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REPORT ON A COLLECTION OF MAMMAL BONES FROM ARCHEOLOGIC CAVE-SITES IN COAHUILA, MEXICO[1]

BY RAYMOND M. GILMORE

In 1940–41, Walter W. Taylor, Director of the U. S. National Museum Coahuila Expedition, excavated some prehistoric cave sites near Cuatro Cienegas in central Coahuila, Mexico (fig. 1). The collection of bones was sent to the Division of Mammals of the U. S. National Museum for identification. The fine state of preservation, clean condition, and detailed stratigraphic labeling of the bone specimens, and the lack of information on the mammals of Coahuila, have encouraged the preparation of this report to treat specifically of the mammals represented in the collection. Reference is made also to species *not* represented in the faunal debris. However, lack of recently collected Coahuila mammal specimens, especially skeletons, and the absence of a mammalian and general ecologic survey of the Cuatro Cienegas region, have caused some of the identifications and interpretations to be more haphazard than otherwise would have been the case. Remains of birds and fishes were scarce; lizards were represented by a number of complete skulls and some other bones.

This report is essentially an incomplete Recent mammal list from a specific locality at a time horizon many hundreds of years ago. The ecologic interpretations are as important as the list of species, but they are generally less definite. Information on the physical and vegetational conditions which limit the distribution of some mammal species, and the opposite conditions which give them an optimum environment, are difficult to judge or to obtain from the literature. These points are obviously important to the archeologist, especially in this case the presence or absence of permanent water.

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About 100 of the 2,105 identifications of mammal bones were made by David H. Johnson, Associate Curator of Mammals, before he left for service in the U. S. Navy. These identifications have not been re-examined except in cases where subsequent developments threw doubt on the original decision, and these cases were few. In fact, all doubtful and important identifications by either of us were scrutinized several times.

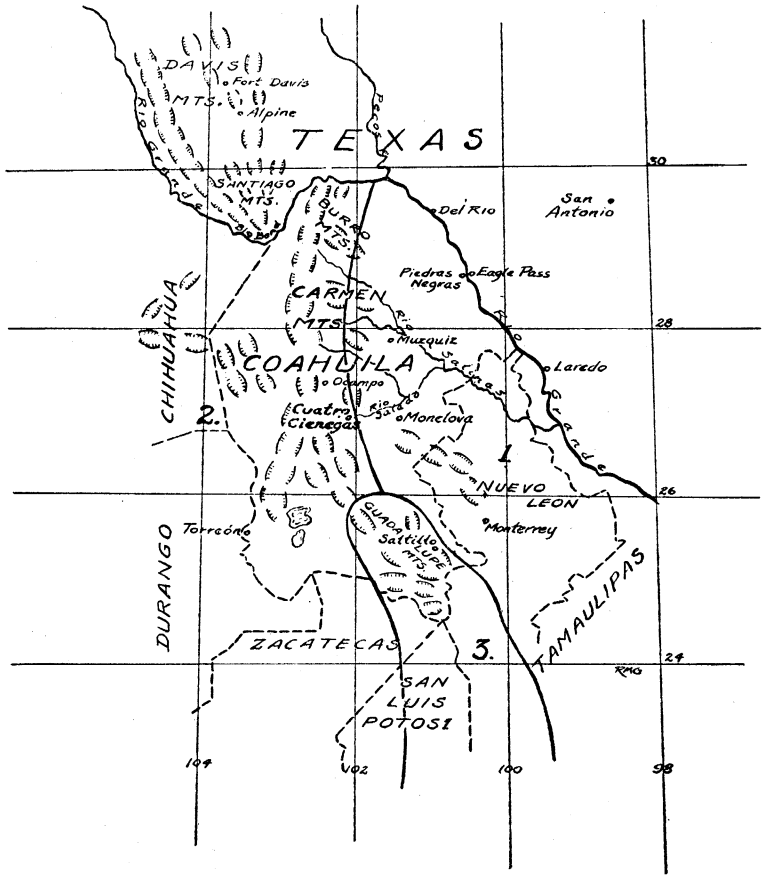

FIG. 1. (map). Coahuila and adjacent region. 1. Tamaulipan biotic province of Goldman and Moore (1946, p. 349). 2. Chihuahua-Zacatecas biotic province. 3. Sierra Madre Oriental biotic province.

Cuatro Cienegas is a town in an intermontane basin, 742 m. (2434 ft.) in elevation, which contains marshes and is surrounded by the Sierra Madre Oriental (see figs. 2 and 3; also pl. 1, fig. 1). The floor of the basin is made up of gypsum sand desert and playa basins, with saline pools set in extensive marshes. In favorable places grow short grass, salt-marsh vegetation, and creosote-bush (*Larrea tridentata*). Most of this desert area may be considered as covered with the typical "creosote-bush association" of the Lower Austral (or Lower Sonoran)

Life-Zone, and its characteristic mammals are pocket-mice, kangaroo-rats, and small spotted and pygmy ground-squirrels (see Nelson and Goldman, 1926). In favorable places, especially on the margins of the flats, are groves of mesquite (*Prosopis*), with interspersed cacti.

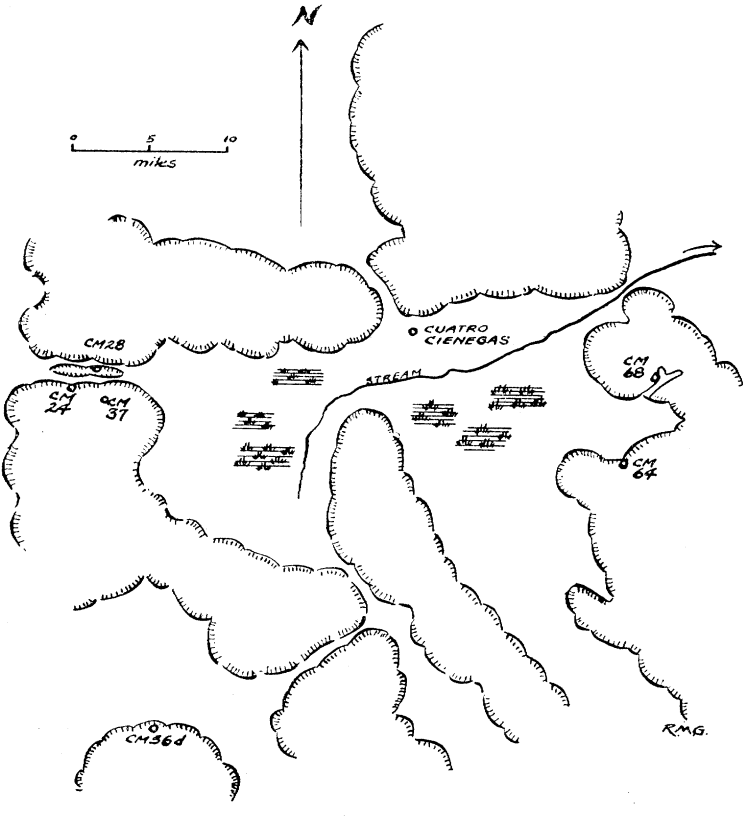

FIG. 2. (map). Cuatro Cienegas basin, showing distribution of mountains and basin, and location of archeologic cave sites, CM24, CM28, CM37, CM56d, CM64, and CM68. Redrawn from sketch of W. W. Taylor.

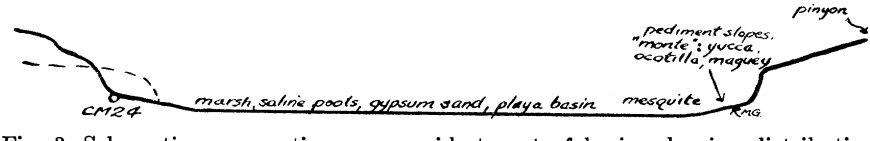

Fig. 3. Schematic cross-section across widest part of basin, showing distribution of geomorphology and vegetation-types. Redrawn from sketch of W. W. Taylor.

From the edges of the valley and reaching to the bases of the cliffs which rise to the surrounding mountains are pediments with "monte" vegetation consisting of grasses (probably sotol, *Dasylirion*; bear-grass, *Nolina*; and grama, *Bouteloua*), lecheguilla (*Agave lecheguilla*), yucca (*Yucca*), ocotillo (*Fouquieria*), and cacti. This marginal area may be considered also as Lower Austral with mammals

similar to those of the desert flats, but jack rabbits, cottontails, wood-rats, and quail are more numerous.

The broken cliffs and the canyons leading into the mountains are rocky with desert flora which merges through pinyon-pine (*Pinus cembroides*) and oak (*Quercus*) into yellow pine (*P. ponderosa*) on the higher summits. The pinyon-rock-association may be considered Upper Austral, and it contains some mammals different from those on the lower slopes, and also higher concentrations of some of the same kinds that are not so numerous below. Rock squirrels, cacomistles, and mule-deer probably are numerous. The pine association, at higher elevations, is considered to be of the Transition Zone, and it is characterized by some slightly to markedly different animals including bear and the white-tailed deer.

Precipitation is light at Cuatro Cienegas and is confined largely to sporadic heavy thunderstorms from July to October. Annual rainfall is in the 0–200 mm belt, but is close to the 200–400 mm belt to the east (Shreve, 1944, p. 106). Permanent water exists today as far as known only in the canyon on the north side of Cuatro Cienegas basin near the town, and also in the marshes and in the small stream which flows eastward through a gap in the mountains to join the Rio Salado, which also flows eastward, to the Rio Salinas and thence to the Rio Grande. A cool, damp fog often drifts over the eastern edge of the basin, but deposits little water. There is some evidence that some centuries ago during the period of aboriginal occupancy of the caves the climate was more humid, and water more plentiful.

The Cuatro Cienegas region is considered by Goldman and Moore (1946) to lie on the eastern edge of the extremely arid Chihuahua-Zacatecas biotic province (the Chihuahuan of Dice, 1943), near where it merges with the Tamaulipan province on the east (fig. 1, map). Although Cuatro Cienegas is on the watershed of the lower Rio Grande, and would seem to belong properly with the Tamaulipan province, the upper, eastern slopes of the Sierra Madre Oriental in this region and northward belong biotically with the province to the west on account of extreme aridity. Biotic provinces are local geographic centers of endemism resulting from the differentiation of local varieties or subspecies, or by the isolation of larger taxonomic units which once occupied a wider area (reliction). Life-zones are microclimatic belts often corresponding with altitude in mountainous areas, and are characterized by a general common plant and animal assemblage (indicators). A life-zone may extend through several biotic provinces, and conversely, a province may have several life-zones within its confines. Soil and terrain may be factors in life-zone distribution at the expense of microclimate. Minor divisions of a life-zone are "associations" which may vary somewhat by biotic provinces through slight local endemism.

The relation between natural and primitive cultural areas in North America was discussed in detail by Kroeber (1939). This study showed that, culturally, the Cuatro Cienegas region is transitional between the Southwest and Mexican centers. Kroeber gave much credit to Clark Wissler for early advocation of the ecologic framework of culture, and said, "We can accept Wissler's findings on

TABLE 1.—*List of mammals represented in cave deposits near Cuatro Cienegas. Numbers are of bone fragments*

NAME	CM24	CM37	CM56D	CM64	CM68	TOTAL
Mastiff-bat (*Eumops perotis californicus*)	—	—	—	—	1	1
Man (*Homo sapiens*). Scattered fragments only	1	—	—	—	10	11
Black bear (*Euarctos americanus*)	—	—	—	—	2	2
Grizzly bear (*Ursus*, of *planiceps* group)	—	—	—	—	1	1
Raccoon (*Procyon lotor*)	—	—	—	—	4	4
Coati (*Nasua narica*)	—	—	—	—	6	6
Cacomistle (*Bassariscus astutus*)	6	—	—	—	63	69
Badger (*Taxidea taxus*)	3	—	—	—	4	7
Hog-nosed skunk (*Conepatus mesoleucus*) (?)	—	—	—	—	3	3
Badger or hog-nosed skunk	—	—	—	—	1	1
Striped skunk (*Mephitis mephitis*)	—	—	—	—	3	3
Spotted skunk (*Spilogale leucoparia*)	2	—	—	—	6	8
Striped skunk or spotted skunk	1	—	—	—	2	3
Gray fox (*Urocyon cinereoargenteus*)	5	—	—	—	18	23
Desert fox (*Vulpes macrotis*)	1	—	—	—	1	2
Coyote (*Canis latrans*)	14	—	1	—	9	24
Coyote or dog (*Canis familiaris*) (?)	4	—	—	—	10	14
Wolf (*Canis lupus*) or dog (?)	1	—	—	—	2	3
Bobcat (*Lynx rufus*)	1	—	—	—	5	6
Puma (*Felis concolor*)	—	—	—	—	6	6
Puma or jaguar (*Felis onca*)	—	—	—	—	3	3
Rock squirrel (*Citellus variegatus*)	16	5	1	3	120	145
Mexican ground squirrel (*C. mexicanus*)	22	—	—	—	1	23
Spotted ground squirrel (*C. spilosoma*)	52	4	1	—	—	57
C. mexicana or *C. spilosoma*	1	—	—	—	—	1
Antelope ground squirrel (*Ammospermophilus interpres*)	9	—	—	—	—	9
White-throated wood-rat (*Neotoma albigula*)	238	30	1	—	32	301
N. albigula or *N. micropus*	5	—	—	—	50	55
Cotton-rat (*Sigmodon hispidus*)	2	—	—	—	—	2
Pocket-mouse (*Perognathus penicillatus*)	2	—	—	—	1	3
Pocket-mouse (*Perognathus nelsoni*)	1	—	—	—	—	1
Kangaroo-rat (*Dipodomys spectabilis*)	2	3	—	—	—	5
Pocket-gopher (*Thomomys umbrinus*)	—	—	—	—	3	3
Pocket-gopher (*Cratogeomys castanops*)	21	—	1	—	4	26
Yellow porcupine (*Erethizon epixanthum*)	—	—	—	—	42	42
Jack-rabbit (*Lepus californicus*)	117	2	14	—	44	177
Cottontail-rabbit (*Sylvilagus audubonii*)	166	8	1	—	17	192
Jack-rabbit or cottontail	—	—	—	—	2	2
Pronghorn (*Antilocapra americana*)	—	1	—	—	22	23
Mountain sheep (*Ovis canadensis*)	1	—	—	—	4	5
Mountain sheep or domestic sheep (*O. aries*) (?)	—	—	—	—	1	1
White-tailed deer (*Odocoileus virginianus*)	23	5	—	—	39	67
Mule-deer (*Odocoileus hemionus*)	1	14	6	2	75	98
White-tailed or mule-deer	18*	—	—	—	260	278
Deer or pronghorn	1	2	—	—	9	12
Elk (*Cervus canadensis*)	—	—	—	—	4	4
Bison (*Bison bison*)	1	—	—	—	8	9
Unidentified mammal bones	29	3	—	—	332	364
Total						2,105

* Includes one fragment from site CM28. No other bones were found at this site.

the relation of culture areas to environment. He (Wissler) concludes that environment does not produce a culture, but stabilizes it. Because at many points the culture must be adapted to the environment, the latter tends to hold it fast. Cultures therefore incline to change slowly once they have fitted themselves to a setting, and to enter a new environment with more difficulty than to spread over the whole of the natural area in which their form was worked out. If they do enter a new type of environment they are subject to change. Once fitted to an environment, they are likely to alter radically only through some factor profoundly affecting subsistence, such as the introduction of agriculture (*ibid*, p. 6)." Kroeber (*ibid*, p. 2) suggested a new name for a geographic and cultural unit, "diaita", to correspond to the term "biota" used by biologists.

The cave-sites, as numbered by Taylor, are CM24, CM28, CM37, CM56d, CM64, and CM68. Only CM24 and CM68 have extensive archeologic deposits and associated faunal debris. Taylor states (personal communication) that all the cave-deposits, except for a small part, are the result of human habitation. Hence, most of the animal remains were deposited through human agency, though some probably represent the natural remains of normal cave-animals that inhabited the caves during periods of occupancy and probable sporadic non-occupancy by man.

CM 24 is a small cave on the west side of Cuatro Cienegas basin, and is situated at the base of a canyon wall about 10 yards above the dry, sandy canyon-bottom (see pl. 1, fig. 1). Today it is about 10 miles from pine-timber, and water is absent except occasionally and briefly following thunderstorms with rain in the late summer and fall seasons. During aboriginal occupancy, it would seem that conditions were more humid and water more nearly permanent, and the presence of two specimens of the cotton-rat and the many specimens of pocket-gophers (*Cratogeomys*) from this site might seem to be corroborative evidence.

CM68 is a long, high and narrow cave at the base of a high cliff (pl. 1, fig. **2**), and is situated at a considerable distance up a long canyon on the east side of Cuatro Cienegas basin, about 1,500 feet above the floor of the valley. It is in the Lower Austral Life-Zone, not far below the pinyon-juniper Upper Austral Life-Zone of the higher elevations, access to which is difficult because of the high cliffs that ring the canyon. Reconnaissance to date in the canyon has not disclosed any permanent water, even in potholes (*tinajas*) which usually retain seasonal water longer than a canyon-arroyo. The cool and damp fog that often drifts in from the eastward and down the canyon in front of the site, keeps the locality cooler and damper than elsewhere in the basin, but deposits little or no water. In former times, permanent water probably was present in the canyon as is indicated by the presence of cave-remains of raccoon, common and hog-nosed skunk, porcupine, and elk.

Several examples show the uncertainty and danger of misidentification inherent in this type of work. At an early stage in the identifications, several bone-fragments were provisionally determined as those of the spider-monkey (*Ateles*). Among these were portions of two ulnae, one radius, and one lumbar vertebra. Later scrutiny, however, threw grave doubt on these identifications, and although some of the bones are not identifiable as yet with certainty (one

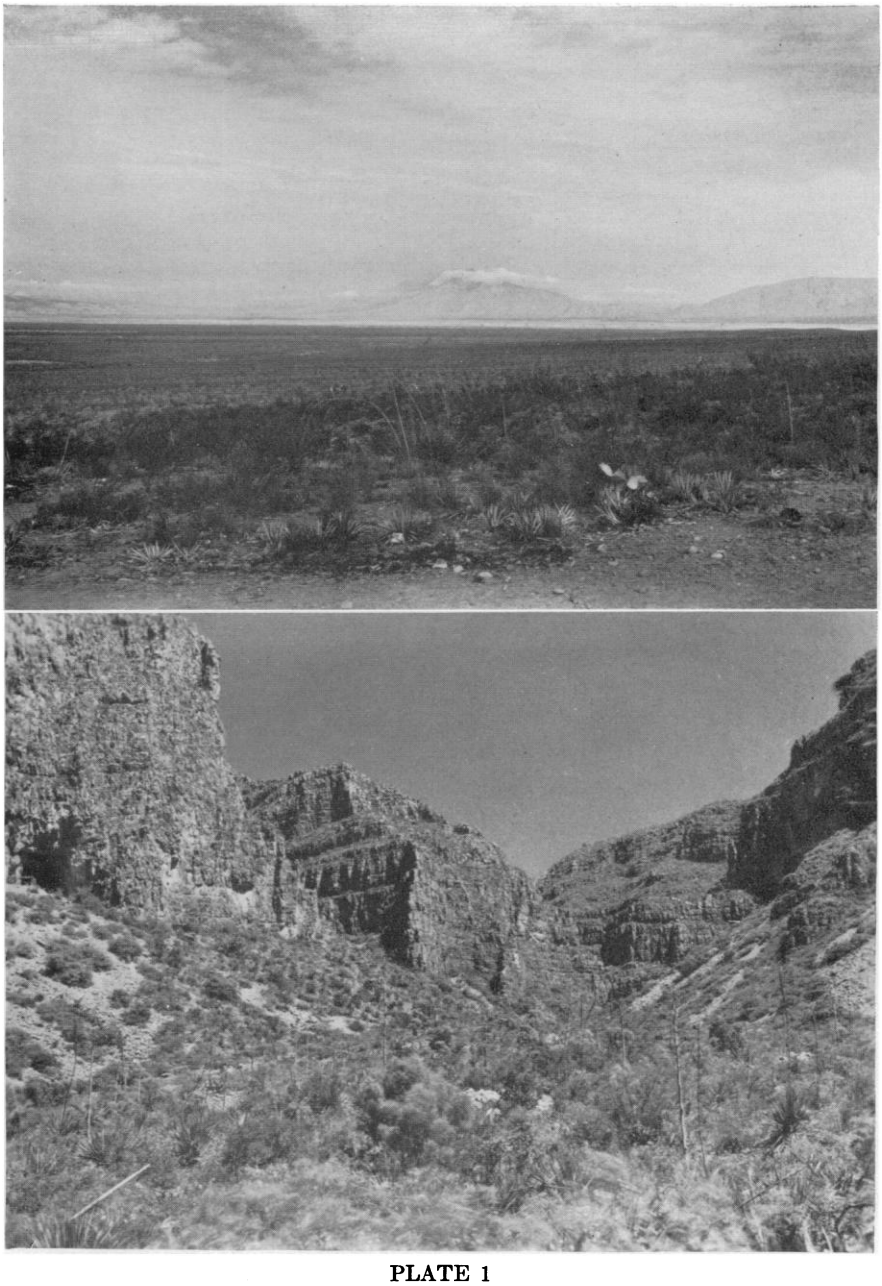

PLATE 1

UPPER: Cuatro Cienegas basin from mouth of canyon leading from CM68, looking northwest. "Monte" in foreground. "Flats" are represented by small patches of white in the left middle foreground. Alkali and gypsum area is the broad white band in the whole middle distance. Town of Cuatro Cienegas is at right of mountain with white cloud. Cave CM24 lies in gap between clouds at left. Photo by W. W. Taylor.

LOWER: Canyon of CM68, with cave at left, looking slightly north of east. The end of the canyon is shown; pinyons occupy a higher elevation far back from the cave. Photo by W. W. Taylor.

ulna fragment may be that of a porcupine, and the lumbar vertebra may have belonged to a coati), it would seem best to refrain from listing the spider-monkey as of even questionable occurrence unless further work discloses other skeletal fragments that are definitely or suggestively those of spider-monkey. Such confirmation might indicate dispersal of the species as a pet by trade, because Vera Cruz and southeastern San Luis Potosi are the present northern limits of the range of the spider-monkey (Kellogg and Goldman, 1944: 33), and the species is associated with unbroken tropical jungle.

Another bone-fragment, composed of the broken frontals and nasals of the skull, strongly resembles that of a mink, but with equal justification can be identified as spotted skunk. The mink is not known to occur today closer than central Texas (Travis and Mason counties) a distance of about 350 miles, whereas the spotted skunk is a present day inhabitant of the rocky, desert-regions of Coahuila. However, if later findings are positively those of mink, this fragment would assume more importance as another possible bit of evidence extending the former range of that animal.

One bone fragment (distal femur) of a rabbit gave considerable trouble in identification, and was finally matched with a femur of the pygmy rabbit (*Sylvilagus idahoensis*). However, as this species is now confined to the northern "great basin" (adjacent parts of Nevada, Utah, Idaho and Oregon), and as our comparative skeletal material is insufficient to cover the complete range of individual specific variation, such an identification seems too unlikely to accept without confirmation. This bone actually may belong to the late Pleistocene *Sylvilagus leonensis* described from southern Nuevo Leon by Cushing (1945, p. 183). Ayer (1936, p. 605) also recorded a very small "*Sylvilagus audubonii*" from recent cave remains in the southern Guadalupe Mountains of extreme northwestern Texas, in which cave were found some extinct species.

Another inherent difficulty in a study of this nature is the relation between numbers of bone-fragments of each species and the interpretation of relative abundance of individuals. One semi-complete skeleton of one individual will give a large number of fragmentary or complete bones for that species, and this at first glance may appear to mean relative abundance. However, in general, many fragments of a species mean many individuals, because disassociation of bones of one individual is commoner than association.

The age of the deposits in the caves has not been determined as yet by human cultural material, and the mammal bones offer little definite evidence themselves. The apparent freshness of the bones may argue against considerable antiquity, but such a criterion is of little value in a cave site in the dry climate of this region where conditions for preservation are good. The absence of remains of European domesticated animals, as well as of associated manufactured trade goods, and even the dog for sure, may argue for at least pre-Spanish age. The presence of the elk and porcupine, now found farther to the north, also may indicate considerable age. The matter is to be settled by more archeologic work.

ACCOUNTS OF SPECIES

Eumops perotis californicus, mastiff-bat.—1 skull without mandible (CM68). This is the only bat-specimen in the entire collection. *Eumops* is generally a dweller of rock-crevices,

often on the face of a cliff. This accords with its scarcity at CM68, a high, open cave, which contained bat-guano only in the farthest recesses where human deposits were least in quantity.

Homo sapiens, man.—11 bone fragments (1 from CM24; 10 from CM68). Taylor found these bones scattered throughout the deposits. They do not represent the total number of human bones taken from the caves.

Euarctos americanus, black bear.—2 bone fragments (CM68). More fragments were anticipated because the black bear presumably was common in the pine-timbered parts of the mountains in former times. *E. a. eremicus* was described by Merriam (1904, p. 154) from the Sierra Guadalupe in southern Coahuila. It is probably rare in the region today.

Ursus, of the *planiceps* group grizzly bear.—1 doubtful fragment of fibula (CM68). *Ursus nelsoni* was described by Merriam (1914, p. 190) from Colonia Garcia, Chihuahua, with range stated as extending through the Sierra Madre from northwestern Sonora south to southern Durango. Hence, the grizzly bear should have occurred formerly in some numbers throughout the broken country around Cuatro Cienegas which is good habitat for the species. It is a formidable opponent for man, and probably is extinct in the region today.

Procyon lotor, raccoon.—4 skull fragments (CM68). These remains are important in that they may indicate the nearby presence of permanent water, and perhaps of associated cottonwood trees, at the time of their deposition. Speaking of raccoons in Texas, Bailey (1905, p. 193) said, "Coons are abundant along the margins of streams, lakes, and bays, along the coast, in marshes, or around water holes, adapting their habits to almost any condition save that of dryness. . . . It is not uncommon for coons to leave the stream where they have been hunting and travel half a mile or a mile to dens in a cliff, though otherwise they are rarely found so far from water." He continued (p. 195): "In western Texas coons are closely restricted to streams, and consequently are rare over wide intervals of dry desert country between. Along the Rio Grande, Pecos, and Devils River valleys they are especially abundant, and their dens are almost invariably located in the broken walls of cliffs and canyons." In New Mexico, Bailey (1932, p. 348) later found raccoons "common along practically every permanent stream . . . [but] not often found far from water, and in many sections of the State [they] are unknown over wide areas where water is scarce or in only scattered localities." Borell and Bryant (1942:13) found raccoons in the Big Bend area only along the waters of the Rio Grande and two tributary streams.

It seems logical to conclude that the raccoon in the arid Southwest is closely restricted to water, and that, in the Cuatro Cienegas region, cave CM68 was within a mile or less of permanent or almost permanent water during some time in the past. Today, as far as known, CM68 is situated far from such water. However, S. B. Benson of the Museum of Vertebrate Zoology, Berkeley, California, informed me recently that raccoons in arid Chihuahua and Sonora often are found many miles from fresh water. It is therefore possible that they can penetrate sporadically to the CM68 canyon in its present arid condition, especially in the "rainy" season, and that the relative scarcity of remains may justify this conclusion only.

The wide ranging raccoon is edible, makes a fine pet, and has an attractive fur. Taylor did not observe it in the region in 1940–41.

Nasua narica, coati.—6 bone fragments, 1 mandible (all from CM68). This long-nosed, long-tailed raccoon-like mammal is a Neotropical species, but it has been an inhabitant of the southern Nearctic fringe for probably several geologic periods. Taylor believed that he saw one in 1940–41 in the apparently waterless canyon of CM68. Although the coati is generally considered to be a tropical forest animal, and probably is commoner in the more humid Tamaulipan province, it may not be so closely restricted ecologically to woods or to water as is the raccoon. However, the number of remains may be indicative of regular occurrence of the species and of more humid conditions in the past. It can be used by man, as is the raccoon, for food, fur, or as a pet.

Bassariscus astutus, cacomistle.—69 bone fragments, including many parts of mandibles and maxillae (6 from CM24, 63 from CM68). This distant relative of the raccoon was a common inhabitant of the rocky areas of the Cuatro Cienegas region as it is today. Some of the bones may be those of naturally deceased individuals, as well as of those utilized by man.

The animal has an attractive fur, makes a fine pet, and probably is edible. It ranges throughout the Upper Austral zone of the arid region of the western United States and the plateau of Mexico, and generally is confined to rocky terrain.

Taxidea taxus, badger.—7 bone fragments (3 from CM24, 4 from CM68). As the badger is not normally a cave-inhabitant, and as two of the bone fragments are smoke-blackened, the presence of the remains in the caves would seem to be the result of human activity. The badger is a morose, savage animal, and ordinarily would be utilized by man for food and fur only. The range of the badger extends to Puebla in the southern table land of Mexico.

Conepatus mesoleucus, hog-nosed skunk.—3 bone fragments (CM68). None of these fragments is absolutely diagnostic of the species, but as the hog-nosed skunk should be a normal inhabitant of the pine and rock associations adjacent to CM68, it is reasonable to conclude that the species was present. Remains of this skunk, as well as of the following two species, may be those of normal cave inhabitants during human occupancy.

Mephitis mephitis, striped skunk.—3 skull fragments (CM68). Both this species and the hog-nosed skunk have been found associated only with stream-bed or riparian associations in the Davis Mountains of Trans-Pecos, Texas, by Blair (1940). This may be indicative of a certain amount of dependence on water in arid regions, and the CM68 specimens, with the other evidences, may indicate permanent water nearby at the time of cave-deposition.

Spilogale leucoparia, spotted skunk.—8 bone fragments (2 from CM24, 6 from CM68). This species is a normal denizen of rocks and caves, and its presence, in greater numbers than the hog-nosed or common skunks, is probably natural.

Urocyon cinereoargenteus, gray fox.—23 bone fragments (5 from CM24, 18 from CM68). "The gray fox is common over all of the western half of Texas, except on the open plains. It is mainly an inhabitant of the timbered or brushy country, living in hollow trees or logs, but preferably in dens among the rocks" (Bailey, 1905, p. 180). This ecologic distribution may account for the greater abundance of the species at CM68 far up a rocky canyon than at CM24, which is near the desert flats. The gray fox has a utilizable fur.

Vulpes macrotis, desert fox.—2 bone fragments (1 each from CM24 and CM68). Rarity of remains of this desert animal, not a cave inhabitant, is not significant.

Canis latrans, coyote.—24 bone fragments (14 from CM24, 1 from CM56d, 9 from CM68). These remains are identical with coyote skeletal material used in comparison. The coyote can be utilized by man for fur, food and also as a pet.

Canis lupus, wolf.—3 bone fragments, 1 a fragment of P^4 (1 from CM24, 2 from CM68). These specimens are much too large for coyote, and thus may be those of wolf or possibly dog. Probably they are wolf, because if Indian dogs had been present, their remains should be common and identifiable, which is not the case. Both the wolf and coyote range too widely for any ecologic interpretation to be drawn from their presence.

Lynx rufus, bobcat.—6 bone fragments (1 from CM24, 5 from CM68). These specimens are definitely those of bobcat, and not ocelot (*Felis pardalis*), a Neotropical form. Remains of bobcat are to be expected from the cave-deposits of Cuatro Cienegas because today the animal often is found in rocky terrain. Human usage of the species includes fur and possibly food. The animal ranges far from water.

Felis concolor, puma.—6 bone fragments (CM68). The puma is often a cave inhabitant, and in addition may have been a desired trophy animal. It is a poor indicator of environment, being widely distributed ecologically and geographically.

Felis onca, jaguar.—3 phalanges (CM68). The occasional occurrence today of the jaguar in the region indicates that it was probably present during the deposition of the cave-debris, though the identification of the above bones is not certain. They may be puma.

Citellus variegatus, rock squirrel.—145 bone fragments (16 from CM24, 5 from CM27, 1 from CM56d, 3 from CM64, 120 from CM68). This large terrestrial squirrel undoubtedly was a common inhabitant of the rocks and cliffs of this region, especially in the oak-pinyon-juniper associations. Taylor saw many of them in 1940–41. The preponderance of bony remains from CM68 is indicative of the better habitat for the squirrels there than near the other caves, and is correlative with longer human occupancy. This species is the fifth most com-

mon in the excavations. Its abundance, together with its size (1 to 2 lbs.) and palatability, render it a good source of food, and it could have been a minor staple-food of the region.

Citellus mexicanus, Mexican ground squirrel.—23 bone fragments (22 from CM24, 1 from CM68). Remains of this small, spotted, ground-burrowing squirrel are almost exclusively from CM24, a fact which may be correlated with the preponderance there of the animal's preferred habitat of sandy soil, grass, and mesquite association, as compared with CM68. The range of *mexicanus* as outlined by Howell (1938, p. 120, fig. 10) almost includes Cuatro Cienegas on its western border, and shows the squirrel as an inhabitant of the more humid Tamaulipan province to the east. If the squirrel does not occur at Cuatro Cienegas today, a fact not confirmable or deniable by the expedition, the presence of the cave-remains would indicate that the range has diminished toward the east, and that the probable cause is progressive aridity of the Cuatro Cienegas region. However, a mammal survey of the Cuatro Cienegas area may disclose *C. mexicanus* to be a common inhabitant today.

Citellus spilosoma, spotted ground squirrel.—57 bone fragments (52 from CM24, 4 from CM37, 1 from CM56d). The cave distribution is similar to that of *C. mexicanus*. Howell's map of the present distribution of *C. spilosoma* (1938, p. 123, fig. 11) does not include the Cuatro Cienegas region, but this is not significant because the mapped range does include areas in southwestern Coahuila, and other areas to the east of the Rio Grande. Absence of collected specimens from the Cuatro Cienegas region is probably responsible for this lacuna. Bones of *C. spilosoma* generally are distinguished by their smaller size from bones of the same age of *C. mexicanus*. In addition, the antero-interanal cusp of M_1 is slightly larger than the external one in *mexicanus*, whereas they are equal in *spilosoma*.

Ammospermophilus interpres, antelope ground squirrel.—9 bone fragments (CM24). The significance of the presence of this small squirrel in cave CM24 exclusively is not clear, as the animal ranges rather widely from creosote-bush flats to rocky canyons (Borell and Bryant, 1942, p. 21). This species is smaller even than *C. spilosoma*. Revival of the generic name *Ammospermophilus* for these small, chipmunk-like ground squirrels is based on the evidence submitted by Bryant (1945, pp. 374–375).

The smaller ground squirrels are important food sources for predators and man because they are numerous and easy to capture.

Neotoma albigula, wood rat.—301 bone fragments, including many skulls and mandibles (238 from CM24, 30 from CM37, 1 from CM56d, 32 from CM68). There are many wood rat specimens in the cave debris, and most of these have been identified as *albigula* on the basis of skull and mandibular fragments with teeth. This rat is a typical inhabitant of the extremely arid Chihuahua-Zacatecas province (Goldman, 1910, p. 32; Goldman and Moore, 1946, p. 349). However, *N. micropus* probably is represented also, although it is typically a representative of the more humid Tamaulipan province (*idem*).

N. albigula is often a "rock-rat", whereas *N. micropus* is generally an inhabitant of wood and brush. Bailey reported (1905, p. 114) that both species occur side by side at El Paso and other localities, but each retains its distinctive characters and habits, *micropus* living mainly in its stick houses in the brush, and *albigula* always keeping among the rocks along cliffs and gulches. For the Big Bend region, Borell and Bryant (1942, pp. 35–36) found that *micropus* occurred in mesquite, catclaw and cactus, while *albigula* was found in brush and near *Agave lecheguilla*. Blair (1940, p. 32) indicated that for the Davis Mountains of Trans-Pecos Texas, *micropus* is definitely a brush rat, while *albigula* was taken in rocks and grass.

Most of the Cuatro Cienegas specimens came from CM24, although more were expected from the rocky canyon environment of CM68. The degree of tolerance of these wood rats to the absence of water is high. The species is palatable to predators and man, but small.

Sigmodon hispidus, cotton rat.—2 mandibles with teeth (CM24). The presence of this species at CM24 may indicate that there existed a grassy area at marsh or stream-bank, and thus permanent water at the time of the deposition of the bones, although two mandibles are too few for positive conclusions. Bailey (1905, p. 117) stated that in west Texas, the cotton-rats were found along "the more fertile stream valleys." In New Mexico, the species had a range "continuous along the river and stream valleys" although some colonies were found on

hill-slopes (presumably in suitable grassy association) (Bailey, 1932, p. 167). Blair (1940, pp. 15, 32) found this cotton-rat common in the Davis Mountains of Texas, in the "riparian-meadow association." All these occurrences connote the nearby presence of water, although at times and places, the cotton-rat may range far from water and grassy habitat.

Perognathus penicillatus, desert pocket mouse.—3 bone specimens, including a dessicated individual, and a braincase (2 from CM24, 1 from CM68). Bailey stated for the species in west Texas (1905, p. 139): "While they are evidently partial to valley bottoms, the one essential for their burrows is a bit of mellow soil which may be found among broken boulders or between thin strata of limestone, as well as on the sandy flats, or in the soft mesa soil that collects around the base of desert bushes." Borell and Bryant (1942, p. 25) stated that "It was plentiful in the river bottom and in every wash and sandy area up to about 3500 feet elevation." This species is evidently typical of sandy desert areas in the Lower Austral zone where soft soil occurs.

Perognathus nelsoni, Nelson pocket mouse.—1 nearly complete skull (CM24). Bailey (1905, p. 139) found this species to inhabit similar places as *P. penicillatus* in western Texas, but Borel land Bryant (1945, p. 26), writing of theBig Bend area, found that "in general the habitats of the two were not the same. This pocket mouse [*nelsoni*] inhabited hard, rocky areas which were occasionally overgrown with grass, sotol, and bear grass."

Dipodomys spectabilis, bannertail kangaroo rat.—5 bone fragments (2 from CM24, 3 from CM37). This animal is a typical inhabitant of arid mesas and hillslopes with loose gravelly soil; it avoids fine sand. Scarcity of remains do not indicate its usual importance as a source of food for predators. It is highly palatable to man also.

Thomomys umbrinus, pocket gopher.—2 bone fragments, including 1 skull and 1 mandible. The presence of this species is not significant; "they live in scant stony soil" (Bailey, 1905, p. 135). The remains may have been brought to the cave by a predatory bird or mammal. Generally, pocket gophers are difficult to cpapture by man, though probing of the burrows may have been a common diverting activity, and occasionally profitable in yielding a victim. E. A. Goldman has informed me that Mexican natives catch pocket-gophers today by a noose held at the burrow-opening and eat the victims.

Cratogeomys castanops, pocket gopher.—26 bone fragments, including many skull fragments (21 from CM24, 1 from CM56d, 4 from CM68). This species inhabits soft, sandy or loamy, fertile soils of the Lower Austral zone. Bailey (1932, p. 243) stated that in New Mexico "they avoid the hard soil of the arid mesas and the upper slopes but extend their range as far as possible along the valleys and side streams, which furnish moisture and fertility." Blair (1940, pp. 27–28) found them in grassy associations in the Davis Mountains of northwestern Texas, and "most abundant where the association was found on stream terraces." Borell and Bryant (1945, p. 23) found them common along the Rio Grande in the Big Bend region "throughout the sandy-loam river bottom, but . . . absent in the dry rocky soil away from the river." The abundance of remains at CM24 may signify former permanent water or permanently damp soil nearby. Several fragments are smoke-blackened and indicate human usage for food. The animal is large enough (a half pound or more) to form a tasty food-item for man, and is not too difficult to capture in its burrows in soft soil.

Erethizon dorsatum epixanthum, yellow porcupine.—42 bone fragments, including many skull parts and mandibles. The porcupine is palatable, and is one of the easiest of mammals to capture by man. It is also of an appropriately utilizable size, averaging 15 to 20 lbs. in weight (Seton, 1929, vol. 4, p. 605). The quills were used by many North American Indians to decorate buckskin garments. The yellow procupine, although partial to rocky locations in high or cold pine-timbered regions (white pine, lodgepole pine, yellow pine), also is found in warmer areas timbered with pinyon and juniper, and sometimes even away from these. The exclusiveness and number of remains from cave CM68 reflects the rocky surroundings and proximity to the pine timber of the higher parts of the mountains.

Noteworthy from the zoologic angle is the fact that in the Recent geologic epoch, the yellow porcupine has not been recorded south of Alpine, which is just south of the Davis Mountains in Trans-Pecos Texas. Even there itis rare and probably is confined to the higher

elevations as it is in Culberson County, a little to the northwest (see Bailey, 1905; Davis and Robertson, 1944, p. 271). New Mexico is the present southern limit of abundance, and here it is "often as common in the nut pine [pinyon] and juniper areas as in the heavily timbered mountains" (Bailey, 1932, p. 223). It is possible that a biological survey of the Carmen Mountains and even of the Cuatro Cienegas region, will show the porcupine to be an uncommon inhabitant there today, although Stanley P. Young, who recently visited the Del Carmens on a study of the mountain lion, informed me that he saw no sign of porucupine there.

The indicated progressive southern extinction seems to have been natural, because there is no reason to assume extermination by man in such apparently favorable habitats and where human population is so scanty as in the Carmen and Burro mountains of northern Coahuila. However, both natural and human agencies may have been operative in extinction. A "single mandible of an immature porcupine" was found among the remains of thousands of individuals of many other mammals (including rodents) in the "late Pleistocene" deposits of the San Josecito Cave, near Aramberri, southern Nuevo Leon (Cushing, 1946, p. 185). This suggests that the porcupine was rare there at that time and that the range has oscillated considerably along its southern edge in the last 25,000 years or so, probably on account of shifts of climatic conditions and flora.

The remains are distributed throughout all the levels of deposition of cave CM68, although with progressive diminution from lower to upper levels. The time of possible extinction in the region is impossible to judge. However, the large numbers of remains from CM68 would indicate a time of deposition considerably prior to extinction, and may indicate that at that time there existed slightly lower temperature, slightly more rainfall, and more extensive pine forests.

It is conceded generally that animals change less rapidly in habit and structure than the environment, and currently seek their optimum environment. Even plants, with their immobility, are considered less rapidly plastic than environment. Hence, relatively rapid species changes in fauna imply similar changes in flora, and both are conceded to indicate changes in the environment—changes which were too sustained and rapid for adaptation to meet successfully.

The ancestors of the North American porcupine came originally from South America, effecting occupation of North America in post-Pliocene times (Scott, 1937, pp. 131–132). The genus *Erethizon* is found in North America only, probably evolving *in situ*, and in Pleistocene times became concomitantly a boreal adaptive. As such is would seem likely to remain until extinction.

Similar southern extinction in Mexico has taken place "recently" with the elk, the marmot (*Marmota* sp. ?), and bog-lemming (*Synaptomys cooperi*) (Cushing, 1946), and probably with other species. This is a phenomenon which appears to be worthy of detailed study.

Lepus californicus, black-tailed jack rabbit.—177 bone fragments (117 from CM24, 2 from CM37, 14 from CM56d, 44 from CM68). Jack rabbit remains are the third most common in the caves. The great preponderance from CM24 reflects the more ideal habitat of brushy, sandy flats near this cave than in the rocky canyon of CM68. Jack rabbits are quite independent of permanent water, metabolizing water from vegetation or obtaining it in the form of dew. The species is an important small mammal source of food for predator and man; individuals weigh from 5 to 8 lbs. (Seton, 1929, vol. 4, p. 736).

Sylvilagus audubonii, Audubon cottontail.—192 bone fragments (166 from CM24, 8 from CM37, 1 from CM56d, 17 from CM68). This species was also very common around CM24, which is in accordance with the proximity to ideal grassy and brushy habitat. This cottontail is as independent of permanent water as is the jack rabbit, and is almost as important a source of food for predator and man, weighing from 2 to 3 lbs. (Seton, 1929, vol. 4, p. 782).

Identification of these bones as *audubonii* was made on the basis of general geography, ecology and size. *S. floridanus* ranges to the Sierra Madre of Coahuila from the eastern United States, but is more a forest and thicket rabbit than is *audubonii* which prefers the more open arid country and is confined to southwestern Nearctica. *S. nuttallii* ranges south

in the Rocky Mountain region as far only as central New Mexico and Arizona. *S. audubonii* is slightly the largest and *S. nuttallii* slightly the smallest of the three species, but quantitive as well as qualitative studies of skeletons could not be made because of lack of comparative material.

Bones of the cottontail usually are distinguished readily by their smaller size from those of the jack rabbit of the same age as indicated by epiphyseal closures.

Antilocapra americana, pronghorn.—23 bone fragments (1 from CM37, 22 from CM68). The pronghorn is a fleet animal of the flat, open country, and is difficult to capture by chase or stalk, although its inordinate curiosity often leads it into danger. The preponderance of remains at CM68, which is far up a rocky canyon where fewer pronghorns are expected to occur than on the floor of the basin, may be explainable by the greater ease of ambushing stray individuals there by predator or man. The range of the pronghorn extended south to about 21 degrees N. in the central arid table-land of Mexico in the 16th century (Nelson, 1925, fig. 1).

Ovis canadensis, mountain sheep.—5 bone fragments, including 3 teeth (1 from CM24, 4 from CM68). Mountain sheep inhabit the Carmen and Guadalupe mountains today (Stanley P. Young and E. A. Goldman, personal communications). Their remains in the caves may indicate mammalian predator activity or extensive and skilled hunting by the early human inhabitants, although the species often takes refuge in caves. In the desert-mountain ranges, mountain sheep are concentrated around water holes, but in this region these individuals might have lived far back in the mountains above Cuatro Cienegas.

Odocoileus virginianus, white-tailed deer.—67 bone fragments (23 from CM24, 5 from CM37, 39 from CM68). These are considered quite positive identifications, and probably many other fragments of this species are in the group identified only as "deer." Identification of the white-tailed deer, as distinct from the mule deer, is difficult unless the specimen is a mandibular symphysis or almost complete antler. The species is not a cave dweller; it inhabits the high, brushy and rocky areas in preference to the more open, lower places. Evidently both CM24 and CM68 were close enough to the higher elevations to make whitetails available to the human cave inhabitants. Borell and Bryant (1942, p. 42) stated that "white-tailed deer or flagtail are plentiful throughout the Chisos Mountains [Big Bend region of Texas, about 200 miles north of Cuatro Cienegas] above 4500 feet elevation. They occasionally range down to 3500 feet. . . . They favor the canyons and steep slopes of the Upper Sonoran and Transition life zones where junipers, piñons, several species of oaks, and brush, afford dense shelter."

Odocoileus hemionus, mule deer.—98 bone fragments (1 from CM24, 14 from CM37, 6 from CM64, 75 from CM68). This species, like the white-tailed deer, probably was common in the region during the deposition of the cave-deposits. It was evidently commonest around CM68, and rare around CM24, even though the latter cave is at a lower altitude and nearer open country, which the mule deer prefer. However, presumably the open country near CM24 was too arid and of too purely a desert character to be entirely suitable. Borell and Bryant (1942, p. 41), reporting on the mammals of the Big Bend area of Texas, stated that the mule deer "ranges from about 2500 feet up to 5000 feet elevation, but is most abundant on the mesas and slopes between 3000 and 4000 feet. Between these elevations, grass, sotol, yucca, and several kinds of brush furnish food and shelter. The upper range of the mule deer overlaps the lower range of the white-tailed deer. The whitetail usually selects the rough, brushy habitats, whereas the mule deer favors more open areas, and its favorite habitat appears to be at the head of a draw which supports a good stand of sotol and grass."

Cervus canadensis, elk.—4 bone specimens, including 3 teeth (CM68, bottom level). The former occurrence of the elk in the Cuatro Cienegas region is a distinct surprise. The usual historic records, and specimens, do not place the elk farther south than extreme northern Chihuahua at the New Mexican border (Bailey, 1932, p. 88, map) and extreme northeastern Sonora (Mearns, 1907, p. 213). However, Nelson (1925, pp. 1–2), citing "Torquemada's Monarquia Indiana (vol. 1, book 5, pp. 611–612)" for references to the antelope, quoted a "great hunt made in honor of the viceroy . . . . in 1549 . . . . in the extreme south-

western part of the State of Hidalgo and adjoining parts of the State of Mexico . . . . [at a place] known from that day to the present as the Llano de Cazadero . . . ." At this hunt, besides many deer and a number of antelope, were taken some "large stags", which, when now considered with the specifically mentioned deer and antelope, probably were elk. This is borne out by references in the obscure publication of Ignacio de Armas (1888, pp. 75–76), who quoted the following early Spanish authors as listing in Mexico a large "ciervo" like the *Cervus elaphus* of Spain (the European elk, or red deer).

Hernandez mentioned "aculliame" (singular "aculliatl") with form and size like the Spanish elk (Ignacio de Armas considered this the moose, *Alces*, which does not seem justified). Alcedo described a large deer from "Nuevo Mejico" as "alanes (*Cervus alces*)" which was surely elk and not moose (although considered such by Ignacio de Armas). Torquemada (Monarquia Indiana, book 14, p. 41) listed large deer called "ciervos" in the "cordillera de Malpaises, y Cerros Bajos". Torquemada also mentioned deer "like the proper and natural elk of Spain" in the "sierras de Perote y de Maltrata". Torquemada (book 5, p. 12) mentioned a viceroy's hunt in Durango, at Otomies, between "Xilotepec y San Juan del Rio", where many large elk of Spain were captured with 600 deer (this is probably a different viceroy's hunt than the one quoted above by Nelson from Torquemada).

Bailey (1932, p. 42) quoted Humboldt to the effect that Montezuma showed to companions of Cortez some enormous stag antlers which Humboldt thought might have come from Monterey, California (*Cervus nannoides*, the tule elk), but which Bailey thought were probably obtained from southern New Mexico. More probably these antlers (certainly those of elk) came from central eastern Mexico not far from Mexico City.

These references, together with the Cuatro Cienegas specimens, indicate the certain former presence of the elk in Mexico in historic and protohistoric times. However, extinction in Mexico must have been rapid following the 16th century, and the elk may be presumed to have been scarce even then; late historic records are not known to me.

On the above dating of the elk in Mexico, the specimens from Cuatro Cienegas, cave CM68, probably do not indicate considerable antiquity, although they came from the lowest levels of the cave. However, they may contribute to the general evidence of former slightly greater rainfall and lower temperature in the region during deposition of the archeological material. The elk is not speleophilic, and the cave remains should be the result of predator or human activity. The specimens are deposited with the U. S. National Museum, Division of Mammals.

Bison bison, bison.—8 bone fragments (1 from CM24, 7 from CM68). Some of these specimens are questionably referred to bison. The bison ranged into Mexico, at least as far as 25 degrees N. at the time of the Spanish discovery (Allen, 1876, p. 129), and Montezuma had in his menagerie at least one individual that Hornaday said must have come from Coahuila (Hornaday, 1889, p. 373, quoting Antonio de Solis, Historia de la Conquista de Mexico, 1684, ed. 1724).

CERTAIN MAMMALS ABSENT FROM THE CAVE SITES

The absence of certain mammals from archeologic sites is often as interesting as the presence of others. This absence of remains may mean unimportance of the species to the aborigines or deliberate avoidance by them, or it may mean complete absence from the region at the time of deposition of the archeologic material. The concluded absence of a certain species from a region *can* be interpreted as meaning absence of some one or several factors that are associated with the optimum conditions under which that species lives. This has been stated in Liebig's law of the minimum, developed into the law of tolerance by Shelford (1913, p. 303).

In the following account, only the most important cave "absentees" will be discussed.

Didelphis marsupialis, opossum.—This species was included in a provisional list of mammals likely to occur in the Cuatro Cienegas region. However, their remains were absent from the cave sites, and no opossums were seen by Taylor in 1940–41. Probably the aridity of the region is and was too extreme. Had the species been present, its remains quite cer-

tainly would be represented, because the animal is of an appropriate size (6 to 10 lbs.) for food, and is easy to capture.

Dasypus novemcinctus, nine-banded armadillo.—As with the opossum, and for the similar reason of extreme aridity, this species was not found. In southwestern Texas, Bailey (1905, p. 54) noted the occurrence of the species in the semi-arid "Lower Sonoran Zone", but not "to any extent into the extremely arid region west of the Pecos." The armadillo since then has extended its range eastward to the Mississippi, but has not penetrated farther into the extremely arid regions to the west (see Kalmbach, 1943, p. 5, fig. 1).

This animal where it is found is a more prized food item than the opossum, and is as easy to capture. Absence of its remains, which include such characteristic hard parts as the carapace and distinctive bones, is good evidence of complete absence of the species from the region.

Canis familiaris, dog.—There are no definitely identified remains of dog. Some bones are listed as "coyote or dog", or "wolf or dog", but these probably should be coyote and wolf respectively, because if dog had been present, good specimens should have been found.

Felis pardalis, ocelot.—This tropical cat has penetrated into the southern fringes of Nearctica, but it is not common there and its absence from the cave sites does not mean necessarily absence from the arid Cuatro Cienegas region.

Cynomys mexicanus, Mexican prairie-dog.—It was hoped that remains of this species, now restricted to a small area of southern Coahuila and northern San Luis Potosi, would be found. Then, perhaps, an explanation could be given for its present isolated range. The species is colonial and highly palatable, and absence of remains should indicate absence from the region during the time of cave deposition. This may mean, if suitable, open, grassy habitat exists around Cuatro Cienegas, that *C. mexicanus* long has been separated from its nearest relative, *C. ludovicianus*, or that former contact was once to the eastward of Cuatro Cienegas. *C. ludovicianus* now is not found south of latitude 30, some 250 miles north of the range of *C. mexicanus*.

Tayassu angulatus, collared peccary.—The absence of remains of the peccary should indicate absence from the region during cave occupation, as is the case today. Taylor found no evidence of it in 1940–41. The animal is prized for food and hide where found, and also makes a good pet when young.

Such absence is explainable on the basis of extreme aridity, as is the case with the absence of the opossum and the nine-banded armadillo, even though peccary habitat of brush and oak-thicket is present. Bailey (1905, p. 55) showed that the distribution of the peccary in Texas did not include the arid region west of the Pecos, nor did it include the arid, grassy Staked Plains. Borell and Bryant (1942, p. 39) showed that the peccaries were found in a few places in the Big Bend region west of the Pecos, although much desirable habitat there was uninhabited by them. Nevertheless, it seems clear that the peccary is not tolerant of extremely arid conditions, and hence probably is absent from most of the Chihuahua-Zacatecas province. This would account for its absence from the Cuatro Cienegas region.

European domesticated mammals (sheep, goat, horse, pig). No definite remains of any of these mammals were found in the cave debris. This may be good evidence for the pre-Columbian age of the sites. One doubtful bone of sheep was found, but this is not conclusive. Taylor states verbally that in the last few years, goats have been stabled in the CM68-cave. However, they left no bony remains on the surface.

SUMMARY

A total of 2105 mammal bone fragments, collected by the U. S. National Museum Coahuila Expedition, were examined from several cave sites in Cuatro Cienegas. Of these, 1746 were identified as belonging to 39 species. Most of these species are utilizable as food by humans; some are also natural cave-inhabitants; others may be adventitious as archeologic cave specimens. The most important human food species appear to have been the mule and white-

tailed deer, followed by cottontails and jack rabbits, and the rock and spotted squirrels. Antelope, mountain-sheep, bison, and elk were present, perhaps in numbers, although their remains are relatively scarce. The large number of remains of wood rat probably means some degree of former human utilization, together with some extent of natural occurrence as cave inhabitants in the absence (or even presence) of man. The remains of the cacomistle may be judged similarly. Many bones are in a fine state of preservation, even with tendons adhering, but this, because of the generally favorable condition for preservation in caves in the arid "southwest", may not mean recent age (less than 500 years or so). Nothing in the faunal debris suggests anything more than moderate antiquity.

Noteworthy occurrences of mammal species are those of the elk and the yellow porcupine. Neither species has been recorded hitherto so far south, and both appear to have become extinct in northern Mexico within the last 500 years or so. This local, progressive southern extinction of the elk, procupine, and some other mammals is a recent phenomenon. It appears to have been natural, and presents a problem worthy of more investigations.

Unexpected absences are those of the opossum, armadillo, Mexican prairie-dog, and especially the collared peccary and the dog. The absence of European domesticated mammals indicates a pre-Spanish contact date for the aboriginal human occupancy. The absence of the collared peccary is a problem in itself for further study; the apparent reason of extreme aridity may not be as good as supposed.

Certain differences in species occurrence and species abundance, according to cave sites, may be explainable on the different conditions that immediately surround each cave. Thus, CM24, near the floor of the basin, had a greater number (some exclusively) of purely desert mammals which frequent cactus-creosote bush-mesquite-grass-sand areas, *e.g.*, jack rabbits, cottontails, desert wood-rats, small ground-squirrels, pocket mice, kangaroo rats, and the pocket gopher (*Cratogeomys*). On the other hand, CM68, far up the head of a rocky canyon, had a greater number of rock, brush and timber inhabiting species (some exclusively), *e.g.*, cacomistle, spotted skunk, gray fox, rock squirrel, porcupine, mountain sheep, deer, and elk. Some of these differences, however, may be the result also of the facts that CM68 is a larger cave with much more debris than CM24, and probably was inhabited by humans longer. Biotic conditions around cave CM68, in conjunction with its large size, appear to have favored the locality for human residence over the other caves excavated in the region.

There is some faunal evidence that the climate was more humid during deposition of the cave debris than it is today. The striped and hog-nosed skunks, and especially the raccoon and cotton-rat, suggest the presence of permanent water near the caves. The porcupine and the elk suggest slightly lower temperatures and perhaps more humidity. On the other hand, the absence of the opossum, armadillo and the peccary indicate that former conditions were as unfavorably dry for these animals as are conditions today. Furthermore, the

porcupine and elk may have been relict survivors long after the climate had approximated its present condition. Finally, lack of a present day mammal and ecologic survey of the region makes any of the interpretations risky.

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CRICETINE RODENTS ALLIED TO PHYLLOTIS

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Classification of the cricetine rodents of South America encounters unusual difficulties. Knowledge of them has been acquired piecemeal over a long period and some past mistakes still trouble the present. Both specific and generic names have been applied rather freely on the basis of characters which at one time seemed sufficient but which become increasingly unsatisfactory as connecting forms continue to be discovered. Oldfield Thomas, who is responsible for most of the names and for preliminary attempts at natural groupings, seldom had large series of specimens from contiguous regions and he was not much given to synthesis. The high degree of differentiation which may exist notwithstanding complete intergradation was not often evident to him and, at least in some cases, characters thought to be generic have proved to be scarcely more than subspecific. On the other hand, there was considerable justification for the divisions made by Thomas and others, since the morphological differences observed in limited and scattered material were often such as elsewhere had proved to be diagnostic and unconnected. As more and more material is studied it becomes evident that standards established for older faunas in other continents fail in South America.

These cricetines entered South America from the north, some of them apparently in late Pliocene and a greater number doubtless in middle or late Pleistocene, some probably in comparatively recent times. Those which differ most from existing northern forms may be assumed to have had a longer residence and lineage in the south, but all are so closely interconnected that many individual cases are very puzzling and probably cannot be clearly understood until or unless paleontological evidence greatly exceeds what is now available. A common experience with recent workers is to find species that combine the characters of two, three, or more supposed genera long recognized and apparently well characterized. The disposition of such species thus becomes a problem.