MAMMALIAN SPECIES No. 101, pp. 1–4, 2 figs.

Spermophilus spilosoma.

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Published 21 September 1978 by the American Society of Mammalogists

Spermophilus spilosoma Bennett, 1833

Spotted Ground Squirrel

Spermophilus spilosoma Bennett, 1833:334. Type locality restricted to Durango, Durango, by Howell, 1938:122; lectotype designated by Thomas, 1927:548.

Spermophilus obsoletus Kennicott, 1863:157. Type locality restricted (Howell, 1938:131) to "50 miles west of Fort Kearney," Nebraska, by designation of lectotype.

Spermophilus canescens Merriam, 1890:38. Type locality Willcox, Cochise Co., Arizona.

Spermophilus cryptospilotus Merriam, 1890:57. Type locality "Tenebito" [=Dinnebito] Wash, Painted Desert, Coconino Co., Arizona.

CONTEXT AND CONTENT. Order Rodentia, Family Sciuridae. The genus includes at least 21 species. There are 14 New World species; seven species are restricted to Eurasia. In North America, Howell (1938) recognized eight subgenera, with *S. spilosoma* assigned to *Ictidomys*. Twelve living subspecies of *S. spilosoma* are recognized (Howell 1938; Dalquest, 1951; Hoffmeister, 1959; Anderson, 1972) as follows:

S. s. spilosoma Bennett, 1833:40, see above.
S. s. obsoletus Kennicott, 1863:157, see above.
S. s. canescens Merriam 1890:38, see above (*macrospilotus* Merriam, *microspilotus* Elliot, and *arens* Bailey are synonyms).
S. s. cryptospilotus Merriam 1890:57, see above.
S. s. pratensis Merriam, 1890:55. Type locality north base of San Francisco Mountain, Coconino Co., Arizona (*obsidianus* Merriam a synonym).
S. s. annectens Merriam 1893:132. Type locality "The Tanks," 12 miles from Point Isabel, Padre Island, Texas.
S. s. marginatus Bailey, 1902:118. Type locality Alpine, Brewster Co., Texas (*major* Merriam a synonym).
S. s. pallescens (A. H. Howell, 1928:212). Type locality LaVentura, Coahuila.
S. s. cabrerai (Dalquest, 1953:106). Type locality 10 km NNW Nuñez, San Luis Potosí.
S. s. ammophilus Hoffmeister, 1959:37. Type locality 9 km N Samalayuca, Chihuahua.
S. s. altiplanensis Anderson 1972:275. Type locality 5 km ESE LaJunta, Chihuahua.
S. s. bavicorensis Anderson 1972:276. Type locality 3 km SW San José Babícora, Chihuahua.

DIAGNOSIS. *Spermophilus spilosoma* is a small ground squirrel with white non-linear dorsal spots, and white underparts. Measurements (in mm) range as follows: total length 185 to 253, tail 55 to 92, hind foot 28 to 30, greatest length of skull 34.1 to 42.7 (Howell, 1938; Hall and Kelson, 1959). In members of the subgenus *Ictidomys* the metaloph on P4 is not continuous. The molars are hypsodont, with the parastyle ridge on M1 and M2 joining the protocone with an abrupt change of direction.

The three other species in the subgenus *Ictidomys* can be distinguished from *S. spilosoma* as follows: *S. tridecemlineatus* has pronounced dorsal striping alternating with longitudinal rows of spots; *S. mexicanus* possesses dorsal spots arranged in linear series; *S. perotensis* has buff-colored underparts, and either lacks dorsal spots or the spots are buff in color.

GENERAL CHARACTERS. Hall and Kelson (1959) described *S. spilosoma* as follows: "Upper parts drab, cinnamon drab, avellaneous, smoke gray, fawn, wood brown, snuff brown, or verona brown, more or less spotted with squarish white spots; tail above usually resembling back but having fuscous black at tip; tail beneath some shade of cinnamon." Anderson (1972) noted much color variation in this species in Chihuahua and we have noted that variation is not unusual in other areas with varied substrates. The skull resembles that of *S. tridecemlineatus*, but as noted by Hall and Kelson (1959) is "relatively broader, especially in rostrum and interorbital region; auditory bullae much larger." Average skull measurements (in mm) taken from the seven subspecies listed by Howell (1938) are: greatest length 39.3, palatilar length 17.6, zygomatic breadth 23.4, cranial breadth 18.2, interorbital breadth 8.4, postorbital constriction 13.6, length of nasals 13.5, and maxillary toothrow 8.0. See Howell (1938) for a more detailed morphological comparison of the subspecies of *S. spilosoma*. The skull is illustrated in Figure 1.

DISTRIBUTION. The species ranges from south-central South Dakota, through the sandhills of Nebraska, and into southeastern Wyoming; it also occurs throughout eastern Colorado, northwestern Oklahoma, western Kansas, western Texas, most of New Mexico, the southeastern corner of Utah, and eastern Arizona, south to central Mexico (Moore, 1930; Davis and Robertson, 1944; Cockrum, 1952; DeWitt, 1957; Hall and Kelson, 1959; Jones, 1964; Maxwell and Brown, 1968; Armstrong, 1972; Findley *et al.*, 1975). Figure 2 shows the distribution of the 12 subspecies of *S. spilosoma*.

FOSSIL RECORD. Harris and Findley (1964) reported that fossils of *S. spilosoma* occur together with fossil *Cynomys gunnisoni*. Dalquest (1967) discovered 18 isolated complete and partial *S. spilosoma* teeth from the Pleistocene Slaton local fauna of Texas. Beyond these two sites, fossil evidence of the species is lacking.

FORM AND FUNCTION. *Spermophilus spilosoma* has two distinct pelages and molts each year. Adults emerge from hibernation in winter pelage and undergo molt by late May in New Mexico and Colorado (Sumrell 1949; Streubelt 1975). The autumn molt is not conspicuous in the adults, being more noticeable in juveniles. Generally, the pelage of adults is paler than the juvenile pelage (Sumrell 1949). Blair (1941) reported on pelage differences between two populations of *S. s. major* in New Mexico. He observed that a population from the White Sands National Monu-

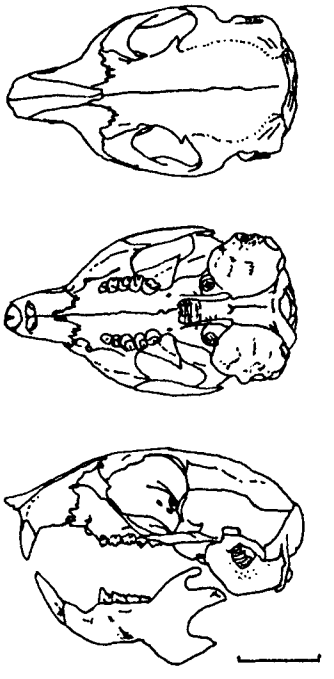

FIGURE 1. Views of skull (×1) of *Spermophilus spilosoma* (N end Mariscal Mtn., 700 m, Brewster Co., Texas MVZ 80346). From Hall and Kelson, The mammals of North America, copyright © 1959 The Ronald Press Company, New York. The scale represents 10 mm.

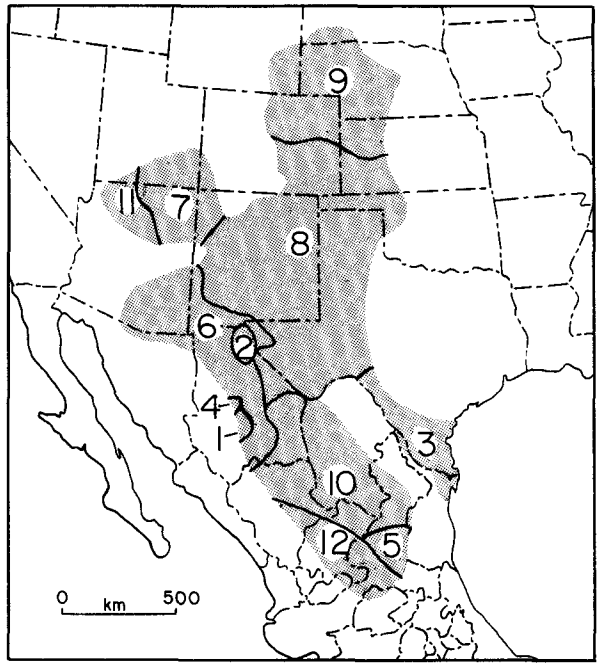

FIGURE 2. Distribution of *Spermophilus spilosoma* modified from Hall and Kelson (1959) and revised by S. Anderson: 1, *S. s. altiplanensis*; 2, *S. s. ammophilus*; 3, *S. s. annectens*; 4, *S. s. bavicorensis*; 5, *S. s. cabrerai*; 6, *S. s. canescens*; 7, *S. s. cryptospilotus*; 8, *S. s. marginatus*; 9, *S. s. obsoletus*; 10, *S. s. pallescens*; 11, *S. s. pratensis*; 12, *S. s. spilosoma*.

ment had a significantly paler color with larger, more distinct spots than did another population living on relatively dark soil only 15 miles distant.

Harris (1965) presented an interesting discussion on size relationships of ground squirrels from the Chaco Basin of New Mexico with animals from other parts of the state. He suggested that the small size of the Chaco animals indicates a separation from adjunct populations some 4,000 years ago.

Hudson and Deavers (1973) studied physiological adaptations of eight species of ground squirrels from different environments. They classified *S. spilosoma* as a high desert species. Their observations indicated these animals: 1) have a low pulmocutaneous water loss, 2) have a high level of conductance irrespective of body weight, 3) can decrease conductance and increase insulation at high ambient air temperatures, and 4) have a basal metabolism about 60% of that expected from standard metabolic equations.

REPRODUCTION AND ONTOGENY. The gestation period for *S. spilosoma* has not been documented, although Sumrell (1949) had a pregnant female in captivity for 24 days prior to parturition. Gestation in *S. tridecemlineatus* is reported to be 27 to 28 days (Bridgewater, 1966). The spotted ground squirrel probably has a similar gestation period.

Streubel (1975) analyzed the breeding season of *S. s. obsoletus* in Colorado based on behavioral observations and the presence of mature sperm in the testes and epididymides of males. Breeding began in mid-April, two to three weeks after emergence from hibernation. Most males were still capable of breeding through June, but by mid-July their breeding season ended. Sumrell (1949) observed that males of *S. s. marginatus* in New Mexico had descended testes by mid-April and that the testes were abdominal by the first of August.

In Colorado, Streubel (1975) collected pregnant females between 11 May and 24 July. Weights of female reproductive tracts and behavioral observations indicated that most breeding occurred in May and June but that some occurred in early July. The extended breeding season seems to result from later breeding on the part of yearling females. Sumrell (1949) reported females in New Mexico with open vulvas from late April through mid-May.

Numerous authors (Bailey, 1893; Rinker, 1942; Davis and Robertson, 1944; Cockrum, 1952; Jones, 1964) have suggested that *S. spilosoma* is diestrous in the southern part of its range. Streubel (1975) in Colorado found no evidence the animals were diestrous and suggested that such reports could be based on observations of yearling females that conceived late in the season.

Litter sizes reported for *S. spilosoma* are: 6.6 (range four to 11) in New Mexico (Sumrell, 1949), five to 12 in Kansas (Cockrum, 1952), 7.0 in Colorado (Burnett, 1924; Streubel 1975) and five to eight for the species in general (Asdell, 1964).

The development of young *S. spilosoma* was studied by Blair (1942), Sumrell (1949) and Streubel (1975). In early development, the weight gained by juveniles compared closely to gains reported in other ground squirrel species by Neal (1965) and Clark (1970). Streubel (1975) found that juveniles weighed 40 to 50 g at the time of emergence from their nest burrows.

ECOLOGY. The spotted ground squirrel is generally found in areas with deep sandy soils and sparse vegetation (Cockrum, 1952; Hall and Kelson, 1959; Jones, 1964; Maxwell and Brown, 1968; Lechleitner, 1969; Green, 1969; and Armstrong, 1972). In Colorado, this ground squirrel is most abundant in the sand hills of the northeastern part of the state and along the Arkansas River in the southeast (Armstrong, 1972). McCampbell (1926) captured two *S. spilosoma* from abandoned prairie dog burrows south of Cortez, Colorado.

Hall (1955) related the distribution of *S. spilosoma* in Kansas to areas where the vegetation was sparse as a result of natural site factors or overgrazing. *Spermophilus spilosoma* is common in drifted sand along rivers in southwestern Kansas (Cockrum, 1952).

In Texas, *S. spilosoma* was reported in the desert scrub association consisting primarily of creosote (*Larrea divaricata*) and blackbrush (*Flourensia cernua*) by Davis and Robertson (1944).

Sumrell (1949) in New Mexico, found spotted ground squirrel burrows predominately on short-grass mesas or along banks of arroyos. He also found the species inhabiting disturbed areas along highways where the soil consisted of gravelly sand with enough clay to hold the particles together. DeWitt (1957) characterized *S. spilosoma* in New Mexico as a mammal present on vast expanses of overgrazed sheep range and in the open country between river bottoms and foothills at altitudes from 1490 to 1770 m. He noted that *S. spilosoma* was found on mesa tops, alluvial slopes, arroyo banks and bottoms, on good black grama range, and on hummocky ground of the sand drift-shrub community. Findley *et al.* (1975) found the species to be "often conspicuous both visually and auditorially" in arid, often sandy, grasslands and deserts in New Mexico.

Moore (1930) collected two specimens at 2120 m elevation in Utah and noted that they preferred lighter soils for their burrows, and that burrow entrances were usually located under low shrubs.

In Nebraska, the species is characteristic of the Sand Hills where it occurs sympatrically with *S. tridecemlineatus*. However, *S. spilosoma* generally is found in drier habitats than is *S. tridecemlineatus* (Jones, 1964).

Maxwell and Brown (1968) captured *S. spilosoma* in southeastern Wyoming on three distinct community types—sand dunes, yucca-grass, and sage-grass. In all three communities the soil was sand to loamy sand, the height of the dominant vegetation exceeded 254 mm and more than 40% of the soil surface was bare.

Some evidence indicates that *S. spilosoma* favors land that is heavily grazed. Green (1969) in northeastern Colorado, found *S. spilosoma* to be most abundant on deep sand soils that were grazed heavily by cattle. Green found the species on ungrazed areas only in June when the standing crop of plants was low. Streubel (1975) studied *S. spilosoma* in sympatry with *S. tridecemlineatus* on a heavily grazed area in which *Distichlis stricta*, *Festuca octoflora*, and *Bouteloua gracilis* were the three primary grass species, and *Artemisia filifolia* was the primary woody plant. Vegetation was sparse (48.8% of the ground was void of vegetation). However, one of us (JPF) and his students have found good numbers of this species on lightly to moderately grazed areas of sand hills, where the vegetation consisted primarily of communities of *Artemesia filifolia*, *Stipa comata*, and *Ambrosia trifida*, or *Artemesia filifolia*, *Helianthus* sp., and *Calamovilfa longifolia*.

Scant information is available on population density of *S. spilosoma*. McMurry (1947) estimated a population density of two to seven per ha in Oklahoma. Streubel (1975) captured and marked 38 *S. spilosoma* on a 10-ha study area (3.8 per ha) where the species occurred sympatrically with *S. tridecemlineatus*.

Streubel (1975) obtained data on ratios of males to females. In four litters born in captivity, the sex ratio at birth was 1:0.58 (N = 19). Trapped juveniles showed a sex ratio of 1:0.93 (N = 25), whereas the observed adult sex ratio was 1:0.71 (N = 156).

Spermophilus spilosoma apparently is less carnivorous than is *S. tridecemlineatus*, being more dependent on seeds and green plant parts (Lechleitner, 1969). Sumrell (1949) observed spotted ground squirrels eating numerous plants and listed six plant species in order of their importance: *Salsola pestifer*, *Tribulis terrestris*, *Oryzopsis hymenoides*, *Curcurbita foetitissima*, *Thelesperma megapotamicum*, and *Erigonum* sp. Streubel (1975) observed that *S. spilosoma* relied heavily on seeds of *Solanum rostratum*, *Mentzelia nudastricta*, and *Croton texensis* early in spring. Green grass shoots became important as they appeared

and in late May and June the flowers and seeds of *Festuca octoflora* and other grasses were utilized. This squirrel was observed feeding on insect larvae and it appeared to rely heavily on grasshoppers in late July and August. Streubel (1975) also observed its feeding on kangaroo rats (*Dipodomys ordii*) and lizards (*Holbrookia maculata* and *Cnemidophorous sexlineatus*).

Jones (1964) suggested that *S. spilosoma* is sympatric with *S. tridecemlineatus* in Nebraska. In Colorado, Streubel (1975) studied behavioral aspects of sympatry of *S. spilosoma* and *S. tridecemlineatus* and found that interspecific competition was minimized by temporal differences in their annual cycles. Various events in the annual cycle of *S. tridecemlineatus* occurred two to four weeks before they occurred in *S. spilosoma* and in spite of their coexistence in the same habitat, competition was minimal. Only 20 interspecific encounters were observed in 150 hours of observation of the two species, indicative of the tolerance that existed between them.

Streubel (1975) calculated home ranges of the *S. spilosoma*. In May and early June, during the breeding season, one male had a home range of 3.16 ha. In late June and early July, three males had home ranges of 1.02, 1.12, and 4.86 hectares.

Three gestating females had a mean home range size of 1.55 ha. Two females had home ranges of 0.50 and 0.52 ha after their litters had emerged from the nest burrows, but before the young were weaned. Three other nonparous females had a mean home range size of 0.71 ha during the prehibernation period. The mean size of home range for all *S. spilosoma* in this study was 1.51 ha.

Sumrell (1949) recorded three species of roundworms (*Physaloptera* sp., *Rictularia* sp. and *Sabulaura* sp.) in *S. spilosoma*. Additionally, Sumrell collected fleas (*Thrassis pansus*, *Echidnophaga gallinaceae*), a tick (*Dermacentor parumapertus*), and biting lice, and Streubel (1975) collected numerous fleas (*Thrassia fotus*) from the species.

Bull snakes (*Pituophis catenifer*) may represent a major predator on *S. spilosoma* in Colorado as Streubel (1975) observed these snakes crawling from burrow to burrow on his study area. Additionally, a red-tailed hawk (*Buteo jamaicensis*) was observed capturing a ground squirrel (species unknown) on the study area.

BEHAVIOR. Sumrell (1949) described some aspects of the behavior of *S. spilosoma*. Streubel (1975) reported that foraging and feeding comprised about 66% of all activity above ground, alert behavior 15%, other maintenance behavior (including sunning, grooming, eliminating, resting in shade, sandbathing) 8%, investigative (non-foraging) behavior about 6%, and sexual and agonistic behavior less than 2% for males and less than 0.5% for females.

In the breeding season, the time spent in definite sexual and agonistic behavior was 5 to 7% for males and 2 to 2.5% for females. Although actual copulation was never observed, sexual behavior was indicated by a noticeable "frenzy" of activity at a particular burrow system. This activity was characterized by individual males repeatedly approaching a female, which generally adopted a threat posture. Occasionally a male and female would enter a burrow system together; perhaps copulation occurred there. Streubel (1975) noted: "On one occasion during 1.36 hours of continuous observation of a male near a female, it definitely appeared that the male was enticing the female into the burrow. The male entered the female's burrow seven times and spent a total of 5.5 minutes in the burrow. The female entered the burrow with the male twice, one time for 2.8 min. and the other time for 0.66 min."

Seven different alert postures have been observed in the species. These postures are similar to alert postures described by Balph and Stokes (1963) for the Uinta ground squirrel (*S. armatus*) and by Wistrand (1974) for the thirteen-lined ground squirrel (*S. tridecemlineatus*). Foot stomping (alternately, rapidly stomping the hind feet) was observed on several occasions; twice while a bull snake was investigating the burrows of two different females, and also when a male was approaching a female. This behavior may be a form of displacement behavior or signify threat or apprehension and has been observed by Grubitz (1963) and Wistrand (1974) in *S. tridecemlineatus*. Streubel (1975) observed that behavior in juvenile animals appeared to be similar to that of juvenile *S. tridecemlineatus* (McCarley, 1966). The dependence of juvenile *S. spilosoma* on their mother appears to cease two to three weeks after their first emergence from the nest burrow.

Daily activity of the species varies seasonally and with weather conditions. Favorable air temperatures for *S. spilosoma* activity in New Mexico were 19° to 34°C with emergence generally occurring when air temperature was 20°C or more (Sumrell, 1949). In March and April the squirrels were usually active between 0800 and 0900 and usually remained in their burrows after 1600. In July and August, they emerged from 0630 to 0700, returned to their burrows by 1100, and re-emerged from 1530 to 1600 and remained active until after 1700. On bright, hot days, they usually remained in their burrows until the air temperature dropped to 33°C or less. They became inactive during strong winds or rain (Sumrell, 1949).

In Colorado, male *S. spilosoma* emerged from hibernation from 1 to 15 April and females from 20 April to 15 May. The first animals of either sex to emerge were young of the previous year, followed shortly by the adults. The males began entering hibernation in late July, and by mid-August none was present on the study area. Most young of the year entered hibernation in late September, but some were observed into October. The seasonal activity cycle was estimated to be 115 to 135 days for males and 95 to 125 days for females (Streubel, 1975). Some confusion exists as to whether this species hibernates in the southern part of its range. However, Smith (1973) observed that *S. s. annectens* from Texas definitely was capable of true hibernation.

GENETICS. Nadler and Hughes (1966) examined karyotypes of three of the species of ground squirrels in the subgenus *Ictidomys*. They found *S. spilosoma* to have 32 chromosomes, whereas *S. tridecemlineatus* and *S. mexicanus* both have 34 chromsomes. These authors noted: "Comparison of karyotypes from the three species reveals three important features: 1) *S. spilosoma* lacks a pair of metacentrics; 2) the Y chromosome of *S. spilosoma* is a minute rather than an acrocentric; and 3) the submetacentric autosomes of *S. spilosoma* are morphologically intermediate between the other species because the fourth longest pair has a more terminal centromere like *S. tridecemlineatus*, but this pair is relatively longer, similar to *S. mexicanus*."

REMARKS. The authors use the generic name *Spermophilus* in preference to *Citellus* on the basis of the Law of Priority.

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