Observations on the feeding biology and behaviour of the Fat Dormouse, *Glis glis orientalis* Nehring, 1903 (Mammalia: Rodentia) in captivity

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Abstract: The preferred food of the Fat Dormouse, *Glis glis orientalis,* in captivity consists of hazel nuts, fresh hazels, sunflower seeds, chestnuts, acorns, grapes, and apples. The gnawing patterns shown on the nuts are different from those of some sympatric rodent species such as *Sciurus anomalus*, *Apodemus flavicollis* and *A. sylvaticus*. Fat Dormice consumed 2.0–26.1 g food per day in the hibernation season and up to 52.0 g in the warm season. Fat dormice are not aggressive against each other, and males and females live together in the same cage without interference. Lactating females suckle the newborn of other females. The species hibernated in captivity as single individuals in holes under the ground surface. Waking from hibernation takes about 50 minutes. Reproduction was never observed in the laboratory over five years.

Kurzfassung: In Gefangenschaft bestand die bevorzugte Nahrung des Siebenschläfers *Glis glis orientalis* aus Haselnüssen, frischen Haselfrüchten, Sonnenblumenkernen, Kastanien, Eicheln, Weintrauben und Äpfeln. Das Nagemuster auf den Nüssen unterscheidet sich deutlich von dem anderer, sympatrisch lebender Säuger wie dem von Eichhörnchen *Sciurus anomalus* und dem von *Apodemus flavicollis* bzw. *A. sylvaticus*. Siebenschläfer verbrauchten in der Überwinterungsphase pro Tag 2.0–26.1 g Nahrung, in der warmen Jahreszeit bis zu 52.0 g pro Tag. In Gefangenschaft waren die Siebenschläfer untereinander nicht aggressiv, und Männchen und Weibchen konnten im gleichen Käfig gehalten werden. Während der Jungenaufzucht säugten Weibchen auch die Jungen anderer Weibchen. In Gefangenschaft überwintern die Siebenschläfer einzeln in Öffnungen unter der Erdoberfläche. Das Aufwachen aus dem Winterschlaf dauert etwa 50 Minuten. Während fünf Jahren Gefangenschaftshaltung pflanzten sich die Siebenschläfer nie fort.

Key words: Fat Dormouse, feeding biology, behaviour, Turkey, Middle East.

Introduction

The Fat Dormouse, *Glis glis,* is represented in the Palaearctic region by ten subspecies (OGNEV 1947). Of these, *Glis glis pindicus* Ondrias, 1966 occurs in the coastal regions of the European part of Turkey, and *Glis glis orientalis* (Nehring, 1903) in the Black Sea region of Anatolia (e.g. CORBET 1978, KOCK 1990, DOĞRAMACI & TEZ 1991, KURTONUR 1992). The first studies on the biology of *G. glis* were conducted in Turkey by ÇOLAK et al. (1994, 1997, 1998) and KIVANÇ et al. (1995). The present study aims to contribute information on the feeding biology and behaviour of *G. glis orientalis*, and to provide comparative data for other subspecies of *Glis glis*.

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Material and methods

The study was conducted between 1990 and 1994 and was based on both field and laboratory observations. In the field, several localities in the Black Sea Region of Turkey were studied, and specimens were collected dead and alive using snap-traps and wooden live-traps. The laboratory studies were conducted by monitoring eight adult females and 46 newborn, caught in a few colonies at Çayeli, Rize in 1990. The age of the newborn was determined by the rate of increase of body weight, which is on average 0.9 g/day up to the 11th day (GEBCZYNSKI 1981). These young dormice with an age of about 5 days were housed in a cage in the laboratory together with their mothers, and at an age of three months they were transferred to individual cages (19 x 22 x 37 cm). Each cage was provided with nesting material, food and water. The food intake of adult dormice was determined daily for non-hibernating individuals. Hibernation was monitored by the sawdust technique (SCOTT & FISHER 1972). In addition, we captured some sympatric rodent species such as *Sciurus anomalus*, *Apodemus flavicollis* and *Apodemus sylvaticus* in order to compare gnawing patterns on the nuts. All animals were kept in ambient laboratory conditions.

Results and discussion

Daily activity pattern

Fat dormice live mainly in the deciduous forests of the coastal region of northern Turkey. During 1990 and 1992, we collected many specimens with traps set up on the ground. This shows that the Fat Dormice are arboreal rodents but that they frequently descend to the ground. We never encountered the species during the day. Their main activities were noted to occur at dusk and in the early morning. The same findings have been reported by OGNEV (1947) and STORCH (1978).

Feeding biology

We offered the Fat Dormice in their cages different kinds of food (hazelnuts, chestnuts, walnuts, beech nuts, linden nuts, sunflower seeds, apple, mulberry, strawberry, fig, cherry, grape, acorn, oak leaves and fresh branches). All food was readily consumed, except for walnuts. However, in the field, we found the shells of fresh walnuts on the ground; these might have been eaten by Fat Dormice or Squirrels. OGNEV (1947), MROSOVSKY & BOSHES (1986) and RODOLFI (1994) also reported that the Fat Dormouse feeds on nuts.

We studied the gnawing pattern of the Fat Dormouse on nuts. We observed that the Fat Dormice gnawed the shell of hazel nuts in a characteristic fashion; they first took a hazel nut and turned it a few time in their paws, and later gnawed the shell at the tip of the nut or slightly at one side by using their lower incisors. The paws and upper incisors were used to hold the hazel nuts in a certain position. No tooth mark across the cut edge of the shells was observed. In addition, the gnawing pattern of holes was usually jagged and not a neat hole (Fig. 1). The most common gnawing pattern on hazel nuts and other gnawing patterns were also seen. It was observed that when food such as hazel nuts, chestnuts, acorn and walnuts was provided simultaneously in cages, the dormice preferred hazel nuts, followed by chestnuts and acorn. The dormice rarely tried to gnaw the hard shell of the walnuts, and their attempts were usually unsuccessful. In order to compare the gnawing pattern of some sympatric rodent with that of the dormice, Squirrels (*Sciurus anomalus*) and Wood Mice

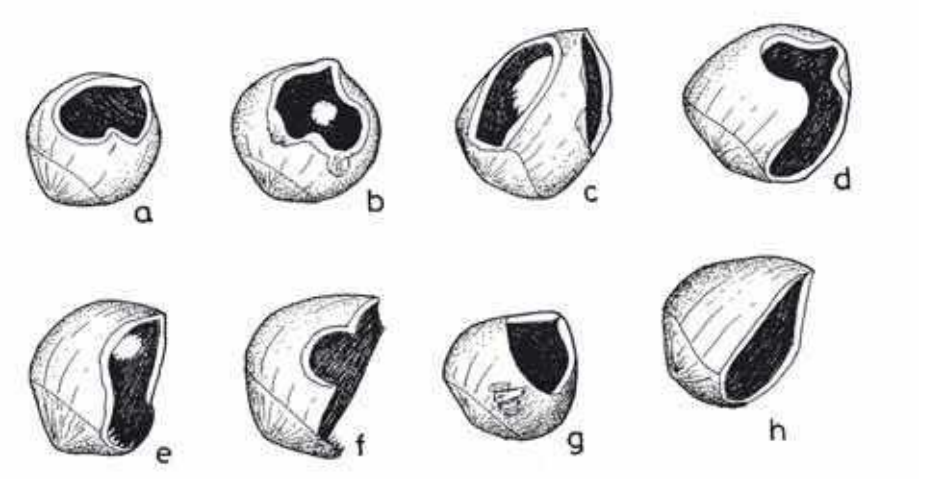

Fig. 1. Hazel nuts gnawed by *Glis glis orientalis*.

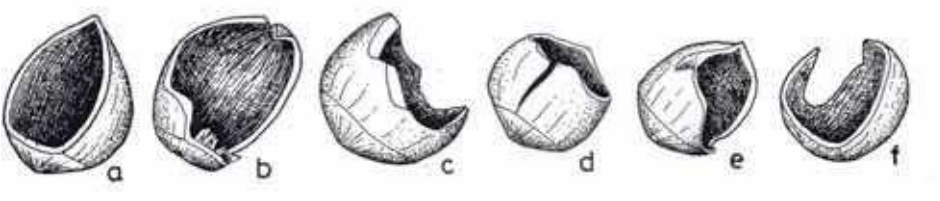

Fig. 2. Hazel nuts opened by *Sciurus anomalus*.

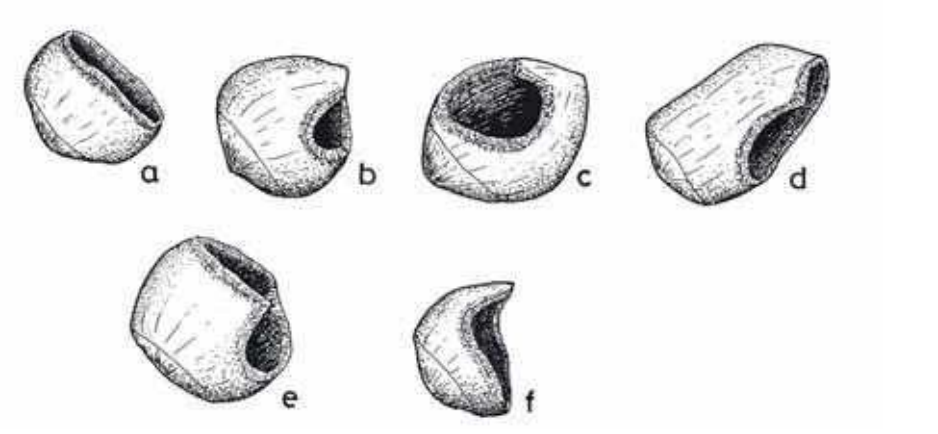

Fig. 3. Hazel nuts opened by *Apodemus sylvaticus* and *A. flavicollis*.

(*Apodemus flavicollis* and *A. sylvaticus*) were housed in separate cages and were fed with hazel nuts, too. Squirrels most frequently cracked hazel nuts in half. Other cracking patterns were very rare, and the holes of hazel nuts were usually jagged (Fig. 2). Wood mice also gnawed the hazel nut, but the hole was mostly opened up at the tip of the nut as a round and neat hole or small neat hole on the one side of the nut (Fig. 3). Our findings for *Sciurus* and *Apodemus* are similar to those given by BRIGHT & MORRIS (1992). According to these findings, the gnawing patterns of the Fat Dormouse are different from *Sciurus anomalus* but the same as wood mice.

Food consumption was determined by providing nuts for their cages. The daily average food consumption, and hibernation bouts of the Fat Dormouse during the hibernating period, were also noted (Tab. 1). It was observed that if the duration of individual bouts of hibernation was short, the species consumed more nuts in the interval of two hibernation bouts than the long bouts of hibernation. In this connection, it was noted that the daily nut consumption of *G. glis orientalis* varied from 2.0 to 26.1 g in the hibernation period (Tab. 1), but ranged from 0 to 52.0 g in the non-hibernation period. Apart from nuts, some fruits such as grapes and apples were provided in the cages to monitor the manner in which the fruits were consumed. It was determined that Fat Dormice readily feed on grapes, apples, cherry, pear, strawberry and mulberry. They first removed the outer layer of grapes and apples, and then ate the endocarp of the apple and drunk the juice of the grapes. Many of these fruits were bitten and left to decay in their cages. OGNEV (1947) stated that the Fat Dormouse is extremely harmful to fruits, but so far *G. glis orientalis* inhabiting the costal parts of northern Turkey has not been reported as causing damage to orchards. We found that adults consume on average 20 g of fruit per day. The highest amount was 47 g of fruit per day in December. DONAUROV and POPOV & KHONYAKINA (after OGNEV 1947) reported that the diet of the Fat Dormouse on the northern slopes of the Caucasus contains oily and watery foods in almost equal amounts. Our findings are consistent with their results. Fat Dormice also feed on the fresh branches of some trees such as oak, linden and acorn.

According to laboratory observations, the newborn started to climb onto the branches and gnaw food materials in the cages at an age of 20 days, when they were still suckling. The young stopped suckling at an age of 30–35 days, and began to feed freely. According to ÇOLAK et al. (1998), Fat Dormice start hibernation in October and awake in June. They also reported that the species ate after long uninterrupted bouts of hibernation rather than after short ones, in order to compensate lost weight. The present study shows that the daily food consumption of Fat Dormice was significantly larger in the long-lasting periodic arousal rather than in the short ones. FISHER & MANERY (1967) noted that *G. glis* took food during its periodic arousal, as in the present study. MROSOVSKY & BOSHES (1986) reported that *G. glis* consumed 30% food during the day and 70% at night. In contrast to MROSOVSKY & BOSHES, we observed that the Fat Dormouse did not take food at all in daytime if there was sufficient food in their cage, and did not suffer from starvation.

The Fat Dormouse has been reported as being a rodent harmful to fruits: ALKAN (1966) considered the species harmful to fruits without any evidence, and TUNÇDEMIR (1987) reported that they damage hazelnuts, walnuts, apples, pears and peaches in the costal parts of north-east Turkey. OGNEV (1947) noted that they are extremely harmful to fruits, which are damaged, bitten and left aside. Unlike these, we did not obtain any evidence about the harmful effects of Fat Dormice on fruit gardens, and we seldom encountered gnawed nuts in gardens near forests in the Black Sea Region of Turkey.

Tab. 1. The daily average nut consumption during the hibernation period and the individual bouts of hibernation per month (H), All values in gram per H.

No.	sex	Oct.	Nov.	Dec.	Jan.	Febr.	March	April	May	June
1	♂	18.4/0	16.4/0	19.2/0	21.8/0	18.9/0	16.4/4	10.9/0	17.0/0	13.1/8
2	♂	20.7/0	24.5/0	15.8/0	20.8/0	17.5/1	15.4/2	4.3/17	15.5/0	17.3/0
3	♀	26.1/0	23.7/0	14.0/0	19.1/0	16.5/1	15.8/0	7.1/1	14.0/1	21.0/0
4	♂	17.2/0	14.2/0	13.4/0	15.6/0	17.6/0	14.0/0	8.4/0	10.2/0	13.4/0
5	♀	12.2/2	8.2/13	4/29	0/31	0/28	0/31	17.8/21	12.6/13	19.7/0
6	♂	18.4/0	20.2/0	8.7/1	21.6/0	20.6/14	15.5/0	8.7/10	10.1/5	12.1/3
7	♀	17.6/0	6.8/16	0/31	0/31	0/28	0/31	0/30	0/30	15.1/6
8	♀	19.9/0	36.8/0	13.0/12	0/31	0/28	7/30	0/30	5.0/29	11.1/10
9	♀	15.7/0	10.3/12	5.6/23	0/31	5.7/22	2/30	2/27	6.0/28	17.0/7
10	♂	10.3/0	19.2/0	17.0/0	19.7/0	21.0/1	18.4/0	14.7/0	11.4/0	16.8/0
11	♀	18.2/0	13.4/0	20.6/10	4.0/27	Dead	-	-	-	-
12	♂	10.1/0	12.7/0	14.9/0	11.6/0	24.1/2	11.4/0	10.3/0	15.0/0	19.1/0
13	♂	7.7/0	11.0/5	18.6/13	3.5/29	0/28	15.0/24	11.8/1	9.9/0	13.1/0

Behaviour

Fat Dormice were caught in a few colonies in the neighbourhood of Rize in the coastal region of northern Turkey, and were housed in a cage together. Adult dormice and weaned newborn in the same cage tolerated each other well. We did not observe aggressive behaviour. If there were a few nest boxes in the cage, and more than one adult male housed in the same cage, they usually tended to use different nest boxes. The females with litters usually cared for other females' litters. The females housed in the same cage did not suckle newborn at the same time. A female first suckled her litter for 15–20 minutes, and then drank water. Later, this female rested in the nest, and other females started to suckle and so on. JECHE & JECHE (1984) made similar observations. When a newborn crawled out of the nest, the female carried her young back to the nest by seizing its flanks. In addition, the female frequently changed her nest place in the cage by moving the newborn to new one. The young, which opened their eyes in two weeks, were very sensitive to their environment and were always afraid of noise and moving objects. At an age of three weeks, the young tried to gnaw food materials such as apples and walnuts, and to climb on the oak branches in the cage, but they were still suckling. They stopped suckling after a month and started to feed freely in the cage. The Fat Dormouse has a tendency to hibernate underground. It was observed that it usually digs a hole in the ground under the nest box, and hibernates alone in this sphere without nesting materials (Fig. 4). But some Fat Dormice hibernated in nest boxes insulated with soil and nesting materials (Fig. 5), and this observation is consistent with that reported by ÇOLAK et al. (1998). Contrary to our findings, ALKAN (1966) reported that Fat Dormice hibernate in aggregations. Hibernating individuals curl into a tight ball with the nose tucked beneath the tail (Fig. 4–5), a body posture previously reported by ÇOLAK et al. (1998).

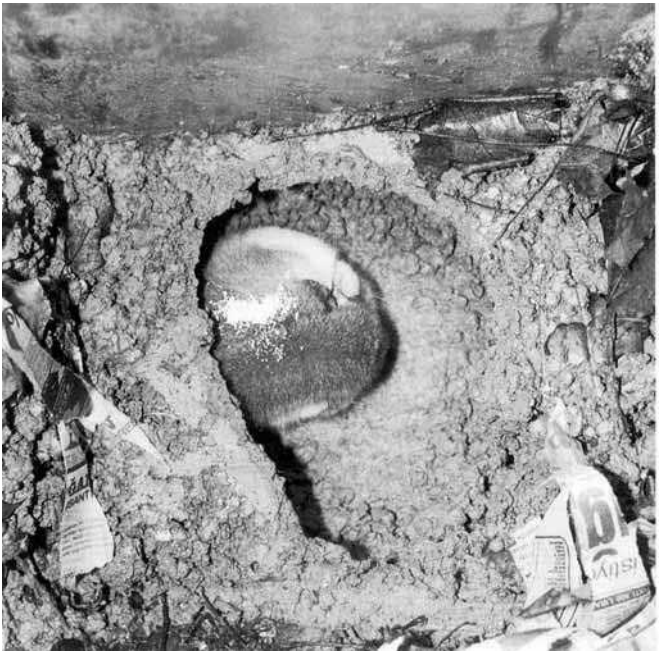

Fig. 4. Hibernating Fat Dormouse in a hole under the nest box.

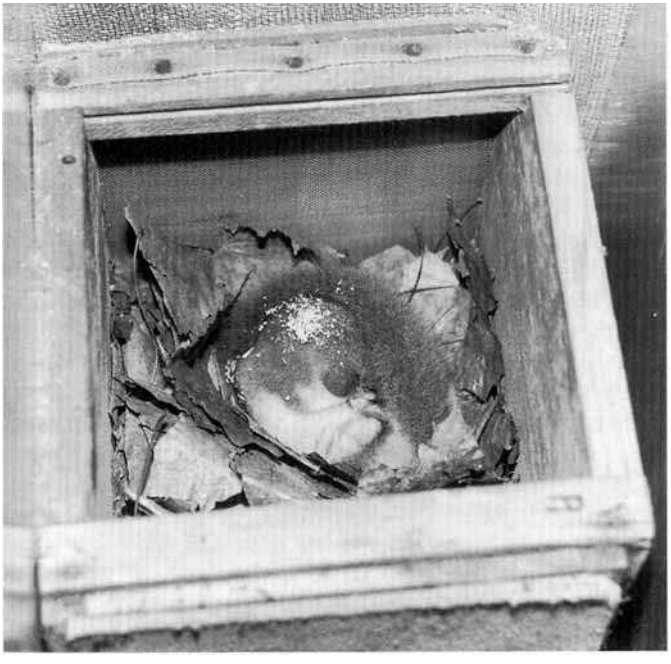

Fig. 5. Hibernating Fat Dormouse in a nest box insulated with nesting material.

According to the present laboratory observations, hibernating Fat Dormice need about 50 minutes to awake. Waking dormice were observed to shiver until arousal was completed. When food and water were provided prior to the hibernation period, it was observed that they did not construct a food storage chamber and store food in their cages, but some nuts varying from 200 g to 700 g under some of the nest boxes were seen after hibernation terminated. MROSOVSKY & SHERRY (1980) stated that food storage is not a necessary precondition even when food is available. Similarly, ÇOLAK et al. (1998) reported that food availability had no effect on the hibernation of fat dormice in captivity. Thus, it may be said that the species does not store food regularly.

Reproduction did not occur in our laboratory over five years. HÖNEL (1991), KULZER et al. (1993) and BIEBER (1997) found that the reproductive success of the Fat Dormouse is extremely low. BIEBER (1997) reported that reproductive failure coincides with a lack of food resources. In addition, he also suggested that bad weather conditions or adverse environmental events, such as absent flower buds in a dry spring, prevented gonad development in males. In the present study, animals did not breed over five years although sufficient food was provided. KIVANÇ et al. (1995) studied the effect of hibernation on the testes and liver of Fat Dormice. They reported gonad activity in captivity by studying histological sections of testes. Even though they observed gonad activities in testes sections, breeding was not reported. That is why it can be said that reproductive success in the Fat Dormice may be affected by other unknown factors rather than by the absence of food, bad weather and environmental factors.

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