

## A Study on the Hibernation of *Spermophilus xanthopyrmnus* (Bennet, 1835) (Mammalia: Rodentia) in Turkey

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**Abstract:** In this study, the hibernation of ground squirrels (*Spermophilus xanthopyrmnus*) distributed in Central Anatolia were studied in laboratory and field conditions. According to our findings, the hibernation period of ground squirrels began at the end of August and terminated in mid February. The longest and shortest hibernation bouts of ground squirrels were found to be 100 and 21 days, respectively. In this period, the longest uninterrupted hibernation was 13 days. Ground squirrels gained weight during the early months of summer and then lost weight constantly throughout hibernation period. No marked periodic cycles were observed in the periods of weight loss, and ground squirrels lost an average of 28% of their total body weight during this period.

**Key Words:** *Spermophilus xanthopyrmnus*, hibernation, Turkey

### Türkiye'deki *Spermophilus xanthopyrmnus* (Bennett, 1835) (Mammalia: Rodentia) un Hibernasyonu Üzerine Bir Çalışma

**Özet:** Bu çalışmada İç Anadolu'da yayılış gösteren *Spermophilus xanthopyrmnus*'un hibernasyonu laboratuvar ve arazi gözlemleriyle çalışıldı. Bulgularımıza göre, yer sincaplarının hibernasyon periyodunun Ağustos ayı sonlarında başlayıp Şubat ayı ortalarında bittiği saptandı. Örneklerde gözlenen en uzun ve en kısa hibernasyonda kalma süresi sırasıyla 100 ve 21 gün olarak bulundu. Bu süre içerisinde kesintisiz en fazla hibernasyonda kalma süresinin 13 gün olduğu, yaz aylarında örneklerin ağırlıkları artarak hibernasyon periyodu boyunca ağırlıklarının düzenli bir şekilde azaldığı ve Yer sincaplarının ağırlık kayıplarında belirgin periyodik siklusların olmadığı görüldü. Laboratuvarda izlenen yer sincaplarının hibernasyon periyodunda ağırlıklarının ortalama %28 ini kaybettikleri belirlendi.

**Anahtar Sözcükler:** *Spermophilus xanthopyrmnus*, hibernasyon, Turkey

### Introduction

The generally accepted belief that hibernation is realized by the double effect of internal rhythm and external factors (1). The ground squirrel, *Spermophilus xanthopyrmnus*, is a terrestrial diurnal rodent and an excellent hibernator of the family Cricetidae. Bennet (2) first described *S. xanthopyrmnus* from Erzurum (Turkey) in 1835. Subsequently, Mursaloğlu (3) assigned the specimens of the Thrace region (European parts of Turkey) to *Citellus citellus citellus* and the specimens of Central Anatolia to *C. c. gelengius*. At present, the genus *Citellus* is considered to be a junior synonymy of the genus *Spermophilus* and thus, the genus *Spermophilus* has been regarded as a valid genus name (4). Ellerman and Morrison - Scott (5) and Corbet (4) rejected *S. xanthopyrmnus*, referring to this taxon as a subspecies of *S. citellus*. However, Ognev (6) reported that the ground squirrel distributed in Northern Anatolia is *S. xanthopyrmnus*. In the most recent taxonomic study in Turkey, Doğramacı et al. (7) stated that the kayotypes

distinguish the Anatolian populations from the Thrace populations, and they also noted that, according to this karyologic difference, the ground squirrel in Central Anatolia is *S. xanthopyrmnus*. For this reason, the species name *S. xanthopyrmnus* is considered to be a valid taxon, and is used in the present study for the specimens of Central Anatolia. In addition to these taxonomic remarks, ecological and biological works on Palearctic ground squirrels are very scarce. In contrast, intensive hibernation studies have been undertaken on ground squirrels ranging across the Amercian continent (8, 9, 10, 11). However, some ecological observations on ground squirrels were made on Caucasus species by Sviredenko (12), Orlov (13), Argyropolu (14) and Birula (15), and on European and Anatolian species by Strallen, (16), Calinescu (17) and Karabağ (18). In addition to these, Niethammer and Krapp (19) studied the hibernation of ground squirrels in Europe. The aim of this study is to examine the hibernation pattern along with changes in the body weight of ground squirrels in uncontrolled conditions.

## Materials and Methods

This study was carried out in 1996 and 1997 on 29 live specimens captured from 40 km S of Polatlı (Ankara) (Fig. 1). The data on hibernation biology was obtained from laboratory and field observations. Eleven ground squirrels were marked by toe-clipping and then released to the field in order to monitor their activity over a year. Eighteen ground squirrels were transferred to the laboratory in Ankara. Of these specimens, 15 adults (7 male, 8 female) were kept one to a cage (40 cm x 40 cm x 40 cm) to examine their hibernation. Hibernation was monitored by the sawdust technique (20). Animals were visited daily and a note was made of whether they were active or hibernating, and they were weighed weekly. By the sawdust technique, periodic arousal and the duration of individual bouts of hibernation were detected. Animals were provided with nesting materials, food (wheat seeds, sunflower seeds, carrot, fresh grass, biscuit enriched with vitamins) and water. The ambient temperature was recorded daily (°C) at maximum and minimum during the inspection period (Fig. 2). All ground squirrels were also kept in laboratory conditions similar to their natural climatic environment (temperature, photoperiod, humidity) in Ankara.

## Results and Discussion

**The field observations:** The activities of ground squirrels were observed to be very intensive between 10 am and 17 pm during the homothermic period. This finding is consistent with Sviredenko (12). The last ground squirrels disappeared at the end of August. At this time, burrow entrances were closed by collapsed soil. The ground squirrels were very rarely seen out of burrows in the field inspections conducted in autumn and winter months. Especially in winter months, the station site was completely covered by snow. These findings are similar to those given by Karabağ (18), who studied ground squirrels around Ankara. Additionally, Torke and Twente (9) reported similar results for *S. lateralis* in Canada. In contrast to these, Davis and Swade (11) reported that females of *S. beecheyi* were rarely observed above ground from November to January in the wild but that males were frequently seen out of burrows during this period. In this study, when the ground squirrels disappeared, the vegetation was completely dried out and water was unavailable around the station site.

**Entering hibernation:** The ground squirrels kept in the laboratory gained weight during the summer months. The food consumption was determined to be an average of 44 g (18 g seeds, 26 g fresh grass) in August, whereas

it was only an average of 16 g (4.5 g seeds, 26 g fresh grass) in October when the ground squirrels predominantly entered hibernation. Just before hibernation started, the animals' day-time activity decreased and they remained more in their nest. They became torpid for a few days just before hibernation. Such a periodicity (about 5 days) was reported by Calinescu (17) for European ground squirrels. Of the ground squirrels, number 3 hibernated with a body weight of 405 g and numbered 2 with a body weight of 264 g, and they first hibernated on August 28 and 29, respectively. This first hibernation lasted only one day at an ambient temperature of 22°C. Although the first hibernation occurred on August 28 and 29, the ground squirrels generally began to hibernate in mid September. The average ambient temperature in mid September was almost the same as in the previous month. Our findings on the timing of hibernation were consistent with those of Niethammer and Krapp (19). Additionally, these researchers stated that the initiation and termination of the heterothermic period were affected by the temperature and altitude of the localities. The hibernating ground squirrels curled themselves into a tight ball, the back upwards and the tail extended under and beyond the head. This hibernation posture is consistent with the findings given for *S. lateralis* by Torke and Twente (9).

**Changes in Body weight:** After the first hibernation began at the end of August, other animals started to hibernate in September (Fig. 3). It was found that body weights at the start of hibernation were a maximum of 495 g in number 4 and a minimum of 250 g in numbers 1 and 11. Fig. 4 depicts the changes in the body weight of the ground squirrels monitored in the laboratory. Body weight ranged from 263 to 495 g with an average of 339 g on August 24 when number 3 first started hibernation (Table 1). The body weights of animals regularly decreased, and no marked fluctuations in the body weights were observed throughout the year (Fig. 4). Weight losses terminated between the 45th and 47th weeks and then the animals rapidly gained weight from mid July to early August. The rate of weight loss varied from 14.6% to 40% with an average of 28% in the hibernation season. There was no direct correlation between weight loss and the number of days spent in hibernation. When the hibernation terminated in mid February, the average body weight was determined to be 240 g, and this rose to an average of 354 g in the first week of August. This value seems to be very close to the previous year's mean of 339 g.

**The duration of hibernation and temperature:** The hibernation season lasted from late August to mid

February in the laboratory. This data is consistent with our field findings. The rates of the duration of hibernation in a year are presented in Fig.5 and Table 1. These show that the rates varied from 28.83% to 5.75% with an average of 15.5%. According to Fig. 3 and Table 1, the timing patterns and the duration of hibernation in 15 adult ground squirrels were very different from each other.

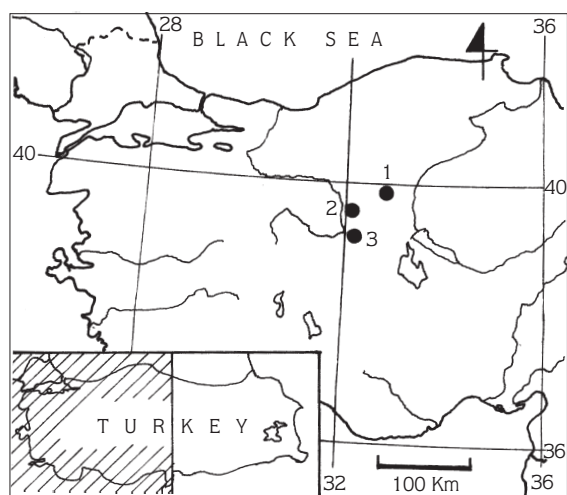


Figure 1. The station site (●) where the field observations were performed around Polatlı (1)/Ankara (2).

We did not determine any correlation between the start and termination of hibernation and the sex and age of the specimens. In contrast, Niethammer and Krapp (19) noted that older ground squirrels entered and terminated hibernation earlier than younger ones. They also reported that males began to hibernate earlier than females of the same age. In the laboratory, we saw that aroused ground squirrels ate in heterothermic period but they were highly torpid between hibernation bouts. After arousal was completed, their first movements were found to be consistent with the findings of Torke and Twente (9). The number of days spent in hibernation is given in Table 1. As can be seen, it fluctuated from 21 to 100 with an average of 54 days. The longest duration spent in hibernation in a heterothermic period was determined to be 100 days in number 13, followed by 87 and 84 days in numbers 3 and 14, respectively. The maximum uninterrupted periods of hibernation were 13 days in number 14, 12 days in number 12 and 10 days in number 3. The bouts of hibernation lasted from 1 to 13 days. Karabağ (18) reported that the maximum time spent in hibernation was 154 days and the maximum bouts of hibernation was 7 days in *S. xanthopyrmus*. These findings are highly different from our results. Although the last periodic arousal occurred in February

Table 1. The body weight (g) in the hibernation season and the days spent in hibernation for 15 adult ground squirrels.

Animal no.	Body Weight in August 24	Body Weight in February 16	Rates of Weight Loss %	First Hibernation Entrance	Last Hibernation Arousal	Number of Days Spent in Hibernation
1	277	200	27	September 11	January 4	24
2	285	224	21	August 29	January 17	57
3	423	309	27	August 28	January 24	87
4	495	308	38	September 18	January 19	25
5	295	255	14	September 9	February 12	39
6	453	300	34	September 19	January 31	35
7	391	267	32	September 9	January 20	77
8	315	220	30	September 20	January 20	45
9	306	207	32	September 10	January 24	46
10	283	222	22	September 20	February 4	55
11	263	197	25	September 16	January 16	61
12	381	227	40	September 20	January 13	21
13	321	209	35	September 9	January 23	100
14	297	217	27	September 7	January 20	84
15	306	237	23	September 19	January 6	56

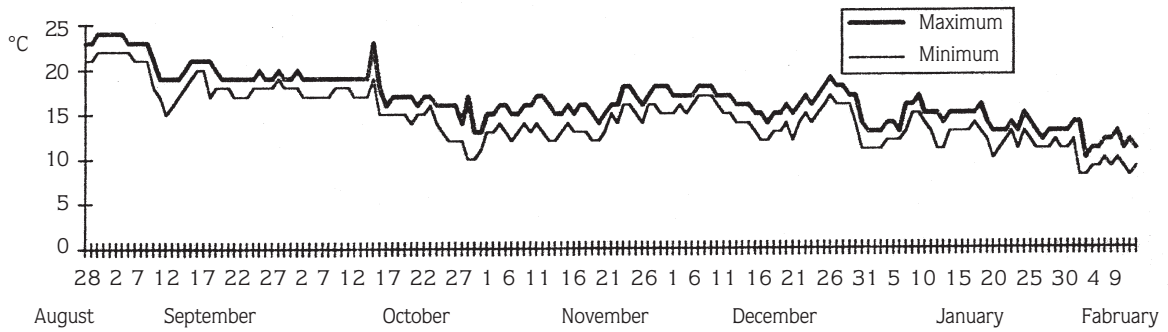


Figure 2. The ambient temperature recorded in the hibernation period in the laboratory where the ground squirrels were housed.

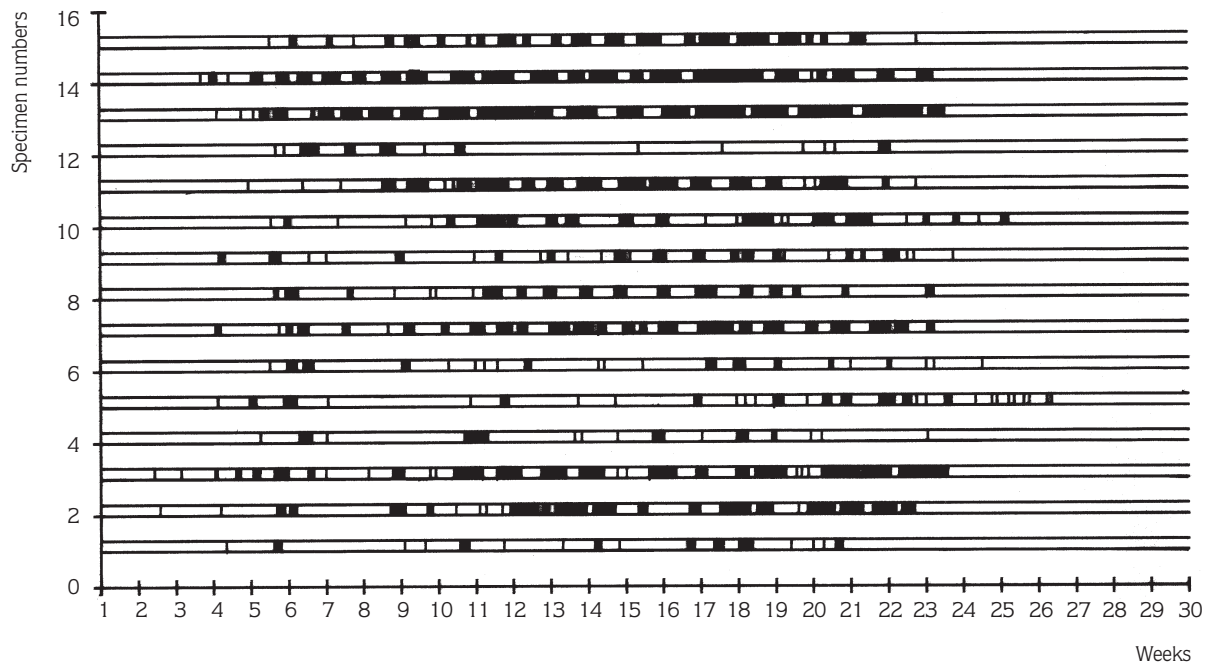


Figure 3. The period of continuous hibernation of 15 adults ground squirrels. The black vertical bars indicate hibernation bouts. The first week begins August 20.

(numbers 1, 5, 10, 12, 15), there was a tendency to terminate hibernation in the second half of January (numbers 2, 3, 4, 6, 7, 8, 9, 11, 13, 14).

The fluctuations in ambient temperature in a hibernation season are illustrated in Figure 2. The lowest temperature recorded in the hibernation period was 8°C. Although February was the coldest month, the ground squirrels terminated hibernation in mid February. It was revealed that the hibernation of ground squirrels was not

directly correlated with temperature. Pengelley and Asmundson (10) stated that light had an appreciable effect on the hibernation of *C. lateralis*. In contrast, Dresher (8) stated that temperature had a major stimulating influence on the hibernation of *S. undulatus*. According to our findings, the endogenous rhythm is the essential factor for initiating and maintaining the hibernation. Thus, it might be said that this endogenous rhythm requires the environmental timing cues such as photoperiod, temperature and starvation.

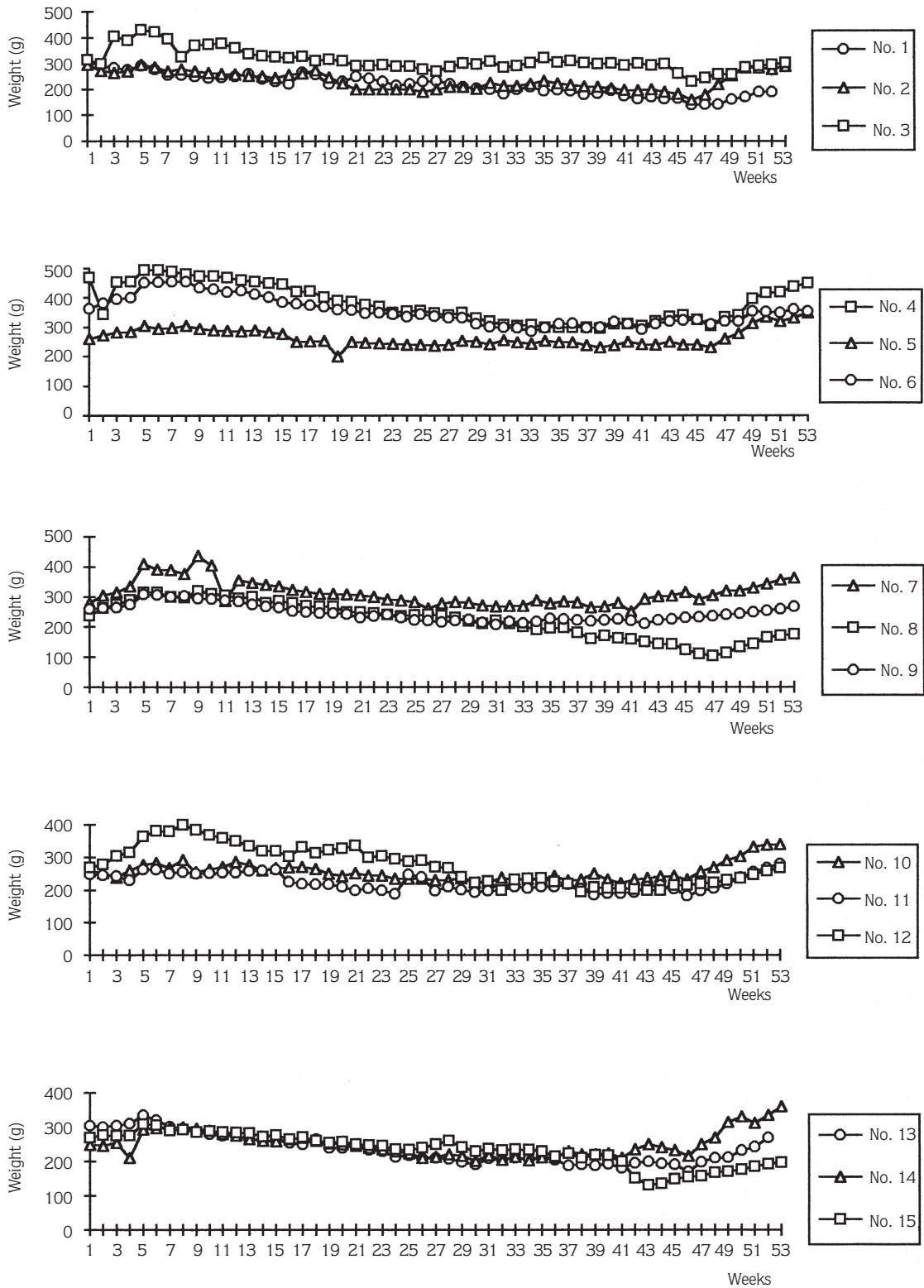


Figure 4. Body weight in grams of 15 ground squirrels during the inspecting period.

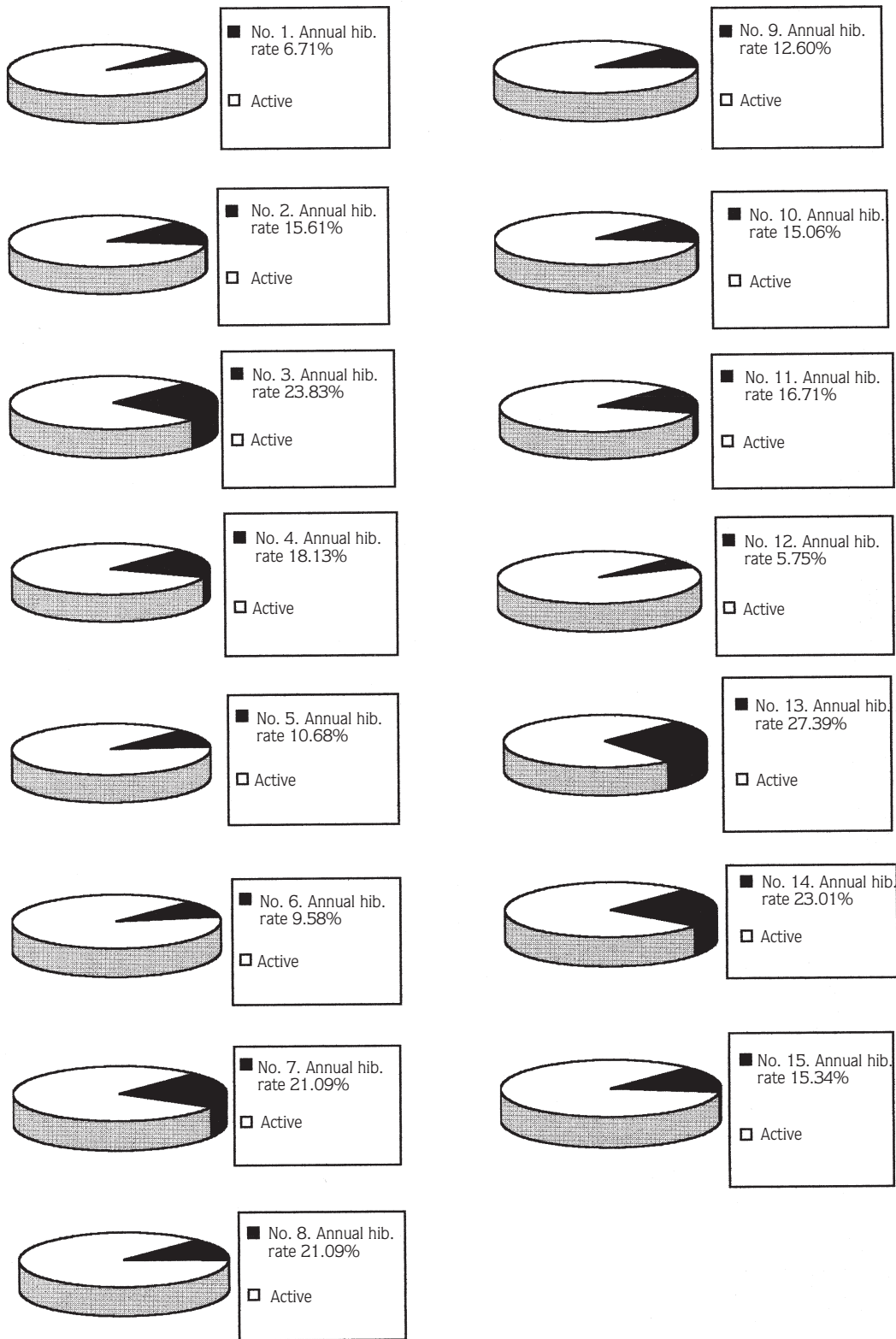


Figure 5. Hibernation percentages of ground squirrels monitored throughout a year.

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