a nest to protect the offspring. She broke wood shavings into needle-like pieces and entangled threads of absorbent cotton with them to make a nest. The nest was divided into one part for the offspring and the other part for the parents. The cage had two holes that looked like an exit and a breathing hole. The exit was made on the side of the part for the parents and the breathing hole on the side for the offspring. When a breeder touched an offspring, the mother brought it to the hole or enabled it to escape in to the hopper by holding it in her mouth. Such maternal behaviors were observed until about 2 weeks after the birth of the offspring.
The pocket mouse is a small mammal that hibernates seasonally. Some morphological and biochemical studies of this species have been made \[1,6,8\]. Lately, the pocket mouse was equal to the dog in an egg recovery as definitive host for *Echinococcus*, and showed some worms developing (Kamiya et al., unpublished). This means that infection experiments can be in a small full-sealed type cabinet in safety, because an adult pocket mouse is small to weigh 8.0g.

But there have been no reports on laboratory breeding of the pocket mouse. We attempted laboratory rearing in order to utilize the pocket mouse as an experimental animal. Pocket mice could be reared under the usual conditions for rearing of mice. Individuals could be maintained on the amount of water contained in the diet (seeds), eliminating the need to supply water. Therefore, rearing and managing were easy because the floor did not become so dirty. When the males and females were combined for mating, either the male or female of many pairs attacked the other, and when these pairs were housed together, some animals were killed. Thus, the compatibility of the pair should be taken into consideration when combining males with females. The doubling time \( T_2 \), i.e., the number of days for the body weight at birth to double, an index of postnatal growth, was found to be 4 days for the pocket mouse. \( T_2 \) is 5 days in the rat and 3 days in the house musk shrew, which grows relatively rapid. The \( T_2 \) for the pocket mouse was intermediate between the \( T_2 \) for the rat and house musk shrew. Subsequently, the body weight of house musk shrew reaches that of an adult animal (8.0g) 6 weeks after birth; the pocket mouse reached adult weight 5–7 weeks after birth. This finding also suggests extremely rapid growth of this species. Sexual maturataion accompanying growth will be an important subject for the future. The period of breeding in hibernating animals and conditions of environmental temperature necessary for hibernation should also be studied in detail.

As the basic breeding colony used in these experiments was small to consist of 5 females and 3 males. So the wild pocket mice ware caught by Kamiya et al. in October 1992, and Terry in November 1993 again. They were brought to our laboratory, and we have been attempted to breed them renewing the breeding colony.

This work was supported by Grant-in-Aid (02404083, 03044016) for Scientific Research from the Ministry of Education, Science and Culture, Japan.

References

冬眠動物ポケットマウス *Perognathus flavus* の実験室内飼育の試み

松崎哲也・横畑泰志*・神谷正男*・テリー・ヤテス**

国立精神神経センター神経研究所
*北海道大学農医学部家畜寄生虫病学講座
**ニューメキシコ大学生物科学部門

1990年9月に北海道大学農医学部より冬眠動物であるポケットマウス（*Perognathus flavus*）を導入し、実験室内飼育を試みた。ポケットマウスの飼育環境はマウス飼育条件で可能であった。繁殖の試みでは、雌4：雄2をランダム交配させた結果、一組に妊娠が成立し、室内飼育で初めて出産が観察された。その1胎から3子が誕生し、新生子は赤裸で体毛がなく閉鎖していた。体重は1.0gであった。3週齢の体重は雌で6.5g、雄は5.6gとなり離乳が可能であった。その後の成長速度は速く、雌では5週齢で、雄では7週齢でほぼ成熟体重（8.0g）に達した。なお、妊娠期間は26日と推定された。上記の結果、ポケットマウスの室内飼育繁殖の可能性が示唆された。