The Domestication of *Crocidura dsinezumi* as a New Laboratory Animal

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The *dsinezumi* shrew (*Crocidura dsinezumi*), a small insectivore, has been bred for the first time as a laboratory animal. The original animals were captured using Sherman’s live traps and transferred into wooden cages. After several generations they were housed in plastic cages. Their diet consisted of trout pellets, cat food, and water provided *ad libitum*. Monogamous pairs were housed together for 2–3 weeks for mating, and the male was separated from the female during delivery and nursing. In captivity, the reproductive activity was observed throughout the year and the gestation period was estimated at 28–30 days with a litter size of between 1 and 4 pups. Pups grew very rapidly, and reached adult body size (mean: male, 9.7g; female, 8.3g) and sexual maturation at 6–8 weeks of age. The reproductive life was estimated at one and a half years, while the longevity was approximately 2 years. — KEY WORDS: *Crocidura dsinezumi*, domestication, insectivore

Laboratory animals have played an important role in medical investigations. Another approach, however, is required for the investigation of diseases whose causes and/or mechanisms may vary from species to species and for which no direct relation can be found between humans and established laboratory animals. To solve this problem, studies using as many species as possible may provide useful information. As new laboratory animals, the order *Insectivora* is interesting because their size is conducive for handling, they are thought to be the most primitive of Eutherian mammals, and they belong to the same cohort, as Primates, Unguiculata. The family Soricidae is widely distributed in Asia, Africa, Europe and North America. Some species have been studied in captivity, e.g., *Blarina brevicauda* [1], *Cryptotis parva* [12], *Sorex araneus* [17], *Crocidura russula* [4], *Suncus etruscus* [19], and *Suncus murinus* [2].

*Suncus murinus*, from Asia, was established as a laboratory animal for comparative biology [11,13]. Several lines of *Suncus murinus* have morphological and karyotological characteristics of note [9]. In addition, some mutant genes for coat color [7,16], hair abnormality [10,14] and waltzing behavior [15] were found and genetically analyzed. Recently, a physiological reaction, motion sickness, was observed in *Suncus murinus* [18]. It is an interesting characteristic which has never been easily induced in laboratory animals such as the rat and mouse. This example illustrates the need for a wide range of laboratory animals.

*Crocidura horsfieldi watasei*, which originates from the southern islands of Japan,

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has recently been initiated to domesticate as a laboratory animal [3]. But Crocidura dsinezumi (Fig. 1), the most common shrew which is widespread in the low mountains and plains of Japan [6] has not yet been studied systematically. We have been domesticating the shrew C. dsinezumi since 1984, to increase our knowledge of the comparative biology of this Insectivore. In this paper we describe the steps taken to domesticate Crocidura dsinezumi, and report on the biological data obtained in captivity.

Materials and Methods

Capture: Sherman’s live traps were used for catching animals with dry cat food, oat meal and/or sausage as a bait. These traps were set in the forests, grass fields and storage houses in Aichi, Gifu and Toyama prefectures, central Japan, between 1984 and 1989. Captured animals were placed in wooden cages containing soil and hey, given water immediately. Three males and three females were transported to the laboratory in good condition (Table 1). Two females were pregnant when captured, and they subsequently delivered successfully in the wooden cages. Their progeny, four males and one female were weaned in good condition. Therefore, our present shrew colony is originating from wild populations in the above three areas in Japan.

Husbandry and management: Recently captured animals were kept in wooden cages (W×D×H: 25×42×18 cm) with a soil and sawdust base. Chopped hay and paper tubes were added for concealment and nesting material (Fig. 2). These cages were placed inside a building with natural light, humidity and temperature conditions. Dry pelleted food designed for feeding musk shrews (Central Institute for Experimental Animals, Kawasaki, Japan), commercial cat food (Nippon Pet Food KK, Tokyo, Japan), oat meal, silk worm powder and water on a dish were provided daily. The six captured animals were kept in these conditions for 3, 7, 9, 16, 16 and 20 months respectively. After successful breeding and maintenance of the colony for 4~5 generations in captivity, the animals were transferred to plastic cages with a lattice wire lid constructed for mice (W×D×H: 15×22×12 cm) with a sawdust base. Inside these cages there

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Table 1. Capture of the dsinezumi shrew in Japan

Area 1; Mitake, Gifu (continually)  2; Seto
Aichi (continually)  3; Sitara, Aichi (summer)
4; Nyuzen, Toyama (summer)
was a nestbox (W × D × H: 10 × 10 × 6 cm) with chopped paper as nesting material covered with a wooden plate (Fig. 2). The temperature was above 15°C in winter and under natural light and humidity conditions during 1989 and 1990. In 1991 they were housed in a temperature and light controlled room (18±2°C, 14 L:10 D), but humidity was not controlled. A mixture of commercial trout pellets (Nippon Nohsan, KK., Yokohama, Japan) and commercial cat food was supplied ad lib. Water was provided in bottles. The plastic cages were cleaned once a week, by replacing soiled sawdust. The dsinezumi shrew adapted well to the small plastic cages, and some of them have been kept for more than one and a half years.

Reproduction: For mating purposes a male and female were housed in one cage for 2~3 weeks. They were then separated and the female was observed for three weeks. If there was no sign of pregnancy, a different male was housed with the female. Pups were removed from the female’s cage at 22 days of age. Male and female pups were housed separately after 5 weeks of age until breeding age. To prevent inbreeding, the colony was maintained using a 4 group rotational mating system.

Postnatal growth: The body weight of 35 pups from 21 litters was measured every other day. After weaning, their weight was measured once a week until 2 months of age.

Results

Size of animals: Table 2 shows the body size of adult animals in captivity. The average body weight was 9.74 g in males and 8.37 g in females. The head-body length and tail length measured with sliding caliper averaged 72.7 mm and 50.7 mm in males and 68.9 mm and 46.1 mm in females respectively. In general males are bigger than females.

Life span: Figure 3 shows the survival rate of the dsinezumi shrew. About 70% of animals survived for more than one year. Half the animals died at between 14 and 16 months of age.
Fig. 5. Monthly distribution of parturition in the breeding colony from 1989 to 1991.

Fig. 6. Growth curves of the dsinezumi shrew: □, male (n=17); ○, female (n=18) each value represents the mean ± SD.

age and the longest life span was 28 months in females and 27 months in males.

Duration of gestation: The gestation period was estimated from breeding records: in 107 cases mating behavior was observed soon after the male was introduced to the female; in 4 cases birth intervals were used; on two occasions over night mating experiments were used; in 6 cases separation of males from postpartum females were used. If the day after the male was housed with the female or the day when the male was separated from the female was determined as day 0 of pregnancy, the gestation period of *C. dsinezumi* varied between 26 and 33 days, with an average of 28.9±1.2 days (Fig. 4).

Litter size: Data were obtained from 144 litters from 59 females. The litter size varied between 1 and 4 pups, with an average of 2.6±0.9 pups. 74.8% (279/373) pups born in captivity were weaned. The male : female ratio was 146 : 133. There was a tendency for the gestation period to be inversely related to the litter size. Litters with 4 pups were usually preceded by a short gestation period (27±1 days).

Breeding season: Figure 5 shows the distribution of parturitions in the breeding colony in relation to month of the year from three consecutive years of data. Reproductive activity was observed throughout the year, and it was higher in spring and summer. In 1989, no parturitions were seen in January, March, November and December. In 1990, however, parturition was seen except January and has been seen every month in 1991.

Reproductive life: Four females were mated at 5 weeks of age and delivered for the first time at 9 weeks of age. When five young males were mated at 8-10 weeks of age, they proved fertile. A brother-sister pair delivered at 65 days of age. The young mother nursed her litter which was weaned in good condition. Thus, *C. dsinezumi* can be fertile at about 35 days of age. Parturitions were not generally seen in females over 14 months. The oldest female which delivered was 22 months of age, but she did not wean the litter. The oldest male which had a fertile mating was 20 months of age.

Postnatal growth: The growth curves of 17 males and 18 females in 21 litters are shown in Fig. 6. The body weight of newborn shrews, which contained milk in their stomachs, was about 0.85g. They gained body weight very rapidly and on the third day the mean body weight had increased to 1.85g. Rapid growth continued for 12 days but then slowed. At weaning (22 days of age), the mean body weight was 7.5±1.4g in males and 6.7±0.9g in females, which was about 80% of the mean adult body weight. After weaning shrews continued to gain weight for about 2 weeks. Changes in body weight ceased at 2 months of age.

Development during lactation: The newborn pup was naked with a pink skin, and the eyes and ears were closed. On the second day, gray pigmentation was seen on the back, nose, limbs and tail. At 6 days hairs on the dorsum
started to develop, and after about 11 days a short, gray fur completely covered the body. After 6 days a slit-like aperture in the external ear could be observed, and at 9 days all animals had completely opened ears. The eyes of some animals started to open at 8 days, and were complete at between 10 and 12 days after birth. Caravanning was observed at between 6 and 20 days, showing the highest frequency at between 10 and 14 days after birth.

Discussion

Because the relative density of population of the dsinezumi shrew is not high [6], it was difficult to capture many animals at one time. Fortunately, two of the captured females were pregnant. Capture of animals in the breeding season, if known, considerably increases the chances of successful breeding.

In view of the body size measurements this species was thought to be C. dsinezumi chisai. The size is similar to that of C. russula [4], but much smaller than the Suncus murinus, originating from Nagasaki, Japan, which has a weight of 60–70g for males and 40–45g for females [13].

The gestation period and litter size of C. dsinezumi is similar to the data obtained from other Crocidurinae in captivity, e.g. 28.5 (24–32) days and 3 (1–7) pups in Crocidura russula [4] and 28–32 days and 2.7 (1–5) pups in Suncus murinus [8]. The time of first parturition indicated that sexual maturation in C. dsinezumi is at about 5 weeks of age while the optimum time of mating is supposed to be at 2 months of age. The reproductive activity of the shrew declines after about one and a half years. A rapid growth rate was observed in the dsinezumi shrew and it is also reported for other Crocidurinae, e.g. C. russula [5], C. horsfieldi [3] and Suncus murinus [2, 8]. The life span in captivity of C. dsinezumi was estimated at about 2 years. The litter size, gestation period, rapid growth and life span of this animal are well suited for study and use as a laboratory animal.

Continuous breeding is preferred for laboratory animals. In this study there was an obvious breeding season. After moving the cages into the artificial climate of an animal room, we observed parturition throughout the year.

Crocidura dsinezumi advantages as a laboratory animal include its small size which in turn reduce the space required and cost of the programme. However, sampling techniques require some skill. In the next part of this programme we shall study handling techniques, environmental and genetic control, and their propagation. C. dsinezumi may become a useful laboratory animal for comparative biology.

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References


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**ジネズミ (Crocidura dsinezumi) の実験動物化**

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新たな実験動物として小型食虫類のジネズミ (Crocidura dsinezumi) を飼育・繁殖した。動物の捕獲はシャーマンライプトラップを用いて行い、木製ケージにて飼育した。数世代経過後はプラスチックケージにて飼育し、餌は飼養用ベレットおよびキャットフードを、水は給水瓶にて自由摂取させた。繁殖は雄1雌1個体を

2～3週間同居させ、出産・哺育時は雄親を離すようにした。ケージ内飼育においては通年繁殖し、妊娠期間は28～30日、リッターサイズは1～4匹であった。新生児は急速に成長し、生後6～8週齢で成体になった（雄9.7g，雌8.3g）。繁殖期間は約1年半，生存期間はおよそ2年以上と考えられた。