

Observations on the Ecology, Reproduction and Behavior of *Spermophilus Bennett, 1835 (Mammalia: Rodentia) in Turkey*

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Abstract: Field and laboratory investigations on the ecology, reproduction and behavior of *Spermophilus citellus* and *Spermophilus xanthophrymnus* were performed over a period of 4 years. Both *S. citellus* and *S. xanthophrymnus* are diurnal species and occupy semiarid steppe areas in Turkish Thrace and Anatolia, respectively. Distribution of the former species is confined to restricted steppe areas in Turkish Thrace while the latter lives on the Anatolian steppe, and is sympatric with *Meriones tristami*, *Mesocricetus brandthi*, *Allactaga williamsi* and *Microtus* spp. The burrows of both species have one entrance, and are built separately in the field. They constitute small social colonies and communicate with each other by emitting hoarse, sharp and shrill sounds. *S. xanthophrymnus* enters hibernation in August and emerges in February. It was observed that they were tolerant of each other. Based on field and laboratory studies *S. citellus* and *S. xanthophrymnus* give birth once a year. The litter size was at 3 for the former species, and 1-4 for the latter. Average weight at birth was 5 g for both species. Newborns of both species became hairy at 15-17 days, their eyes opened at 22-25 days, and their ears at 30 days and offspring were weaned at the end of the second month after birth. The external characters of 2 babies from Edirne attained those of adults 4 months after birth.

Key Words: *Spermophilus*, ecology, reproduction, behavior, Turkey

Türkiye *Spermophilus* Bennet, 1835 (Mammalia: Rodentia) larının Ekolojisi, Üreme Biyolojisi ve Davranışı Üzerine Gözlemler

Özet: Bu çalışmada; *Spermophilus citellus* ve *S. xanthophrymnus*'ların ekolojisi, üremesi ve davranışı üzerine 4 yıl süreli arazi ve laboratuvar çalışmaları yapılmıştır. *S. citellus* Trakya' da yarı kurak step alanlarda yayılmaktadır. *S. xanthophrymnus* Anadolu'da yarı kurak steplerde habitatını *Meriones tristami*, *Mesocricetus brandthi*, *Allactaga williamsi*, *Microtus* spp. gibi nokturnal türlerle paylaştığı tespit edildi. Arazide *S. xanthophrymnus*'ların yuva yapıları araştırıldı. Arazide tek tek yuvalanmalarına karşın küçük sosyal koloniler oluşturdukları, kısık, keskin ve tiz sesler çıkararak birbirleriyle haberleştikleri belirlendi.

S. xanthophrymnus'un hibernasyon periyodu Ağustos ta başlayıp Şubat sonlarında sona erdiği belirlenmiştir. Laboratuvar gözlemlerinde birbirlerine karşı toleranslı oldukları, arazi ve laboratuvar gözlemlerinde *S. citellus* ve *S. xanthophrymnus*'ların senede 1 kez doğum yaptığı, bu doğumlarda *S. citellus*'ta yavru sayısının 3, *S. xanthophrymnus*'ta ise 4 olduğu, yavruların doğum ağırlığının ortalama 5 g olduğu, kürklenmenin 15-17. günlerde tamamlandığı, gözlerin 22-25 günlerde, kulakların 30 günde açıldığı ve örneklerin doğumdan sonra 2. ayın sonuna doğru süttten kesildikleri belirlendi. Edirnedeki yakalanan örneğin doğurduğu 2 yavrunun dış vucut ölçüleri 4 ay sonra erişkin ölçülerine ulaştığı tespit edilmiştir.

Anahtar Sözcükler: *Spermophilus*, ekoloji, üreme, davranış, Türkiye

Introduction

Spermophilus xanthophrymnus (Bennett, 1835) was first described from Erzurum (Turkey) by Bennett

(Bennett, 1835). The taxonomy and biology of the genus *Spermophilus* were studied by Karabağ (1953), Osborn (1964), Şimşek (1986), Yiğit et al. (2000) and Özkurt et

al. (2002). According to Turkish and foreign scientists (Ellerman and Morisson-Scott, 1951; Karabağ, 1953; Osborn, 1964; Mursaloğlu, 1964; Mursaloğlu, 1965; Corbet, 1978; Şimşek, 1986;), only *Spermophilus citellus* (L., 1766) lives in Turkey. Wilson and Reeder (1993) and Mitchel-Jones et al. (1999) reported that the genus *Spermophilus* is distributed in SE Germany, Czechoslovakia, and SE Poland through SE Europe to European Turkey, Moldova and W Ukraine. Zima and Kral (1984) suggested that, depending on karyological differences in the population of this genus, *S. xanthoprimum* is a separate taxon from *S. citellus*. Doğramacı (1994) described *S. citellus* with $2n = 40$ chromosomes from Thrace and *S. xanthoprimum* with $2n = 42$ chromosomes from Anatolia based on his karyological studies. Özkurt et al. (2002) described a new karyotypic form of $2n = 40$ from southern Anatolia in the Taurus mountains.

Although there have been several taxonomic studies on Turkish ground squirrels, Karabağ (1953) and Yiğit (2000) published biological and ecological notes. In addition, species of the genus *Spermophilus* were considered agricultural pests for years despite the lack of any certain evidence or data. Our aim was aimed to contribute to the knowledge of the behaviour, burrowing and reproduction biology of the genus *Spermophilus* in Turkey.

Materials and Methods

The study was conducted between 1996 and 1999 in central Anatolia and Turkish Thrace. Burrow structures during summer months were recorded, excavated and drawn, and the observations were noted. The data on hibernation biology were obtained from laboratory and field observations. Eleven ground squirrels were marked by toe-clipping and then released 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 1 to a cage (40 cm x 40 cm x 40 cm) to examine their hibernation patterns. Hibernation was monitored by the sawdust technique (Scott and Fisher, 1972). Animals were visited daily and a note was made of whether they were active or hibernating, and they were weighed weekly. Using the sawdust technique, periodic arousal and the duration of individual bouts of hibernation were

determined. Live specimens were captured from various localities using Sherman traps. Reproductive signs (lactation, pregnancy, embryos and swollen testes) were recorded in the laboratory and in the field. Five external characters (total length, body length, tail length, hind foot length and ear length) were measured, and newly collected specimens were weighed. Other measurements were taken according to Harrison and Bates (1991). Live specimens were transferred to laboratory cages (60 x 60 x 60 cm), and were provided with nesting material food (wheat, sunflower seeds, and fresh grass) and water. In the laboratory, newborns were weighed and their external characters were measured. Measuring continued throughout postnatal development. All specimens were kept in ambient conditions similar to their natural climatic environment in Ankara. The skins and skulls of 52 specimens collected were deposited in the Department of Biology, Faculty of Science, in the University of Ankara.

Abbreviations in the text: ToL, total length; BL, body length; TL, tail length; HFL, hind foot length; EL, ear length; W, weight.

Results and Discussion

Distribution and Habitat

As reported by Mursaloğlu (1964, 1965) and Doğramacı and Kefelioğlu (1994), the distribution of *S. citellus* is confined to the steppe areas of Turkish Thrace. This species was recorded from 2 different localities in Turkish Thrace; Edirne (15 km W) and Pınarhisar-Kırklareli. The specimens were caught in a meadow area near a riverside at an altitude of 100-350 m in the first locality, and in steppe areas in the second locality.

S. xanthoprimum is widely distributed in the steppe areas of Anatolia. This species was recorded from Polatlı, Maden, Erzurum, Akseki, Mut and Hadim. The Polatlı population (Ankara 140 km S) is located in central Anatolia, which is a steppe habitat, at an altitude of 825 m. The Maden population (Niğde 20 km SW) is located in central Anatolia altitude of about 1900-2900 m. Ground squirrels occupy open meadows in the Erzurum habitat (10 km E). Specimens from Erzurum were obtained from a steppe area in eastern Anatolia at an altitude of 1950 m. In Akseki (15 km E) ground squirrels were caught from meadows in this highland area (1100 m), though these sometimes penetrate into rocky areas. The Mut and Hadim populations (15 km W, 12 km E) were close to

each other at an altitude of 950 m in southwest Anatolia. This species was also reported from Erzurum by Bennett (1835), from Aksaray and Van by Mursaloğlu (1964, 1965), from Gölbaşı–Ankara by Karabağ (1953), and from Çorum by Dođramacı et al.(1994).

The Anatolian population of ground squirrels has wide habitat tolerance, and prefers steppe areas in Central Anatolia, although it lives in mountainous regions of southern Turkey, and builds its burrows in stony areas. The locations of summer and winter burrows were also different. Species of the genus are diurnal, and the Anatolian population lives in the same habitat as nocturnal species like *Meriones tristrami*, *Mesocricetus brandti*, *Allactaga williamsi* and *Microtus* ssp. Although they live in colonies their burrows are not close to each other. It was also observed that they do not use other species burrows when forced to flee or hide. In their semiarid habitat with poor vegetation, they sometimes colonize areas close to water sources, and are considered an agricultural pest, although this mostly depends on personal opinions. Ground squirrels prefer not to build burrows in grain fields, but they sometimes choose to live near them, and eat tolerable amounts of grain. Under the Berne Convention, these species are under protection in Appendix II, although Turkey has not declared these species to be protecting. However, the population size of these species, especially in Turkish Thrace, is decreasing to a very low level because of intensive land use.

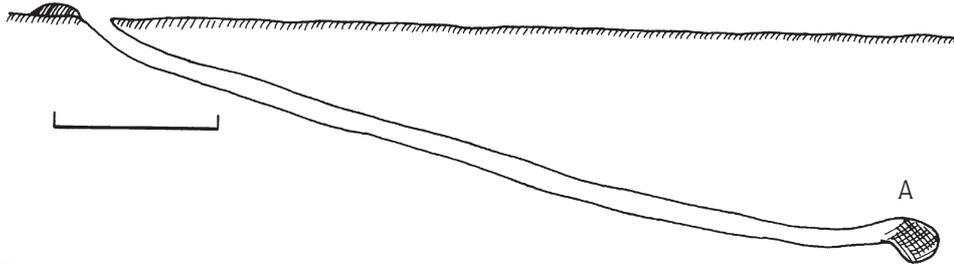
Burrowing Habits

That they generally burrow in flat or gently sloping areas in steppe regions. However, we identified ground squirrel burrows in stony areas in the southern Taurus mountains. These burrows were simpler and shallower than those in steppe areas. In addition, summer and winter burrows were different from each other. Winter burrows were more complex than summer ones. We show the structure of a summer burrow from Gölbaşı in Figure 1. There were 2 types of summer burrow. The first has one entrance with a width of 10–11 cm. The length of the burrow varies from 1.92 m to a few meters, with a nesting chamber with a diameter of 20 cm. insulated with dry grass The second burrow was a sort of tunnel used for emergency flight Figure 1. Both types of burrow had an angled slope. The winter burrow had 2 entrances, the first being 10 cm in diameter, and was the same as described above. The second is located close to the first, but it is vertical with a narrow hole and

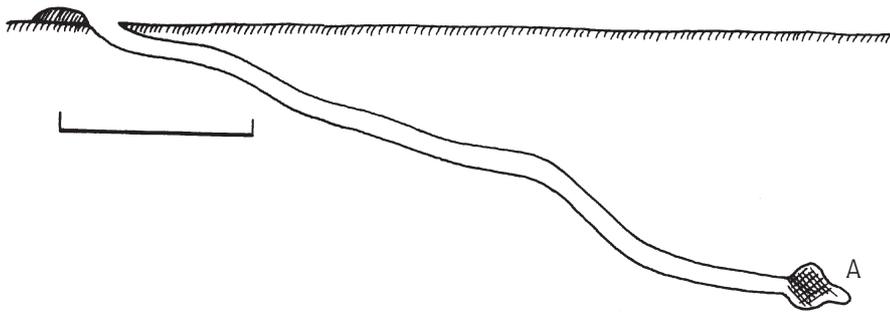
a depth of about 1 m. In the mountainous Akseki province some yearling ground squirrels were found in a *Spalax* tunnel in flatsoil patches. However, older animals preferred to occupy stony slopes, and their tunnels were very shallow, only 20 cm in depth. In general, the winter burrows were constructed in a region located far from flooding. Karabağ (1953) (in Heck and Troussart) reported that there were different burrow types for males and females. In contrast, Vinogradov and Obolensky (1932), Calinescu (1935), Bolderev (1936) and Karabağ (1953) stated that there are no differences among the sexes. Karabağ (1953) also studied the burrow structure of the Anatolian ground squirrel population in detail (Karabağ, 1953). He reported that there were 2 types of burrow; the first was temporary (summer burrow), and the second was permanent (winter burrow). The first type corresponded to our summer burrow. Karabağ (1953) divided the winter burrow into 3 subgroups Figure 2. In this study we dug out many winter burrows and usually encountered the first type. Karabağ (1953) also stated that the first type of burrow was the most frequently used.

Behavior

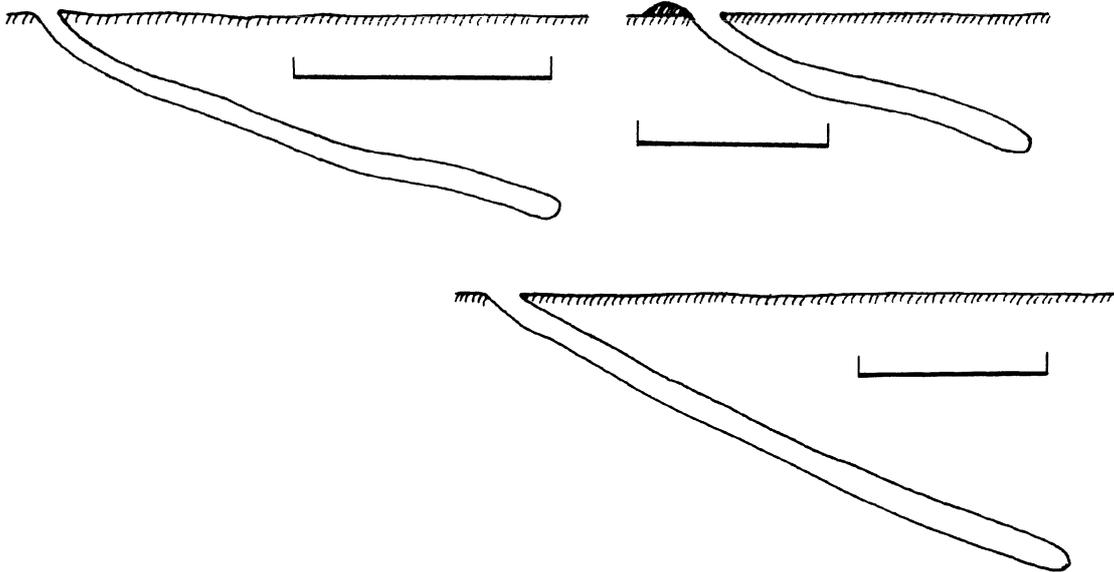
Ground squirrels started their activities at different times of the season depending on the climatic conditions of the various localities in Turkey. Their activities started in mid-May in the Bolkar mountains (at an altitude of 2900 m) in Niğde when the snowy season was over. However, activity started at the beginning of March in Ankara and Kırşehir provinces in Central Anatolia. According to laboratory and field observations, ground squirrels enter hibernation at the end of August and emerge at the end of February in Central Anatolia. This finding is consistent with the findings of Yiğit et al. (2000) for *S. xanthoprymnus*, and of Kenneth and Twente (1970) for *S. lateralis* in Canada. Detailed information about the hibernation of *S. xanthoprymnus* was also given by Yiğit et al. (2000). According to Yiğit et al. (2000), the hibernation period of ground squirrels starts from the end of August and terminates in mid-February. The longest and the shortest hibernation periods of ground squirrels were 100 and 21 days, respectively. The longest uninterrupted hibernation period was 13 days. Ground squirrels gain weight during the early months of summer and then lose weight constantly throughout the hibernation period. No marked periodic cycles were observed in the periods of weight



First type: Deep and large summer burrow.

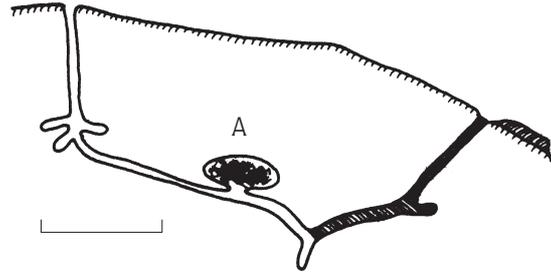
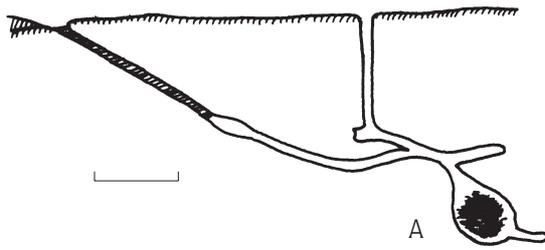


Second type: Deep and small summer burrow.

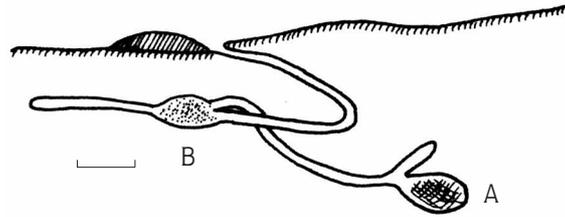
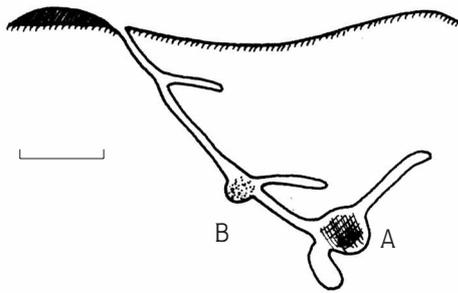


Third type: Small escape burrows

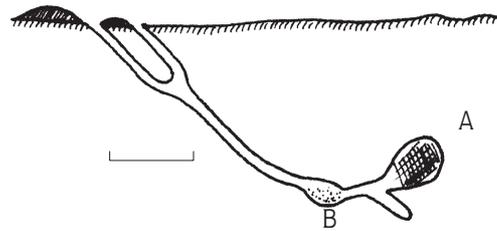
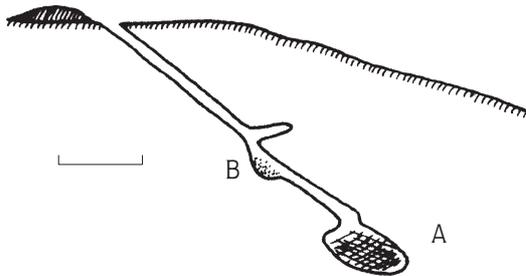
Figure 1. Three burrow types in summer from Ankara-Gölbaşı.
A. Nesting material. Scale: 50 cm.



First type: Vertical entrance burrow types.



Second type: Sloping entrance burrow types.



Third type: Sloping entrance and small deep burrow types.

Figure 2. Three different types of winter burrow (Karabağ 1953).
A. Nesting material B. Additional food Scale: 50 cm.

loss, during which ground squirrels lost an average of 28% of their total body weight.

From the observations performed around Kırşehir province young animals started to appear in their burrows from mid-May in groups, and they never went

far from the entrance. We also observed that young animals did not eat food outside the burrow during the first 5-day period. In this period they are afraid of any moving or sound producing objects, and flee to their burrows. After this 5-day period they start to feed on

fresh grass. At the beginning of June, young individuals start to make their own burrows. Their new burrows are not far from the maternal burrows, but are not so complex or deep. These inexperienced young individuals are generally active throughout the day. In contrast, adult and old individuals prefer to be active in the early mornings and afternoons. Thus we can say that young individuals are exposed to more predation than adults. When the adult animals emerge from their burrows, they first inspect the environment, and then communicate with other individuals by means of whistling, thus warning each other of any threats. Adult pairs do not use the same burrows, except for in the mating season in spring. Only young ground squirrels enter the same burrow when they are frightened. In laboratory observations it was found that animals constituting a large colony in the same cage never fight.

It was also observed in the field that ground squirrels emerge from the burrow and generally stand up on their hind legs and eat green grass and seeds using their forefeet. Animals did not carry food to their burrows, and rarely stored food in their small cheek pouches. These results were consistent with the studies by Svridenko (1937) and Karabağ (1953). According to Davis and Swade (1926), male individuals of *S. beecheyi* are generally observed outside their burrows, whereas females stay in their burrows between November and January. Karabağ (1953) also noted footprints in the snow in winter. However, in our study, ground squirrels

were never observed outside the burrow during winter in Central Anatolia.

Reproduction and Postnatal Development

It was determined from the field and laboratory studies that ground squirrels give birth once per year and the litter size ranges between 1 and 4. According to Karabağ (1953), ground squirrels give birth once per year and their litter size ranges between 1 and 6. During field studies in 1998, a female *S. citellus* specimen was caught from Edirne in the first week of May and gave birth on 17 May. Five external characters of 3 newborn specimens were recorded as: average total length, 60.6 mm; average tail length, 8 mm; average hind foot length, 8 mm; average ear length, 1 mm; and average body weight, 5 g (Table 1). Another female specimen caught from Niğde, Maden, on 10 May, 1996, gave birth 17 days later. Five external characters of 4 newborn specimens were recorded as: average total length, 53.75 mm; average tail length 7.5 mm; average hind foot length, 7 mm; average ear length, 1 mm; and average body weight 5.49 g (Table 2). The abdomens of newborns were light pink, the backs of their bodies were gray, their eyes and ears were closed and their bodies were hairless. They became hairy at 15-17 days, their eyes opened between 22 and 25 days and they started to move freely in the cages. Between 25 and 27 days after birth their upper and lower incisors erupted. Their ears opened on day 30 and weaning took place between 45 and 50 days.

Table 1. The average measurements of external characteristics (mm) and weights (g) of the specimens from Thrace born in the laboratory (n = number of newborn). f = female, m = male.

| Date | days | n | ToL | BL | TL | HFL | EL | W |
|--------------------|------|----|-------|-------|------|-------|------|-------|
| 17 May, 1998 | 0 | 3 | 60.6 | 52.6 | 8 | 8 | 1 | 5 |
| 28 May, 1998 | 12 | 3 | 82.6 | 71 | 11.6 | 11 | 1.6 | 12 |
| 8 June, 1998 | 23 | 3 | 113.3 | 90.7 | 22.6 | 20.33 | 3.33 | 31 |
| 11 June, 1998 | 26 | 2 | 132.5 | 100 | 32.5 | 26.5 | 5.5 | 43.5 |
| 17 June, 1998 | 32 | 2 | 159.5 | 120 | 39.5 | 33.5 | 5.5 | 61.5 |
| 4 July, 1998 | 49 | 1f | 205 | 161 | 44 | 34 | 5.7 | 114 |
| 12 July, 1998 | 57 | 1f | 211.5 | 165.5 | 46 | 35 | 6 | 137.5 |
| 22 July, 1998 | 67 | 1f | 222.5 | 174.5 | 48 | 35.5 | 6.1 | 141 |
| 6 August, 1998 | 82 | 1f | 236 | 186 | 50 | 36 | 6.4 | 208 |
| 24 August, 1998 | 100 | 1f | 233.5 | 187 | 51 | 37 | 6.7 | 226 |
| 20 September, 1998 | 127 | 1f | 239 | 187 | 52 | 38 | 7 | 272 |
| 25 October, 1998 | 162 | 1f | 241 | 187.5 | 53.5 | 38 | 7 | 343.5 |

Table 2. The average measurements of external characteristics (mm) and weights (g) of the specimens from Niğde-Maden born in the laboratory (n = number of newborn, f = female, m = male).

| Date | days | n | ToL | BL | TL | HFL | EL | W |
|-----------------|------|---|-------|-------|------|------|----|-------|
| 27 May,1996 | 0 | 4 | 54.25 | 46.25 | 8 | 7 | 0 | 5.49 |
| 4 June, 1996 | 9 | 4 | 70 | 60 | 10 | 10 | 0 | 10.15 |
| 11 June, 1996 | 16 | 2 | 87 | 73 | 14 | 15 | 3 | 18.43 |
| 18 June, 1996 | 23 | 2 | 102.5 | 83.5 | 19 | 21.5 | 3 | 28.18 |
| 25 June, 1996 | 30 | 2 | 122 | 101.5 | 20.5 | 26 | 3 | 32.07 |
| 3 July, 1996 | 38 | 2 | 132.5 | 101.5 | 31 | 27 | 3 | 34.33 |
| 11 July, 1996 | 46 | 2 | 134 | 102.5 | 31.5 | 28 | 4 | 37.39 |
| 18 July, 1996 | 53 | 2 | 145 | 111.5 | 33.5 | 28 | 5 | 41.5 |
| 25 July, 1996 | 60 | 2 | 154.5 | 120 | 34.5 | 28 | 5 | 47.52 |
| 2 August1996 | 69 | 1 | 158 | 123 | 35 | 28 | 5 | 48.1 |
| 15 August, 1996 | 82 | 1 | 158 | 123 | 35 | 29 | 6 | 61 |
| 23 August, 1996 | 90 | 1 | 161 | 123 | 38 | 31 | 6 | 70 |

The external characters of the 2 babies belonging to a female caught from Edirne, which attained adult size 4 months after birth, were: average total length, 233.5 mm; average tail length, 46.5 mm; average hind foot length, 43.5 mm; average hind foot length, 43.5 mm; average ear length, 8.5 mm; and average body weight, 226 g. Body developments of these specimens is given in Figures 3-8. A comparison of these

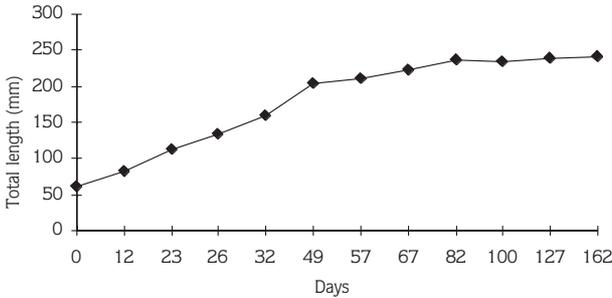


Figure 3. Increase in total length of Spermophilus from Thrace during postnatal development.

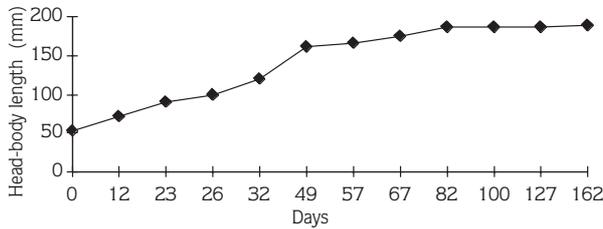


Figure 4. Increase in head-body length of Spermophilus from Thrace during postnatal development.

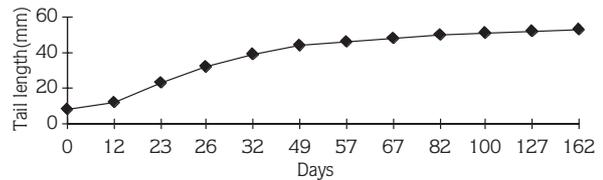


Figure 5. Increase in tail length of Spermophilus from Thrace during postnatal development.

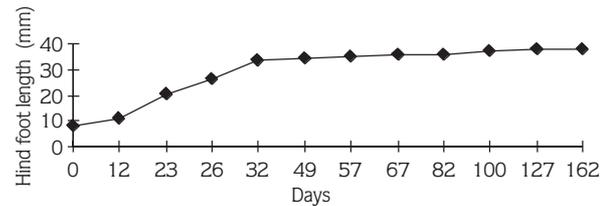


Figure 6. Increase in hind foot length of Spermophilus from Thrace during postnatal development.

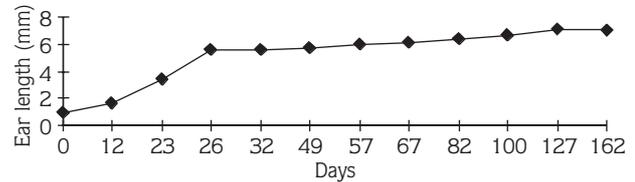


Figure 7. Increase in the ear length of Spermophilus from Thrace during postnatal development.

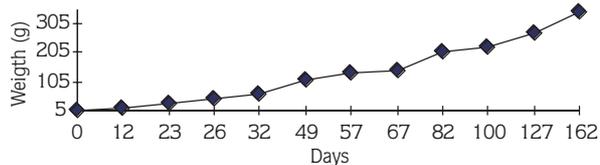


Figure 8. Increase in weight of *Spermophilus* from Thrace during postnatal development.

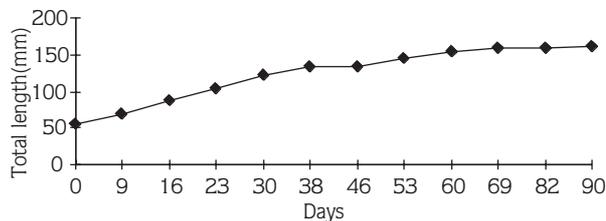


Figure 9. Increase in total length of *Spermophilus* from Maden-Niğde during postnatal development.

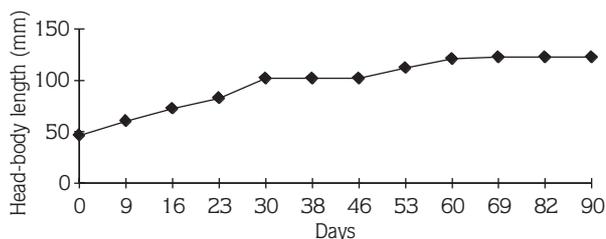


Figure 10. Increase in head-body length of *Spermophilus* from Maden-Niğde during postnatal development.

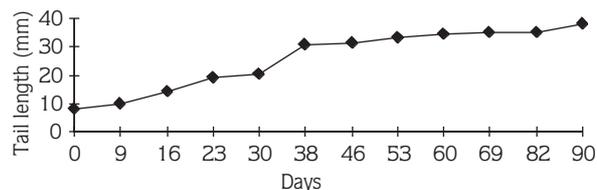


Figure 11. Increase in tail length of *Spermophilus* from Maden-Niğde during postnatal development.

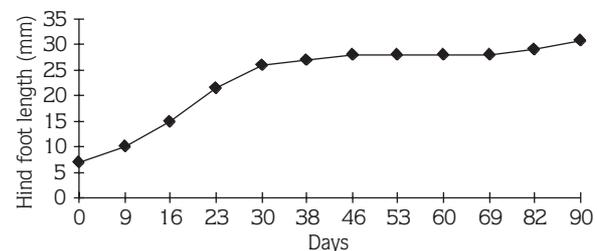


Figure 12. Increase in hind foot length of *Spermophilus* from Maden-Niğde during postnatal development.

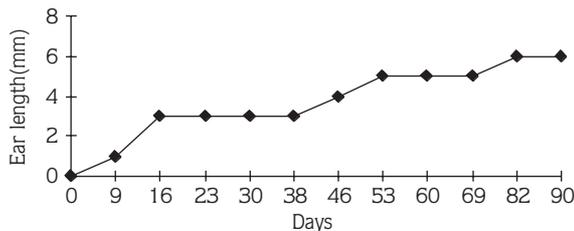


Figure 13. Increase in the ear length of *Spermophilus* from Maden-Niğde during postnatal development.

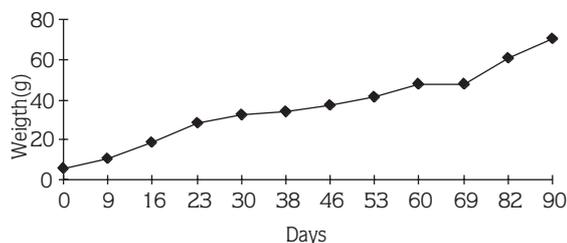


Figure 14. Increase in weight of *Spermophilus* from Maden-Niğde during postnatal development.

measurements to those of the adults (on average: total length 263 mm; tail length 58 mm hind foot length 40.3 mm ear length 7.2 mm; and weight 212 g) showed that the weight, ear and hind measurements foot of the young the an age of 4 months had attained those of adults and were even close to the average, but that total length and tail length were slightly less than those of adults. The measurements of all the young reached those of these adults in a year, as in the case of the babies of the specimen caught from Maden. Two of the young from Maden died 14 days after they were born, one died 82 days after birth, and the measurements of the last one were recorded until it died 90 days after birth. The graphics are given in Figures 9-14. Individuals born between the end of April and the beginning of May reached adult size by August, and after one hibernation period they become reproductively active. We obtained these data from observations in the field, in which young animals showed mating behavior after their first hibernation period. Although the pregnant specimens captured from the field were observed to give birth, and some juveniles have registered successful development during 4 years of laboratory studies, no mating in the cages was observed. There is a difference between the postnatal development of newborns in the Thracian population and that of newborns in the Anatolian

population, as in adult specimens, and this difference results from species and habitat differences.

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