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# Breeding of sugar gliders (*Petaurus breviceps*, Waterhouse 1839) captive population in Moscow zoo

L. Kondratyeva, O. Ilchenko, G. Vakhrusheva

Russian Federation, Moscow, 123242, B. Gruzinskaya St., 1, Moscow Zoo, Research Department; e-mail: pholida@valneft.ru, zoosci@cdt.ru

**Abstract:** The research on sugar gliders (*Petaurus breviceps*) breeding and social behavior took place in Moscow Zoo, Scientific Department, in the period from December, 2004 to January, 2006. We studied two pairs and five family groups, which included adult, subadult and juvenile animals. For registration we used videotaping and such methods as time sampling and continuous journaling. All together 476 hours of observations had been processed. In the period when adult male and female are introduced to each other, the establishment of friendly relations takes place and only afterwards mating occurs. Great variety in behavioral repertoire and evident superiority of friendly contacts shows that this species appears to be highly social. Apart from the process of pair formation, we described the state of females pouch depending on their reproductive status, and stages of development of the young. In all family groups, each animal has its own role, which depends on individual characteristics of this glider. It is typical for sugar gliders juvenile to have relatively long "childhood", when social learning occurs. In raising a juvenile mother undoubtedly plays the main role, but all other members take part as well.

**Key words:** sugar glider *Petaurus breviceps*, parental behavior, pair formation, captive breeding

## Introduction

Sugar gliders inhabit open forests in eastern Australia, New Guinea and Tasmania. These smart and attractive animals are social, in the wild they form family groups containing up to 7 adult animals and their young (Nowak, 1991). Nowadays sugar gliders are common in zoo collections and many people keep them as pets. Nevertheless many aspects of their biology, particularly reproduction, are not studied well, in many respects because of their nocturnal activity and secretiveness. And so there are hardly few publications devoted to pair formation and maternal behavior of sugar gliders.

This species has been kept in Scientific Department of Moscow zoo since 2000. The main goal of the present study was to characterise captive breeding of sugar gliders. For that we:

1. Analysed all breedings of sugar gliders' colony in Moscow zoo in 2004-2006;
2. Video-taped the process of pair formation;
3. Described mother-cub interactions in five family groups;
4. Estimated effect of all group members on development of the young;
5. Described ontogenesis of the young and dynamics of their behavior from the moment of leaving the pouch up to the end of weaning period.

### **Material and methods**

We collected data in Moscow zoo during 2004-2006. Animals were housed at 26°C in vertical cages (80x40x130 cm) in the room with reverse schedule of light. All cages contained tree branches for climbing, two wooden nest-boxes, feeding and drinking bowls. The nest-boxes each had one glass side to make animals visible permanently. Out of observations we closed that glass sides with cardboard pieces. Animals were fed on a daily routine; their diet consisted of fruit, insects, cottage-cheese, boiled eggs, honey. All our sugar gliders were marked individually by cutting off hair on different parts of body.

Before starting the main observations, we video-taped behavior of sugar gliders in two family groups (24 hours of taping for each group). This helped us to reveal peaks of animals' activity and to compile ethogram of this species. Our following observations were conducted 2-3 times a week under red light, lasted about 3 hours and were timed to the period of top activity of animals. Pouches of nonpregnant females were examined once a week.

To study pair formation in two pairs of sugar gliders 144 hours of video-taping have been done and analysed.

During observations on interactions between juvenile and adult animals (284 hours) we fixed all contacts, appearance and forming of new behavioral acts and duration of stay of the young out of nest-boxes. Five family groups were under the study. They consisted of 6 males and 7 females who produced 8 litters (10 young) during the analysed period.

So, total time of observations was 476 hours. Also we kept a diary of all events in parallel. While analysing breeding of the species in Moscow zoo, we used data on 14 litters (18 young, 4 of them have died).

### **Results and discussion**

Differences in behavior of our captive sugar gliders are significant and concern individual behavior as well as social on all stages of pair formation and further breeding. That's why our subsequent discussions are generalized.

#### **Pair formation**

To form a reproductive pair we commonly united the partners in a neutral territory. For several days, female was kept alone in the new cage. Then we introduced a male.

On the whole they showed mutual interest by a lot of sniffing (up to 68% of all the contacts). Few agonistic interactions initiated by the female have been noticed, but they didn't cause any damage to the male. Considering two pairs introductions the whole period of pair formation could be divided into several stages:

1. On the first day of introduction, apart from high social activity, the animals showed exploratory activity and marking.
2. During the second day the animals started coming closer – they spent more time together, different types of sniffing prevailed; at the end of the active period the sugar gliders sheltered in one and the same nest-box to sleep.
3. The day before mating the female showed some sexual activity, such as mounting the partner, clenching his neck, as well as social grooming.
4. Sexual behavior included anogenital grooming, male mounting and female mating game. The female involving the male stood in front of him and her tail started to wriggle. Then she turned her back to the male still keeping the tail wriggling and touching the male's nose. Such behavior provoked the attempts of male mounting. The mating took place in the nest-box, where the partners spent 7 hours. Continuous grooming preceded the mating, two copulations followed, which precise duration we couldn't estimate. After mating the female went into another nest-box, and stayed there for a long time. Male followed her around and spent his time sitting on the roof of that shelter.
5. The day after mating male was initiative for most of the contacts (up to 60%).
6. The animal relations grew stable during the following days: state of partners' activity and the number of social contacts didn't really vary. So, we concluded pair formation period to be finished.

To sum it up, the mating took place with both observed pairs of sugar gliders during the first 6 days of introduction. Firm social bonds have been formed between the partners. In both cases introduction successfully led to reproduction. Nevertheless, the length of pair formation period between different sugar gliders may vary.

### Pregnancy

According to the literary data the sugar gliders' pregnancy is about 16 days, which coincided with our own observations. No postnatal estrus is observed. It's impossible to identify pregnancy if to rely on the female weight dynamics, because the young weigh 0,19g at birth (Nowak, 1991). From our experience, the beginning of pregnancy can be diagnosed by the state of the female's pouch (Jackson, 2003). A female, which hasn't given birth before, has a small, clean and dry pouch without skinfolds, the teats being very small, as well. A female that have bred previously but not presently, has a small but distinct, dry and dirty pouch, the teats are slightly elongated. Pregnant females pouch is pink in colour and glandular in appearance, skin folds may be observed on the lateral margins.

### Baby in the pouch

After birth cubs migrate to the pouch by themselves. They attach to the teat and don't get off for approximately 40 days. They are always located upside down in the pouch.

The birth usually stimulates the female to build a nest. With the tail curled into a loop, the animal heads for the chosen object (a stick, hay or a leaf), picks it up with its

fore feet and hangs upside down clinging with its hind feet. Then it puts the material into the loop on the tail and starts its slow way back. Though, sometimes they fail to make it all the way to the nest-box. They also carry sticks in their teeth. Such a nest building behavior is peculiar not only for females but sometimes for males.

According to our observations, while having a cub in the pouch, females groom mostly in the nest-box. They roll over in order to lie on the back: this way the lower part of the body leaning upon the wall and turns out to be higher than the head. After that the female stretches the pouch with its forepaws and licks it over.

### Cub makes its way out of the pouch

Cubs start leaving the mother's pouch at the age of 70-74 days. At this time they are ill-developed with poor thermoregulation. At first, the cubs are blind and almost bare. The body gets hair starting from the back and ending up on the belly. The ears go up gradually, the eyes fully open 6-10 days after leaving the pouch. The lower incisors are rather well developed, the upper ones show up in 25 days. From the first day after emerging the pouch they can produce barking sounds – the scream of the left alone cub. Quickly enough they make their acoustic repertoire wider.

The process of leaving the pouch takes place also gradually. During 2-3 days the cubs leave the pouch for a short period of time and come back. At this time they can perfectly cling to mother's fur. Little by little they spend more time outside and climb on mother's back. They easily find the way back to the pouch, the muscles of which are always relaxed at this period. The skinfolds are not distinct, the pouch hair is rare and dirty, the skin is smooth and dark pink, the teats are very elongated.

Female spends a lot of time in the nest-box, so the cubs gradually get off her. In cases when the female leaves the nest and the cubs are left all alone, they doubtfully move about the nest-box, sometimes sit helpless shivering, dropping the head from time to time. Approximately 10 days after they leave the pouch, when the eyes are wide open, the cubs can sit without falling and start moving around more. We observed the case, when the female was dragging a stick into the nest to make it easier for the cubs to climb. At the same time the female starts bringing food for the cubs. One of our females used to bite the head of an insect off, push and pass it to the cubs. They would lick the content but didn't try to hold it in their paws at that age.

In the course of two weeks after leaving the pouch, the cubs get out of the nest only on top of the mother, sometimes on the male, but later they do it by themselves. Gradually they investigate the cage area and learn to jump. The first planned jump was noticed 21 days after leaving the pouch. During the walking-out the adult gliders follow the cubs.

The cubs start playing two weeks after they leave the pouch. First of all they play individual games with their tails and nest material. Few days later the cubs play with each other or with adult animals. Games include catching the partner by the fore feet, pouncing, crawling under the partner and running one after another. Later the adult gliders get involved in similar games. We noticed some elements of sexual behavior (neck bites, mounting attempts, tailset bites) in juvenile games.

During the weaning period and when cubs were leaving the nest, females used to become aggressive toward the keeper (seldom to other members of the group). Female aggression disappeared after the end of lactation period.

Also, a very strong outdoor activity decrease has been noticed among the females after the young left the pouch. During the first days, female spends a lot of time with the cubs in the nest, though feeding happens not oftener than once an hour and a half, or two hours. Cubs' thermoregulation is ill-developed at this stage, that's why female can't leave them alone in the nest-box for a long time. Later female visits the nest-box more seldom and stays there only for feeding and grooming the cubs.

Usually mating takes place at the end of lactation period, so the reproduction happens once in 6 months. Supposedly, cubs leaving the pouch contribute to a female hormonal balance change. Indirectly it's proved by the male behavior at that moment: elements of sexual behavior have been noticed (anogenital area grooming, following the female, attempts of mounting). One of our females produced three litters during our period of investigation; and twice the mating happened almost right after the previous cub had left the pouch. In both cases the interval between reproduction became twice shorter, but all the litters developed normally. Such a phenomenon is common for other marsupials, though it has never been registered among the sugar gliders (Dr. David Croft, personal comment).

#### The end of weaning period

All the young had approximately the same dates of development. 40-45 days after the pouch leave they all became independent. By that age they had successfully finished investigation of the whole cage area, and could move around independently from the parents. Sometimes, though, they kept riding on female back. They would independently go down to the feeding place, eat and drink water. We could observe a well-formed grooming complex before and after sleep. The weaning period stopped when the cubs came to an age of 110-120 days.

#### Helping behavior

The presence of grown up cubs doesn't prevent the main pair from breeding. Short after the end of lactation period, female cycle usually restores, mating takes place, and new litter appears. Immature group members show increased interest towards newborns when the latter leave the pouch. They play with them and carry them on top. Optionally paternal behavior comes out – some males build a nest, carry cubs on top, and are respondent to their signals. We observed two cases when mother's attention was distributed among the cubs not equally: she gave distinct preference to one of her daughters. That cub spent most of the time on top of mother. Sometimes mother would deliberately drop the other cub down in order to leave it in the nest. In that case father would partially compensate the lack of mother's attention: he began to spend more time in the nest-box together with the left alone cub. And when the cub started going out of the nest independently, it followed the father, not mother, imitating him. Often the father would sleep in one nest-box with that cub, separately from other members of the group.

#### Sexual maturity

According to literary data, sugar gliders become sexually mature by the age of 12 months (females), and 8-15 months (males) (Nowak, 1991; Jackson, 2003). ~~Mass from~~

our colony started breeding approximately at the mentioned age but females recorded as mating were aged 11 months.

Sexual maturity of males can be judged upon development of their frontal gland. There are three stages of its activity (Jackson, 2003):

1. Little or no activity – little or no hair loss over the gland area; no obvious gland product.
2. Medium level activity - some loss of hair over the gland area; waxy glandular products visible.
3. High activity – total loss of hair over gland area; waxy glandular product prominent.

Female sexual maturity and the beginning of reproduction can be determined according to the changes of the pouch, as it has been described above. When young females start to breed, they can stay in the group or may be driven away, this depends on behavior of adult female. Young males start their breeding in the group if the group includes not only adult but young females, too. Then the young male and the young female form a new pair and occupy the free nest-box. We used to separate such a pair.

#### General data on reproduction

Having analyzed all the cases of sugar gliders' reproduction in Moscow Zoo for the period of September, 2004 – April, 2006, we got the following data.

All formed pairs ( $n=9$ ) initiated reproduction. 14 litters appeared during the mentioned period, with 18 cubs in total. Among them were 11 males and 6 females; one cub couldn't be sexed. No seasonal differences in reproduction have been noticed; the litters appeared evenly during the whole year. Most females reproduced only once a year, but there were cases when the female produced two ( $n=1$ ), and also three litters ( $n=2$ ) during 12 months. Young females, just starting to breed, produced one litter during the year, and only one female reproduced twice. In 65% of cases there was one cub in the litter, and two cubs in the rest of cases. Out of 18 cubs 4 died: one, being in the pouch, the others – soon after leaving the pouch. In all those cases, they were the cubs of females, which gave birth for the first time. The cubs of such females survived in 55% of cases.

### Conclusions

To sum up, sugar gliders are social species with strong family relations. The behavior of all the animals depends on each other. The birth of a cub and its leaving the pouch plays a very important role for the whole group. A newborn is fully dependant on mother's attention and on other members of the group. Gradually developing, it gets to know more about the outer world, learns actively, and approximately in 45 days after leaving the pouch, becomes independent.

The process of sugar gliders pair formation, the phenomenon of shortened interval between reproductions and some peculiarities of parental behavior have been described in the present work for the first time.

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### References

JACKSON S., 2003. Australian mammals: biology and captive management. CSIRO Publishing, Australia. 206-244.

NOWAK R.M., 1991. Walker's Mammals of the World. The Johns Hopkins University Press, London, Baltimore. Vol I: 74-76.