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# Neotoma mexicana.

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## *Neotoma mexicana* Baird, 1855

### Mexican Woodrat

*Neotoma mexicana* Baird, 1855:333. Type locality near Chihuahua, Chihuahua.

*Neotoma ferruginea* Tomes, 1862:282. Type locality Dueñas, Sacatepequez, Guatemala.

*Neotoma torquata* Ward, 1891:160. Type locality abandoned mine between Tetela del Volcán and Zacualpan, Morelos.

*Neotoma tenuicauda* Merriam, 1892:169. Type locality north slope Sierra Nevada de Colima, 12,000 ft, Jalisco.

*Neotoma pinetorum* Merriam, 1892:111. Type locality San Francisco Mountain, Coconino Co., Arizona.

*Neotoma fallax* Merriam, 1894:123. Type locality Gold Hill, Boulder Co., Colorado.

*Neotoma fulviventer* Merriam, 1894:121. Type locality Toluca Valley, México.

*Neotoma orizabae* Merriam, 1894:122. Type locality Volcán de Orizaba, Puebla.

*Neotoma sinaloae* J. A. Allen, 1898:149. Type locality Tatámeles, Sinaloa.

*Neotoma navus* Merriam, 1903:47. Type locality Sierra Guadalupe, Coahuila.

*Neotoma distincta* Bangs, 1903:89. Type locality Texolo [=Teocelo], near Jalapa (Hall and Kelson, 1959), Veracruz.

*Neotoma picta* Goldman, 1904:79. Type locality mountains near Chilpancingo, 10,000 ft, Guerrero.

*Neotoma isthmica* Goldman, 1904:80. Type locality Huiltepec, 100 ft, 8 mi S Tehuantepec, Oaxaca.

*Neotoma parvidens* Goldman, 1904:81. Type locality Juquila, 5,000 ft, Oaxaca.

*Neotoma tropicalis* Goldman, 1904:81. Type locality Totontepec, 6,500 ft, Oaxaca.

**CONTEXT AND CONTENT.** Order Rodentia, Family Muridae (considered Cricetidae by some authors), Subfamily Sigmodontinae. The genus *Neotoma* contains four Recent subgenera and approximately 22 Recent species. *Neotoma mexicana* is a member of the *mexicana* species group within the subgenus *Neotoma*. Currently, 24 subspecies of *Neotoma mexicana* are recognized (Hall, 1981):

*N. m. mexicana* Baird, 1855:333, see above (*madrensis* Goldman is a synonym).

*N. m. ferruginea* Tomes, 1862:282, see above.

*N. m. torquata* Ward, 1891:160, see above (*fulviventer* Merriam and *orizabae* Merriam are synonyms).

*N. m. tenuicauda* Merriam, 1892:169, see above.

*N. m. pinetorum* Merriam, 1893:111, see above.

*N. m. bullata* Merriam, 1894:122. Type locality Santa Catalina Mountains, Pima Co., Arizona.

*N. m. fallax* Merriam, 1894:123, see above.

*N. m. sinaloae* J. A. Allen, 1898:149, see above.

*N. m. navus* Merriam, 1903:47, see above.

*N. m. distincta* Bangs, 1903:89, see above.

*N. m. picta* Goldman, 1904:79, see above.

*N. m. isthmica* Goldman, 1904:80, see above.

*N. m. parvidens* Goldman, 1904:81, see above.

*N. m. tropicalis* Goldman, 1904:81, see above.

*N. m. ochracea* Goldman, 1905:30. Type locality Atemajac, 4,000 ft, near Guadalajara, Jalisco.

*N. m. solitaria* Goldman, 1905:31. Type locality Nentón, 3,500 ft, Guatemala.

*N. m. chamula* Goldman, 1909:141. Type locality mountains near San Cristóbal, 8,400 ft, Chiapas.

*N. m. inopinata* Goldman, 1933:471. Type locality Chuska Mountains, 8,800 ft, San Juan Co., New Mexico.

*N. m. vulcani* Sanborn, 1935:84. Type locality south slope Volcán Tajumulco, San Marcos, 13,200 ft, Guatemala.

*N. m. inornata* Goldman, 1938:60. Type locality Carmen Mountains, 6,100 ft, Coahuila.

*N. m. atrata* Burt, 1939:1. Type locality 4 mi W Carrizozo, Lincoln Co., New Mexico.

*N. m. griseoventer* Dalquest, 1951:363. Type locality Xilitla, San Luis Potosí.

*N. m. scopulorum* Finley, 1953:529. Type locality 3 mi NW Higbee, 4,300 ft, Otero Co., Colorado.

*N. m. eremita* Hall, 1955:328. Type locality 1 mi S San Francisco, 50 ft, Nayarit.

**DIAGNOSIS.** Form rat-like (Fig. 1); body of average size for genus; skull of medium size for genus; anterointernal re-entrant angle of M1 deep, extending more than halfway across the crown (Hall, 1981). According to Hall (1981), the upperparts are grayish, grayish buff, dull brown, russet, or bright rufous, usually darkened dorsally by an admixture of blackish hairs; underparts white or yellowish with hairs plumbeous basally, except that inguinal and gular hairs of some subspecies may be white to base; tail is black to dusky above and grayish to whitish below. A narrow dusky line usually borders the mouth (Finley, 1958). The combination of size, color, and deep anterointernal re-entrant angle of M1 distinguish this species from cogeners (Hall, 1981).

**GENERAL CHARACTERS.** The following skull characteristics were reported by Finley (1958): skull light and smooth (Fig. 2); rostrum slender; interorbital region narrow; maxillovomerine notch present; posterior margin of bony palate convex or pointed; interpterygoid fossa narrowly rounded; sphenopalatine vacuities large; upper incisors small. The dental formula is i 1/1, c 0/0, p 0/0, m 3/3, total 16. Means and extremes of external measurements and selected cranial measurements (in mm) of individuals of *N. m. fallax* from El Paso Co., Colorado (Finley, 1958), are as follows: eight males—total length, 333 (314 to 351); length of tail, 143 (132 to 154); length of hindfoot, 35 (33 to 38); basilar length, 36.8 (35.3 to 38.0); zygomatic breadth, 22.8 (21.7 to 23.9); interorbital breadth, 5.5 (5.2 to 5.7); diastema, 12.6 (11.8 to 13.7); alveolar length of maxillary toothrow, 9.3 (9.0 to 9.7); length of incisive foramina, 9.6 (8.9 to 10.0); length of palatal bridge, 8.4 (7.7 to 9.3); six females—total length, 327 (307 to 350); length of tail, 148 (140 to 154); length of hindfoot, 33 (31 to 35); basilar length, 36.2 (35.0 to 37.3); length of nasals, 18.1 (17.1 to 18.8); zygomatic breadth, 23.3 (22.8 to 23.6); interorbital breadth, 5.2 (4.9 to 5.6); diastema, 7.0 (6.9 to 7.3); alveolar length of maxillary

FIG. 1. Photograph of a Mexican woodrat (*Neotoma mexicana*).

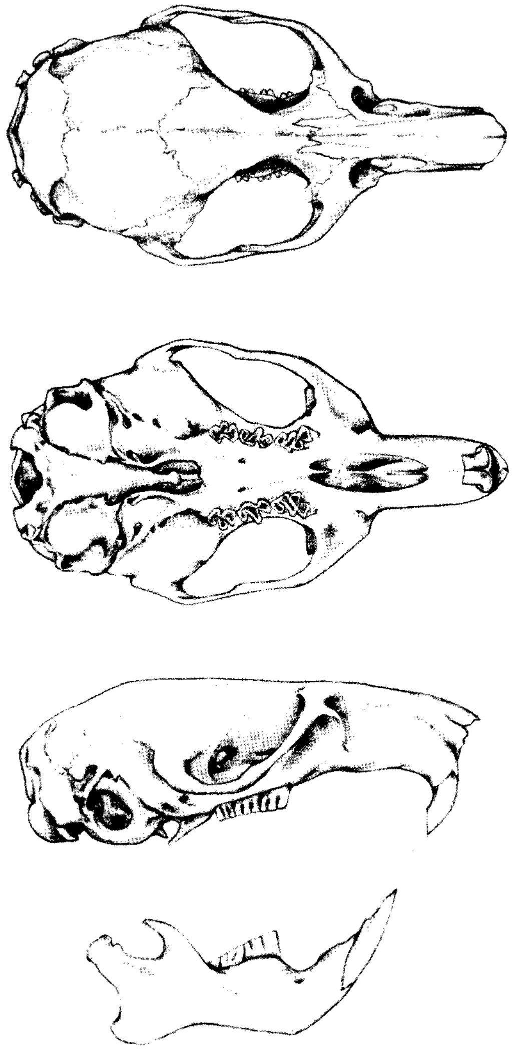

FIG. 2. Dorsal, ventral, and lateral views of the cranium and lateral view of lower jaw of a female *Neotoma mexicana fallax* (TTU 8126) from Jefferson Co., Colorado. Greatest length of skull is 46.2 mm.

toothrow, 9.2 (8.8 to 9.8); length of incisive foramina, 9.4 (9.0 to 9.6); length of palatal bridge, 8.2 (7.8 to 8.9). Mean external measurements of five adults of *N. m. mexicana* from Chihuahua (Anderson, 1972) are: total length, 324.5; length of tail, 148.0 (4); length of hindfoot, 34.9; length of ear, 32.0. Mean skull measurements of six adult *N. m. mexicana* from Chihuahua (Anderson, 1972) are: occipitonasal length, 42.66; alveolar length of maxillary toothrow, 8.73; length of rostrum, 14.55; breadth of braincase, 16.58; postdental breadth, 6.52; posterior zygomatic breadth, 21.58; breadth of molar teeth, 2.42; interorbital breadth, 5.38.

**DISTRIBUTION.** *Neotoma mexicana* occurs from northern Colorado south through western and central Mexico, through Guatemala into western Honduras (Fig. 3). In the United States, Mexican woodrats occur from the western tip of the Oklahoma panhandle (Blair, 1939) westward to the south rim of the Grand Canyon (Bailey, 1935; Hoffmeister, 1971). Their altitudinal distribution ranges from 15 m in Nayarit (Hall, 1955) to 4,025 m on Volcán Tajumulco in Guatemala (Hall, 1955; Sanborn, 1935).

**FOSSIL RECORD.** Hibbard (1967) suggested that the stock that gave rise to *Neotoma* must have separated from a generalized cricetine in the late Miocene. Fossil evidence of *Neotoma mexicana* is rare. Van Devender et al. (1977) reported remains of Mexican woodrats from Pleistocene deposits in Rampart Cave in Grand Canyon National Park, Arizona. They remarked that *N. mexicana* apparently occurred at much lower elevations in that area during the Pleistocene than at present. Remains of Pleistocene Mexican woodrats were found in Wisconsin deposits in Burnet Cave (Murray, 1957; Schultz and Howard, 1935) in the Guadalupe Mountains in southern New Mexico. Harris (1984*b*) reported Pleistocene remains of *N. mexicana* from Baldy Peak Cave, New Mexico and Holocene remains from Dry Cave, New Mexico. According to Harris (1984*b*), *N. cinerea* abruptly disappeared from southern New Mexico and western Texas at the close of the Pleistocene and was replaced by *N. mexicana*. Logan and Black (1979) identified *N. mexicana* remains from Pleistocene deposits in Upper Sloth Cave, Guadalupe Mountains National Park, Texas. Dalquest and Stangl (1984) found *N. mexicana* represented by a single lower jaw in Pleistocene deposits in Fowlkes Cave in southern Culberson Co., Texas, and reported that *N. mexicana* does not occur in the desert habitat near the cave at present. A molar from Pleistocene deposits in Tlapacoya, México, was identified as that of Mexican woodrat (Alvarez, 1969). A newly described, extinct species (*N. findleyi*) from Dry Cave seems to be allied with *N. cinerea* or *N. mexicana* (Harris, 1984*a*, 1984*b*).

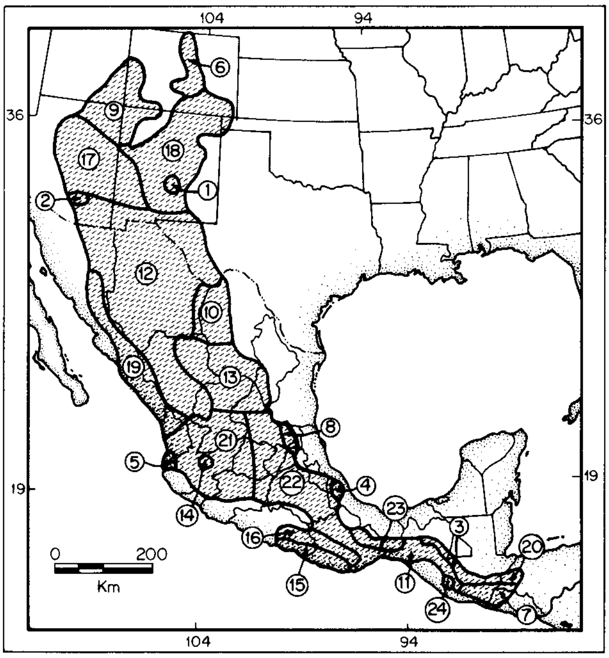

FIG. 3. Map showing the distribution of *Neotoma mexicana* (after Hall, 1981). Guide to subspecies: 1, *N. m. atrata*; 2, *N. m. bullata*; 3, *N. m. chamula*; 4, *N. m. distincta*; 5, *N. m. erimita*; 6, *N. m. fallax*; 7, *N. m. ferruginea*; 8, *N. m. griseoventer*; 9, *N. m. inopinata*; 10, *N. m. inornata*; 11, *N. m. isthmica*; 12, *N. m. mexicana*; 13, *N. m. navus*; 14, *N. m. ochracea*; 15, *N. m. parvidens*; 16, *N. m. picta*; 17, *N. m. pinetorum*; 18, *N. m. scopulorum*; 19, *N. m. sinaloae*; 20, *N. m. solitaria*; 21, *N. m. tenuicauda*; 22, *N. m. torquata*; 23, *N. m. tropicalis*; 24, *N. m. vulcani*.

**FORM AND FUNCTION.** Howe (1977) reported that males of *Neotoma mexicana* have prominent, midventral sebaceous glands. Melanistic specimens of *N. mexicana* were collected on dark lava flows in New Mexico (Blair, 1941; Burt, 1939; Dice, 1942; Hooper, 1941). Burt (1939) described a new subspecies, *N. m. atrata*, from two dark specimens collected on the malpais near Carrizozo, New Mexico. According to his description, *N. m. atrata* is distinctly darker than *N. m. mexicana* and *N. m. fallax*. The buffy subterminal bands on the hairs were reduced but not replaced entirely with black as in *N. albigula melas*. Hooper (1941), who obtained dark individuals of *N. m. fallax* from lava flows in Valencia Co., New Mexico, noted that the tendency for woodrats captured on dark substrates to be darker was more evident in juvenile pelage. Warren (1913) reported an instance of dichromatism in *N. m. fallax* from Colorado.

The baculum of *N. mexicana* is distinct (Burt and Barkalow, 1942); the shaft is nearly straight and the basal end is slightly expanded and inverted U-shaped in cross section. The bone narrows abruptly then more gradually from the lateral proximal projections to the distal tip. It differs from bacula of other *Neotoma* in that it is wider near the middle of the shaft then gradually narrows again near the distal end. A slight knob may be present near the distal end. Hooper (1960) reported that the shape of the osseus part of the baculum differed in each specimen examined. The ventral surface was flat on one specimen, shallowly concave in two, and more deeply concave in a fourth, but the dorsal surface was narrowly concave in all of them. The distal half was club-like with a slightly cleft terminal enlargement. Measurements (in mm) of bacula from two *N. m. mexicana* (Burt and Barkalow, 1942) are: length, 5.38, 5.6; dorsoventral diameter of base, 0.89, 1.09; lateral diameter of base, 1.84, 2.21; dorsoventral diameter of shaft near middle, 0.51, 0.55; lateral diameter of shaft near middle, 0.61, 0.70.

Hooper (1960) described the glans penis of *N. mexicana* as robust, oblong, and spinous. He reported that it generally resembled those of *N. albigula, N. floridana,* and *N. micropus* with the following exceptions: internal crater deeper, with the floor below the tip of os penis leaving the distal part of the bone and all of the terminal cartilagenous spine contained within the crater and free of its walls; urethral flap was shorter, blunt, and entire.

According to Cockerell et al. (1914), the malleus of *N. m. fallax* is bimarginate with no processus muscularis, but with a distinct tubercle present above the orbicular apophysis. The orbicular apophysis is large and the cephalic peduncle elongated, terminating in a relatively small head. The bony lamina is extensive and the processus gracilis is long.

The incus (Cockerell et al., 1914) has a thick, short processus brevis and a long stapedial process with a distinct and well-developed sylvian apophysis. A distinct broad groove is around the inner margin of the articular surface.

The stapes has a stout bony intercrural canal (Cockerell et al., 1914). One crus is shorter and straighter than the other, making the ossicle asymmetrical.

Sprague (1941) reported that the hyoid apparatus of *N. mexicana fallax* is about the same size as in *N. albigula*. The ceratohyals are long, slender, and slightly bifurcated distally. The hypohyals are triangular, the thyrohyals straight, and the shoulders well developed. Measurements (in mm) of the hyoid apparatus of one specimen (Sprague, 1941) were as follows: width of basihyal, 6.2; length of thyrohyal, 5.0; length of ceratohyal, 3.0; arch of basihyal and thyrohyal, 5.4; thickness of basihyal through the entoglossal process, 2.4.

Carleton (1973) reported that Mexican woodrats have a bilocular-discoglandular stomach with incisora angularis and fornix ventricularis similar to those of *Peromyscus*. Stomachs of *N. mexicana* possessed a relatively greater area of glandular epithelium than those of *Peromyscus*.

Brownfield and Wunder (1976) calculated the following renal indices for *N. mexicana*: percent medullary thickness, 79; relative medullary thickness, 6.3; percent medullary area, 43.9; relative medullary area, 0.79. All of these values were lower than those for *N. albigula* indicating that *N. albigula* has greater urine concentrating ability than *N. mexicana*. Boice (1969) and Boice and Boice (1968) were unable to complete water-relation studies when specimens of *N. mexicana* given drinking water and dry food began to lose conditioning. They drank more readily after capture than individuals of *N. albigula* and *N. micropus*, but they could not be maintained in good health without succulent foods until habituated to the laboratory for several months.

**ONTOGENY AND REPRODUCTION.** At the northern limit of the range of the species in Colorado, adult females breed from March through May, producing two litters annually (Brown, 1969). Farther south, the breeding season is longer but few details are available. Pregnant females have been captured in January, and March through August (Baker, 1956; Birney and Jones, 1971; Cary, 1911; Davis, 1944; Finley, 1958; Genoways et al., 1979; Hoffmeister, 1971; Hooper, 1941; Warren, 1926). Males with enlarged testes were captured in June, July, August, and November, and subadults were observed or collected in every month except February and May (Baker, 1956; Birney and Jones, 1971; Burt and Hooper, 1941; Cary, 1911; Davis, 1944; Finley, 1958; Genoways et al., 1979; Hall and Dalquest, 1963).

The average gestation period of *N. mexicana* is 32.7 days with a range of 31 to 34 (Olsen, 1968). Data were collected in the laboratory from eight pregnancies of five different females obtained in the San Mateo Mountains of New Mexico. Mean litter size was 2.1 with a range of 1 to 3. A total of 17 young (eight males, nine females) was born in the eight litters. Brown (1969) reported mean litter sizes for adult females in Colorado based on counts of embryos (3.43; $n = 19$), corpora lutea (3.66; $n = 45$), and pigmented sites of implantation (3.47; $n = 22$). Juvenile females born in April or May in Colorado produced litters in June or July and had an average of 2.44 ($n = 14$) embryos and 2.52 ($n = 19$) corpora lutea. Some young females born late in the reproductive season failed to produce a litter even though they ovulated in September and October. Reproductive failure apparently was caused by an absence of fertile males at that season. Brown (1969) found that gonadal development of juvenile males progressed slowly with low testicular weight and activity through November (61.9 mg), accelerated in December (476.8 mg), and reached full development during the following breeding season. Peak testicular development in adult males was attained in April (1,540.2 mg), whereas minimum size and activity occurred in November (119.6 mg).

Finley (1958) described the molt patterns of *N. mexicana* as being much like those of *N. cinerea*. Both species usually have three molts the first year. In the postjuvenal and second molts, the inguinal region molts earlier in *N. mexicana* than in *N. cinerea*, but later than in *N. floridana* or *N. micropus*. Molt lines from the body sides meet on the dorsal surface at the lumbar region and rump before they join at the base of the tail. The third molt may begin on the belly before completion of the second molt, but follows the same pattern as the second molt (Finley, 1958). The third molt was recognized in specimens taken in the period September through January, and only in adults about 5 to 8 months of age.

**ECOLOGY.** Throughout its range, *N. mexicana* generally is saxicolous, preferring rock outcrops, rocky slopes, and cliffs (Baker, 1956; Baker and Greer, 1962; Birney and Jones, 1971; Blair, 1939; Findley et al., 1975; Finley, 1958; Genoways and Jones, 1973; Hall and Dalquest, 1963; Schmidly, 1977). These rats occur from the Upper Sonoran Life-zone to the upper limits of the Transition Zone (Bailey, 1931; Finley, 1958). In western Colorado, Finley (1958) reported them to be more abundant in the Upper Sonoran Zone, whereas in Arizona, New Mexico, and western Texas they are more abundant in the Transition Zone (Bailey, 1905, 1931; Findley et al., 1975). Mexican woodrats are predominantly montane and are associated most often with open woodland or shrub vegetation types.

The most widespread plant community occupied by *N. mexicana* in Colorado is piñon (*Pinus edulis*)-juniper (*Juniperus communis*) woodland (Armstrong, 1972; Finley, 1958). Finley (1958) found them commonly in scrub oak (*Quercus gambelii*) with scattered ponderosa pine (*Pinus ponderosa*).

In New Mexico, Mexican woodrats reach their greatest numbers in montane mixed coniferous forests (Findley et al., 1975). They are common in piñon–juniper woodland (Bailey, 1931; Dice, 1930, 1942; Thompson and Hier, 1981), ponderosa pine–scrub oak (Hill, 1942), and ponderosa pine (Bailey, 1931; Hooper, 1941). Ivey (1957) collected these woodrats in Douglas fir (*Pseudotsuga menziesii*)-Engelmann spruce (*Picea engelmanni*) forest.

In western Texas, Mexican woodrats occur in piñon, juniper, ponderosa pine, and mixed deciduous coniferous forest (Bailey, 1905; Blair, 1940; Cornely, 1979). They sometimes occur on relatively open, steep, rocky slopes. On one such slope in Guadalupe Mountains National Park, the dominant plants near active woodrat dens were *Nolina micrantha, Muhlenbergia pauciflora, Dasylirion leiophyllum, Cercocarpus montanus,* and *Quercus undulata* (Cornely, 1979).

Mexican woodrats inhabit ponderosa-pine forest in montane areas of Arizona (Bailey, 1931, 1935; Cahalane, 1939; Hoffmeister, 1956, 1971; Hoffmeister and Goodpaster, 1954; Merriam and Stejneger, 1890). They occur also in piñon–juniper (Hoffmeister, 1971), oaks (Cahalane, 1939), and firs and aspens (Hoffmeister and Goodpaster, 1954).

In Coahuila, specimens were taken in the Sierra del Carmen in mixed oaks and conifers; in the Sierra de la Madera in an association of oaks, pine, and madroño (*Arbutus xalapensis*); and in the Sierra Madre Oriental in an association of pine, aspen, and fir (Baker, 1956). Hooper (1955) obtained these rats in a riparian forest of fig trees and other tropical plants in Sinaloa; Birney and Jones (1971) found them in a tropical thorn forest above the Río Piaxtla in the same state. They also have been taken in tropical deciduous thorn forest in Jalisco (Genoways and Jones, 1973). A specimen was collected from boreal forest in the state of México (Davis, 1944). In Morelos, Mexican woodrats were obtained in the Mixed Forest Association and in the Arid Tropical Scrub Association (Davis and Russell, 1954; Ward, 1891). Goodwin (1934) reported them in cactus hedges in Guatemala.

In Colorado, Cary (1911) noted that these rats ate acorns, piñon nuts, and juniper berries. Finley (1958) examined 51 dens in Colorado and inferred the diet from plant remains in the litter at each den. Foliage was utilized in much greater quantities than fruits, flowers, stems, or woody parts. Conifer needles were common, but cactus apparently was avoided. The most common food plants were those most abundant and most accessible in the scrub oak and piñon–juniper (Finley, 1958). Among those plants were scrub oak, skunkbush (*Rhus trilobata*), mountain mahogany (*Cercocarpus montanus*), and juniper. Finley (1958) concluded that the food of *N. mexicana* is relatively generalized, similar to that of *N. cinerea* and in contrast to the specialized food habits of *N. albigula* and *N. micropus*.

Bailey (1931) reported that food of these rats in New Mexico consisted of a great variety of green plants, berries, fruits, seeds, nuts, acorns, and mushrooms. At lower elevations, pine nuts, juniper berries, and cactus pulp and fruits were common foods. In the Guadalupe Mountains in southern New Mexico and western Texas, acorns and juniper berries were commonly eaten (Bailey, 1905, 1931). In The Bowl, in Guadalupe Mountains National Park, Texas, Cornely (1979) observed a young Mexican woodrat eating acorns from a large cache in an old log cabin. Schmidly (1977) reported that favorite foods included acorns, juniper berries, nuts, seeds, and mushrooms. Davis (1944) reported that Mexican woodrats in western Texas ate a variety of plants including green vegetation, nuts, berries, acorns, and fungi. He stated that cactus was eaten if available. According to Baker (1956), woodrats in the Sierra de la Madera, Coahuila, seemed to feed mostly on acorns.

Finley (1958) reported that Mexican woodrats in Colorado apparently cure and store large quantities of food. The greatest collecting activity occurred in the late summer and autumn. The stored food consisted almost entirely of dried cuttings of foliage.

Mexican woodrats generally do not build houses typical of most species of *Neotoma* (Bailey, 1931, 1935; Cornely, 1979; Finley, 1958; Schmidly, 1977), but construct nest chambers in well-protected rock crevices, tree cavities, or abandoned buildings. Finley (1958) reported that they have a relatively weak collecting instinct compared with that of other species of woodrats in Colorado. Sticks and other objects often are stuffed into crevices near the den. Although stick houses of *N. mexicana* rarely have been found, several authors reported that they are capable of building houses (Bailey, 1931; Davis, 1966; Hoffmeister, 1971). According to Finley (1958) individuals sometimes move into vacant houses constructed by other species of woodrats. Six nest chambers examined by Finley (1958) were either cup-shaped or ball-shaped and constructed mainly of shredded juniper bark.

Because Mexican woodrats are principally montane, the distribution is often disjunct, with adjacent populations isolated on the tops of mountain ranges. Often two or more species of woodrats with different altitudinal distributions occur in such areas. Mexican woodrats were reported in sympatry or contiguous allopatry with other species of woodrats in several localities (Cary, 1911; Cornely, 1979; Dice, 1942; Finley, 1958; Hill, 1942; Hoffmeister and de la Torre, 1960; Howe, 1977). Where *N. cinerea* is present, it apparently uses the higher vertical crevices in cliffs, whereas *N. mexicana* occupies the lower ledges and spaces under talus blocks (Finley, 1958). In the absence of *N. cinerea*, *N. mexicana* often occupies the higher vertical crevices and caves (Cornely, 1979; Finley, 1958). Finley (1958) reported *N. mexicana* and *N. albigula* in the same habitats at many localities in southwestern Colorado. In Dolores Canyon near Gateway, Colorado, he noted a clear distinction in habitats occupied by the two; Mexican woodrats occupied steep sides of canyons and cliff bases near the valley bottom and white-throated woodrats occupied the valley floor. The same pattern was reported in upper Dog Canyon in Guadalupe Mountains National Park, Texas (Cornely, 1979). Findley et al. (1975) described the distribution of these two species in New Mexico as "islands" of *N. mexicana* surrounded by a "sea" of *N. albigula*. In Padre Canyon east of Flagstaff, Arizona, *N. mexicana* reportedly is sympatric with both *N. albigula* and *N. stephensi* (Howe, 1976). According to Goldman (1937), the Colorado River serves as a barrier between woodrats on the North Rim of the Grand Canyon (*N. cinerea* and *N. lepida monstrabilis*) and those inhabiting the South Rim (*N. mexicana*, *N. albigula*, *N. stephensi*, and *N. lepida lepida*).

FIG. 4. Karyotype of a male *Neotoma mexicana* from the Graham Mountains, Graham Co., Arizona (after Baker and Mascarello, 1969).

Remains of Mexican woodrats have been identified in barn owl (*Tyto alba*) pellets from Miñaca, Chihuahua (Anderson and Long, 1961), Jalisco (Twente and Baker, 1951), and Oaxaca (Mones, 1968), and a carcass was removed from the digestive tract of a black-tailed rattlesnake (*Crotalus molossus*) at Rancho Las Margaritas, Durango (Baker and Greer, 1962).

The following parasites were collected from Mexican woodrats in Colorado by Finley (1958): Taeniidae, *Taenia* sp.; Ixodidae, *Dermacentor andersoni*, *Ixodes spinipalpis*, *I. woodi*; Laelaptidae, *Eviphis* sp., *Eubrachylaelaps circularis*, *Haemolaelaps glasgowi*; Macronyssidae, *Hirstionyssus* sp.; Trombiculidae, *Leeuwenhoekia americana*, *Euschogastia criceticola*, *E. lacerta*, *E. hoffmannae*, *E. finleyi*, *Trombicula alfreddugesi*, *T. hoplai*, *T. potosina*, *T. harperi*; Haematopinidae, *Neohaematopinus inornatus*; Reduviidae, *Triatoma protaacta*; Hystrichopsyllidae, *Anomiopayllus* sp., *Megarthroglossus* sp., *Stenistomera alpina*; Ceratophyllidae, *Diamanus montanus*, *Malares* sp., *Archopeas sexdentatus*, *Peromyscopsylla* sp. Loomis (1971) reported *Euschoengastoides neotomae* from a specimen of *N. mexicana* taken in San Juan Co., New Mexico. Hoffmeister (1971) captured Mexican woodrats in Grand Canyon National Park, Arizona, that were infected with warbles (*Cuterebra* sp.). One specimen had three warbles, each nearly 2.5 cm long. Hill (1942) reported one specimen of *N. mexicana* from northeastern New Mexico had a large warble on the rump.

Finley (1958) examined two specimens of *N. mexicana* that had alveolar abscesses of the upper molars apparently caused by the lodgement of cactus glocids or other foreign material. Holdenreid and Quan (1956) reported that these rats were as susceptible to experimental infections of plague as laboratory mice. *Neotoma* is a possible reservoir for kala-azar (black disease) in Mexico (Lopez et al., 1966).

**BEHAVIOR.** Howe (1976, 1977, 1978) reported quantitative differences in some behavioral patterns of three species of woodrats (*N. albigula*, *N. mexicana*, *N. stephensi*) that occur sympatrically in Padre Canyon near Flagstaff, Arizona. Both scent-marking and foot-stomping were used frequently by *N. mexicana*, whereas *N. stephensi* exhibited little foot-stomping and *N. albigula* exhibited little scent-marking. Scent-marking in *N. mexicana* may be accomplished by ventral rubbing, perineal dragging, and rolling on the back. During ventral rub, a male woodrat rubs a prominent, midventral sebaceous gland against the object being marked as he slowly moves forward. Females have no midventral gland and did not exhibit ventral rub. Perineal drag, exhibited by both sexes, involved the lowering of the rump while slowly moving forward. Urine may be deposited during perineal drag (Howe, 1976, 1977; Kinsey, 1972). Rolling on the back was described as an individual wriggling on its back for some seconds while possibly depositing scent (Howe, 1976). This behavior was used less often by *N. mexicana* than by *N. albigula* or *N. stephensi*. Scent-marking occurred during several agonistic and sexual encounters, by both dominant and submissive animals, and in both intraspecific encounters.

According to Howe (1976, 1977, 1978), *N. mexicana* was dominant over *N. albigula* and *N. stephensi* in both a large outdoor arena and a small indoor arena. During olfactory choice tests in which conspecific scent and heterospecific scent were offered as alternatives, male *N. mexicana* were attracted strongly to urine from estrous conspecifics, whereas males of the other two species paid little attention to either alternative. Female *N. mexicana* also were attracted more strongly to conspecific male glandular odor over that from heterospecifics. Females of *N. albigula* and *N. stephensi* showed strong interest in male glandular odor but no differences were apparent between species.

Howe (1976) observed that male Mexican woodrats frequently produced a low pitched, raspy vocalization in the presence of conspecific females presumed to be in estrus. This gasping sometimes became louder as the male approached the female. Males did not grasp females during mounting and copulation, but placed their forepaws lightly on the female's rump. Coquettishness (Ewer, 1968; Howe, 1976) was exhibited by females before mating. Lordosis was observed in receptive females. Copulatory lock was evident when a female attempting to move away dragged the male along. Howe (1976) noted a considerable amount of agonistic behavior interspersed with sexual behavior.

Seven Mexican woodrats that Colton (1933) observed on activity wheels averaged 14.3 to 30.8 km per night. The longest distance recorded in one night was 91.2 km. Because most of the woodrats learned to sit on the axle and rotate the wheel with one hindleg, the distances were considered to be indicative only of the general activity of the animals. These woodrats are chiefly nocturnal (Colton, 1933), but have been reported active during the day (Cary, 1911).

**GENETICS.** *Neotoma mexicana* has a diploid number of 52 (Baker and Mascarello, 1969; Paulete et al., 1971). Specimens from Arizona, Colorado, New Mexico, and Durango had all acrocentric autosomes (Fig. 4) except for a small pair of submetacentric elements (Baker and Mascarello, 1969). The G-banded karyotypes of *N. micropus* and *N. mexicana* differ in chromosomes 3, 17, 23, and 24 (Koop et al., 1985). In chromosome 3 only *N. micropus* had a polymorphic heterochromatic short arm. In chromosomes 17 and 24 the euchromatin distal to the centromere in the long arm appeared to be missing in *N. mexicana*. In chromosome 23 the biarm condition in *N. micropus* appeared to be rearranged to the acrocentric condition in *N. mexicana*. According to Koop et al. (1985), the standard karyotypes of the two species were identical except for the X-chromosome. Paulete et al. (1971) reported a variant karyotype for specimens of *N. m. torquata*. Zimmerman and Nejtek (1975) found a single hemoglobin pattern in all the specimens of *N. mexicana* they examined ($n = 36$). They found three patterns in *N. floridana* and eight in *N. albigula*. The pattern in *N. mexicana* was species specific with an intermediate band migrating between the first and second bands found in *N. floridana*.

Electrophoretic patterns of albumins revealed the presence of at least five different mobilities (Zimmerman and Nejtek, 1975). A definite north to south clinal increase in heterozygosity at the albumin locus was noted.

**REMARKS.** In spite of its wide distribution and relative abundance in North America, *N. mexicana* has not been studied extensively. The systematics of this species has not been documented fully, particularly in the southern part of the range. A number of subspecific boundaries merit further investigation. Hall (1981) suggested that *N. chrysomelas* may prove to be a subspecies of *N. mexicana*.

*Neotoma* is derived from the Greek words *neos*, meaning "new," and *tomos*, meaning "cut." Together they refer to a new kind of mammal with cutting teeth. The specific name, *mexicana*, is a latinized word meaning "of Mexico."

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