MAMMALIAN SPECIES 42(864):183–194

Spermophilus xanthoprymnus (Rodentia: Sciuridae)

MUTLU KART GÜR AND HAKAN GÜR

Department of Biology, Faculty of Arts and Sciences, Ahi Evran University, Aşık Paşa, 40100, Kırşehir, Turkey; mkartgur@gmail.com (MKG); s.xanthoprymnus@gmail.com (HG)

Abstract: *Spermophilus xanthoprymnus* (Bennett, 1835), the Asia Minor ground squirrel, is a group-living, diurnal, obligately hibernating marmotine squirrel. It inhabits the steppes and alpine meadows throughout central lowland and eastern highland Anatolia and adjacent Armenia and northwestern Iran. Its preferred elevation appears to range from about 800 to 2,900 m. The species displays sexual dimorphism in size, with adult males being considerably larger than adult females and exhibits geographic variation in body size. It is presently listed as ''Near Threatened'' on the *2009 International Union for Conservation of Nature and Natural Resources Red List of Threatened Species* because of large-scale agricultural activities that result in habitat destruction and fragmentation. DOI: 10.1644/864.1.

Key words: Anatolian ground squirrel, annual cycle, Asia Minor ground squirrel, body-size variation, hibernation, Marmotini, near threatened species, phylogeography, sciurid, Turkey

Synonymy completed 1 December 2009

www.mammalogy.org

Spermophilus xanthoprymnus (Bennett, 1835)
Asia Minor Ground Squirrel

Citillus xanthoprymna Bennett, 1835:90. Type locality ''Erzeroun'' (= Erzurum), Turkey.
Sp[*ermophilus*]. *xanthoprymnus*: Schinz, 1845:72. First use of current name combination.
Citellus schmidti Satunin, 1908:28. Type locality ''Kars,'' Turkey.
Citellus citellus gelengius Mursaloğlu, 1965:86. Type locality ''Aksaray,'' Turkey.

CONTEXT AND CONTENT. Order Rodentia, suborder Sciuromorpha, family Sciuridae, subfamily Xerinae, tribe Marmotini (Wilson and Reeder 2005). *Spermophilus xanthoprymnus* is considered polytypic by Mursaloğlu (1965), with 2 named and 1 unnamed subspecific taxa based on body size: the largest (nominate) *S. x. xanthoprymnus* occurring in northeastern highland Anatolia (note that geographically Anatolia is the Asian part of Turkey), the intermediate *S. x. gelengius* occurring in central lowland Anatolia, and the smallest (unnamed) subspecies occurring in the east of Lake Van. Although Kryštufek and Vohralík (2005) reluctantly accepted the taxonomic validity of the 2 named subspecies, these subspecies are not well supported by geographic patterns of morphometric and mitochondrial DNA (mtDNA) variation (Gündüz et al. 2007a; Gür 2007). Much of the morphometric variation occurs along environmental gradients, making the recognition of subspecies untenable. Furthermore, neither *S. x. xanthoprymnus* nor *S. x. gelengius* yields a monophyletic set of the cytochrome-*b* mtDNA sequences.

NOMENCLATURAL NOTES. The generic name, *Spermophilus* Cuvier, 1825, should be used in preference to *Citellus* Oken, 1816, because Oken's names were inconsistently binomial (Hershkovitz 1949) and thus the International Commission on Zoological Nomenclature (1956—Opinion 417) validated

Fig. 1.—Adult female *Spermophilus xanthoprymnus* from Fakıbeyli village, Yozgat, Turkey. Photographed in the wild by H. Gür on 14 June 2005.

the next oldest appropriate name, *Spermophilus* (Yensen and Sherman 2003). Helgen et al. (2009) recognized 8 genera formerly subsumed in *Spermophilus*. Only *Spermophilus* sensu stricto is restricted to Eurasia. Thus, the generic name, *Spermophilus*, is still valid for the Asia Minor ground squirrel.

The generic name *Spermophilus* means seed-loving and is derived from the Greek *spermatos* for seed and *philos* for loving. The specific epithet *xanthoprymnus* means yellowish underparts and is derived from the Greek *xanthos* for the various shades of yellow and *prymnos* for undermost (Jaeger 1955). *S. xanthoprymnus* has also been referred to as the Anatolian ground squirrel (Gür and Barlas 2006; Gür and Kart Gür 2005; Kart Gür et al. 2009; Kryštufek et al. 2008) or Anatolian souslik (Çakır and Karataş 2004) and in Turkish most commonly as gelengi or tarla sincabı (Demirsoy 1997; Eren 1999; Yiğit et al. 2006a). *Spermophilus taurensis*, which occurs in the eastern part of the western Taurus Mountains, was known as *S. xanthoprymnus* until Gündüz et al. (2007a) provided data to support their separation.

Ground squirrels from east of Lake Van were identified by Thomas (1905:523) as "*Citellus concolor* Geoff.," but are actually *S. xanthoprymnus*. *Spermophilus concolor* I. Geoffroy Saint-Hilaire, 1831, is a junior synonym of *S. fulvus* Lichtenstein, 1823 (Ellerman and Morrison-Scott 1951; Kryštufek and Vohralík 2005).

DIAGNOSIS

In addition to *Spermophilus xanthoprymnus*, the European ground squirrel (*S. citellus*) and newly recognized *S. taurensis* are native to Turkey. *S. citellus* is distributed in eastern Europe, including the European part of Turkey west of the Bosphorus (Mitchell-Jones et al. 1999). *S. taurensis* is distributed in the Anatolian part of Turkey, in the eastern part of the western Taurus Mountains, and is parapatric with *S. xanthoprymnus* at the northernmost limit of its distribution area (Gündüz et al. 2007a; Özkurt et al. 2007).

Tail is shorter and pterygoid fovea of the condylar process of the mandible is more anteriorly positioned in *S. xanthoprymnus* than in either *S. citellus* or *S. taurensis* (Gündüz et al. 2007a; Kryštufek and Vohralík 2005; Özkurt et al. 2007; Yiğit et al. 2005). Compared to *S. citellus*, further diagnostic characters are as follows: pelage has a more uniform color with no spotted pattern (Fig. 1); tail lacks a dark stripe along its dorsal side; skull is more angular in dorsal view (Fig. 2); anterior margins of the zygomatic arches are more posteriorly positioned; anterior parts of the zygomatic arches are thicker; interorbital region is wider; and auditory bullae are shorter and more rounded (Gündüz et al. 2007a; Kryštufek and Vohralík 2005). Compared to *S. taurensis*, further diagnostic characters are as follows: pelage has a less reddish color; tail is narrower and lacks a black tip; supraorbital ridges are divergent posteriorly; sagittal and

Fig. 2.—Dorsal, ventral, and lateral views of skull and lateral view of mandible of an adult female *Spermophilus xanthoprymnus* from İncesu village, Gürün, Sivas, Turkey (Ahi Evran University, 534). Collected by H. Gür on 27 June 2005. Condylobasal length is 40.84 mm.

lambdoidal crests are not reduced; and cheek toothrows are more posteriorly positioned (Gündüz et al. 2007a, 2007b; Özkurt et al. 2007). Although skull characters are not consistently diagnostic (Gündüz et al. 2007a; Kryštufek and Vohralík 2005), when geometric morphometrics methods are used, divergence in skull (cranium and mandible) shape is sufficient to classify about 95% of individuals correctly into the 3 species, *S. citellus*, *S. taurensis*, and *S. xanthoprymnus* (Gündüz et al. 2007a).

GENERAL CHARACTERS

Spermophilus xanthoprymnus is a medium-sized ground squirrel with a round body, short limbs, and a short, round tail (Fig. 1). Head is convex in dorsal profile, eyes are large, and ears are small. The upperparts are "nearly uniform reddish buff but vary from nearly grayish to dark brown with hardly any yellowish tinges; there are no spots" (Kryštufek and Vohralík 2005:44–45). Eye rings are whitish. Throat and chin are usually white. Abdomen is whitish or yellowish. Limbs are pale, whitish or yellowish. Tail is approximately of the same coloration as the upperparts (Kryštufek and Vohralík 2005).

Spermophilus xanthoprymnus displays extensive sexual size dimorphism, with adult males considerably larger than adult females (Gür 2007; Mursaloğlu 1964). Means ± *SD* (ranges) of standard external measurements (mm) for adult males (n = 13) and females (n = 18), respectively, from Erzurum (in northeastern highland Anatolia), the province from which *S. xanthoprymnus* was 1st recognized, were: total length, 273.5 ± 7.0 (265–289), 255.8 ± 8.0 (245–275); length of tail, 48.2 ± 3.4 (42–52), 44.2 ± 3.0 (38–50); length of hind foot, 41.8 ± 1.2 (40–43), 40.3 ± 1.0 (38–42); length of ear, 10.6 ± 1.3 (8–13), 10.5 ± 1.5 (7–13—Mursaloğlu 1965). The same measurements (mm) for adult males (n = 14) and females (n = 14), respectively, from Aksaray (in central lowland Anatolia), the province from which *S. xanthoprymnus gelengius* was 1st recognized, were: total length, 260.4 ± 9.4 (248–281), 247.0 ± 8.0 (231–260); length of tail, 46.8 ± 5.9 (39–58), 41.5 ± 5.7 (31–54); length of hind foot, 40.9 ± 2.0 (38–45), 39.0 ± 1.7 (36–42); length of ear, 9.4 ± 1.6 (7–12), 8.4 ± 1.3 (6–11—Mursaloğlu 1965). Means ± *SD* (ranges) of body mass (g) and skull measurements (mm) for adult males (n = 78) and females (n = 90), respectively, collected during June and July from 10 geographic localities, covering almost all of the distribution area of *S. xanthoprymnus* were: body mass, 328.8 ± 77.0 (235–490), 256.8 ± 58.6 (170–410); condylobasal length, 44.00 ± 1.56 (39.14–47.33), 42.00 ± 1.30 (38.49–45.15); zygomatic width, 30.45 ± 1.34 (27.58–33.39), 28.99 ± 0.88 (27.25–30.97); length of mandible, 30.32 ± 1.29 (26.80–32.86), 28.91 ± 1.01 (26.47–30.95); height of mandible, 16.18 ± 0.82 (14.67–18.72), 15.40 ± 0.66 (13.73–16.81); length of mandibular toothrow, 8.80 ± 0.36 (8.01–9.48), 8.58 ± 0.39 (7.74–9.47—based on data in Gür 2007).

Spermophilus xanthoprymnus exhibits considerable geographic variation in body size (estimated from skull characters). Interlocality differences account for about 65% of the variation in body size of adult males and females. In both sexes, body size increases toward colder, more seasonal environments with higher summer precipitation and productivity, toward northeastern highland Anatolia. Males respond more strongly than females, especially to seasonality of the environment, and therefore both sexes exhibit slightly different patterns of geographic variation in body size. Food availability and, especially in males, overwinter fasting endurance are likely the primary underlying mechanisms generating the observed pattern of geographic variation in body size. As expected, sexual size dimorphism, too, varies geographically and appears to increase toward northeastern highland Anatolia (Gür 2007, 2010).

The baculum of *S. xanthoprymnus* was described by Kaya and Şimşek (1986) and is essentially the same shape as in *S. citellus* (Kryštufek and Vohralík 2005). Length of baculum ranges approximately from 2.1 to 2.7 mm (estimated from Kaya and Şimşek 1986:figures 6 and 8).

DISTRIBUTION

Spermophilus xanthoprymnus is endemic to Turkey and small areas nearby, where it is distributed in central lowland and eastern highland Anatolia and in small areas in adjacent Armenia and northwestern Iran (Fig. 3; Gündüz et al. 2007a; Gür 2007; Kryštufek and Vohralík 2005; Osborn 1964; Özkurt et al. 2007; Yiğit et al. 2006a). The species also is known from a few localities in southern Anatolia, in both the Teke Peninsula and Çukurova plain (Çakır and Karataş 2004; Corbet and Morris 1967; Kryštufek and Vohralík 2005; Özkurt et al. 2007; Yiğit and Çolak 1998). In these 2 regions, the populations are probably isolated from the main distribution area (Fig. 3) and warrant further biogeographical studies. For example, because *S. taurensis* was recently recognized in the eastern part of the western Taurus Mountains (Gündüz et al. 2007a), the designation of populations in the Teke Peninsula, in the western part of the western Taurus Mountains, as *S. xanthoprymnus* requires confirmation. The presence of the species in the Çukurova plain, regarded as biogeographically different from the main distribution area, also requires explanation. Competition with *S. taurensis* may be preventing expansion of the distribution area of *S. xanthoprymnus* into the eastern part of the western Taurus Mountains. Documented elevational range of *S. xanthoprymnus* is from about 800 to 2,900 m above sea level (Kryštufek and Vohralík 2005; Özkurt et al. 2005).

FOSSIL RECORD

The fossil records of ground squirrels in Anatolia are from early Pleistocene in Karain, Antalya (Storch 1988) and

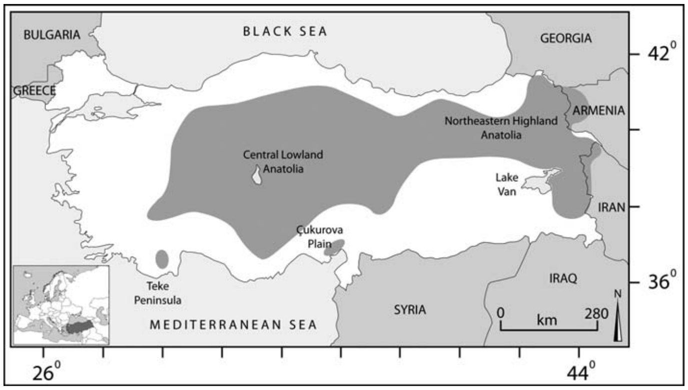

Fig. 3.—Geographic distribution of *Spermophilus xanthoprymnus* in Turkey and adjacent countries (see text for literature citations).

Dursunlu, Ilgın, Konya (Güleç et al. 1999), and middle Pleistocene in Sakız (Chios) Island (Storch 1975) and Emirkaya-2, Seydişehir, Konya (Şen et al. 1991). The fossil remains from Karain and Sakız Island were described as *Spermophilus xanthoprymnus* (Kryštufek and Vohralík 2005) and those from Dursunlu and Emirkaya-2 as *Spermophilus*. Modern species of ground squirrels have evolved within, or relatively close to, their present distribution areas (Harrison et al. 2003). Dursunlu falls within the present distribution area of *S. xanthoprymnus*. Thus, the fossil remains from Dursunlu probably represent this species. Because Emirkaya-2 is also close geographically to the present distribution area of *S. taurensis*, the fossil remains from this site may belong to either of the 2 species (*S. taurensis* and *S. xanthoprymnus*). Karain and Sakız Island are outside the present distribution area of *S. xanthoprymnus*. The latter site suggests that the species had a much larger distribution area in the middle Pleistocene than today. Holocene records of *S. xanthoprymnus* are from the Bolkar Mountains (Hír 1992), the Caucasus (Kryštufek and Vohralík 2005), Göbekli Tepe, Şanlıurfa (Peters and Schmidt 2004), and Kaman-Kalehöyük, Kırşehir (Hongo 1997).

FORM AND FUNCTION

Form.—The dental formula is i 1/1, c 0/0, p 2/1, m 3/3, total 22 (Karabağ 1953; Kryštufek and Vohralík 2005; Mursaloğlu 1964; Özkurt et al. 2007). The 1st upper premolar has 1 root, and the 2nd upper premolar and the upper molars have 3 roots each. The lower premolar has 2 roots, and the lower molars have 4 roots each (Kryštufek and Vohralík 2005; Özkurt et al. 2007). Nevertheless, intraspecific variation in number of roots has been observed in the lower premolar and the lower and upper molars (Dikmenli 1996).

There are 4 (1 pair pectoral, 2 pairs abdominal, and 1 pair inguinal) or, more commonly, 5 (1 pair pectoral, 2 pairs abdominal, and 2 pairs inguinal) pairs of mammae in females (Karabağ 1953; Kryštufek and Vohralík 2005). Intraspecific variation in number of mammae occurs in other sciurids (Bryant 1945).

As in other species of ground squirrels (Kivett et al. 1976), in *Spermophilus xanthoprymnus*, anal glands, present in both sexes, open through 3 retractable, nipplelike papillae near the anal aperture, 1 medial and 2 lateral (Karabağ 1953). These glands are involved in scent communication (Kivett et al. 1976).

As is typical of mammals, male *S. xanthoprymnus* have 3 accessory reproductive glands: the vesicular gland (vesicula seminalis), the prostate, and the bulbourethral gland (Cowper's gland), arranged in order from the beginning of the urethra to caudal body parts. Means $\pm$ *SD* (ranges) of some measurements (mm) for these glands ($n = 69$) were: length of vesicular gland, right: 3.96 $\pm$ 0.48 (2.40–4.80), left: 3.70 $\pm$ 0.55 (2.35–4.80); length and width, respectively, of prostate gland, 2.55 $\pm$ 0.38 (1.65–3.20), 2.63 $\pm$ 0.45 (1.60–3.65); length of bulbourethral gland, right: 2.32 $\pm$ 0.33 (1.80–3.10), left: 2.37 $\pm$ 0.39 (1.40–3.25—Çakır and Karataş 2004). Histologically, the vesicular gland is composed of branched tubulo-alveolar glands. The prostate has only a few tubulo-alveolar glands and it has dense fibrous connective tissue between alveoles characteristic of seasonal reproductive activity in a hibernating species. The bulbourethral gland is a tubulo-alveolar gland with a large and serrated lumen and septa between alveoles consisting of fibro-muscular fibers (Çakır and Karataş 2004).

Function.—In *Spermophilus xanthoprymnus*, the hibernation pattern has been studied both in the field and in the laboratory and is similar to that in other species of ground squirrels such as *S. citellus* (Hut et al. 2002) and 5 species that were formerly included in *Spermophilus* but were recently reassigned to new genera (Helgen et al. 2009): arctic ground squirrel (*Urocitellus parryii*—Barnes and Ritter 1993), Belding's ground squirrel (*U. beldingi*—French 1982), Richardson's ground squirrel (*U. richarsonii*—Michener 1992), Columbian ground squirrel (*U. columbianus*—Young 1990), and golden-mantled ground squirrel (*Callospermophilus lateralis*—Twente and Twente 1967). The hibernation season, which lasts from about late summer or early autumn to late winter or early spring, is characterized by numerous torpor bouts (periods of low body temperature lasting longer than 24 h) interrupted by brief periods of euthermia (Fig. 4). Body temperature often exhibits a moderate (2–4°C), slow (taking several hours) decline before the 1st test drop or torpor bout. Test drops (periods of low body temperature lasting less than 24 h) before the 1st torpor bout are commonly observed. Test drops and torpor bouts precede any significant decline in soil temperature (in the field) or air temperature (in the laboratory). In the laboratory, duration of torpor bouts lengthens gradually and, toward the end of the hibernation season, shortens gradually; however, in the field, duration of torpor bouts lengthens progressively throughout the hibernation season

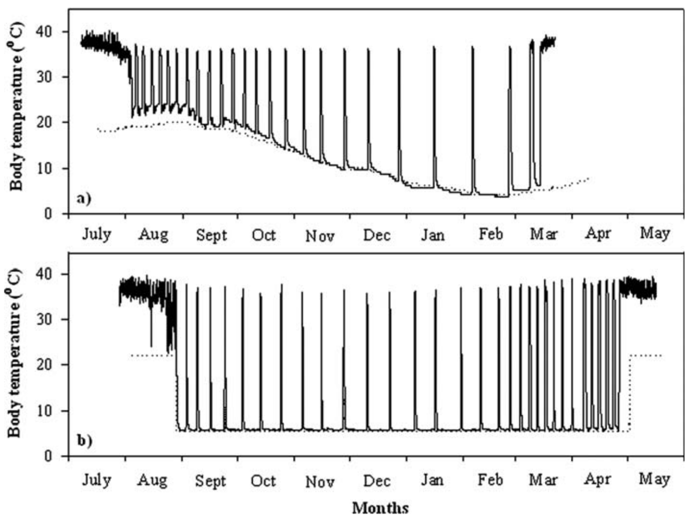

Fig. 4.—Hibernation patterns of 2 representative adult females *Spermophilus xanthoprymnus* from Bezirhane, Gölbaşı, Ankara, Turkey, as shown by body temperatures during the hibernation period for a, an adult female living in the field and b, an adult female housed in the laboratory (from Kart Gür 2008). Dashed lines indicate soil temperature in a and air temperature in b. Soil temperature in the field was recorded continuously at 50-min intervals by a temperature data logger at 1 m depth. Air temperature in the laboratory was set, 1st from 22°C to 6°C in late August and then from 6°C to 22°C in early May.

and shortens only a few days before the final arousal (Fig. 4). Body temperature during torpor bouts seems to follow ambient (soil or air) temperature closely (Kart Gür et al. 2009).

Entry times into short torpor bouts (≤5 days), which occur very early in the hibernation season, are slightly concentrated in evening hours (modal time = 2000 h). However, entry times into long torpor bouts (5 days or longer) and arousal times from either short or long torpor bouts are not concentrated at any time of day. Also, entry into and arousal from test drops occur at a certain time of day (Kart Gür et al. 2009).

Despite robust circadian rhythmicity in body temperature during euthermia, there is no evidence of circadian rhythmicity in body temperature during hibernation. Parameters of the body temperature rhythm during the euthermic stage preceding hibernation for free-living (n = 21) and laboratory-housed (n = 12) individuals, respectively, are as follows (mean and 95% *CI*): mesor (the average value around which the variable oscillates, °C), 37.2 (37.0–37.4), 36.8 (36.4–37.1); amplitude (the difference between the peak and the mean value of a wave, °C), 0.9 (0.8–1.0), 1.0 (0.9–1.1); acrophase (the time of day at which the peak of a rhythm occurs, h), 1211 (1156–1225), 1332 (1205–1458); robustness (the stationarity of a rhythm, %), 38 (34–42), 56 (48–64). The only difference between the field and laboratory means is in robustness of the rhythm. Robustness is considerably higher in the laboratory than in the field, probably because of the more stable environment of the laboratory (Kart Gür et al. 2009).

Body mass of *S. xanthoprymnus* varies with season, age, and sex. At emergence from hibernation, males are heavier than females in the same age class, and older adults (≥2 years old) are heavier than yearlings in the same sex class. Body mass (g; mean ± *SD*, range) at emergence in spring for reproductive males and females, respectively, from Gölbaşı, Ankara (in central lowland Anatolia) were: older adults, 283.8 ± 32.1 (235–335, n = 12), 177.9 ± 22.4 (140–220, n = 28); yearlings, 191.0 ± 21.8 (165–220, n = 10), 145.4 ± 19.3 (115–185, n = 14). Nonreproductive yearling males (i.e., those with abdominal testes) have relatively low spring body mass (135–160 g; based on pooled data from Gür and Kart Gür [2005] and Kart Gür [2008]). Yearlings of both sexes and older females are at their lowest body mass of the active season at emergence. Females gain body mass throughout gestation, but lose body mass at parturition (about 25–50 g). Body mass is almost constant during lactation, but increases after mid-June in Gölbaşı, Ankara, through the end of the active season. Older males lose body mass during the mating season, whereas yearling males gain body mass after emergence. Thus, after 1–2 months of activity in spring, body mass is indistinguishable between yearling and older males. Males increase body mass after June in Gölbaşı, Ankara, through the end of the active season (Gür and Kart Gür 2005).

ONTOGENY AND REPRODUCTION

Ontogeny.—Uterine litter size is 5.2 ± 0.9 (mean ± *SD*, range = 3–6, n = 23) with 2.9 ± 1.3 (range = 0–6, n = 23) and 2.3 ± 1.2 (range = 0–5, n = 23) embryos in the right and left uterine horns, respectively. Embryos are equally distributed in the 2 uterine horns. Embryo distribution is not associated with uterine litter size (based on data in Karabağ [1953:table 5]). Litter size at birth is 5.8 ± 2.4 (range = 4–9, n = 4) in the laboratory (Gür and Kart Gür 2005) and there is no significant difference between uterine litter size and litter size at birth (based on data in Gür and Kart Gür [2005] and Karabağ [1953]). Neonates are naked and pink with eyes and ears closed and teeth unerupted. Body mass of neonates is 5.7 ± 0.5 g (range = 5.0–6.7 g, n = 23). Litter mass at birth is 32.7 ± 11.8 g (range = 21.7–47.9 g, n = 4—Gür and Kart Gür 2005). Means of standard external measurements (mm) for neonates (n = 4) were: total length, 54; length of tail, 8; length of hind foot, 7; length of ear, 1. Pelage appears at 15–17 days, eyes open at 22–25 days, lower and upper incisors erupt at 25–27 days, ears open at 30 days, and weaning occurs at 45–50 days (Özkurt et al. 2005).

Body mass of newly emerged juveniles is 62.1 ± 16.8 g (mean ± *SD*, range = 40–100 g, n = 42). Litter mass at 1st emergence from the natal burrows is 292 g. Thus, at 1st emergence from the natal burrows, juveniles have a body mass about 25% and litters 115–120% of body mass of the mother (247.5 ± 23.2 g, range = 210–275 g, n = 8). Juveniles increase body mass throughout the active season. There is no significant difference between growth rates of juvenile males and females (males, 18.7 g/week; females, 19.0 g/week—Gür and Kart Gür 2005).

Births occur underground, in April in central lowland Anatolia (Gür and Kart Gür 2005) and in May in northeastern highland Anatolia and adjacent Armenia (Kryštufek and Vohralík 2005). Juveniles 1st emerge from natal burrows when about 4 weeks old, in May in central lowland Anatolia (Gür and Kart Gür 2005) and in June in northeastern highland Anatolia and adjacent Armenia (Kryštufek and Vohralík 2005). Litters thus appear aboveground about 8 weeks after females emerge from hibernation. Dates of the mother's 1st capture and emergence of her litter from the natal burrows are positively correlated, indicating that early-emerging females wean litters at an earlier date than late-emerging females. Litter size at 1st emergence from the natal burrows is 4.7 ± 1.4 (mean ± *SD*, range = 3–9, n = 15) in the field. The most common litter sizes are 4 (46%) and 5 (33%—Gür and Kart Gür 2005).

Reproduction.—*Spermophilus xanthoprymnus* usually mates in March in central lowland Anatolia (Gür and Kart Gür 2005; Karabağ 1953) and in April in northeastern highland Anatolia and adjacent Armenia (Kryštufek and Vohralík 2005), soon after females emerge from hibernation (as in other species of ground squirrels [Gür and Kart Gür 2005:table 2]; see "Behavior" section for the emergence sequence of age and sex classes). However, the species emerges and therefore mates later at higher elevations than at lower elevations. For example, a field-impregnated female from a high-elevation site (1,900–2,900 m) in the Bolkar Mountains gave birth on 27 May in captivity (Özkurt et al. 2005). Assuming a gestation period of about 25 days (see below), this female probably emerged at the end of April and mated at the beginning of May. The mating season lasts for a period of about 3 weeks in central lowland Anatolia (Gür and Kart Gür 2005).

Males reach adult body size during their 2nd summer. For this reason, many of yearling males probably do not reproduce, but all older males (about 2 years old or more) do. However, yearling males usually have scrotal testes when they emerge from hibernation or shortly thereafter, especially in central lowland Anatolia, but their testes are smaller than those of older males. All older males have scrotal testes at emergence from hibernation and therefore can inseminate females shortly thereafter. Testes of males regress during April in central lowland Anatolia (Gür and Kart Gür 2005).

Females produce 1 litter per year, commencing as yearlings. Females mate shortly after emergence from hibernation. Maximum latency between emergence and conception is 4.6 ± 1.0 days (mean ± *SD*, range = 3–6 days, n = 7). Latency between last arousal from torpor and conception, determined for laboratory-impregnated females, is 7.7 ± 1.5 days (range = 6–9 days, n = 3). Gestation period is 25.4 ± 0.6 days (range = 25–26 days, n = 5—Gür and Kart Gür 2005).

ECOLOGY

Population characteristics.—The sex ratio among both juvenile and yearling *Spermophilus xanthoprymnus* does not differ from 1:1, but the sex ratio among older adults (≥2 years old) is biased toward females, indicating that the sex ratio is adjusted within the 2nd year of life of a cohort. This pattern suggests that from their 2nd year of life as yearlings onward, males experience higher mortality than females. Interyear recovery rates of males and females are more similar among juveniles (11% and 16%, respectively), but less similar among adults (including yearlings and older adults; 8% and 30%, respectively). In other words, among adults, males are less likely to be recovered the following year than females, thus supporting the suggestion of sex-biased mortality (Gür and Barlas 2006). As noted above, many yearling males probably do not reproduce, but all older males do (Gür and Kart Gür 2005). Thus, the youngest age at which the female-biased sex ratio is apparent coincides with the 1st successful mating attempts of males, a pattern observed in many other species of ground squirrels (Gür and Barlas 2006:table 3), probably because dispersal is potentially risky (Schwartz et al. 1998) and males usually disperse from their natal areas during the active season before they reproduce successfully (Holekamp 1984). Furthermore, higher mortality of males as a consequence of their overwintering and mating strategies is likely to increase the female bias among older adults (Gür and Barlas 2006).

In *S. xanthoprymnus*, males are probably the shorter-lived sex. The shorter life span of males is a demographic consequence of sexual differences in survival between males and females, as is the female-biased sex ratio among older adults (Gür and Barlas 2006). Gür and Barlas (2006) reported that on the study area in the 3rd year of their study, 7 (44%) of 16 females were yearlings, 3 (19%) were ≥2 years old, and 6 (37%) were ≥3 years old. In contrast, 6 (60%) of 10 males were yearlings, and 4 (40%) were ≥2 years old, but none had a minimum age of 3 years. Furthermore, of 11 *S. xanthoprymnus* resident on the study area throughout the 3 years of study, only 2 were males.

Population densities of adult males and females during late March in 2000 were 2.3 individuals/ha (7 males) and 6.3 individuals/ha (19 females), respectively, based on the study of Gür and Barlas (2006) of a 3-ha area. Population density increased dramatically to about 33 individuals/ha (about 100 individuals—Gür 2001) with the synchronous emergence of litters from the natal burrows during the 2nd half of May and then decreased throughout the summer mainly due to dispersal and mortality.

Space use.—*Spermophilus xanthoprymnus* primarily inhabits steppes and alpine meadows within its distribution area. The species is mainly distributed in the central and northeastern Anatolian climate zones, which are colder and drier than other climate zones in Turkey (see Ünal et al. [2003] for the recently redefined climate zones of Turkey). The close correspondence between the 2 climate zones and the distribution area of *S. xanthoprymnus* suggests that distribution is determined, at least to a certain extent, by climate, probably especially by summer precipitation (Gür 2007).

Some plant species occurring in the habitat of *S. xanthoprymnus* are, in central lowland Anatolia, Amaranthaceae: *Salsola kali*; Apiaceae: *Eryngium campestre*, *Torilis leptophylla*; Asteraceae: *Achillea setacea*, *Artemisia fragrans*, *Centaurea solstitialis*, *C. squarrosa*, *Scolymus hispanicus*, *Senecio vernalis*; Euphorbiaceae: *Euphorbia tinctoria*; Fabaceae: *Alhagi camelorum*, *Astragalus angustifolius*; Geraniaceae: *Erodium laciniatum*; Lamiaceae: *Salvia aethiopis*, *S. cryptantha*, *Teucrium polium*, *Thymus spyleus*, *Ziziphora capitata*; Plantaginaceae: *Veronica polita*; Poaceae: *Bromus tectorum*, *Cynodon dactylon*, *Festuca ovina*, *Poa bulbosa*; Solanaceae: *Hyoscyamus niger*; Urticaceae: *Parietaria judaica*; Valerianaceae: *Centranthus longiflorus*; Zygophyllaceae: *Peganum harmala*; and, in northeastern highland Anatolia, Apiaceae: *Eryngium campestre*; Asteraceae: *Echinops ritro*; Fabaceae: *Astragalus microcephalus*; Gramineae: *Agropyron repens*; Poaceae: *Bromus tomentellus*, *Festuca valesiaca* (Karabağ 1953; Yiğit and Çolak 1998; Yiğit et al. 2003). In Aksaray plain, *S. xanthoprymnus* lives on bare ground with scattered clumps of *Juncus* or bushes of *Peganum harmala* (Kryštufek and Vohralík 2005).

Spermophilus xanthoprymnus uses burrows for sleeping, thermoregulation, refuge from predators and unfavorable weather, copulation, rearing litters, and hibernation. There are 3 types of burrows: auxiliary burrows, nest burrows, and hibernation burrows (Karabağ 1953). Auxiliary burrows, used mainly for retreat, are simple and of shallow depths (21–57 cm) and usually consist of a single tunnel descending gradually to a slightly enlarged space that does not contain a nest. Nest and hibernation burrows are more complex than auxiliary burrows. They extend to depths of 67–219 cm and have 1 or 2 openings, a few branching tunnels, 1 nest chamber, and sometimes 1 food chamber (observed in at most 15 of 36 nest and hibernation burrows excavated—Karabağ 1953). Nest chambers are usually built near the deepest part of the burrow system and contain nest materials composed of shredded grasses (*Poa bulbosa*; Fig. 5). Food chambers may contain bulbs, seeds, and rabbit and sheep feces. Abandoned auxiliary burrows may be used by Tristram's jird (*Meriones tristrami*—Karabağ 1953). Bumblebees (*Bombus fragrans*—Rasmont et al. 2008) and a small passerine, the Isabelline wheatear (*Oenanthe isabellina*—Ramsay 1914) also may use burrows of *S. xanthoprymnus*. We have sometimes accidentally livetrapped Isabelline wheatears while trapping *S. xanthoprymnus*.

Fig. 5.—Adult *Spermophilus xanthoprymnus* carrying vegetation, perhaps transporting nest materials to its burrow, in Bala, Ankara, Turkey, on 31 March 2007. Used with permission of the photographer, M. Özbek.

Diet.—*Spermophilus xanthoprymnus* is predominantly herbivorous, consuming primarily seeds, leaves, stems, seedlings, and bulbs. The diet changes seasonally, with green vegetation constituting the bulk of the diet in spring and seeds the bulk of it in summer, largely because of increased availability in the habitat. The natural plants consumed include Alliaceae: *Allium*; Apiaceae: *Eryngium*; Asteraceae: *Achillea setacea*, *Artemisia fragrans*, *Centaurea solstitialis*, *Scorzonera cana*, *Xanthium spinosum*; Brassicaceae: *Capsella bursa-pastoris*, *Euclidium syriacum*, *Sisymbrium altissimum*; Fabaceae: *Astragalus oxytropifolius*, *Trigonella brachycarpa*; Geraniaceae: *Erodium laciniatum*; Plantaginaceae: *Veronica polita*; Poaceae: *Bromus tectorum*, *Eremopyrum*, *Poa bulbosa*; Ranunculaceae: *Ranunculus constantinopolitanus*; Zygophyllaceae: *Peganum harmala* (Karabağ 1953; Kart 2000; Kral and Benli 1979; Kryštufek and Vohralík 2005). The animals consumed, based on analysis of stomach or fecal contents, include insects such as Coleoptera, Hemiptera, Lepidoptera (*Agrotis*), Orthoptera (*Gryllus*), and Formicidae; earthworms (Lumbricidae); and small vertebrates such as lizards (Lacertilia—Karabağ 1953; Kart 2000). In addition, frog (Anura) and Williams's jerboa (*Allactaga williamsi*) remains were observed at burrow entrances. *S. xanthoprymnus* also may exhibit a cannibalistic tendency in nature and captivity. The species meets its water need by consuming green vegetation. Water is rarely drunk, because it is usually not available (Karabağ 1953).

Spermophilus xanthoprymnus living near cultivated fields consumes seeds and seedlings of wheat (*Triticum*), barley (*Hordeum*), oat (*Avena*), rye (*Secale*), alfalfa (*Medicago*), trefoil (*Trifolium*), and chickpea (*Cicer*). Because the species may damage various crops and therefore may cause economic losses, it has sometimes been considered an agricultural pest and the subject of control programs (Alkan 1945; Karabağ 1953; Kral and Benli 1979; Tunçdemir 1987; Yüzbaş and Benli 1995). The common form of control has been to use chemical toxicants such as strychnine sulfate, thallium sulfate, and zinc phosphide distributed on wheat (Alkan 1945; Kral 1975).

Diseases and parasites.—Ectoparasites include fleas (Siphonoptera: *Nasopsyllus fasciatus* and *Pulex irritans*) and ticks (Acari: Ixodidae: *Ixodes* and *Haemasphysalis*). Fleas can transmit diseases such as the plague, murine typhus, and tularemia, although *Spermophilus xanthoprymnus* itself (given in the article incorrectly as *Citellus citellus*) is not known to be infected with any of them (Uslu et al. 2008). Endoparasites include tapeworm cysticerci (*Taenia*—Karabağ 1953) and the protozoans *Toxoplasma gondii* (Karatepe et al. 2004), *Eimeria callospermophili*, *E. morainensis*, *E. pseudospermophili*, and *E. lateralis* (Çiçek et al. 2010). *S. xanthoprymnus* may serve as a natural reservoir of toxoplasmosis for carnivores, especially for Felidae, because cysts of *T. gondii* have been found in the muscles of *S. xanthoprymnus* (Karatepe et al. 2004).

Interspecific interactions.—*Spermophilus xanthoprymnus* co-occurs most commonly with *Allactaga williamsi*, the gray dwarf hamster (*Cricetulus migratorius*), Tristram's jird (*Meriones tristrami*), Brandt's hamster (*Mesocricetus brandti*), voles (*Microtus*), the house mouse (*Mus musculus*), and the lesser blind mole rat (*Spalax leucodon*—Özkurt et al. 2005; Yiğit and Çolak 1998; Yiğit et al. 2003). There is no mention of interspecific competition for the species. However, we observed an aggressive encounter between *S. xanthoprymnus* and a mole rat, probably for burrow space.

Spermophilus xanthoprymnus may be prey to any small- or medium-sized predators in its habitat. Natural predators include the eagle owl (*Bubo bubo*—Obuch 1994), long-legged buzzard (*Buteo rufinus*; Fig. 6), falcons (*Falco naumanni*, *F. tinnunculus*, and *F. vespertinus*—Gür and Barlas 2006; Steiner and Vauk 1966), and the red fox (*Vulpes vulpes*—Karabağ 1953). Domestic dogs (*Canis familiaris*—Karabağ 1953) and the domestic cat (*Felis catus*—Gür and Barlas 2006) also prey on the species. Gür and Barlas (2006) reported that of 28 adults (8 males and 20 females) resident in spring, 32% (2 males and 7 females) disappeared over a 1-week period in the 1st half of June and did not reappear thereafter. The disappearance of these ground squirrels was probably due to predation, likely by 1 or 2 domestic cats that were observed frequently in the study area between late May and mid-June. Potential predators also include the least weasel (*Mustela nivalis*) and marbled polecat (*Vormela peregusna*—Gür and Barlas 2006; Kart Gür 2008). Other potential predators, based on behavioral responses of *S. xanthoprymnus*, include eagles (*Aquila*—Kryštufek and Vohralík 2005) and the grass snake (*Natrix natrix*—Karabağ 1953). These records indicate that the species is an important prey item in steppe areas for a wide range of avian, mammalian, and reptilian predators.

Fig. 6.—Juvenile male *Spermophilus xanthoprymnus* captured by a long-legged buzzard (*Buteo rufinus*) in Ayrancı, Karaman, Turkey, in 2007. Used with permission of the photographer, T. Zeybek.

Miscellaneous.—*Spermophilus xanthoprymnus* is easily trapped using treadle-style, wire-mesh live traps (e.g., Single Door Squirrel/Muskrat Trap, model 202, 48 by 15 by 15 cm with 2.5 by 2.5-cm wire mesh; Tomahawk Live Trap Co., Tomahawk, Wisconsin) baited with peanut butter, placed at burrow entrances (Gür and Barlas 2006; Gür and Kart Gür 2005; Kart Gür et al. 2009), although some individuals are trap-shy (Gür 2001). Individuals are also easily marked permanently with a numbered metal tag in each ear. In addition, fur is painted with a commercial hair dye in individually recognizable patterns to facilitate field recognition at a distance. Individuals are identified as juvenile if trapped during the active season of their birth year and as adult after their 1st hibernation. Thus, the term "adult" includes yearlings that had hibernated once and older adults ($\geq$2 years old) that had hibernated more than once. Juveniles are distinguished from adults by body size and mass during most of the summer. Anogenital distance, which is shorter in females than in males, is a reliable character for determining sex at any age, including newborn (Gür and Barlas 2006; Gür and Kart Gür 2005; Kart Gür et al. 2009).

HUSBANDRY

Spermophilus xanthoprymnus is housed successfully under both uncontrolled and controlled laboratory conditions (Gür and Kart Gür 2005; Karabağ 1953; Kart 2000; Kart Gür et al. 2009; Yiğit et al. 2000). Free water is essential if individuals are fed dry food. Captive individuals are maintained on an ad libitum diet of commercial rat chow and water (supplemented regularly with sunflower seeds, grains, and greens—Kart Gür et al. 2009); however, they appear to prefer the other foods to commercial rat chow. Field-impregnated females successfully give birth and rear their pups in captivity. Although there is no systematic captive breeding program for the species, reproductively mature males are paired with females inside the female's cage within the 1st week of continuous activity in captivity in early spring (Gür and Kart Gür 2005).

BEHAVIOR

The time of emergence from hibernation by *Spermophilus xanthoprymnus* varies among years and geographic populations depending on local environmental conditions. Earlier times of emergence in the study area in 2001 than in 2000 were associated with warmer than normal spring temperatures (Gür and Kart Gür 2005). The species usually emerges from hibernation in March in central lowland Anatolia (Gür and Kart Gür 2005) and in April in northeastern highland Anatolia and adjacent Armenia (Kryštufek and Vohralík 2005). However, time of emergence is later at higher elevations than at lower elevations. For example, *S. xanthoprymnus* emerges from hibernation in mid-May at a high-elevation site (2,900 m) in the Bolkar Mountains (Özkurt et al. 2005). The species immerges into hibernation in August and the 1st half of September in central lowland Anatolia (Gür and Kart Gür 2005; Kart Gür 2008) and probably later in northeastern highland Anatolia and adjacent Armenia. Thus, *S. xanthoprymnus* is active mainly from March to September, and hibernates during the remaining months. However, individuals become relatively inactive prior to hibernation (Kart 2000).

Reproductive males emerge from hibernation before females in the same age class and older adults before yearlings in the same sex class. Nonreproductive yearling males that have relatively low spring body mass emerge later than their reproductive counterparts. Adults immerge into hibernation before juveniles, and adult females before adult males. Juvenile males and females immerge at the same time (Gür and Kart Gür 2005; Kart Gür 2008).

Spermophilus xanthoprymnus is strictly diurnally active. Aboveground activity decreases at midday especially during midsummer. In hot days, some individuals in traps cool themselves by using evaporative cooling of salivation (Kart 2000). One of us (M. Kart Gür) has sometimes found that individuals trapped in midday have died in traps, presumably because of overheating. Commercial trap covers, cardboard affixed to tops of traps or shading traps with vegetation could be helpful to reduce the likelihood of mortality from heat stress (Murie 1982).

Spermophilus xanthoprymnus copulates underground (Gür and Kart Gür 2005). The mating system is probably polygynous, because the sex ratio among reproductive individuals is biased toward females (Gür and Barlas 2006) and all females mate during the mating season (Gür and Kart Gür 2005). During early spring, older males (≥2 years old) spend more time moving and less time foraging than females. Furthermore, older males engage in injurious fights. Thus, during the mating season, older males lose body mass, as a result of increased energy expenditure and reduced energy intake (Gür and Kart Gür 2005). No information is available on social organization, spatial associations, and kinship relationships.

GENETICS

Chromosomal data are available for numerous populations of *Spermophilus xanthoprymnus* from Polatlı, Ankara, and Selçuklu, Konya, in the west to Armenia and Makü, Iran in the east, thus covering most of its distribution area. The species is characterized by a karyotype with a diploid number (2n) of 42 chromosomes with variable numbers of autosomal arms (NFa = 64, 66, 74, 76, or 78); the X chromosome is metacentric or submetacentric, whereas the Y chromosome is biarmed or acrocentric (Arslan 2005; Doğramacı et al. 1994; Gaffaroğlu and Yüksel 2006; Gündüz et al. 2007a; V. N. Orlov et al., in litt.; Özkurt et al. 2002, 2007; Vorontsov et al., in litt.; Yiğit et al. 2006b; Zima and Král 1984). For example, Özkurt et al. (2002) report that the karyotype of *S. xanthoprymnus* from the type locality consists of 2 pairs of metacentric, 17 pairs of submetacentric, and 1 pair of acrocentric autosomes (thus resulting in an NFa = 78), a metacentric X chromosome, and an acrocentric Y chromosome. The diploid number of chromosomes (2n = 42) distinguishes the species from *S. citellus* and *S. taurensis* (2n = 40—Gündüz et al. 2007a; Özkurt et al. 2007).

In blood serum proteins (globulin and albumin) electrophoretically analyzed for several populations of *S. xanthoprymnus*, polymorphism is observed especially for globulin; 9, 10, or 11 separate bands are present. *S. xanthoprymnus* differs from *S. taurensis*, another species of ground squirrel living in Anatolia, especially with respect to postalbumin; 1 or 2 (*S. xanthoprymnus*) and 4 (*S. taurensis*) separate bands are present (Çolak et al. 2006; Çolak and Özkurt 2002).

Phylogeographic analyses of molecular data show that *S. xanthoprymnus* is most closely related to the clade represented by *S. citellus* and *S. taurensis* (Gündüz et al. 2007a; Yiğit et al. 2005). DNA sequences for the haplotypes (16S rRNA [Yiğit et al. 2005], cytochrome-*b*, tRNAs + D-loop, X chromosome, and Y chromosome [Gündüz et al. 2007a] haplotypes) used in those phylogeographic analyses are available in GenBank for further studies. Molecular dating using cytochrome-*b* data suggests that *S. xanthoprymnus* diverged from the common ancestor of *S. citellus* and *S. taurensis* approximately 5 million years ago (Gündüz et al. 2007a), or 5–9 million years after early diversification of the genus *Spermophilus* restricted to Eurasia (estimated to have occurred 10–14 million years ago—Harrison et al. 2003). The underlying cause of this divergence may be the communication of the Mediterranean with the Atlantic Ocean and therefore the separation of Europe from Anatolia at the end of the Miocene, about 5.3 million years ago (see Koufos et al. [2005] for paleogeographic changes in the eastern Mediterranean). *S. xanthoprymnus* is phylogeographically structured into 5 cytochrome-*b* lineages that likely diverged 0.30–0.75 million years ago with the majority of population splits taking place 0.50–0.65 million years ago. These cytochrome-*b* lineages have signals of recent range expansion (Gündüz et al. 2007a). Gündüz et al. (2007a) suggested that the species survived the last glacial maximum in small suitable habitats (refugia) and that postglacial recolonization of Anatolia arose from these refugia. In the last glacial maximum, and probably in other glacial maxima, when the climate is thought to have been drier, colder, and more seasonal in Anatolia (Atalay 1992, 1996), it is likely that *S. xanthoprymnus* shifted its range toward small suitable habitats (refugia) where summer precipitation was sufficiently high to allow accumulation of the fat reserves required to survive the prolonged winters under more extreme glacial conditions (Gür 2010). According to Gündüz et al. (2007a), mountain ranges may have been refugia during the last glacial maximum because precipitation was higher there than at lower elevations.

CONSERVATION

Spermophilus xanthoprymnus was initially rated as "Least Concern/Lower Risk" on the *1996 International Union for Conservation of Nature and Natural Resources Red List of Threatened Animals* (Baillie and Groombridge 1996). The species is presently listed as "Near Threatened" on the *2009 International Union for Conservation of Nature and Natural Resources Red List of Threatened Species* (International Union for Conservation of Nature and Natural Resources 2009), because it was postulated that population size may have declined by approximately 20–25% over the last 10 years due to large-scale agricultural activities that result in habitat destruction and fragmentation, especially in central lowland Anatolia. *S. xanthoprymnus* also is almost qualified as "Vulnerable" under criterion A2c (Kryštufek et al. 2008). Furthermore, the species is presently listed as "Under Protection" by the Republic of Turkey Ministry of Environment and Forestry. In spite of the above-mentioned evaluations, however, populations have not been studied in any systematic way. Special attention should be given to some populations (e.g., in the Teke Peninsula and Çukurova plain; see "Distribution" section).

One method for capturing *S. xanthoprymnus* (by researchers and others) has been to pour water down burrows, thereby forcing individuals to the surface (Çakır and Karataş 2004; Karatepe et al. 2004; Kral 1975; Kral and Benli 1979; Tunçdemir 1987). Clearly, this method should not be used by researchers (or anyone else), because it poses a threat to the study population, especially in the lactation period.

ACKNOWLEDGMENTS

We very much thank all the scientists who have contributed to our understanding of *Spermophilus xanthoprymnus*. We are grateful to 2 anonymous reviewers for their comments on the account. We thank M. Özbek and T. Zeybek for the photographs, and A. B. Albayrak for drawing Fig. 3. The account includes data from the master's thesis of Mutlu Kart Gür submitted to Hacettepe University.

LITERATURE CITED

Alkan, B. 1945. Tarla sincabı ve savaşı (The ground squirrel and its control). Ziraat Dergisi 70:4–8.

Arslan, A. 2005. Cytogenetic studies on *Spermophilus xanthoprymnus* (Rodentia: Sciuridae) in Central Anatolia. Folia Zoologica 54: 278–284.

Atalay, İ. 1992. The paleogeography of the Near East (from late Pleistocene to early Holocene) and human impact. Ege University Press, İzmir, Turkey.

Atalay, İ. 1996. Palaeosols as indicators of the climatic changes during Quaternary period in S. Anatolia. Journal of Arid Enviroments 32:23–35.

Baillie, J. E. M., and B. Groombridge. 1996. 1996 International Union for Conservation of Nature and Natural Resources Red list of threatened animals. International Union for Conservation of Nature and Natural Resources, Gland, Switzerland.

Barnes, B. M., and D. Ritter. 1993. Patterns of body temperature change in hibernating arctic ground squirrels. Pp. 119–130 in Life in the cold: ecological, physiological, and molecular mechanisms (C. Carey, G. L. Florant, B. A. Wunder, and B. Horwitz, eds.). Westview Press, Boulder, Colorado.

Bennett, E. T. 1835. Mammals of the neighbourhood of Trebizond and Erzeroun. Proceedings of the Zoological Society of London 3: 89–90.

Bryant, M. D. 1945. Phylogeny of Nearctic Sciuridae. American Midland Naturalist 33:257–390.

Çakir, M., and A. Karataş. 2004. Histo-anatomical studies on the accessory reproductive glands of the Anatolian souslik (*Spermophilus xanthoprymnus*) (Mammalia: Sciuridae). Anatomia, Histologia, Embryologia: Journal of Veterinary Medicine Series C 33: 146–150.

Çiçek, H., M. Karatepe, B. Karatepe, M. Cakir, and M. Eser. 2010. *Eimeria* species (Apicomplexa: Eimeriidae) detected from the Anatolian ground squirrel, *Spermophilus xanthoprymnus* (Rodentia: Sciuridae) in Niğde Province, Turkey. Ankara Üniversitesi Veterinerlik Fakültesi Dergisi 57:143–144.

Çolak, R., M. M. Gharkheloo, and Ş. Özkurt. 2006. Distribution and electrophoretic aspects of blood-serum proteins of the genus *Spermophilus* (Mammalia: Rodentia) in eastern Turkey and Iran. Pakistan Journal of Biological Sciences 9:519–521.

Çolak, R., and Ş. Özkurt. 2002. Electrophoretic comparison of blood-serum proteins of *Spermophilus citellus* and *Spermophilus xanthoprymnus* (Mammalia: Rodentia) in Turkey. Zoology in the Middle East 25:5–8.

Corbet, G. B., and P. A. Morris. 1967. A collection of recent and subfossil mammals from southern Turkey (Asia Minor), including the dormouse *Myomimus personatus*. Journal of Natural History 4:561–569.

Cuvier, F. 1825. Des dents des mammifères, considérées comme caractères zoologiques. F. G. Levrault, Le Normant, Paris, France.

Demİrsoy, A. 1997. Memeliler (The mammals). Meteksan A. Ş., Ankara, Turkey.

Dİkmenlİ, M. 1996. The importance of the skull and tooth roots on taxonomy of subspecies of the ground squirrel, *Spermophilus citellus* Linnaeus, 1766 (Mammalia: Rodentia) living in Turkey. M.S. thesis, Selçuk University, Konya, Turkey.

Doğramaci, S., H. Kefelİoğlu, and İ. Gündüz. 1994. Türkiye *Spermophilus* (Mammalia: Rodentia) cinsinin karyolojik analizi (Karyological analysis of the genus *Spermophilus* (Mammalia: Rodentia) in Turkey). Turkish Journal of Zoology 18:167–170.

Ellerman, J. R., and T. C. S. Morrison-Scott. 1951. Checklist of Palaearctic and Indian mammals 1758 to 1946. British Museum (Natural History), London, United Kingdom.

Eren, H. 1999. Türk dilinin etimolojik Sözlüğü (Etymological dictionary of the Turkish language). Bulak Neşriyat, Ankara, Turkey.

French, A. R. 1982. Intraspecific differences in the pattern of hibernation in the ground squirrel *Spermophilus beldingi*. Journal of Comparative Physiology, B. Biochemical, Systemic, and Environmental Physiology 148:83–91.

Gaffaroğlu, M., and E. Yüksel. 2006. Karyotype analysis of ground squirrel (Mammalia: Rodentia) in Malatya (Türkiye). Journal of Biological Sciences 6:754–757.

Geoffroy Saİnt-Hİlaİre, I. 1831. Dictionaire classique d'histoire naturelle. J. B. G. M. Bory de Saint-Vincent, Paris, France.

Güleç, E., F. C. Howell, and T. D. White. 1999. Dursunlu—a new lower Pleistocene faunal and artifact-bearing locality in southern Anatolia. Pp. 349–364 in Hominid evolution: lifestyles and survival strategies (H. Ulrich, ed.). Edition Archea, Berlin, Germany.

Gündüz, İ., M. Jaarola, C. Tez, C. Yenİyurt, P. D. Polly, and J. B. Searle. 2007a. Multigenic and morphometric differentiation of ground squirrels (*Spermophilus*, Sciuridae, Rodentia) in Turkey, with a description of a new species. Molecular Phylogenetics and Evolution 43:916–935.

Gündüz, İ., M. Jaarola, C. Tez, C. Yenİyurt, P. D. Polly, and J. B. Searle. 2007b. *Spermophilus torosensis* Özkurt et al., 2007 (Sciuridae, Rodentia) is a subjective junior synonym of *Spermophilus taurensis* Gündüz et al., 2007, a newly described ground squirrel from the Taurus Mountains of southern Turkey. Zootaxa 1663:67–68.

Gür, H. 2001. Population biology of *Spermophilus xanthoprymnus* (Rodentia: Sciuridae). M.S. thesis, Hacettepe University, Ankara, Turkey.

Gür, H. 2007. Morphometric variation in Anatolian ground squirrel (*Spermophilus xanthoprymnus*) and its relationship to selected environmental variables. Ph.D. dissertation, Hacettepe University, Ankara, Turkey.

Gür, H. 2010. Why do Anatolian ground squirrels exhibit a Bergmannian size pattern? A phylogenetic comparative analysis of geographic variation in body size. Biological Journal of the Linnean Society 100:695–710.

Gür, H., and N. Barlas. 2006. Sex ratio of a population of Anatolian ground squirrels *Spermophilus xanthoprymnus* in Central Anatolia, Turkey. Acta Theriologica 51:61–67.

Gür, H., and M. Kart Gür. 2005. Annual cycle of activity, reproduction, and body mass of Anatolian ground squirrels (*Spermophilus xanthoprymnus*) in Turkey. Journal of Mammalogy 86:7–14.

Harrison, R. G., S. M. Bogdanowicz, R. S. Hoffmann, E. Yensen, and P. W. Sherman. 2003. Phylogeny and evolutionary history of the ground squirrels (Rodentia: Marmotinae). Journal of Mammalian Evolution 10:249–276.

Helgen, K. M., F. R. Cole, L. E. Helgen, and D. E. Wilson. 2009. Generic revision in the Holarctic ground squirrel genus *Spermophilus*. Journal of Mammalogy 90:270–305.

Hershkovitz, P. 1949. Status of names credited to Oken, 1816. Journal of Mammalogy 30:289–301.

Hír, J. 1992. Subfossil *Mesocricetus* population from the Toros Mountains (Turkey) (Mammalia). Folia Historico Naturalia Musei Matraensis 17:107–130.

Holekamp, K. E. 1984. Dispersal in ground-dwelling sciurids. Pp. 297–320 in The biology of ground-dwelling squirrels: annual cycles, behavioral ecology, and sociality (J. O. Murie and G. R. Michener, eds.). University of Nebraska Press, Lincoln.

Hongo, H. 1997. Patterns of animal husbandry, environment, and ethnicity in central Anatolia in the Ottoman Empire period: faunal remains from Islamic layers at Kaman-Kalehöyük. Japan Review 8:275–307.

Hut, R. A., B. M. Barnes, and S. Daan. 2002. Body temperature patterns before, during, and after semi-natural hibernation in the European ground squirrel. Journal of Comparative Physiology, B. Biochemical, Systemic, and Environmental Physiology 172:47–58.

International Commission on Zoological Nomenclature. 1956. Opinion 417. Rejection for nomenclatorial purposes of volume 3 (Zoologie) of the work by Lorenz Oken entitled Okens Lehrbuch der Naturgeschichte published in 1815–1816. Opinions and Declarations Rendered by the International Commission on Zoological Nomenclature 14:1–42.

International Union for Conservation of Nature and Natural Resources. 2009. International Union for Conservation of Nature and Natural Resources Red list of threatened species. Version 2009.2. www.iucnredlist.org, accessed 4 December 2009.

Jaeger, E. C. 1955. A source-book of biological names and terms. 3rd ed. Charles C. Thomas Publisher, Springfield, Illinois.

Karabağ, T. 1953. Ankara dolaylarındaki tarla sincaplarının (*Citellus*'ların) biyolojisi ve bunlarla savaş usulleri (The biology of ground squirrels (*Citellus*) near Ankara with methods for their control). No. 48. Ankara Üniversitesi Ziraat Fakültesi Yayınları, Ankara, Turkey.

Karatepe, M., C. Babür, B. Karatepe, S. Kiliç, and M. Çakir. 2004. Prevalence of *Toxoplasma gondii* antibodies in Anatolian ground squirrels, *Spermophilus xanthoprymnus* (Rodentia: Sciuridae) from Niğde, Turkey. Revue de Médicine Vétérinaire 155:530–532.

Kart, M. 2000. The investigation of hibernation on *Spermophilus xanthoprymnus* from behavioral and biochemical points of view. M.S. thesis, Hacettepe University, Ankara, Turkey.

Kart Gür, M. 2008. Hibernation pattern of Anatolian ground squirrel (*Spermophilus xanthoprymnus*). Ph.D. dissertation, Hacettepe University, Ankara, Turkey.

Kart Gür, M., R. Refinetti, and H. Gür. 2009. Daily rhythmicity and hibernation in the Anatolian ground squirrel under natural and laboratory conditions. Journal of Comparative Physiology, B. Biochemical, Systemic, and Environmental Physiology 179: 155–164.

Kaya, M. A., and N. Şimşek. 1986. The importance of the baculum in distinguishing the subspecies of ground squirrel, *Spermophilus citellus* (L. 1766), (Mammalia: Rodentia) in Turkey. Turkish Journal of Biology 10:385–390.

Kivett, V. K., J. O. Murie, and A. L. Steiner. 1976. A comparative study of scent-gland location and related behavior in some northwestern Nearctic ground squirrel species (Sciuridae): an evolutionary approach. Canadian Journal of Zoology 54: 1294–1306.

Koufos, G. D., D. S. Kostopoulos, and T. D. Vlachou. 2005. Neogene/Quaternary mammalian migrations in eastern Mediterranean. Belgian Journal of Zoology 135:181–190.

Kral, E. 1975. Çinko fosfür ve sitriknin sülfat'ın gelengi (*Citellus citellus gelengius* Mursaloğlu)'ye LD_{50} kıymetinin araştırılması (Determination of LD_{50} levels of zinc phosphate and strychnine sulphate in the ground squirrel (*Citellus citellus gelengius* Mursaloğlu)). Türkiye Cumhuriyeti, Gıda-Tarım ve Hayvancılık Bakanlığı, Ziraî Mücadele ve Ziraî Karantina Genel Müdürlüğü, Ankara Bölge Ziraî Mücadele Araştırma Enstitüsü Müdürlüğü Yayınları, Araştırma Eserleri Serisi 38:1–32.

Kral, E., and O. Benlİ. 1979. Orta Anadolu'nun kemirici türleri ve zarar yaptığı kültür bitkileri (Rodent species of central Anatolia and cultivated plants damaged by those species). Bitki Koruma Bülteni 19:191–217.

Kryštufek, B., and V. Vohralík. 2005. Mammals of Turkey and Cyprus. Rodentia I: Sciuridae, Dipodidae, Gliridae, Arvicolinae. Knjiznica Annales Majora, Koper, Slovenia.

Kryštufek, B., N. Yiğit, and R. Hutterer. 2008. *Spermophilus xanthoprymnus*. In: International Union for Conservation of Nature and Natural Resources 2009. International Union for Conservation of Nature and Natural Resources Red list of threatened species. Version 2009.2. www.iucnredlist.org, accessed 4 December 2009.

Lichtenstein, M. H. C. 1823. Verzeichniss der Doubletten des Zoologischen Museums der Königlichen Universität zu Berlin nebst Beschreibung vieler bisher unbekannter Arten von Säugethieren, Vögeln, Amphibian un Fishien. Konigheh Preussische Akademie der Wissenschaften, T. Trautwein, Berlin, Germany.

Michener, G. R. 1992. Sexual differences in over-winter torpor patterns of Richardson's ground squirrels in natural hibernacula. Oecologia 89:397–406.

Mitchell-Jones, A. J., et al. 1999. The atlas of European mammals. T & A D Poyser Natural History, Academic Press, London, United Kingdom.

Murie, J. 1982. Franklin's ground squirrels (*Spermophilus franklinii*). Pp. 150–151 in CRC Handbook of census methods for terrestrial vertebrates (D. E. Davis, ed.). CRC Press, Inc., Boca Raton, Florida.

Mursaloğlu, B. 1964. Statistical significance of secondary sexual variations in *Citellus citellus* (Mammalia: Rodentia) and a new subspecies of *Citellus* from Turkey. Communications, Faculty of Science, University of Ankara C9:252–273.

Mursaloğlu, B. 1965. Geographic variation in *Citellus citellus* (Mammalia: Rodentia) in Turkey. Communications, Faculty of Science, University of Ankara C10:78–109.

Obuch, J. 1994. On the food of the eagle-owl (*Bubo bubo*) and tawny owl (*Strix aluco*) in the eastern part of Turkey. Tichodroma 7: 7–16.

Osborn, D. J. 1964. The hare, porcupine, beaver, squirrels, jerboas, and dormice of Turkey. Mammalia 28:573–592.

Oken, L. 1815–1816. Lehrbuch den Naturgeschichte, Zoologie. Vol. 3. August Schmid und Comp, Jena, Germany.

Özkurt, Ş. Ö., et al. 2007. Taxonomic status of the genus *Spermophilus* (Mammalia: Rodentia) in Turkey and Iran with description of a new species. Zootaxa 1529:1–15.

Özkurt, Ş., N. Yiğit, and E. Çolak. 2002. Karyotype variation in Turkish populations of *Spermophilus* (Mammalia: Rodentia). Mammalian Biology 67:117–120.

Özkurt, Ş., N. Yiğit, E. Çolak, M. Sözen, and M. M. Gharkheloo. 2005. Observations on the ecology, reproduction and behavior of *Spermophilus* Bennett, 1835 (Mammalia: Rodentia) in Turkey. Turkish Journal of Zoology 29:91–99.

Peters, J., and K. Schmidt. 2004. Animals in the symbolic world of Pre-Pottery Neolithic Göbekli Tepe, south-eastern Turkey: a preliminary assessment. Anthropozoologica 39:179–218.

Ramsay, L. N. G. 1914. Observations on the bird-life of the Anatolian Plateau during the summer of 1907. Ibis 2:365–387.

Rasmont, P., A. M. Aytekin, and M. S. Kaçar. 2008. Ousting of the common redstart (Aves: Turdidae: *Phoenicurus phoenicurus*) from its nests by the bumblebee *Bombus niveatus vorticosus* (Hymenoptera: Apidae). Annales de la Société Entomologique de France (Nouvelle Série) 44:251–255.

Satunin, K. A. 1908. Beitrage zur Kenntnis der Säugetierfauna Kaukasiens und Transkaspiens; u. a. IX. Über die Zieselmaus des Kars-Gebiets Citellus schmidti (Satunin Spec. Nova). Mitteilungen des Kaukasischen Museums Tiflis 4:117–125.

Schinz, H. R. 1845. Systematisches Verzeichniss aller bis jetzt bekannten Säugethiere oder Synopsis Mammalium, nach dem Cuvier' schen System. Vol. 2. Jent und Gassmann, Solothurn, Switzerland.

Schwartz, O. A., K. B. Armitage, and D. Van Vuren. 1998. A 32-year demography of yellow-bellied marmots (*Marmota flaviventris*). Journal of Zoology (London) 246:337–346.

Şen, Ş., L. Bonis, N. Dalfes, D. Geraads, J. J. Jaeger, and J. M. Mazin. 1991. Première découverte d'un site à mammifères pléistocènes dans une fissure karstique en Anatolie centrale. Les Comptes Rendus de l'Académie des Sciences Paris, Série II 313: 127–132.

Steiner, H. M., and G. Vauk. 1966. Säugetiere aus dem Beyşehir-Gebeit (Vil. Konya, Kleinasien). Zoologischer Anzeiger 176: 97–102.

Storch, G. 1975. Eine mittelpleistozäne Nager-Fauna von der Insel Chios, Ägäis. Senckenbergiana Biologica 56:165–189.

Storch, G. 1988. Eine jungpleistozäne/altholozäne Nager-Abfolge von Antalya, SW-Anatolien (Mammalia, Rodentia). Zeitschrift für Säugetierkunde 53:76–82.

Thomas, O. 1905. On a collection of mammals from Persia and Armenia presented to the British Museum by Col. A. C. Bailward. Proceedings of the Zoological Society of London 2:519–527.

Tunçdemir, Ü. 1987. Karadeniz Bölgesindeki zararlı kemirici türlerinin, yayılış alanlarının ve zarar yaptığı bitkilerin tespiti üzerinde araştırmalar (Investigations on distributions of rodent species living in Black Sea region and plants damaged by those species). Bitki Koruma Bülteni 27:65–86.

Twente, J. W., and J. A. Twente. 1967. Seasonal variation in the hibernating behavior of *Citellus lateralis*. Pp. 47–63 in Mammalian hibernation III (K. C. Fischer, A. W. Dawe, C. P. Lyman, E. Schonbaum, and F. E. South, eds.). Oliver and Boyd, Edinburg, United Kingdom.

Ünal, Y., T. Kindap, and M. Karaca. 2003. Redefining the climate zones of Turkey using cluster analysis. International Journal of Climatology 23:1045–1055.

Uslu, U., B. Dik, and A. Gökçen. 2008. Ectoparasites of the ground squirrel (*Citellus citellus* (L.)) in Turkey. Türkiye Parazitoloji Dergisi 32:142–145.

Wilson, D. E., and D. M. Reeder (eds). 2005. Mammal species of the world: a taxonomic and geographic reference. 3rd ed. The Johns Hopkins University Press, Baltimore, Maryland.

Yensen, E., and P. W. Sherman. 2003. Ground squirrels (*Spermophilus* species and *Ammospermophilus* species). Pp. 211–231 in Wild mammals of North America (G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds.). The Johns Hopkins University Press, Baltimore, Maryland.

Yiğit, N., and E. Çolak. 1998. Contribution to the geographic distribution of rodent species and ecological analyses of their habitats in Asiatic Turkey. Turkish Journal of Biology 22: 435–446.

Yiğit, N., E. Çolak, M. Sözen, and A. Karataş. 2006a. Rodents of Türkiye (A. Demirsoy, ed.). Meteksan Co., Ankara, Turkey.

Yiğit, N., E. Çolak, M. Sözen, and Ş. Özkurt. 2000. A study on the hibernation of *Spermophilus xanthoprymnus* (Bennett, 1835) (Mammalia: Rodentia) in Turkey. Turkish Journal of Zoology 24:87–93.

Yiğit, N., E. Çolak, M. Sözen, and Ş. Özkurt. 2003. A study on the geographic distribution along with habitat aspects of rodent species in Turkey. Bonner Zoologische Beiträge 50:355–368.

Yiğit, N., et al. 2006b. The karyotypes of some rodent species (Mammalia: Rodentia) from eastern Turkey and northern Iran with a new record, *Microtus schidlovskii* Argyropulo, 1933, from eastern Turkey. Turkish Journal of Zoology 30:459–464.

Yiğit, N., K. Neumann, Ş. Özkurt, E. Çolak, and R. Çolak. 2005. Biometric and genetic evaluation of *Spermophilus* (Mammalia: Rodentia) populations in western Turkey. Israel Journal of Zoology 51:191–198.

Young, P. J. 1990. Hibernating patterns of free-ranging Columbian ground squirrels. Oecologia 83:504–511.

Yüzbaş, M. A., and O. Benli. 1995. Akdeniz Bölgesi kemirgen (Rodentia) faunası üzerinde çalışmalar (Investigations on rodent (Rodentia) fauna in Mediterranean region). Ziraî Mücadele Araştırma Enstitüsü 35:1–9.

Zima, J., and B. Král. 1984. Karyotypes of European mammals II. Acta Scientiarum Naturalium Academiae Scientiarum Bohemicae Brno 18:1–62.

Associate editor of this account was Barbara H. Blake. Editor was Meredith J. Hamilton.