# KEEPING AND BREEDING JERBOAS AT MOSCOW ZOO

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## Introduction.

Jerboas are interesting and exotic rodents, inhabiting steppes, semi-deserts and deserts. However, current zoo collections are unable to even approximately represent this unique group. There are a lot of difficulties in the captive maintenance of jerboas. First, little is known about their breeding, particularly that of jerboas from Central Asia and Kazakhstan. The *International Zoo Yearbook* does report some success in breeding individuals from the *Jaculus* genus; but these species, unlike most, do not hibernate in the winter. While other jerboas tolerate the absence of hibernation in captivity (Bekenov and Ismagilov, 1977; Fokin, 1978), no one has been able to breed them in such conditions. Where births have occurred in captivity, this has taken place with wild females who were pregnant when captured (Fokin, 1978). We suggest that the absence of normal hibernation appears to be one of the reasons for jerboa infertility in captivity. Methods of hibernating jerboas in captivity have not yet been developed.

When we attempted to keep and breed jerboas in Moscow Zoo it was necessary to develop methods of hibernation maintenance. To prepare jerboas for breeding, we created a whole complex of different conditions which appeared to mimic nature. This attempt led to successful breeding in a single case.

## Materials and methods

In this paper we report on our regimes for feeding, maintaining and breeding for nine species of jerboa from Central Asia and Kazakhstan, including the induction of hibernation (Table 1). The data are from studies conducted from August 1988 to May 1992 and represent four hibernation cycles for the jerboas.

Animals were weighed weekly (± 1 g for animals below 100 g weight, ± 5 g for animals above 100 g). Temperature was controlled using M-16 AH thermographs. Maintenance and feeding conditions were varied depending upon the stage of the animals' life cycle. We divided the jerboa life cycle into four stages: 'rest'; preparation for hibernation; hibernation; breaking hibernation and post-hibernation breeding. To determine the females' estrous cycle stage, vaginal smears were taken during the putative breeding period.

**Table 1. Jerboa species in the study.**

| Species | Years of study | | | | Year and place of capture |
|---|---|---|---|---|---|
| | 1988 | 1989 | 1990 | 1991 | |
| *Allactaga major* | | 0.2 | 1.2 | 1.1 | 1989 - Saratov region (0.2)<br>1990 - Leningrad Zoo (1.0) |
| *A. severtzovi* | | | | 1.2 | 1991 - SW Kyzyl Kum |
| *A. sibirica* | 3.5 | 3.4 | 1.1 | | 1987-northern Balkhash region (1.0)<br>1988 - northern Balkhash region (2.5) |
| *A. elater* | 1.3 | | | 3.1 | 1988 - southern Balkhash region<br>1991 - SW Kyzyl Kum |
| *Allactodipus bobrinskii* | | | | 1 | 1991 - SW Kyzyl Kum |
| *Pygeretmus pumilio* | 2.0 | 2.0 | | | 1988 - northern Balkhash region |
| *Stylodipus telum* | 4.5 | 5.5 | 1.2 | 0.1 | 1988 - northern Balkhash region (4.5)<br>1989 - born at Moscow Zoo (2.2)<br>1989 - northernBalkhashregion(2.1) |
| *Dipus sagitta* | | | | 1 | 1991-SW Kyzyl Kum |
| *Jaculus turcmenicus* | | | | 0.1 | 1991-SW Kyzyl Kum |

Note: scientific names follow Pavlinov and Rossolimo (1987).

## Results: conditions for each life cycle stage

### 1. Non-reproductive 'rest' period (June-September)

Initially animals were kept in group cages with three to four, or in some cases as many as six, animals per cage. However, our experience is that group cages led to mortality in the non-aggressive species (*Allactaga elater, Stylodipus telum).* One of the animals usually started to lose weight and subsequently died. Soon after the death of the first animal, another individual in the same cage would begin to lose weight until it too died. This process continued until the animals were separated. Therefore, we maintained jerboas in separate cages. Small and medium sized species were kept in 50 x 50 x 40 cm cages, while larger species were placed in cages twice as large. Nest boxes (15 x 20 x 15 cm) were placed in each cage, along with some turf for bedding. The bedding was changed every three to four months.

Animals were fed three times a week. The food ration consisted of grain (a mixture of sunflower seeds and oats in 1-3 ratio), protein (cottage cheese, eggs and occasionally live insects) and carbohydrates (apples, carrots or grass). The amount of food was adjusted based upon each animal's consumption. When animals lost weight or exhibited reduced activity, partial baldness or an abnormal fur condition, we added minerals and nutrient supplements to the diet. Liquid water was not provided except shortly after hibernation.

**Table 2. Proportion of jerboas gaining weight before hibernation (in % of all animals for given species.**

| | |
|---|---|
| *Allactaga major* | 100% |
| *Allactaga severtzovi* | 100% |
| *Allactaga sibirica* | 88.2% |
| *Allactaga elater* | 12.5% |
| *Pygeretmus pumilio* | 50% |
| *Stylodipus telum* | 52.2% |

**Table 3. Jerboa weight gain before hibernation.**

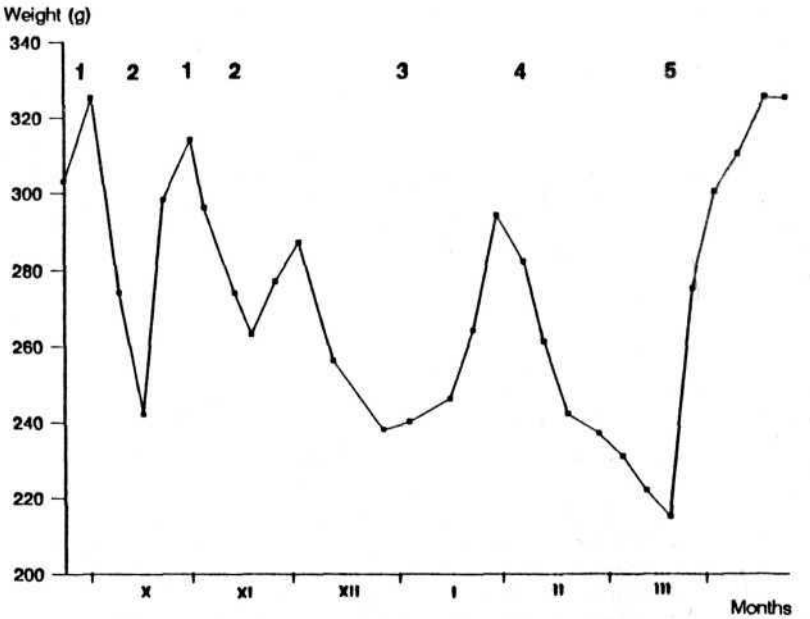
| Species | n | Mean duration of weight gaining (weeks) | Weight gained (g/week) | Maximum weight before hibernation (g) Males | Females |
|---|---|---|---|---|---|
| *A. major* | 6 | 5.93±1.51 | 15.55±2.12 | 35.6.5±6.52 | 346.01±0.18 |
| *A. severtzovi* | 3 | 1.38±0.21 | 12.92±0.54 | 225.0 | 210.0±5.04 |
| *A. sibirica* | 11 | 3.16±0.43 | 13.70±1.74 | 19.2.9±8.43 | 166.71±7.90 |
| *A. elater* | 2 | 4.07±0.93 | 4.39±1.06 | | 69.75±1.25 |
| *P. pumilio* | 3 | 2.47±0.91 | 11.19±3.33 | 76.67±7.56 | |
| *S. telum* | 8 | 3.11±0.23 | 7.10±1.22 | 87.5±3.14 | 86.43±0.89 |

## 2. Preparation for hibernation

In order to survive through the hibernation period animals need to have adequate fat reserves. While some animals had been gaining fat since September, others had insufficient fat. We altered the diet of this latter group to assist fat accumulation. Specifically, we decreased the proportion of carbohydrate and protein rich food and increased the proportion of grain. However, in cases when the animals' weight gain occurred too fast - i.e. the hibernation room had not been prepared - we decreased the proportion of grain in the diet and thus reduced the rate of weight gain (Fig. 1). Normally animals gained weight quite rapidly prior to entering hibernation. Not surprisingly, the animals' weight was greatest at this time (Tables 2, 3).

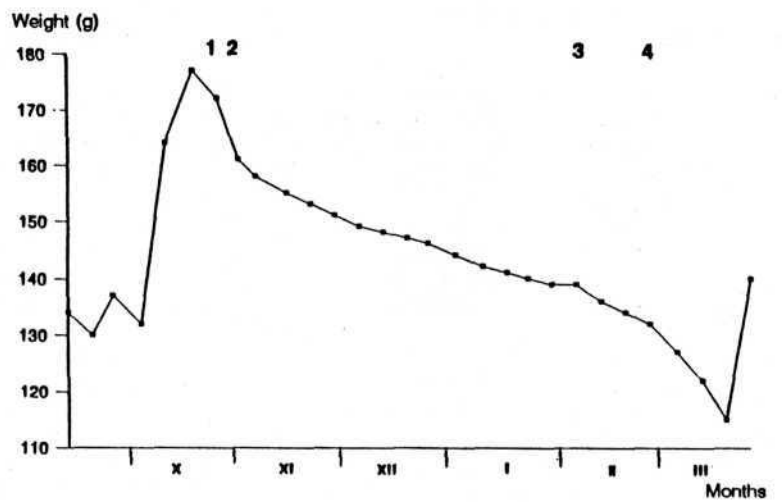
As the animals began to gain weight rapidly we increased the frequency of weighing to two or three times a week. This allowed us to determine the rate of weight gain. As the rate slowed, or when animals began to lose weight, we transferred them to the hibernation room (Figs. 2, 3). If animals were not transferred at this time, they would lose weight rapidly, fail to sleep, refuse to eat, grow bald and sometimes die. Thus it appears that the physiological changes engendered by the induction of hibernation are irreversible over short periods of time. Failure to enter hibernation clearly disrupted the normal homeostatic mechanisms. For three individuals of *Stylodipus telum* who failed to hibernate after a first attempt, we were able to stimulate a second period of weight gain. All these animals successfully entered hibernation after the second induction.

Figure 1. Regulation of the female *Allactaga major* body weight before hibernation by ration correction.



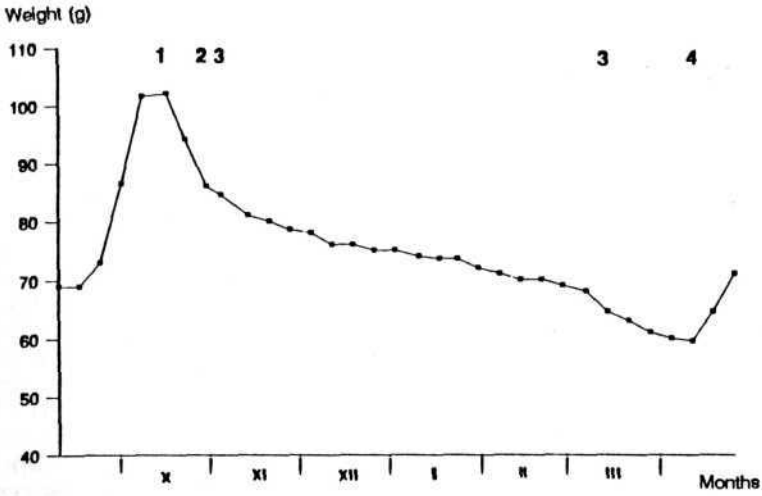

**1 - ration without grain; 2 - standard ration; 3 - decrease of rich food, increased proportion of sunflower seeds; 4 - transfer of animal to hibernation room without food; 5 - emergence from hibernation.**

Figure 2. Weight changes of *Allactaga sibirica* male before and during hibernation.




**1 - transfer to hibernation room; 2 - falling asleep; 3 - brief waking period; 4 - emergence from hibernation.**

**Figure 3. Weight changes of *Stylodipus telum* female before and during hibernation.**




1 - transfer to hibernation room; 2 - falling asleep; 3 - brief waking period; 4 - emergence from hibernation.

### 3. Hibernation (November-March)

Jerboas ready for hibernation were placed in small metal cages (15 x 25 cm) without food or litter. This prevented the animals from making nests. The hibernation place was a small unheated basement. The temperature of the room never dropped below 2°C. In our experience the optimal temperature range for jerboa hibernation is 2°—5°C. Common refrigerators appear to vibrate so much that animals fail to sleep, so these were found unsuitable for conducting hibernation.

Typically jerboas sleep curled in a sitting position with their head positioned between their back legs with their front legs and tail pressed against their body. During the first two to three weeks of hibernation, animals did not sleep deeply and often woke in response to minor temperature fluctuations. Weight loss in this phase was greater than in that of deep sleep. When in deep sleep the rate of weight loss was considerably less, and animals failed to rouse even in response to temperature fluctuations of 2°-3°C. During this phase we closely monitored the condition of the animals. They were weighed daily, and we also examined tail width, fatness and fur condition. If the tail width declined to the levels typical of the non-reproductive period in the case of *Stylodipus*, or if we could feel the tail vertebrae in *Allactaga*, animals were taken out of hibernation. Similarly, we removed animals from hibernation if weight loss was too great (5 g per day for small animals or 10 g per day for large ones). Generalized hibernation data are presented in Table 4.

**Table 4. Some characteristics of jerboa hibernation process.**

| Species | n | Mean duration of hibernation (weeks) | Weight loss (g/week) | Weight at the time of hibernation breaking (g) | |
|---|---|---|---|---|---|
| | | | | Males | Females |
| *A. major* | 7 | 11.35±1.28 | 7.10±0.97 | 275.0±5.01 | 232.6±7.82 |
| *A. severtzovi* | 2 | 14.64±1.07 | 2.13±0.21 | 185.0 | 175.0 |
| *A. sibirica* | 10 | 17.94±1.61 | 3.01±0.38 | 129.0±2.21 | 115.5±3.24 |
| *A. elater* | 1 | 20.0 | 1.1 | | 41.0 |
| *P. pumilio* | 2 | 21.36±1.07 | 1.05±0.03 | 41.8±1.25 | |
| *S. telum* | 8 | 15.41±1.73 | 1.39±0.09 | 58.0±3.67 | 52.57±1.10 |

## 4. Breaking hibernation and breeding preparation

When weight loss exceeded the values noted above, animals were placed in a warm room and came out of hibernation. Occasionally a few animals woke of their own accord, but this was rare. In one case we failed to remove the animal when it lost weight rapidly, and the animal died. In our experience one must monitor individuals carefully and not use published average weights as the sole indication of when hibernation should be broken. We failed to create such conditions when jerboas woke up naturally. Likewise, we did not find such data in the literature.

Naturally, males wake up approximately one week prior to females (Bekenov, 1985). At that time, males usually have a slightly greater weight than females. The males are ready for reproduction by the moment the females are waking up. Usually, females become ready for reproduction two to three days after waking up, and the mating period begins at that time.

In attempting to form mating pairs, we tried to wake animals up following the conditions mentioned above. In our experience, animals of both sexes usually started to gain weight immediately after being woken. Sometimes they gained more weight than they had before hibernation. We believe that the absence of the energy loss which would normally be associated with foraging, accompanied by the temperature regime, led to cases of overweight and prevented the beginning of reproductive activity. Additionally, we suggest that vitamin E deficiency could be one reason for failure to breed. Normally, vitamin E should accumulate in the fat and subsequently be released following fat use, activating the function of the gonads (Kalabukhov, 1985).

In March 1989 we succeeded in breeding a pair of *S. telum* jerboas. These animals were caught in the Northern Balkhash region in June 1988. They were prepared for hibernation beginning in late September 1988 and transferred to the hibernation room on 31 October 1988. The room was maintained at 2°-10° C. At the time of the transfer the female weighed 73.8 g and the male weighed 77.0 g. The female fell asleep on 2 November, and the male three days later.

The male was roused from hibernation on 21 November 1 988, as he was losing weight too quickly; he then weighed 67.8 g. We immediately began his preparation for breeding. His diet consisted of plenty of carbohydrates, germinated oats and walnuts. This was supplemented with vitamin E oil solution. We attempted to simulate natural diurnal temperature cycles. The daytime temperatures were 26°-31°C, with night temperatures between 14° and 18°C.

The female was roused on 28 February 1989, at which time she weighed 51.8 g. Her diet was also supplemented with vitamin E oil and walnuts, but otherwise she received the diet described for the non-reproductive period. She was kept in the same temperature regime as the male.

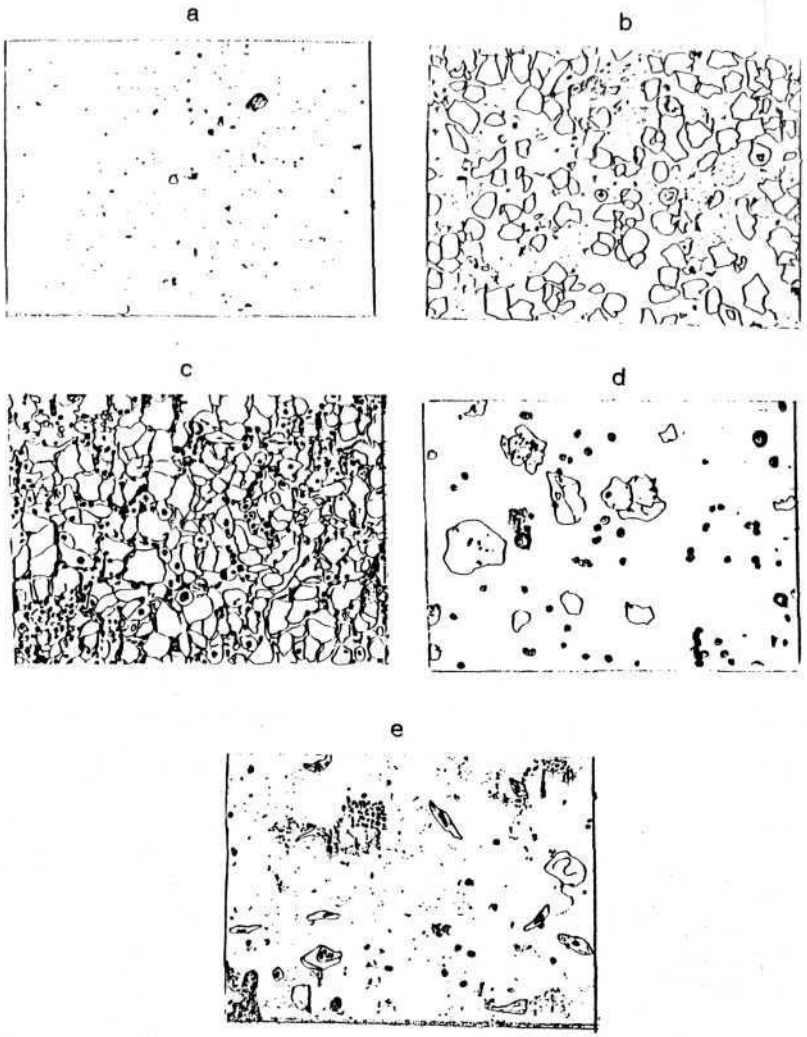
The female's vagina opened five days after the animal woke. Vaginal smears were taken daily to determine the stage in the reproductive cycle. On 5 March we noticed single cornified vaginal surface cells, or their fragments and dirt (Figure 4a). Such smears were termed 'empty'. The following day the smear was characterized by numerous scales, cornified surface cells and epithelial cells from vaginal surfaces (Figure 4b). On this day, the external sex organs were highly visible, swollen and pink. We removed the barrier between the cages, giving the pair a total cage size of 130 x 80 x 45 cm. The 7 March vaginal smear had numerous cornified surface cells, epithelial cells and leucocytes. This smear was very dense and filled with cell elements (Figure 4c). The following day another vaginal smear was taken; this had single epithelial cells, widely distributed, and leucocytes (Figure 4d). The female was very aggressive towards the male, and we separated the pair that day. Nevertheless, the 9 March smear had the same cell types, though they were fewer in number; we also observed some long, narrow cells (Figure 4e). All subsequent smears were empty. On 26 March four offspring were born.

It is possible to make the following simple conclusions: the female's vagina opened five days after waking; cycle duration was approximately five days; mating apparently took place on the second day of the cycle at the oestrus stage. The gestation period was 19—20 days; during this time, the female's weight increased from 64.2 g to 84.5 g. During the first month we did not disturb the female and her litter. Afterwards, we started to measure and weigh the young ones every week. By the beginning of June they had achieved the size and weight of the adults.

We suggest that Moscow Zoo's successful breeding with this pair of S. *telum* was due to correct hibernation and our methods of preparation for breeding after hibernation, together with the fact that the pair was united during the female's oestrus period.

In conclusion, we would like to emphasize several points to be followed in the successful maintenance of jerboas. First, prepare the animals for hibernation: this includes appropriate changes in the balance of the diet, strict weight control, and putting the animals in hibernation without food and litter. Secondly, strict adherence to all requirements for sleeping: maintaining a temperature of 2°-5°C without violent fluctuations, and the absence of vibration. Likewise, it is important to wake males at least one or two weeks prior to females, following strict weight and body fat control, gradually increasing the temperature of the hibernation place. Finally, it is necessary to stimulate reproductive activity by a combination of various abiotic factors, and to monitor the female's

**Figure 4 (a-e). The vaginal smears of *Stylodipus telum* female during oestrus cycle.**




breeding readiness using vaginal smears. However, we must admit that methods of withdrawing animals from hibernation and stimulating reproductive activity are the least developed parts of our study. These issues will be addressed in future research.

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