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Tamias dorsalis.

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Tamias dorsalis Baird, 1855

Cliff Chipmunk

Tamias dorsalis Baird, 1855:332. Type locality "Fort Webster, Coppermines of the Mimbres," near present site of Santa Rita, Grant Co., New Mexico, lat. 32°47', long. 108°4' (Howell, 1929; Mearns, 1907).

Eutamias canescens Allen, 1904:208. Type locality "Guanacevi, 8000 ft., Durango, Mexico."

CONTEXT AND CONTENT. Order Rodentia Family Sciuridae, Subfamily Sciurinae. Tribe Marmotini. Six subspecies of *Tamias dorsalis* are recognized (Hall, 1981).

T. d. carminis (Goldman, 1938:56). Type locality "Carmen Mountains, 7400 ft., Coahuila, Mexico."

T. d. dorsalis Baird, 1855:332, see above (canescens Allen is a synonym).

T. d. grinnelli (Burt, 1931:300). Type locality "Mormon Well, Sheep Mountains, 6500 ft., Clark Co., Nevada."

T. d. nidoensis (Lidicker. 1960:267). Type locality "5 mi. N Cerro Campana, 5600 ft., Chihuahua, Mexico."

T. d. sonoriensis (Callahan and Davis, 1977:71). Type locality "24 km NE Guaymas, 100 m, Sonora, Mexico."

T. d. utahensis (Merriam, 1897:21). Type locality "Ogden, Utah."

DIAGNOSIS. Because of its dark stripes and lack of white ones, *T. dorsalis* is one of the most handsome and strikingly marked members of the genus (Fig. 1; Howell, 1929). *T. obscurus* and *T. merriami,* both allopatric in California and Baja California, respectively, have lateral striping similar to *T. dorsalis.* Western chipmunks with ranges that often are broadly sympatric with *T. dorsalis* include *T. canipes*, *T. cinereicollis, T. minimus, T. quadrivittatus,* and *T. umbrinus;* all have well-defined white stripes (Hall, 1981; Howell, 1929).

The skull is similar to *T. cinereicollis,* except that *T. dorsalis* has a longer, lower braincase which also is narrower in the front with broader incisors (Mearns, 1907). Compared with *T. merriami,* the braincase of *T. dorsalis* is shorter and deeper and the rostrum is straighter and broader (Howell, 1929). The braincase of *T. dorsalis* is slightly less flattened than *T. panamintinus* and the incisive foramina diverge posteriorly rather than parallel (Hall, 1981).

The baculum of *T. dorsalis* is diagnostic of the species. It has a thin shaft with a low keel that is 20% of the length of the tip. The tip is 29-40% of the length of the shaft. The angle formed by the tip and the shaft is 140°. The distal 50% of the shaft is slightly compressed laterally. The shaft is 2.64-3.69 mm in length (White, 1953).

GENERAL CHARACTERS. *Tamias dorsalis* is a medium-large chipmunk. It exhibits sexual size dimorphism as females are larger than males (Levenson, 1990). Adults average nearly 70 g. Adult female and male mean body mass is 70-74 g and 61-64.5 g, respectively, in Arizona (Dunford, 1974). The braincase is dorsally flat and wide (Fig. 2) with relatively broad rostrum (Hall, 1946). It is inflated with robust zygomata and narrowly-oval or slit-like infraorbital foramen (Long, 1965).

Coloration of upper parts is tones of smoke or neutral gray, ears are pale smoke or grayish white. Darker stripes are fuscous black with sayal brown. Lighter dorsal stripes are grayish or creamy white. Sides are sayal brown, the shoulders and rump are gray, and the thighs are sayal brown or cinnamon. The long, bushy tail is black above and tawny-cinnamon below with creamy-white underparts (Howell, 1929).

Some degree of intergradation occurs among parapatric subspecies of *T. dorsalis.* A cline exists between *T. d. dorsalis* and *T. d. sonoriensis;* however, they are mostly morphologically separable (Callahan and Davis, 1977). *T. d. dorsalis* and *T. d. utahensis* may not be separable in northern Arizona and southern Utah (Hoffmeister and Ellis, 1979). *T. d. utahensis* and *T. d. grinnelli* intergrade in northwestern Utah (Egoscue, 1968; Murray, 1973).

There is distinct intraspecific morphological variation within the species. Compared to *T. d. dorsalis,* the following differences exist: *T. d. carminis* differs in pelage, skull and dental characteristics (Goldman, 1938); *T. d. nidoensis* differs in body and skull dimensions (Lidicker, 1960); *T. d. grinnelli* has paler pelage with similar skull (Burt, 1931); *T. d. sonoriensis* has the narrowest skull of the species, but baculae and baubellae are longer than *T. d. dorsalis* (Callahan and Davis, 1977); *T. d. utahensis,* almost as large as *T. d. dorsalis,* has differing pelage, skull, and dental characters (Hoffmeister and Ellis, 1979; Merriam, 1897).

Mean external measurements (in mm; range in parenthesis) of combined males and females are: total length, 230 (217-249); length of tail vertebrae, 100 (85-115); length of hind foot, 35 (34-37); length of ear, 21 (18-23; Lidicker, 1960). Mean cranial measurements (in mm; range in parenthesis) of combined males and females: zygomatic breadth, 19.45 (18.4-20.6); cranial length, 35.2 (34.0-36.8); interorbital breadth, 8.8 (8.0-10.0); cranial breadth, 16.9 (15.6-17.5); nasal length, 10.7 (9.9-11.7; Sutton, 1953); length of mandibular tooth row, 5.1 (5.00-5.15); condylo-alveolar length of mandible, 17.9 (17.7-18.1); crown length of maxillary toothrow, 5.25 (4.8-5.7); mastoid breadth, 16.8 (16.5-17.4; Lidicker, 1960).

DISTRIBUTION. *Tamias dorsalis occurs* in the Rocky Mountains of western United States south into Mexico (Fig. 3). It ranges from Utah (with limited populations in contiguous border areas of Idaho, Wyoming, and Colorado) and Nevada southward through New Mexico and Arizona into the Sierra Madres Occidental of Chihuahua, Durango, Coahuila, and Sonora. In the south, *T. d. sonoriensis* (coastal Sonora) and *T. d. carminis* (from two isolated localities in Coahuila) occupy disjunct ranges. The cliff chipmunk typically resides at elevations from 1,500 to 3,700 m. However, some populations are known to inhabit the low-altitude deserts and lava fields of southern Arizona and New Mexico and are present at sea level in coastal Sonora (Callahan and Davis, 1977; Findley, 1969; Hall, 1981).

FOSSIL RECORD. Known fossil cliff chipmunk records are from the Pleistocene. Skeletal fragments (six mandibles, four maxillae) of *T. dorsalis* were recovered from Crystal Ball Cave near Gandy, elevation 1,760 m, Millard Co., Utah. Associated materials were dated as 2,300 years BP and represent populations of Qua-

FIG. 1. A juvenile *Tamias dorsalis utahensis,* female, from 7.5 mi E Logan, Cache Co., Utah.

FIG. 2. Dorsal, ventral, and lateral view of cranium, and lateral view of mandible of a female *T. d. utahensis* from 10 mi N, 3 mi W Greystone, Moffat Co., Colorado (University of Kansas Museum of Natural History 131866). Greatest length of skull is 35 mm.

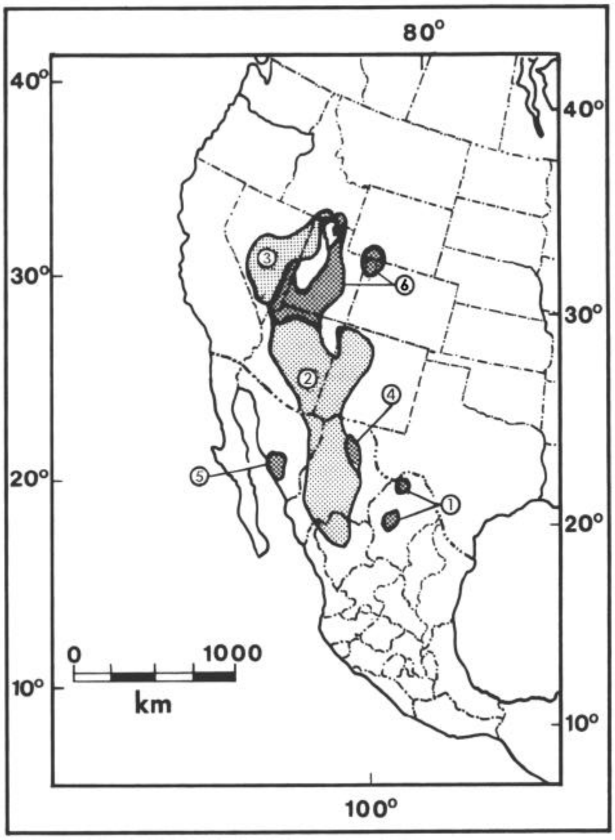

FIG. 3. Distribution of *Tamias dorsalis* (Hall, 1981): 1, *T. d. carminis;* 2, *T. d. dorsalis;* 3, *T. d. grinnelli;* 4, *T. d. nidoensis;* 5, *T. d. sonoriensis;* 6, *T. d. utahensis.*

ternary chipmunks (Heaton, 1985). An assemblage of late Pleistocene, early Recent vertebrates (minimum age, 8,000 years BP) from Mormon Mountain Cave, 112 km NE of Las Vegas, Lincoln Co., elevation 1,370 m, Nevada, includes 26 *T. dorsalis* that represent 6.5% of the entire vertebrate sample (Jefferson, 1982). Two presumable *T. dorsalis* were found in the late Pleistocene fauna of Papago Springs Cave, 8.8 km SE Sonita, elevation 3,060 m, Santa Cruz Co., Arizona (Skinner, 1942).

Tamias dorsalis may have colonized the Great Basin mountain ranges of Nevada and Utah at the end of the Wisconsin or during early Holocene across habitat bridges of juniper *(Juniperus)* woodland (Thompson and Mead, 1982). Distribution of extant woodland and boreal montane mammals, including *T. dorsalis,* may support a vicariant explanation of the Pleistocene biogeography in the southern Rocky Mountains (Patterson, 1980). Alternatively, *T. dorsalis* presence may be due to original access into the Great Basin from the Rocky Mountains or some other center of origin (Dobson et al., 1987).

FORM AND FUNCTION. Females have eight mammae. One pair is inguinal, two pairs are abdominal, and one pair is pectoral.

Cliff chipmunks have two annual molts in Utah and Arizona. The initial spring molt progresses anteroposteriorly. The autumn molt progresses posteroanteriorly (Howell, 1929). Adult males molt from winter to summer pelage mainly in May and June, and from summer to winter pelage during September and October. Females are similar, except summer molt is delayed from June to July during pregnancy and lactation. There is no difference between molting in breeding versus nonbreeding females in Arizona (Dunford, 1974). Molt by *T. d. grinnelli* is regular in July in Nevada (Burt, 1934). In late June, three young Utah *T. dorsalis* in bright-cinnamon juvenile pelage were in the process of molting from juvenile to adult summer pelage (Hall, 1931). There is little variation in *T. d. nidoensis* pelage season-to-season in Chihuahua, although summer hair is less red, shorter, and dorsal striping is more prominent than winter pelage; *T. d. carminis* pelage is darker overall with less distinct dorsal striping (Lidicker, 1960).

Cliff chipmunks exhibit prey threat behavior when exposed to visual and auditory threat stimuli in the laboratory. They undergo sudden prolonged immobility responses lasting from 3 to 25 min. The degree of immobility does not correspond to recency of capture, frequency of testing, or time of day tested. Heartbeat rates are elevated to 462/min (compared to normal of 235/min); rates for males increase beyond those of females. Heartbeat arrhythmias include sinus arrhythmias, sinus arrests with escape beats, incomplete atrioventricular block, and complete atrioventricular block with ventricular ectopic beats. Respiration rates change dramatically from averages of 52 to 402/min; males increase the most (Hofer, 1970).

The baculum of *T. dorsalis nidoensis* varies from those of *T. d. dorsalis* and *T. d. utahensis. T. d. nidoensis* has an enlarged base with lateral diameters of 0.74 mm, nearly twice the width of the shaft. There is a slight medial notch on the proximal end of the base (neither of which is present in *T. d. dorsalis).* The baculum averages 3.95 mm in shaft length and 4.89 mm in total length. The height of the keel (0.35 mm) is not quite one-third of the tip length (1.19 m). The greatest width of the shaft (other than base) averages 0.35 mm (Lidicker, 1960).

The baubellum of *T. d. grinnelli* has a slender base about 18% shorter than the shaft and is tapered from near the base-shaft angle towards the proximal end. Depth of shaft is more like that of *T.*

amoenus, about half that of *T. cinereicollis.* At the tip-shaft angle apex, there is no heel. The keel is quite prominent on the comparatively short tip. There is a peculiar widened extension of flanges across the distal end of the shaft. The tip is bent to the right from the shaft 9° and shows no rotation or twist. Mean measurements of the baubellum of *T. dorsalis* are: length of base, 0.503; length of shaft, 0.601; depth or thickness of shaft, 0.276; length of tip, 0.658; width of keel, 0.276, and the tip-shaft angle is 140° (Sutton, 1982). The baubellum is more variable than the baculum in *T. d. sonoriensis;* the base is divided with ventral spurs significantly more than in *T. d. dorsalis* (Callahan and Davis, 1977).

ONTOGENY AND REPRODUCTION. Cliff chipmunks in Arizona usually breed in April and May, depending on temperature. Males are reproductively active from January through June. Recrudescence of male testes apparently occurs in December and regresses in July, being somewhat delayed in adult males during their first year. *T. dorsalis* has a more extended breeding season than any other species of chipmunk in western North America. The same population may have early and late breeding individuals within or between years. Breeding may be related to precipitation and short, mild winters (Dunford, 1974). Inferences based on sightings of newly emerged young in late May suggest that breeding in northern Utah occurs in March while there is often snow cover (Hart, 1976a). In the Lower Sonoran life zone of Sonora, breeding by *T. d. sonoriensis* is similar to that of *T. merriami meridionalis;* the peak appears to be over by late May (Callahan and Davis, 1976).

In Arizona, timing of breeding by females varied between years. In 1970, copulation occurred in May and June. Parturition took place in late June and early July and weaning took place in August. There is both earlier and later breeding. In 1971, the females began breeding one month earlier (Dunford, 1974).

Lactating females occur in early April near Ocampo, Coahuila (Baker, 1956). In Chihuahua, lactating females are present from June through August and young are born from April through July. Litter sizes range from four to six (Anderson, 1972). Four females in July were captured with two, three, seven, and eight fetuses in Arizona (Mearns, 1907). In Utah, newly emerged juvenile litters of five, five, and six young were observed in late May (Hart, 1976a).

There is no evidence of production of multiple litters by the same females in Arizona or Utah. A large proportion of females either have low breeding success or do not breed (Dunford, 1974; Hart, 1976a). Individual females do have multiple litters in New Mexico (Bailey, 1931).

Juvenile females average 64 g from June to December. Juvenile males average 52.6 g from June through August (Dunford, 1974).

Transport of half-grown young by a mature female *T. d. dorsalis,* presumably a parent, is recorded from Arizona. She secured the young in the belly area with her mouth; the tail, hind legs, and forepaws of the young curled up and around her neck (Svihla and Svihla, 1931).

Physiological readiness for breeding depends upon new food during spring because emerging adults are typically at their lowest annual mass. When reproduction is delayed, it is probably due to delayed food production caused by drought and cold weather (Dunford, 1974). In Utah, breeding occurs prior to new food production, so physiological readiness is achieved by some other strategy (Hart, 1967).

Sex ratios of adults are approximately equal in Utah. However, virtually all summer observations are of females near the main cliff den areas; males are only rarely observed there during the summer months (Hart, 19766). In Arizona, 61 males and 53 females were captured over a 15-month period (Dunford, 1974). In Nevada, 23 of 34 specimens taken from three different localities were females (Davis, 1934).

ECOLOGY. Especially north of the Sierra Occidentals, cliff chipmunks commonly inhabit pinon pine *(Pinus monophylla),* ponderosa pine *(Pinus ponderosa),* juniper *(Juniperus),* maple *(Acer),* and oak *(Quercus)* associations (Armstrong, 1977; Brown, 1971; Burt, 1931; Cary, 1911; Davis, 1934; Hart, 1967; Pressnall, 1938). In Wyoming, *T. dorsalis* is present in communities designated as the Wyoming Basin Fauna1 Area of North America (Armstrong, 1977). In Colorado, it is present only in two community types, saxicolus brush and pygmy-conifer woodlands, members of the Yuman fauna1 element whose center of distribution is the lower Colorado River drainage (Armstrong, 1972). In Utah, the cliff chipmunk is present in a variety of plant communities and associations also including sagebrush *(Artemesia tridentata),* big tooth maple *(Acer grandidentatum),* four-winged saltbrush *(Atriplex canescens),* snakeweed *(Guitierrezia microphyla),* and bromegrass *(Bromus tectorum;* Hart, 1967; Honeycutt et al., 1981).

In more southern localities, habitat of cliff chipmunks additionally includes aspen *(Populus)* and low-elevation shrubs. In Arizona and New Mexico, cliff chipmunks reside in associations of silverleaf oak *(Quercus hypoleucoides),* gray oak *(Q. grisea),* netleaf oak *(Q. reticulata),* Douglas fir *(Pseudotsuga menziessi),* alligator juniper *(Juniperus deppeana),* and Mexican white pine *(Pinus ayacahuite;* Cahalane, 1939; Dunford, 1974; Findley et al., 1975; Jones et al., 1960). In southern Durango, *T. dorsalis* habitat includes madrone *(Arbutus),* manzanita *(Arctostaphylos),* and other typical lower Sonora" riparian vegetation (Allen, 1895; Baker and Greer, 1962; Dunford, 1974; Findley et al., 1975).

An opportunistic forager, *T. dorsalis* survives on available plant parts and is herbivorous. Tree seeds, such as juniper berries, pine seeds, and acorns, appear to constitute an important percentage of the diet. At no time do cliff chipmunks eat flesh or insects, even though these are available for consumption (Callahan and Davis, 1976). Mayflies, insect larvae, other insects, frogs, salamanders, snakes, birds, and eggs are consumed by *T. dorsalis* in Utah (Barnes, 1922).

In Colorado, additional food resources of *T. dorsalis* include Russian thistle *(Salsola),* sagebrush, serviceberry *(Amelanchier),* and mountain mahogany *(Cercocarpus;* Sutton, 1953). In Logan Canyon, Cache Co., Utah, *T. dorsalis* feeds upon a minimum of 37 different plant species, primarily salsify *(Tragopogon dubius),* bitterbrush *(Purshia tridentata),* bluegrass *(Poa),* wild carrot *(Lomatium dissectum),* big tooth maple, arrowleaf balsamroot *(Balsamorhiza sagittata),* elk thistle *(Cirsium),* serviceberry, and mountain dandelion *(Agoseris glauca).* Maturity of plants directly influences daily and seasonal movements of cliff chipmunks (Hart, 1971, 1976b).

In Nevada, *T. dorsalis* feeds on wild rose (Rosa), prickly pear *(Opuntia),* cliff rose *(Cowania mexicana),* and several grasses and forbs (Brown, 1971). In late July, it forages on wild plums *(Prunus),* sumac *(Rhus trilobata),* and shadbush *(Peraphyllum ramosissimum;* Hall, 1946). In Arizona and New Mexico, chipmunks eat cactus fruits, composite seeds *(Compositae),* lupine *(Lupinus neomexicanus),* hackberry *(Celtis occidentalis),* and acorns *(Q. emoryi;* Cahalane, 1939; Mearns, 1907; Rasmussen, 1941).

The potential for crop damage exists wherever *T. dorsalis* comes into contact with agriculture (Bailey, 1931). A range improvement project in the Kaibab Plateau, Arizona, where junipers and pinons were systematically uprooted, resulted in increased populations of *T. dorsalis* during both years of the project (Turkowski and Reynolds, 1970).

Seeds are gathered during periods of prime availability and carried in cheekpouches either to temporary caching areas or to the home den. Caches are later retrieved to the den for consumption during the winter. In early August, a cliff chipmunk was observed caching seven bitterbrush *(Purshia tridentata)* seeds in a shallow depression, covering them with loose soil. The cache was about 150 m uphill from the home den. The seeds remained in the excavation throughout August, but had been removed by early September (Hart, 1971). In Colorado, juniper berries are cached near tree dens (Davis, 1934). Cliff chipmunks may cache several liters of seeds in the soft soil near the home den, inside hollow logs, and under leaves in late autumn (Barnes, 1922). Eleven pinon nuts were found in the cheekpouches of one *T. dorsalis* (Hoffmeister, 1971).

T. dorsalis and other vertebrates favor breeding from April through June in Arizona, even though these are often times of minimal food availability due to annual seasonal drought. Maximal food resources are more available during July and August when temperatures are lower. It is unclear what natural mechanisms may be operating to compensate for breeding during the earlier, less favorable conditions (Dunford, 1974).

Potential for competition between *T. dorsalis* and other species of chipmunks exists in many areas, particularly at the upper and lower margins of their montane distributions (Findley, 1969; Findley et al., 1975; Hall, 1946). *T. quadrivittatus* and *T. dorsalis* appear to exert a limiting effect on each other in Nevada and New Mexico. When one is absent, the other occupies both its own normal habitat plus that usually occupied by the absent species (Findley et al., 1975; Hall, 1946). Where *T. dorsalis* and its congeners occur sympatrically, each appears to occupy slightly different ecological niches in Arizona. In Nevada, *T. dorsalis* is found more commonly on south-facing slopes at low elevations, whereas, *T. quadrivittatus nevadensis* mostly live in bottoms of cooler canyons and at higher elevations (Burt, 1934). In Arizona, cliff chipmunks are much more abundant in canyon bottoms than on the sides of the canyons (Cahalane. 1939).

T. d. grinnelli and *T. umbrinus nevadensis* were taken from within 100 m of each other in the Hidden Forest area of the Sheep Mountains, Nevada. One *T. d. utahensis* was taken at 2,830 m and two *T. umbrinus* at 3,070 m and 3,270 m on Mt. Ellen, Garfield Co., Utah, with no apparent habitat differences (Sutton, 1953).

In the sparse pinon-juniper forests of lower elevations in Nevada, *T. dorsalis* and *T. umbrinus* compete for food and residences. *T. dorsalis* is more aggressive, occupying the first four places of an interspecific dominance hierarchy which won 80% of interspecific encounters. This aggressiveness works to its disadvantage in places of denser forest where *T. umbrinus* outcompetes it due to the proclivity of *T. dorsalis* for more open areas (Brown, 1971).

Interspecific competition appears to have driven both morphological and ecological niche shifts in *Tamias* in the southwestern US. The convergence hypothesis appears most compatible in relating changes in the niche of *T. dorsalis* with corresponding morphological changes (Patterson, 1981).

Rock squirrel *(Spermophilus variegatus)* and cliff chipmunk habitat is somewhat similar (Hall, 1981). In northern Utah, each appears to occupy different ecological niches. Den selection varies as well as food preferences. For example, rock squirrels feed mostly on the leaves of the mountain dandelion *(Agoseris glauca),* while cliff chipmunks eat stems, blossoms, fruit, and seeds of these same plants (Hart, 1976a).

Daily and seasonal species movement patterns of cliff chipmunks correlate with geography and phenology of food plants. Home ranges (minimum home range method) averaged 0.9 ha during one summer in northern Utah (0.3-1.3 ha, four females) and 1.3 ha (0.4-2.0 ha, six females) the next summer. Observations indicate differential usage of habitat by sexes (Hart, 1967, 1976b). In Nevada, *T. dorsalis* frequently maintains home ranges averaging 100 m in greatest dimension (Brown, 1971).

Migration of *T. dorsalis* populations presumably occurred from South Fork to Cave Creek in the Chiricauhua Mountains of Cochise Co., Arizona. This probably was due to paucity of food, particularly acorns *(Quercus chrysolepis, Q. reticulata;* Cahalane, 1939).

Water requirements may be met through the consumption of dew and other nonpermanent sources. An individual *T. dorsalis* was seen lapping water from a temporary pool on top of a rock (Sutton, 1953). Kidney specialization may be a possible means of coping with xeric habitats (Callahan and Davis, 1976). Water availability is not an important factor in the distribution of *T. dorsalis* (Davis, 1934).

As a prey species, the cliff chipmunk is sought by a variety of predators including Cooper's hawk *(Accipter cooperi)* and the sharp-shinned hawk *(A. jamaicensis)* in Nevada (Burt, 1934). Sparrow hawks *(Falco sparverius),* badgers *(Taxidea taxus),* prairie rattlesnakes *(Crotalus viridis),* coyotes *(Canis latrans),* and long-tailed weasels *(Mustela frenata)* are all potential predators which occur within the same habitat occupied by cliff chipmunks in Utah (Hart, 1976a). Domestic cats prey on *T. dorsalis* in Arizona (Hoffmeister, 1971).

The cliff chipmunk has been observed with bat-fly larva *(Cuterebra)* along the venter, neck, and scrotum; some have multiple infections (Burt, 1934; Hart, 1976a; Sutton, 1953). One flea, two lice, and two white chiggers *(Trombiculi allredi)* were found on cliff chipmunks in Sonora. The chigger was the first of its species recorded from Mexico (Loomis and Stephens, 1965). Necropsies of several *T. dorsalis* from northern Utah revealed no endoparasites (Hart, 1967).

Traps set near the bases of large oaks, at the edges of vegetation, on accumulations of fallen leaves, on talus slopes, and next to rocky outcrops were only moderately successful (Baker, 1956). Following initial live capture, 18% of cliff chipmunks were recaptured (Cahalane, 1939). In Arizona, mean relative annual trap success of males (captured January-December) and females (captured March-December) of varying ages was 0.38 using large Sherman traps baited with sunflower seeds (Dunford, 1974). In Utah, both standard Sherman live traps (7.5 by 7.5 by 25 cm) and 60-mm deep hardware cloth rectangular tubes with Sherman trap (door and treadle) bases were successful in April and May. A mixture of sliced apples, rolled oats, and peanut butter all serve well as bait (Hart, 1967).

BEHAVIOR. *Tamias dorsalis* is shy, and inhabits localities often remote from human activity (Cary, 1911; Davis, 1934; Warren, 1942). In the Sheep Mountains, Nevada, *T. d. grinnelli* is noticeably less shy than *T. d. utahensis* farther east (Burt, 1934). *T. dorsalis* is much more shy and suspicious of traps than those at higher elevations (1,600-2,700 m) in ponderosa pine habitats in the Chiricahua Mountains, Arizona (Cahalane, 1939).

The cliff chipmunk is never found far from refugia; it rarely takes cover in trees, but more often climbs the steep sides of rocks when alarmed (Bailey, 1931). This chipmunk climbs saguaro cactus *(Carnegeia gigantum),* but is not known to nest in them (Callahan and Davis, 1976).

Tamias dorsalis is active throughout the winter in central Arizona (Mearns, 1907); it is most active from February through November (Dunford, 1974). One was seen on 14 January in the Santa Catalina Mountains, Arizona (Allen, 1895). The cliff chipmunk is active in northern Utah from March until late autumn depending on severity of local weather, particularly snowcover and temperature (Hart. 1967).

Tamias dorsalis is diurnal with activity mostly in the mornings and late afternoons until dusk. During hot summers, a period of sedentary activity occurs about mid-day. Morning activity (0600-1200) in an early summer period in northern Utah is 57% food related, 13% locomotory, 12% resting and sleeping, 8% alert, 7% social, and 3% grooming behavior (Hart, 1967).

Laboratory simulations of daily activity cycles of *T. d. dorsalis* and the eastern chipmunk *(T. striatus)* show significant species differences. Both are clearly diurnal yet differ in proportion of time females spend grooming and in quiet inactivity. Significant differences between species are also found in circadian patterns of all categories (except quiet inactive): general activity, locomotor-explore, grooming, feeding, and inactive sleep. Females of both species spend a greater proportion of their time feeding than do males (Estep et al., 1978).

Daily movements of cliff chipmunks radiate out from the home den. Summer movements vary in area traversed and direction traveled, depending mostly upon maturity of food plants. Occasional forays beyond margins of previous feeding areas probably provide cues for subsequent movement into newly maturing food resources. During morning feeding, individual cliff chipmunks appear to traverse approximately the same route on a daily basis. As many as 10 chipmunks, mostly females, form feeding aggregations which slowly forage through local food plants. A distance of 3-10 m usually separates participants. Occasionally a bark chirp is emitted by an aggregation member, ostensibly to maintain position and identity (Hart, 1971).

Tamias dorsalis appears to exhibit territorial defensive behavior towards congeners in the immediate vicinity of the home cliff den; chase behavior may result when conspecific individuals violate minimal individual distances. Encounters away from dens often result in mutual nosing and/or chase behavior (Hart, 1967).

Dens and nests of cliff chipmunks are located in rock heaps, crevices, rocky bluffs and cliffs, underground burrows, and trees (Baker, 1956; Callahan and Davis, 1976). In Chihuahua, a hollow tree contained three young. A hole in a concrete floor yielded a litter of three young (Knobloch, 1942). There is some evidence that temporary summer dens may be utilized during warmer parts of the year in debris such as fallen junipers in northern parts of the range (Hart, 1967).

The three most common vocalizations of *T. dorsalis* are a bark (voiced during normal activity), a sharp "whsst or psst" chirping (often associated with excitement), and a high pitched mixture of sounds (emitted as chipmunks are surprised or threatened). The calls are each mouthed differently (Hart, 1967:56). The chippering alarm calls of *T. dorsalis* are finer and sharper than those of *T. quadrivittatus.* The slow call is softer and more husky, but similar (Bailey, 1931). When the sharp chirp is voiced, typical posturing of *T. dorsalis* is an upright, alert position. The barks are emitted during standing, resting (lying prone), or squatting (sitting; Hart, 1967). The sharp chirp is always accompanied by a twitching of the tail. Chirps number from 146 to 172/min (Hoffmeister, 1971). Sonograms of vocalization of *T. d. dorsalis* and *T. d. sonoriensis* have a terminal pulse in contrast to a terminal trill typical of *T. merriami.* The calls apparently are species specific (Dunford and Davis, 1975).

During dustbathing, the cliff chipmunk lowers the belly into powder-like fine, dry soil, where it synchronously writhes laterally, alternating fore and hind body parts for 3-5 secs. Then, balancing on its back, the hindquarters are vigorously thrown in alternate lateral directions, often repeating the process several times (Hart, 1967).

Tamias dorsalis grooms its face with both forepaws moving along respective sides of the face in concurrent circular motions. While in a squatting posture, it frequently mouths rear body areas, sometimes appearing to chew or scrape the fur with the incisor teeth (Hart, 1967).

About 10-12 cliff chipmunks played in the rocks near Allen's (1890) camp in Arizona. They also frequently sunned themselves nearby.

GENETICS. *Tamias dorsalis* has a diploid number of 38 chromosomes (Nadler et al., 1977). Ten individuals representing *T. d. dorsalis, T. d. carminis. T. d. grinnelli, T. d. sonoriensis,* and *T. d. utahensis* possess karyotype B, common to 14 species of western *Tamias* including *T. townsendii, T. umbrinus,* and *T. amoenus* (Sutton and Nadler, 1969).

Blood serum electrophoresis of *T. dorsalis* compared to other species of *Tamias* indicates that *T. dorsalis* varies from all but *T. quadrivittatus.* The distance from the beta-one and alpha-two globulins is equal to or greater than the distance between beta-one and alpha-one globulin on linear points (Burgwardt, 1967). Protein analyses of some 20 loci in *T. d. dorsalis, T. d. grinnelli,* and *T. d. utahensis* resulted in mean heterozygosity ranges from 0.025 to 0.085 and heterozygous variance from 0.0006 to 0.0019, with one to four polymorphic loci (Levenson et al., 1985).

In the alleles of 21 to 39 electrophoretically resolved enzyme loci in six allopatric populations, variation in coefficients of genetic similarity range from 0.955 to 0.975, with the exception of one population of 0.900. Isolation events are possibly a result of relatively recent conservative genic divergence. Because the presence of highly positive F-values and chi-square analyses indicate excessive homozygotes at several loci, a Wahlund Effect, linkage disequilibrium, posttranslational modification, or some combination of these is postulated to account for these differences (Dobson et al., 1987).

Tamias dorsalis and *T. minimus* are readily differentiated by immunodiffusion. They show almost as much antigenic divergence between each other as from *T. striatus* (Hight et al., 1974).

REMARKS. Analyses of electrophoretic data, rather than supporting any groupings, suggests that *T. dorsalis* is most clearly related to *T. quadrivittatus* and *T. panamintinus.* This suggests morphological divergence from these two closer phylogenetic relatives, with convergence of phenotypic characters towards more distantly related groups (Levensen et al., 1985).

Based on chromosomes and other morphologic characters, all chipmunks should be referred to as members of the genus *Tamias.* There should be only subgeneric differentiation for species from Eurasia, and eastern and western North America (Nadler et al., 1985).

Vernacular names assigned to *T. dorsalis* include cliff chipmunk, Gila striped squirrel, western chipmunk, gray-backed chipmunk, gray chipmunk, pallid chipmunk, chichimuka, and chichimoke (Anderson, 1972; Baker, 1956; Barnes, 1922; Cary, 1917; Hall, 1946; Lidicker, 1960; Mearns, 1907).

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