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THE LATE CENOZOIC VERTEBRATE FAUNAS FROM THE SAN PEDRO VALLEY, ARIZ.

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The collections of fossil vertebrate remains in the United States National Museum from deposits in the San Pedro Valley of southeastern Arizona have come to be of much significance in including materials representing appreciable portions of previously little-known microfaunas of upper Pliocene and early Pleistocene stages. The study of these materials, for the most part collected by J. W. Gidley, was undertaken by him but never completed. Important parts of the two principal collections were left undescribed, so that our knowledge of the faunas as a whole was dependent upon a somewhat inaccurate list, compiled before portions had been studied and before some portions were prepared. Hence, it has been found advisable to complete the undertaking by including in the present paper brief discussions of the elements of both the described and undescribed portions. Revision has been made of certain identifications and conclusions, where such changes are indicated by more recent information.

I wish to express my gratitude to the staff of the Division of Mammals of the United States National Museum, for permitting me unrestrained access to the collections of Recent mammals, and to C. W. Hibbard, of the University of Kansas, for information pertaining to materials from the upper Pliocene of Kansas and for the privilege of examining carnivore and rodent materials therefrom. The drawings depicting *Canis edwardii*, new species, *Spilogale pedroensis*, new species, and *Tanupolama* cf. *longurio* were made by Sydney Prentice. The others, except for a camera lucida drawing of *Sylvilagus? bensonensis*, new species, were made by Rudolf Weber.

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PREVIOUS INVESTIGATIONS

A first systematic search of the fossiliferous deposits was made by Gidley early in 1921, when, in cooperation with the United States Geological Survey and in the company of Kirk Bryan, he examined and collected from localities discovered by Bryan the previous year. The expedition proved to be of marked success, resulting in a collection of materials that included specimens of exhibition value and a representation of faunas of considerable scientific interest, being the earliest to portray sizeable microfaunae of a relatively obscure portion of the Cenozoic.

A popular account of the expedition (Gidley, 1922a) appeared in a report on the Explorations and Field Work of the Smithsonian Institution in 1921. Gidley's preliminary report on the collection and detailed description of the rodents and lagomorphs were published by the United States Geological Survey in 1922, and in 1926 his report of the Proboscidea and Edentata appeared. C. W. Gilmore, in 1922, described a new turtle from the Benson occurrence, and in 1928 and 1938 included statements on the lizard and snake remains from the Benson and Curtis Ranch localities, respectively, in his monographs on these groups. Remains of the rather large avifauna, principally from Benson, were studied by Alexander Wetmore (1924).

The two faunas as a whole, or in part, have been the subject of much discussion in subsequent writings, including those of Hay (1927), Osborn (1936), J. R. Schultz (1937), and Wilson (1937); and new forms were added to the faunas by Frick (1937), Stirton (1931), and A. E. Wood (1935).

On a second trip to the San Pedro Valley in 1924 Gidley made a collection from the Benson and Curtis ranch localities for the American Museum under a grant from Childs Frick. The materials in this collection, except for the heteromyid rodents examined by Wood, have not been described. Additional collecting in these beds has been done by parties for Mr. Frick, and the horned ruminant material therein was described by him (1937).

In the company of E. L. Furlong, I visited the San Pedro Valley in 1928, and together we made a small collection of mammal remains, including the type of *Simonycteris stocki*, from the Curtis ranch for the California Institute of Technology. Again in 1936 I was permitted to revisit the San Pedro Valley for the Smithsonian Institution, and the party of that season was successful in securing additional specimens of small mammals from both the Benson and Curtis ranch localities. A popular account of the 1936 expedition was included in the Smithsonian Institution report of explorations for that year.

BIBLIOGRAPHY ON FOSSIL VERTEBRATES FROM SAN PEDRO VALLEY, ARIZONA

FRICK, CHILDS.

1937. Horned ruminants of North America. Bull. Amer. Mus. Nat. Hist., vol. 69, pp. i–xxviii, 1–669 (507, 527), figs. 1–68.

GAZIN, CHARLES LEWIS.

1937. Hunting for fossil mammals in the Navajo Country. Explorations and Field-Work of the Smithsonian Institution in 1936, pp. 19–22, figs. 13–16.

GIDLEY, JAMES WILLIAMS.

1922a. [Field explorations in the San Pedro Valley and Sulphur Springs Valley of southern Arizona] Explorations and Field-Work of the Smithsonian Institution in 1921, pp. 25–30, figs. 27–30.

1922b. Preliminary report on fossil vertebrates of the San Pedro Valley, Arizona, with descriptions of new species of Rodentia and Lagomorpha. U. S. Geol. Surv. Prof. Paper 131–E, pp. 119–131, pls. 34, 35.

1926. Fossil Proboscidea and Edentata of the San Pedro Valley, Arizona. U. S. Geol. Surv. Prof. Paper 140–B, pp. 83–94, pls. 32–44.

GILMORE, CHARLES WHITNEY.

1922. A new fossil turtle, *Kinosternon arizonense*, from Arizona. Proc. U. S. Nat. Mus., vol. 62, art. 5, pp. 1–8, pls. 1–5.

1928. Fossil lizards of North America. Mem. Nat. Acad. Sci., vol. 22, pp. i–ix, 1–201 (29), figs. 1–106, pls. 1–27 (pl. 27, fig. 6).

1938. Fossil snakes of North America. Geol. Soc. Amer. Special Paper No. 9, pp. i–vii, 1–96 (70), figs. 1–38, pls. 1–3.

HAY, OLIVER PERRY.

1927. The Pleistocene of the western region of North America and its vertebrated animals. Carnegie Inst. Washington Publ. 322B, pp. 1–346 (3, 10, 54, 78, 80, 136–137), figs. 1–19 (4), maps 1–20 (1, 2, 9, 12, 13), pls. 1–12.

OSBORN, HENRY FAIRFIELD.

1936. Proboscidea, a monograph of the discovery, evolution and extinction of the mastodonts and elephants of the world, vol. 1: pp. i–xl, 1–802 (565–566, 678–682), figs. 1–680 (526, 634, 635, 640, 646–649), pls. 1–12.

SCHULTZ, JOHN R.

1937. A late Cenozoic vertebrate fauna from the Coso Mountains, Inyo County, California. Carnegie Inst. Washington Publ. 487, pp. 75–109 (85–86, 94, 98), figs. 1–5 (1–3), pls. 1–8.

STIRTON, RUBEN ARTHUR.

1931. A new genus of the family Vespertilionidae from the San Pedro Pliocene of Arizona. Univ. California Publ. Bull. Dept. Geol. Sci., vol. 20, No. 4, pp. 27–30, figs. 1–2.

WETMORE, ALEXANDER.

1924. Fossil birds from southeastern Arizona. Proc. U. S. Nat. Mus., vol. 64, art. 5, pp. 1–18.

WILSON, ROBERT WARREN.

1937. Pliocene rodents of western North America. Carnegie Inst. Washington Publ. No. 487, pp. 21–73 (39–40, 62–64, 68).

WOOD, ALBERT ELMER.

1935. Evolution and relationships of the heteromyid rodents with new forms from the Tertiary of western North America. Ann. Carnegie Mus., vol. 24, pp. 73–262 (107, 146–148, 156–159), figs. 1–157.

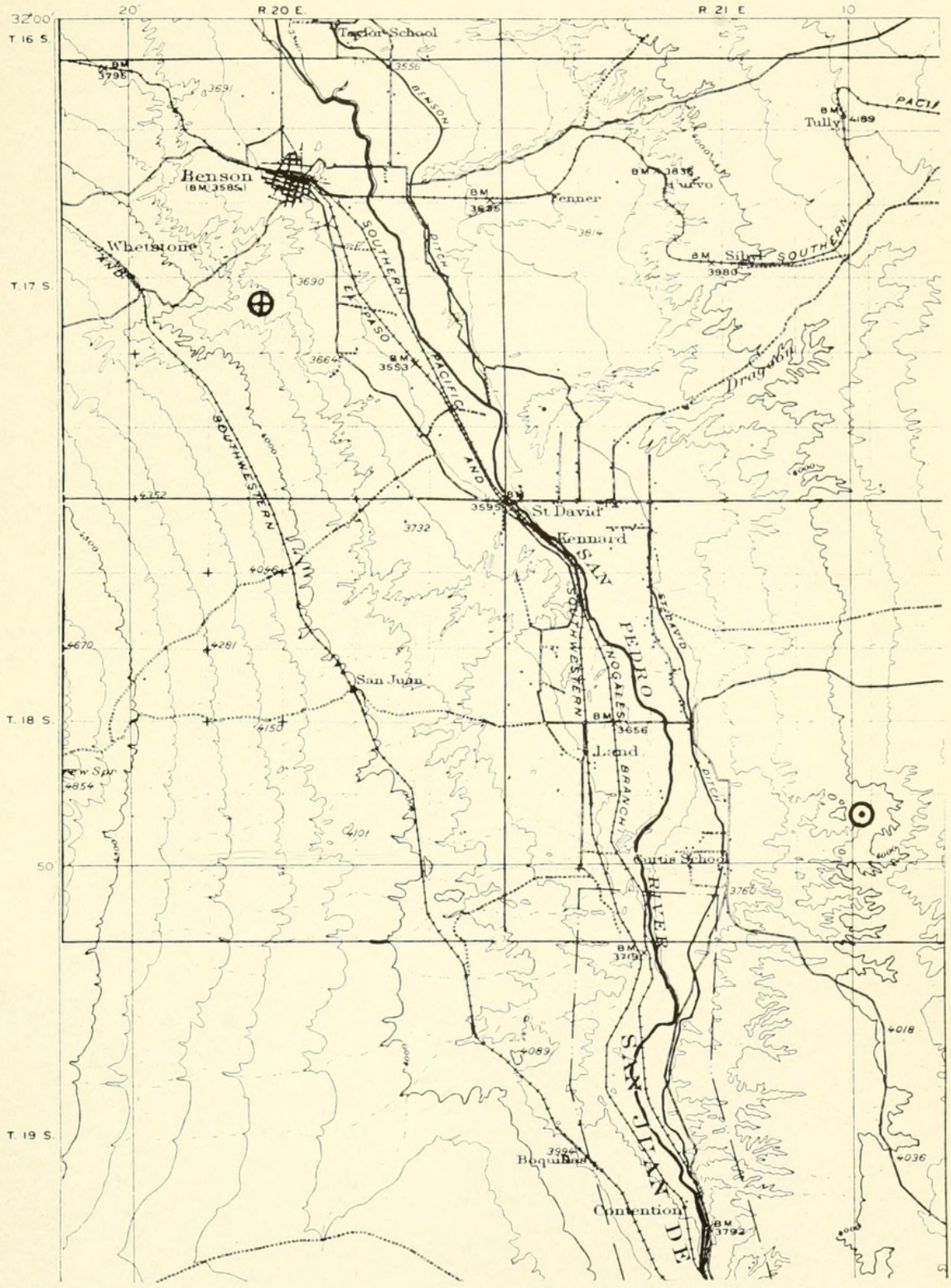
OCCURRENCE AND PRESERVATION OF THE MATERIAL

The principal sites in the San Pedro Valley from which collections were made have come to be known as the Benson and Curtis ranch localities (pl. 42). The Benson occurrence is about 2 miles south of the town of Benson to the west of the San Pedro River. The location is given by Gidley as sec. 22 (this appears to be sec. 21), T. 17 S., R. 20 E. (1926, p. 85), and all the Benson rodent and lagomorph materials collected are stated by him (1922, p. 119) to have come from one spot, a fossil bone quarry. The bone from here, though brittle and apparently well petrified, is light buff or ivory in color, superficially resembling recent bone.

The Curtis ranch locality is about 12 miles southeast of Benson, or about halfway between Benson and Tombstone in a straight line. The mesa at this point is cut back to form a large amphitheatre to the east of the San Pedro River. The locality where Gidley obtained the Curtis ranch rodent collection (pl. 43, fig. 1), one of the mastodonts, and a glyptodont (pl. 43, fig. 2) is about 2 miles in a northeasterly direction from the Curtis ranch house, near the line between secs. 28 and 29, T. 18 S., R. 21 E., on land adjacent to the Curtis ranch proper. The rodent, lagomorph, and mustelid material collected by the 1936 party was all from Gidley's locality, although that collected for the California Institute of Technology in 1928 was from a site about half a mile or more to the west and nearer the ranch house. The bone from the Curtis ranch embayment is light gray or nearly white to black, and often much checked, with calcareous material adhering to it. The small mammal jaws from the rodent locality are nearly all slate-gray or black in contrast to the buff or ivory colored Benson specimens.

The manner in which the fossil materials accumulated in the San Pedro Valley deposits has been discussed by Gidley (1926, p. 84), and his rather vivid account is included herewith:

> The stratified beds of these localities consist principally of red clays, sands, and soft limestones that were evidently laid down in salt lakes of small extent in the central part of the Pliocene basin.
>
> The bones occur for the most part in relatively small patches or layers of greenish tuffaceous clay, which, according to Byran, interfinger on one side with arkosic gravel and conglomerate typical of deposition on alluvial slopes and on the other with the lake beds. This position seems to confirm Bryan's view that these bone-bearing patches of greenish clay represent the marginal and fresh-water springs that are characteristic of the borders of salt lakes in such basins. The localities thus probably constituted the chief watering places for the animals of the region, and here naturally occur their fossil remains.
>
> That these areas were once boggy water holes is supported by the condition and arrangement of the bones they contain. For example, the skull of one of the mastodons was found completely covered by the undisturbed original matrix



Portion of Benson Quadrangle, Arizona, U. S. Geological Survey, showing location of Benson (⊕) and Curtis ranch (⊙) fossil localities. Scale: About 3 miles to the inch. Contour interval: 100 feet.

1. View northeastward overlooking Curtis ranch *Stegomastodon* and rodent locality in foreground.

2. View westward across San Pedro Valley from Curtis ranch *Glyptotherium* locality in the immediate foreground. Whetstone Mountains in background.

and lying in a horizontal position resting on the lower jaws, but the top portion of the skull was crushed and eroded and the tips of the tusks reaching to the same level were broken. This damage had evidently been done while the skull yet lay partly buried in wet mud. Also the left fore leg of this animal was found in nearly normal position relative to the skull, but with the toes directed downward, reaching a level in the clay 2 feet below it. This position indicates that the animal came to his death by being hopelessly bogged. The position and arrangement of the other bones as found suggested that they had been moved about by being more or less trampled and disturbed by contemporary animals who were so fortunate as to escape being engulfed in the soft and sticky mud. A foot of each of the other two mastodons collected was found in a like position, giving additional evidence of boggy conditions. The carapace of *Glyptotherium* showed evidence of trampling. The top had been caved in before being completely covered and may have been thus crushed by the foot of a *Stegomastodon arizonae* while being partly buried.

SAN PEDRO VALLEY FAUNAS

A comparative list of the faunas from the two localities is given below:

Benson	Curtis Ranch
Amphibia:	
Amphibian remains	
Reptilia:	Reptilia:
Testudinata	Testudinata
Kinosternidae	Testudinidae
Kinosternon arizonense Gilmore	*Testudo* sp.
Squamata	Squamata
Iguanidae	Colubridae
Crotaphytus? sp.	Colubrid sp.
Aves:	Aves:
Colymbiformes	
Colymbidae	
Colymbus sp.	
Anseriformes	
Anatidae	
Querquedula sp.	
Dendrocygna eversa Wetmore	
Anabernicula minuscula (Wetmore)	
Anatid (indet.)	
Galliformes	Galliformes
Meleagridae	
Agriocharis sp.	
Phasianidae	Phasianidae
Colinus sp.	Odontophorid (indet.)
Gruiformes	
Rallidae	
Gallinula sp.	

Charadriiformes
Scolopacidae
Micropalama hesternus
Wetmore

Passeriformes
Corvidae
Corvus sp.
Fringillidae
Junco sp.
Fringillid (indet.)

MAMMALIA:

Carnivora
Canidae
Canid sp.
Mustelidae
Mustelid? sp.
Felidae
Felis sp.

Rodentia
Sciuridae
Citellus bensoni Gidley
Heteromyidae
Prodipodomys? minor
(Gidley)

Geomyidae
Nerterogeomys? minor
(Gidley), n. gen.
Cratogeomys bensoni
Gidley
Cricetidae
Baiomys minimus
(Gidley)
Peromyscus sp.

Columbiformes
Columbidae
Columba micula
(Wetmore)
Passeriformes

Fringillidae
Fringillid (indet.)

MAMMALIA:
Chiroptera
Vespertilionidae
Simonycteris stocki
Stirton
Edentata
Glyptodontidae
Glyptotherium arizonae
Gidley
Carnivora
Canidae
Canis edwardii, n. sp.
Mustelidae
Spilogale pedroensis, n. sp.
Felidae
Felis sp., near *F. lacustris*
Gazin
Felis sp., near *F. atrox*
Leidy
Rodentia
Sciuridae
Citellus cochisei Gidley
Heteromyidae
Cf. *Perognathus* sp.
Dipodomys gidleyi Wood
Dipodomys sp.
Geomyidae
Nerterogeomys persimilis
(Hay), n. gen.

Cricetidae
Baiomys brachygnathus
(Gidley)
Onychomys pedroensis
Gidley

Bensonomys arizonae (Gidley), n. gen.
Onychomys bensoni Gidley
Sigmodon medius Gidley
Neotoma fossilis Gidley

Lagomorpha
Leporidae
Hypolagus sp.

Sylvilagus? bensonensis, n. sp.
Leporid sp.

Proboscidea
Mastodontidae
Cordillerion bensonensis (Gidley)
Mastodont sp.

Perissodactyla
Equidae
Nannippus cf. *phlegon* (Hay)
Plesippus sp.

Artiodactyla
Tayassuidae
Platygonus sp.

Camelidae
Camelid sp.

Antilocapridae
Antilocaprid sp., possibly *Texoceros* sp.

Sigmodon curtisi Gidley

Sigmodon minor Gidley
Ondatra sp.

Lagomorpha
Leporidae
Lepus sp., near *L. californicus* Gray
Sylvilagus sp., near *S. floridanus* (Allen)

Proboscidea
Mastodontidae
Stegomastodon arizonae Gidley

Perissodactyla
Equidae
Equus sp.

Artiodactyla

Camelidae
Camelid sp.
Tanupolama cf. *longurio* (Hay)

Antilocapridae
Cf. *Capromeryx gidleyi* Frick

Cervidae
Cf. *Odocoilcus* sp.

AGE AND ENVIRONMENT OF THE FAUNAS

Gidley originally contended that both the Benson and Curtis ranch deposits were of late Pliocene age, based on what he considered to be a peculiar mingling of modern and more ancient forms. In 1926 he tentatively assumed that the Benson fauna was slightly older than that of the Blanco, and the Curtis ranch assemblage was a little younger. It should be noted, moreover, that the Blanco at that time was regarded as about middle Pliocene in age. Gidley's conclusions were arrived at under handicap, through lack of comparable faunas in other areas with which comparisons could be made, except for that of the Blanco with its dearth of smaller forms. He anticipated, however, that the San Pedro Valley faunas would eventually become standards of reference for the stages represented.

The Benson fauna may well be equivalent in age to that of the Blanco, although the faunas are not strictly comparable, perhaps

owing to environmental or geographic factors, but probably in a greater measure to chance preservation and collecting procedure. The horses represented, and in particular *Nannippus phlegon*, appear to be the strongest clue to their relative positions. The stage may be considered as belonging in upper Pliocene time as represented in our North American continental sequence. It definitely falls in the interval which we now call Blancan. Among the other known faunas of Blancan age are those from near Hagerman,[1] Idaho; Meade County,[2] Kans.; and several localities in California, including those currently recognized under the local faunal names Coso Mountains,[3] San Joaquin,[4] San Timoteo,[5] and Tehama.[6]

The Curtis ranch horizon was immediately recognized by Gidley as being somewhat younger than the Benson level, but considered to be Pliocene also. The reasons given for regarding the Curtis ranch level as pre-Pleistocene were somewhat mingled with those intended for the Benson stage, but may be segregated for the later horizon as pertaining to the mastodont, glytodont, canid, "*Merycodus*," and the rodents in general. Later work has shown, however, that *Stegomastodon* is known elsewhere in Pleistocene deposits, and the Curtis ranch form appears intermediate between *S. texanus* of the Blanco and *S. aftoniae*. The latter is regarded as somewhat younger than true Aftonian. *Glyptotherium arizonae* is more advanced than the Blanco form, and glyptodonts in general are known from much later stages of the Pleistocene, as in Florida. The "canid" humerus (fig. 44), exhibiting an entepicondylar foramen, was found to belong beyond question to a cat, as were all other parts of the same skeleton found near the rather modern appearing canid skull and jaws. The "*Merycodus*" material (fig. 47) is recognized as being antilocaprid and probably belongs to the species that Frick has named *Capromeryx gidleyi*. The rodents are all truly extinct species, but this does not preclude an early Pleistocene age.

Gidley was inclined to disregard the presence of *Equus* in the fauna. The species represented is not determined, and although it appears to be true *Equus*, it is not greatly removed from the *Plesippus* stage. This is shown in particular by a collection of upper teeth described in Gidley's notes as coming from the same level and about a hundred yards from a quarry that produced one of the mastodonts, *Canis edwardii*, the small cat, and Gidley's entire Curtis ranch rodent collection. Contributing to the evidence for a Pleistocene age assign-

[1] C. L. Gazin, Proc. U. S. Nat. Mus., vol. 83, pp. 281–320, 1936.

[2] C. W. Hibbard, Trans. Kansas Acad. Sci., vol. 40, pp. 239–265, 1937.

[3] J. R. Schultz, Carnegie Inst. Washington Publ. 487, pp. 75–109, 1937.

[4] J. C. Merriam, Trans. Amer. Philos. Soc., new ser., vol. 22, pt. 3, pp. 32–42, 1915. (As upper Etchegoin.)

[5] Childs Frick, Univ. California Publ. Bull. Dept. Geol., vol. 12, No. 5, pp. 314–334, 1921.

[6] R. D. Russell and V. L. Vander Hoof, Univ. California Publ. Bull. Dept. Geol. Sci., vol. 20, No. 2, pp. 11–21, 1931.

ment is the presence in the collection obtained from the above mastodont quarry of remains of true *Lepus* and apparently *Sylvilagus*, rather than *Hypolagus*.

The absence of *Nannippus* from the Curtis ranch occurrence, geographically so close to that of Benson, can scarcely be attributed to collecting chances or methods, as horse material of a fragmentary nature was observed at many places in the two areas, and none in the Curtis ranch embayment were of the *Nannippus* type. However, teeth of the Curtis ranch type of *Equus* were found by Bryan near a powder mill a couple of miles south of the Benson locality, opposite the town of St. David. These can scarcely be said to occur at the Benson level, but indicate rather the occurrence of deposits of Curtis ranch age on the west side of the valley, undoubtedly at a level stratigraphically higher than that nearer Benson.

It has been argued that there cannot be an appreciable time interval between the Curtis ranch and Benson occurrences because they occupy similar stratigraphic positions in the San Pedro Valley sequence. It is true that the interval between them is probably not great, but the distance and topographic features separating the two localities preclude any but speculative geologic correlation, nor is there any need to regard the sequence as having accumulated in a relatively short time.

To account for the differences between the faunas of the two localities and at the same time preserve what appears to be a nearly equivalent stratigraphic position, Gidley supposed that the Curtis ranch fauna as known did not evolve from that represented at Benson. This is in part obvious but is not necessarily proved for certain forms that may have come through, such as the larger cat and camel, the antilocaprid, kangaroo rat, pocket gophers, *Baiomys*, grasshopper mice, and cotton rats. Were the Benson fauna more completely known it seems likely that an even larger portion of the Curtis ranch ancestry would be included. In line with this it may be noted that glyptodont material was found in association with *Nannippus* and *Plesippus* from what may be regarded as the Benson stage in the nearby Gila Valley.

The forms that seem most likely to have been involved in important migrations during the interval between Benson and Curtis ranch time are the horses, deer, mastodonts, and lagomorphs, these together giving the more obvious criteria for age assignment.

Recently a relatively large fauna has been reported by Barbour and Schultz[7] from deposits in Morrill County, Nebr., regarded as early Pleistocene. This, the Broadwater fauna, has not been reported in full, and only a tentative list of the forms represented has been pub-

[7] E. H. Barbour and C. B. Schultz, Amer. Mus. Nov., no. 942, pp. 1–10, 1937.

lished, but these suggest the possibility of a stage not greatly different from that at Curtis Ranch.

The fauna from near Grand View, Idaho, studied in part by Wilson and the writer, has not been completely recorded. This fauna might be of a relatively early Pleistocene stage but appears to be close to that of Hagerman and may well be a slightly later stage of Blancan or upper Pliocene. The rodents, lagomorphs, and carnivores are more closely related to those of Hagerman than the Curtis ranch forms are to those of Benson. The horse from Grand View is regarded by J. R. Schultz as *Plesippus idahoensis*, a much larger form than *P. shoshonensis* and nearer true *Equus*.

Comparison of the San Pedro Valley faunas with that of Hagerman brings out a number of interesting facts pertaining to the environments of each. Although the Benson fauna is evidently close in age to that of Hagerman, the two San Pedro Valley faunas are more strikingly alike in the type of environment indicated, and quite unlike the Hagerman assemblage. The rodent group is most significant as indicative of habitat, and in both San Pedro Valley faunas has a large percentage of the more brachydont cricetine forms. These genera, though nearly all wide ranging in the modern fauna, are abundantly represented in tropical to arid southern regions. The heteromyids are related to forms of common occurrence in the desert regions of the Southwest. However, a watered area is in no way precluded, and is evident from the avifauna and suggested by certain of the rodents. Standing water or streams of a saline nature would discourage the more water-loving types of mammals, though ducks and the like might be plentifully represented.

In contrast to this the Hagerman fauna shows a preponderance of forms associated with fresh water. These include fishes, frogs, aquatic birds, otter, beaver, and muskratlike forms. The birds are all aquatic, otters are the most common of the Carnivora, and the rodents are predominantly beaver or of the hypsodont, microtine type of cricetids.

SYSTEMATIC DESCRIPTION OF THE BENSON MAMMALIAN FAUNA

Order CARNIVORA

Canid sp.

A relatively large canid is indicated by the presence in the Benson collection of an incomplete third metatarsal, No. 12859. The bone is proportioned about as in material of *Aenocyon dirus* from Rancho La Brea but is somewhat larger. In robustness it compares favorably with a third metatarsal from the Pliocene at Long Island, Kans., referred to *Aelurodon*, but though incomplete distally, the Benson specimen appears to have been longer.

Mustelid ? sp.

Gidley (1922, p. 120) indicated in his list of the San Pedro Valley faunas the presence of mustelid material in the Benson as well as in the Curtis ranch collections. I have been unable to find any specimen of this type in the Benson collection, and although it may have been lost it is possible that the check in Gidley's table indicating its occurrence at Benson may have been a misprint. However, Osborn in his proboscidean monograph (1936, p. 680) indicated in a list of the combined San Pedro Valley faunas the presence of material of a small species of mustelid in the American Museum Benson collection, presumably that made by Gidley in 1924. This too, Dr. Granger informed me, does not seem to be extant. It is highly probable that mustelids were in the Benson fauna, but since this cannot be demonstrated the listing of such is queried.

FELIS sp.

The distal portion of a humerus and three incomplete toe bones of a large cat were found by me near the Benson locality in 1936. The portion of a humerus exceeds in size corresponding material of *Felis concolor* in the National Museum collections but can be closely matched in one of the jaguar skeletons. The fragment, however, shows no important characters allying it to either the puma or jaguar, and the entepicondylar foramen differs somewhat from that in both in being more slitlike and not so distally placed.

Order RODENTIA

CITELLUS BENSONI Gidley

The ground-squirrel material from the upper Pliocene locality near Benson includes the type, No. 10531, consisting of M^1 (probably) and part of P^4 from the right side and M^3 from the left, three lower jaw portions from different individuals exhibiting one, two, and three teeth each, and a few isolated lower teeth.

Citellus bensoni is a little smaller than *C.* (*Otospermophilus*) *beecheyi*, and the teeth are not of the true *Citellus* type, in which there is a development of high, compressed transverse lophs, but correspond more nearly to those in forms belonging to the *Otospermophilus* group, in which some character of the individual cusps is retained. The lingual portion of the upper teeth, notably M^1, does not appear to be so extended anteroposteriorly with the crests at the anterior and posterior margins of the tooth joining the protocone without so marked a lingual expansion. The metaconule in M^1 is conical, more clearly separated from the protocone and closer to the metacone than in M^1 of *Otospermophilus* dentitions, somewhat as in

P^4 of the modern material. In the preserved portion of the fossil P^4 the conical metaconule is even more closely joined to the metacone, also in P^4, the crest at the anterior margin of the tooth appears better developed than in Recent *Otospermophilus*, almost as prominent as in M^1 but for a much less portion of the width of the tooth. M^3 has a relatively smaller talon portion, and shows a small conical cusp in the basin somewhat lingual to the center. Moreover, none of the upper teeth of the type show a mesostyle as seen in upper teeth of some individuals of *O. beecheyi*.

The lower teeth in jaws referred to *C. bensoni* even more closely resemble those in *Otospermophilus* forms. The differences are not striking and consist principally of a slight but distinct notch dividing the crest between the metaconid and protoconid of M_1 (suggestive of P_4), a somewhat more deepened basin immediately adjacent to the crest between the protoconid and hypoconid in all, and a relatively small talonid on M_3.

PRODIPODOMYS ? MINOR (Gidley)

A single right mandibular ramus, No. 10499, in the Benson collection apparently represents an ancestral form close to *Dipodomys*. The specimen includes the incisor and P_4, and exhibits the alveoli for the molars. It is incomplete anteriorly along the inner wall of the incisor and the angle is not entirely preserved.

The jaw of *Prodipodomys ? minor* is a little smaller and slenderer than in *Dipodomys ordii*. The symphysial portion and ascending ramus are shorter and the coronoid relatively smaller than in *D. ordii*, although the length of the tooth row is comparable, as indicated by the alveoli. The masseteric crest is for the most part indistinct but terminates anteriorly in a conspicuous swelling, not so prominent, however, as in most recent material. Also, the fossa lingual to the ascending ramus and posteroexternal to the molars is not nearly so deep or so well defined.

P_4 conforms very closely to that in *D. ordii*, and the pattern can be closely if not exactly matched in Recent teeth. M_1, however, was distinctly larger than in *D. ordii*, and appears from the configuration of bone in the bottom of the alveolus to have had small roots, as indicated for *Prodipodomys kansensis*.[8] M_2 was a little smaller than M_1, and M_3 appears to have been distinctly small, smaller than in *D. ordii*.

A. E. Wood (1935, pp. 155–156) referred a specimen, Amer. Mus. No. 27790, from the Curtis ranch locality to this species. It seems probable, however, that the form represented is not the same. Wood states that the molar (M_1) is rootless, an advance over the rooted

[8] C. W. Hibbard, Trans. Kansas Acad. Sci., vol. 42, p. 458, 1939.

condition indicated by the alveolus of the otherwise hypsodont M_1 in the type of *P. ? minor.*

The evidence of small rootlets on M_1 of *P. ? minor* might suggest that this form should be referred to *Cupidinimus;* however, teeth in *P. ? minor* are markedly hypsodont, and correspondence to the modern genus, *Dipodomys*, in this and other characters seems much closer than to *Cupidinimus*, as characterized by the genotype, *C. nebraskensis.*

Upper teeth, Amer. Mus. No. 21835, from the Benson locality, which Wood (1935, pp. 146–148) referred to *Cupidinimus magnus*, include grooved upper incisors as in *Dipodomys*, but the first two cheek teeth preserved are stated to be rooted. These are markedly hypsodont though much worn. On the basis of Wood's description it seems probable that these are upper teeth of *P. ? minor.*

NERTEROGEOMYS ? MINOR (Gidley)

The Benson species described by Gidley as *Geomys minor* is believed to represent the new genus *Nerterogeomys*, described in the portion of this paper concerned with the Curtis ranch fauna, and having for a type the species *Geomys persimilis* Hay.

The type of *Nerterogeomys ? minor* is a right mandibular ramus, No. 10494, with the incisor and P_4 to M_2. To this was referred an upper incisor, No. 10534, and a few isolated cheek teeth. Unfortunately, the illustration given by Gidley for the upper incisor was interchanged with that for a *Cratogeomys bensoni* incisor, so that the small incisor shown in his plate 34, figure 11, is actually that belonging to *Nerterogeomys ? minor* and not *Cratogeomys bensoni.*

The lower jaw of *N. ? minor* is a little smaller than that of *Geomys texensis* and with somewhat narrower teeth, although the enamel on these is arranged as in the living species. The fossa for the temporal muscle on the lingual side of the ascending ramus and posterolateral to the molars is not so deep and does not extend so far forward as in Recent *Geomys* but is apparently better developed than in *Thomomys.* Also, the masseteric crest extends a little farther forward with respect to the cheek teeth, with the mental foramen below its anterior extremity as in *Nerterogeomys persimilis*, lower and more posteriorly placed than in *Geomys texensis.*

The upper incisor referred to this species conforms in size and is of the bisulcate type characteristic of *Geomys* and *Nerterogeomys.*

CRATOGEOMYS BENSONI Gidley

The type of *Cratogeomys bensoni* is a left lower jaw, No. 10495, carrying all the cheek teeth but lacking the incisor. To this species were referred four additional lower jaws having various teeth preserved and an isolated upper and lower incisor. As noted in the above description of *Nerterogeomys ? minor*, the figure of the upper

incisor of *C. bensoni* in Gidley's paper on these rodents was interchanged with that of *N. ? minor*, so that the tooth shown in his plate 34, figure 8, is actually that intended to portray *C. bensoni* rather than *N. ? minor*.

Cratogeomys bensoni is a much larger pocket gopher than either the later *Nerterogeomys persimilis* or the contemporary *N. ? minor*, about equaling in size *Geomys breviceps* and some specimens of *Cratogeomys castanops* of the Recent fauna of Texas. *C. bensoni* was regarded as belonging to *Cratogeomys* on the basis of the upper incisor, which exhibits a single median groove; however, on close inspection it appears that there is a very slight inner groove at certain points along the length of the incisor. Nevertheless, the development of an inner groove is not comparable with that in typical *Geomys*. Some of the other more southern forms such as *Platygeomys* are characterized as in *Cratogeomys* by a single median groove, but the differences between these various *Geomys*-like gophers may not be of more than subgeneric importance.

The lower jaw of *C. bensoni* is a little slenderer than in the Recent forms, *Geomys breviceps* and *Cratogeomys castanops*, and the fossa for the temporal muscle, though much better developed than in *N. ? minor*, is not so deep as in *G. breviceps* or nearly so deep as in Recent *Cratogeomys*. The masseteric area and crest are not so expanded laterally. The mental foramen is posterior in position and more nearly ventral to the anterior extremity of the masseteric crest than in either Recent *Geomys* or *Cratogeomys* but does not differ in this respect from the Recent material so much as do *N. ? minor* and *N. persimilis*.

The lower cheek teeth have the enamel distributed as in *Geomys* and *Cratogeomys*, but are a little narrower than in the Recent forms, and the reentrants separating the columns of P_4 are more open than in *Geomys*, although in the type the reentrants do not so effectively separate the columns as in Recent *Cratogeomys*. However, in two of the specimens referred to *C. bensoni* the columns of P_4 are connected by a narrow, elongate isthmus almost as in *Cratogeomys*, though possibly not so constricted. M_3, present in the type only of *C. bensoni*, has a slight constricted portion at the posterior margin, or grooved as Gidley has indicated.

BAIOMYS MINIMUS (Gidley)

The type and only known specimen of this species is a left lower jaw, No. 10500, with all the teeth. The jaw and teeth are slightly smaller than in *Baiomys taylori* or the Curtis ranch *Baiomys brachygnathus*. The teeth, though a little worn, appear to be more brachydont than in *B. taylori*, and as noted by Gidley, the anterior lobe of the first tooth is narrow and double cusped. In *B. brachygnathus*

this tooth is wider anteriorly but is so worn that any division of the anterior cusps has been obliterated. The last tooth in *B. minimus* is reduced to about the extent seen in *B. taylori*, not so much as in *B. brachygnathus*.

PEROMYSCUS sp.

A single right ramus, No. 10502, lacking the cheek teeth, but possessing the incisor seems referable to *Peromyscus*. The tooth row as indicated by the alveoli is slightly longer than in the material of *Peromyscus maniculatus gambelii* examined, to which form Gidley compared the specimen, but is more nearly comparable, except for the slenderness of the incisor, to specimens of *P. truei truei* or *P. eremicus anthonyi* from the modern fauna of Arizona.

BENSONOMYS, new genus

Generic characters.—Near *Eligmodontia* with knoblike process at anterior extremity of masseteric crest on lower jaw, last lower cheek tooth reduced, and sulcus between capsular and coronoid processes. Removed from *Eligmodontia* in having deeper lower jaw, dorsally placed mental foramen closer to process at extremity of masseteric crest, more brachydont cheek teeth, notch on anterior lobe of first lower cheek tooth better developed, lower incisor more procumbent.

Genotype.—Eligmodontia arizonae Gidley.

BENSONOMYS ARIZONAE (Gidley)

In addition to the type, which is a left lower jaw, No. 10503, with a complete dentition this species is represented in the Benson collection by three other jaw portions that have preserved one, two and three cheek teeth, respectively. The incisor is present in each, except the jaw with one cheek tooth.

In Gidley's paper on the San Pedro Valley rodents the illustrations pertaining to "*Eligmodontia*" *arizonae* were unfortunately mixed with those of *Onychomys bensoni*, so that the citation, plate 34, figure 15, preceding the text for "*E.*" *arizonae*, refers to a photograph of the type of *O. bensoni* that in no way conforms to the description given for "*E.*" *arizonae*. The type of *Bensonomys arizonae* is actually shown in plate 35, figure 3, captioned *O. bensoni*. The paratypes of *B. arizonae* together with the description given for the type leave no doubt as to the true identity of type specimens. While the illustrations of the two type specimens involved are of little or no value in portraying the specific characters indicated in the text, they have in the past served to identify, erroneously, the specimens intended as the types, thereby confusing research and comparisons that have been made with these specimens.

B. arizonae is about the size of the living *Eligmodontia morgani* of South America, which it resembles in many respects, and at the same time differs from *Peromyscus*, notably in the anterior extension of the masseteric crest into a prominent knoblike process anteroexternal to the anterior root of the first cheek tooth, the dorsal position of the mental foramen, the reduction of the last lower cheek tooth, and the depth of the sulcus between the capsular and coronoid processes. *B. arizonae* differs from *E. morgani* in having a deeper lower jaw, more brachydont teeth, a more procumbent incisor, a distinctly better developed notch in the anterior lobe of the first cheek tooth, slightly less reduced third cheek tooth, and somewhat more dorsally placed mental foramen which is closer to the prominence at the anterior end of the masseteric crest. The shortness of the symphysis indicated by Gidley cannot be certainly determined, as none of the jaws are sufficiently complete anteriorly, and the incisor appears to have slid backward to a different position in each.

ONYCHOMYS BENSONI Gidley

The right ramus of a mandible, No. 10509, with all the teeth, but lacking part of the coronoid and angle, is the type and only specimen of the Benson *Onychomys*. As noted in the above description of the *Bensonomys arizonae* material, Gidley's figure of the type of *Onychomys bensoni* is labelled *Eligmodontia arizonae*, so that *O. bensoni* is actually shown in his plate 34, figure 15, rather than plate 35, figure 3.

Onychomys bensoni is rather close in size to *Onychomys torridus*. It exhibits the same cuspate type of tooth structure seen in modern *Onychomys*, with the narrow, single cusped anterior loph of the first lower cheek tooth, but the teeth are a little lower crowned and the cusps perhaps a little more conical. The third lower cheek tooth is distinctly less reduced, exhibiting a low but much less abbreviated talonid portion than in *O. torridus* or even *O. leucogaster*. The size and height of the coronoid indicated by Gidley cannot be determined, but the basal portion appears to have been of greater anteroposterior extent, as indicated by the length of the broken edge.

SIGMODON MEDIUS Gidley

Five lower jaws, four of which exhibit all the cheek teeth, represent a species of *Sigmodon* in the Benson fauna. The type, No. 10519, a right ramus, which includes the incisor as well as the cheek teeth, and an associated fragment of the right maxilla, with the first two cheek teeth, believed to be from the same individual.

Sigmodon medius is smaller than the modern forms *Sigmodon hispidus* and *Sigmodon sanctae martae* with which Gidley made comparisons. It is intermediate in size between the two Curtis ranch species,

S. minor and *S. curtisi*. *S. medius* is characterized by being more brachydont than modern forms, hence the appearance of somewhat more open valleys and compressed ridges. The anterior reentrant on the lingual surface of the first lower tooth is deeper than the outer in the type, as was noted in certain material of *S. sanctae martae*, but the anterior lobe is distinctly narrower than in modern material. Perhaps the most significant character in the lower teeth is the depth of the posterior reentrant on the lingual surface of the second cheek tooth, a distinct notch being present in this position on the third tooth. This reentrant and perhaps the notch, however, are not so well developed as in material of *Holochilus* from Argentina. Moreover, the posterior portion of the linqual wall of the third cheek tooth makes a sharp angle with the posterior wall of the lingual reentrant, this angle being more rounded in *S. hispidus* material.

In the upper cheek teeth of the type the anterior lobe of the first is narrow as it is in the lower teeth, and as noted by Gidley the external reentrants appear a little more arcuate in an occlusal view.

NEOTOMA FOSSILIS Gidley

The type of *Neotoma fossilis* is a right maxillary portion, No. 19524, with the first cheek tooth preserved and showing the alveoli for the second. To this were referred two right lower cheek teeth, No. 10526, and the greater portion of a left lower jaw, No. 10525, exhibiting the incisor but no cheek teeth.

The first upper cheek tooth in the type is about as wide as in *Neotoma cinerea* but distinctly shorter and lacks the anterointernal fold on the anterior column. The lower teeth referred are also relatively short and wide, and again, the first of these lacks the fold on the anterointernal surface of the anterior column. Possibly a less deeply impressed anterointernal fold may have been present in first upper and lower cheek teeth at an earlier stage of wear, but these cannot have been developed to the extent seen in some of the modern material. Both the upper and lower teeth are well worn so that the reentrants are compressed; however, the posteroexternal of these in the lower teeth is somewhat more open and more noticeably pocketed than the others, a condition markedly developed in material of *Neotoma magister* from Cumberland Cave.[9] Moreover, as Gidley indicated, the cross lophs of the lower teeth, particularly the second, are noticeably oblique; however, this may in part be due to the stage of wear represented together with the greater vertical depth and open character of the posteroexternal folds and the depth of the anterior of the two internal folds.

[9] J. W. Gidley and C. L. Gazin, U. S. Nat. Mus. Bull. 171, pp. 59–60, 1938.

Order LAGOMORPHA

HYPOLAGUS sp.

The lagomorph material, No. 10529, from the Benson locality, which Gidley referred to Species No. 2, clearly represents *Hypolagus*. Gidley's description as well as an examination of the material shows this to be the case; however, the specimen is too fragmentary to warrant detailed comparisons with other species of the genus. Nevertheless, P_3 in this material is seen to be a little larger than this tooth in *Hypolagus browni* from Anita, Ariz.

Certain of the upper teeth included in No. 10535, which Gidley referred to as cf. *Lepus* sp. from the Benson locality, appear to represent *Hypolagus*, although an incomplete P_3 under this number may represent *Sylvilagus ? bensonensis*. Probably more than one individual is included in the material.

SYLVILAGUS ? BENSONENSIS, new species

FIGURE 39

Type.—Left ramus of mandible, U.S.N.M. No. 16595, including P_3 to M_1 inclusive.

Locality.—About 2 miles south of Benson, Ariz., in exposures on the west side of the valley.

Horizon.—Possibly Benson (Late Pliocene) in age, though not from quarry worked by Gidley and Bryan.

Specific characters.—Size near *Sylvilagus floridanus holzneri* now living in Arizona. Jaw relatively robust. P_3 without reentrant from anterior wall but anterior external rentrant deep and complex.

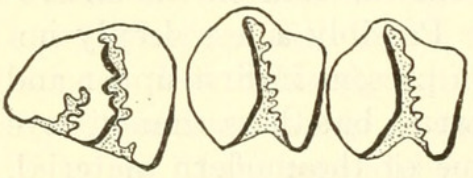


FIGURE 39.—*Sylvilagus? bensonensis*, new species: Left lower cheek teeth, P_3 to M_1 (U.S.N.M. No. 16595), type specimen, occlusal view of enamel pattern. Approximately× 6. Benson upper Pliocene, Arizona.

Description.—The fossil jaw is near specimens of *Sylvilagus floridanus holzneri* or *S. auduboni cedrophilus* in size, but appears relatively robust, particularly in depth anterior to the cheek teeth. The most noticeable differences, however, are to be seen in the enamel pattern of P_3. The posterior portion of all the folds from the buccal surfaces of the cheek teeth are markedly crenulated, but in P_3 the anterior reentrant from the outer surface is much more deeply impressed and more highly crenulated than in any of the modern *Sylvilagus* material which I have examined. Moreover, this tooth lacks the reentrant from the anterior wall seen in *Sylvilagus*, *Lepus*, and certain other genera. Some forms of *Sylvilagus*, etc., have two reentrants on the anterior wall, whereas in *Romerolagus* and *Brachylagus*, forms otherwise distinct from *S. ? bensonensis*, P_3 shows little or no fold in this

position. The San Pedro Valley jaw represents a form which might be regarded as generically distinct from *Syvilagus*.

Measurements in millimeters

	I	P_3	P_4	M_1
Anteroposterior diameter	[1]2.0	2.8	2.2	2.2
Transverse diameter	2.3	2.2	2.5	2.5

[1] Approximate.

Leporid sp.

A relatively large lower jaw, No. 10530, designated as Species No. 1 from Benson cannot be referred with certainty to any of the genera inasmuch as P_3 is missing. Only M_1 and part of P_4 are included in the jaw, and these are much larger than in *Sylvilagus ? bensonensis*.

Order PROBOSCIDEA

CORDILLERION BENSONENSIS (Gidley)

The basal portion of a mastodont skull, No. 10538, having nearly all the cheek teeth preserved, was described by Gidley (1926, pp. 84–86) as *Anancus bensonensis*. Osborn (1936, pp. 565–566) in his monograph on the Proboscidea reallocated this species to *Cordillerion*, regarding it as close to the species *Cordillerion andium* and *C. edensis*. The cheek teeth were described as brachydont and semibunodont. M^2 is trilophodont, and M^3 tetralophodont with a fifth loph in an incipient stage of development.

A referred tusk in the collections of the American Museum was described by Gidley as being about 4 feet long and 4 inches in diameter and of the nearly straight and twisted variety with a wide band of enamel extending along nearly the entire length. There is no certainty that *C. bensonensis* had this type of tusk, but Gidley states that the form of the tusk "agrees exactly with that of the alveolus in the type of *Anancus bensonensis*."

Mastodont sp.

In a footnote Gidley (1926, p. 85) mentioned occurrence at the Benson locality of a mastodont tusk quite unlike that regarded as belonging to *Cordillerion bensonensis*. The specimen "was too badly shattered and displaced to be preserved but it showed by the natural mold left in the matrix which had surrounded it that it was of the short, thick, much curved, and rapidly tapering variety; also, there was no evidence of an enamel band."

Order PERISSODACTYLA

NANNIPPUS cf. PHLEGON (Hay)

FIGURE 40

The type of *Nannippus phlegon*, an isolated lower cheek tooth from the Blanco of Texas, was originally described by Cope [10] as *Equus minutus*, a name preoccupied by *Equus minutus* Marcelles de Serres and probably by *E. minutus* Dubois. Because of this Hay [11] proposed the name *Equus phlegon* for the minute Blanco horse, and subsequently this species has been referred to most of the later Tertiary equid genera, including *Merychippus* by Hay, *Protohippus* by Gidley, *Pliohippus* by Osborn, and *Hipparion* by Matthew, until Matthew [12] in 1926 proposed the subgeneric name *Nannippus*, under *Hipparion*, for its reception. *Nannippus* has since come to be regarded as of generic rank.

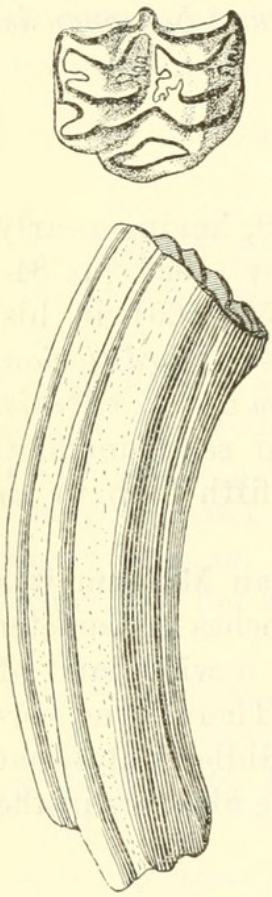


FIGURE 40.—*Nannippus* cf. *phlegon* (Hay): Right upper cheek tooth (U.S.N.M. No. 11745), posterolateral and occlusal views. ×1. Benson upper Pliocene, Arizona.

The published record of the culminating stage of this specialized *Hipparion*-like horse is rather scant although it is known to be represented in several late Pliocene deposits in the Southwest. Matthew's characterization, rather brief and based on material from the Blanco beds, is as follows:

> One group of small American species (new subgenus *Nannippus*) has the teeth very long crowned, up to a fourth longer than in any living horse; oval protocones and extremely slender limbs and feet, in which the side toes are complete but no trace remains of the fifth digit and trapezium. This group is typified by *Hipparion phlegon* of the Blanco formation, of which I secured skulls, feet, etc., in 1924. Contrast it with the contemporary *Plesippus*, with stout limb and foot bones, the side toes reduced to splints but the trapezium and fifth digit still retained.

Three incomplete lower jaws with milk dentitions, several isolated teeth, foot bones, and fragments of limb bones from the Benson locality belong to a small *Hipparion*-like horse, which seems with little doubt to represent *Nannippus phlegon*, although the material from the Blanco, which Matthew collected, was never illustrated or adequately described. The Benson *Nannippus* has extremely hypsodont cheek teeth of rather small cross section, and these may show noticeable curva-

[10] E. D. Cope, 4th Ann. Rept. Geol. Surv. Texas, for 1892, pp. 67–68, 1893.
[11] O. P. Hay, Amer. Geol., vol. 24, p. 345, 1899.
[12] W. D. Matthew, Quart. Rev. Biol., vol. 1, p. 165, 1926.

ture, especially toward the ends of the series. In the lower dentition the curvature is almost entirely in an anteroposterior plane. The cheek teeth exhibit moderately complex folding of the enamel and the isolated protocone in the upper teeth is generally small and smoothly oval in outline in moderate to advanced wear, although in early stages of wear the protocone may be rather irregular in outline.

The upper tooth here figured (fig. 40), probably M^2, measures about 17.5 by 15.6 mm. in cross section and is about 65 mm. long.

The feet are 3-toed, as in *Hipparion*, but strikingly small and slender. The first phalanx of a third digit measures 51 mm. long, and 23.5 and 20.0 mm. wide at the proximal and distal ends respectively. The hoof is scarcely more than 30 or 35 mm. wide.

PLESIPPUS sp.

In his preliminary report, 1922, on the San Pedro Valley faunas Gidley noted the presence in the Benson collection of horse material other than *Hipparion*, which he referred to *Pliohippus*. Later, however, he regarded these as representing *Plesippus*, as indicated by notations on the specimen labels. The material of *Plesippus* is rather scant and consists of a few isolated cheek teeth, most of which are incomplete, and a few toe bones.

The teeth are large and robust, being generally heavier than in the modern horse, but exhibit certain somewhat more primitive characters distinguishing them from Quaternary forms, particularly in the sharpness of the reentrant between the metaconid and metastylid columns of the lower teeth. The teeth and portions of teeth show a striking resemblance to those in *Plesippus shoshonensis* from Hagerman, Idaho, being in a nearly equivalent stage of development. The toe bones can be closely matched in material of *P. shoshonensis*. As in the zebra, these are relatively small and slender as compared with those in *Equus caballus*.

Order ARTIODACTYLA

PLATYGONUS sp.

Several isolated teeth and a maxillary fragment with two deciduous premolars belong to a species of *Platygonus*. The teeth are of moderate size, close in this respect to those in *Platygonus pearcei*[13] from the upper Pliocene at Hagerman, Idaho. They are more rugose than in *P. pearcei*, the cingulum better developed, and the anterior and posterior crests seem more sharply separated.

[13] C. L. Gazin, Journ. Washington Acad. Sci., vol. 28, no. 2, pp. 41–49, figs. 1–3, 1938.

Platygonus is now known to occur in several upper Pliocene deposits, including those at Blanco, Texas; Hagerman, Idaho; Coso Mountain, Calif.; Eden?, Calif.; Meade County, Kans.; and Safford, Ariz., as well as Benson. In those cases where the symphyseal portion of the lower jaw is known at this stage, the third lower incisor is persistent as indicated in the Hagerman and Coso Mountain material.

Camelid sp.

Camelids are represented in the Benson collection by portions of the maxillae of one individual, no. 12856, including M^1 to M^3 of the right side and part of P^4, M^1, and the posterior alveolus for P^3 on the left side. A few isolated foot bones were added to the collection in 1936.

The presence or absence of P^2 cannot be determined, but it may be supposed that at this stage the tooth was absent, as it appears to have been in *Megatylopus*, *Camelops*, and the several other forms which have been named from upper Pliocene and Pleistocene horizons.

The teeth in the maxillae are much worn, so that only a small fraction of an inch remains to the depth of the crown of M^1, and perhaps slightly more than an inch of the rather poorly preserved M^3. Because of this, comparisons with material and figures of the various described forms are difficult; however, even at this advanced stage of wear teeth of relatively large size are indicated, having considerable occlusal area.

The form may not have been appreciably larger than some of the material which has been referred to species of *Camelops*. There appears to be noticeable variation in the size of the teeth in specimens from Hay Springs, Nebr., referred to *Camelops kansanus*, and also in material from American Falls, Idaho, referred to *Camelops hesternus*. I doubt if this represents more than individual variation in each case. The Benson teeth compare favorably in size with certain of the larger teeth from these localities, but are noticeably greater than the average.

Comparison with *Megatylopus? spatula* (Cope) [14] from the Blanco formation is not satisfactory inasmuch as the only described material is the type lower jaw. The measurements given by Cope for the lower teeth do not indicate an animal significantly greater in size than the Benson camelid. Matthew and Stirton [15] regarded the Blanco form as representing *Paracamelus*, a genus of large camels described by Schlosser [16] from the Pliocene of China. J. T. Gregory [17] in review-

[14] E. D. Cope, 4th Ann. Rept. Geol. Surv. Texas, for 1892, pp. 70–73, pl. 21, figs. 1–2, 1893.

[15] W. D. Matthew and R. A. Stirton, Univ. California Publ. Bull. Dept. Geol. Sci., vol. 19, No. 17, p. 367, 1930.

[16] Max Schlosser, Abh. bayer. Akad. Wiss., math.-phys. Kl., vol. 22, p. 95, 1903.

[17] J. T. Gregory, Proc. Geol. Soc. Amer., 1936, p. 388, 1937.

ing the camels of the genus *Pliauchenia* considered the Blanco species to belong in *Megatylopus*. Barbour and Schultz,[18] on the other hand. considered *M. ? spatula* to be closer to their *Gigantocamelus fricki*.

No doubt the number of generic as well as specific names that have been applied to late Pliocene and Pleistocene camels of North America will be reduced when further study is made of these forms. The record suggests a group of large camels in the upper Pliocene and early Pleistocene of North America, probably related to *Paracamelus*, with species occurring in the Blanco, Keams Canyon, Hagerman, Lisco, San Pedro Valley, and certain other deposits; secondly, *Camelops*, a group of moderately large and otherwise distinctive camels, remains of which are found at numerous Pleistocene localities; and third, *Tanupolama*, in upper Pliocene time as well as in various stages of the Pleistocene of North America, being a smaller, long and slender limbed form, related to the South American llama.

Antilocaprid sp., possibly TEXOCEROS sp.

Fragments of the right and left rami of an immature mandible, No. 12860, including the deciduous premolars in each and M_1 in the right ramus, and an isolated molar were cited by Gidley as representing a species of *Merycodus*. There is, however, no necessity for regarding this material as merycodont as the teeth are very close to those seen in an immature individual of *Antilocapra americana*. The teeth are relatively small and on the basis of the material at hand can be described only as antilocaprid.

Frick (1937, p. 507) indicated most of an upper dentition and a couple of isolated molars in his collection from Benson which he referred tentatively to *Texoceros* sp. The National Museum specimen may represent this or *Capromeryx* but is too incomplete for satisfactory comparisons.

SYSTEMATIC DESCRIPTION OF THE CURTIS RANCH MAMMALIAN FAUNA

Order CHIROPTERA

SIMONYCTERIS STOCKI Stirton

The anterior portion of a bat skull, Calif. Inst. Tech. Coll. No. 394, collected by the writer in 1928 at the Curtis ranch locality, was described by Stirton (1931) as a new vespertilionid, *Simonycteris stocki*. Its characters were regarded by Stirton as closer to those of *Eptesicus* than other genera of bats.

[18] E. H. Barbour and C. B. Schultz, Univ. Nebraska State Mus., vol. 2, No. 2, p. 24, 1939.

Order EDENTATA

GLYPTOTHERIUM ARIZONAE Gidley

Glyptotherium arizonae is represented principally by three specimens from the Curtis ranch locality. No. 10536, the type, consists of the lower jaws, complete limbs and feet of the right side, a part of the vertebral column, portions of the carapace, and tail rings. No. 10537 includes a nearly complete tail with vertebrae and armature, and portions of the carapace. No. 10336 is the greater part of a carapace and includes a few teeth and foot bones. A composite skeleton has been mounted for exhibition in the National Museum, consisting of the lower jaws and feet of the type, the carapace of No. 10336, and the caudal rings and vertebrae of No. 10537.

Gidley (1926, pp. 91-94) has given a fairly detailed description of this material, particlarly with respect to the jaws and limbs, but it may be of interest to note further the manner in which the surface of the carapace varies in pattern. In the middorsal region the depressed central areas of the scutes is only slightly larger in diameter than the marginal surfaces, and with the outer figures interfingering with those of adjacent scutes. The central figure becomes relatively larger in the more peripheral areas; more observable in the forward parts. Also, toward the margin of the carapace the pattern on the individual scutes becomes less distinct, with the central area tending to become raised rather than excavated, and about midway fore and aft the scutes are more nearly quadrilateral. Along the anterolateral apronlike portions the four outer rows of scutes are more nearly in serial arrangement, with backward directed bosses reaching greatest development in the marginal row. The marginal row continues around the nuchal border as knoblike segments distinctly set off from the main mass of the carapace. Posteriorly the marginal series becomes a row of downward and backward directed almost hornlike processes increasing in size to the posterolateral extent of the carapace, and extending over the tail armature in more nearly conical form, directed backward and outward.

The tail armature consists of apparently eight movable, biserial rings and a terminal portion composed of the equivalent of about three rings. The proximal group of segments of each ring is relatively plain, except for a groove that extends around the ring near the anterior margin, giving rise to the illusion of a third row of scutes. The posterior series of each ring exhibits a nearly conical, posteriorly placed prominence on each scute, and from about the fifth ring to the tip of the tail the two adjacent dorsal elements are developed to a greater extent than others.

The carapace of *Glyptotherium arizonae* resembles rather noticeably that of *Glyptotherium texanum*[19] from the Blanco beds, in the pattern and arrangement of the scutes in different areas. Also, the tail armature is composed of 8 free rings and the terminal cone as in *G. texanum*. The number of caudal vertebrae is not less than 12, and at least 10 had chevrons. *G. arizonae* differs from *G. texanum* essentially in the greater development of the marginal scutes of the carapace, and the imbricated anterolateral portions appear to be more noticeably flexed from the main body of the carapace; however, the figured carapace of *G. arizonae* was partially crushed as found. The posterior segments of the movable rings of the tail armature also exhibit better developed bosses, and the eighth ring is completely biserial, also, the two anterior of the three ringlike segments of the terminal cone are more nearly biserial through intercalated scutes than in *G. texanum*.

G. arizonae is more advanced and certainly specifically distinct from *G. texanum;* however, the differences may not be sufficiently important to warrant generic separation. *Boreostracon floridanus*[20] or *rivipacis*[21] is from a much later stage of the Pleistocene and the scutes figured by Holmes and Simpson apparently exhibit a different type of surface pattern, particularly in the middorsal areas where the marginal figures of the scutes are more noticeably grooved and less sharply defined than in *G. arizonae*, and these marginal figures do not appear to interfinger with those of adjacent scutes to the extent seen in *G. arizonae*.

In *Brachyostracon mexicanus* (Cuatáparo and Ramirez)[22] the interfingering type of scutes, in which the marginal figures of each are well defined, apparently extend to the periphery of the carapace, although in the illustrations of *Brachyostracon cylindricus* Brown the more lateral scutes appear serially aranged with better developed bosslike central areas than in *B. mexicanus*.

Order CARNIVORA

CANIS EDWARDII, new species

FIGURE 41

Holotype.—Skull and mandible, U.S.N.M. No. 12862.

Locality.—Abount 2 miles northeast by east of Curtis ranch house, San Pedro Valley, Ariz.

Horizon.—Curtis ranch, early Pleistocene.

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[19] H. F. Osborn, Bull. Amer. Mus. Nat. Hist., vol. 19, pp. 491–494, 1903.

[20] G. G. Simpson, Bull. Amer. Mus. Nat. Hist., vol. 56, pp. 581–583, 1929; and W. W. Holmes and G. G. Simpson, *ibid,* vol. 59, pp. 405–418, 1931.

[21] O. P. Hay, Carnegie Inst. Washington Publ. 322, pp. 39–40, 381, 1923.

[22] See Barnum Brown, Bull. Amer. Mus. Nat. Hist., vol. 31, pp. 167–177, 1912.

Specific characters.—Size about equal to that of *Canis rufus* specimens from Missouri and Arkansas. Jaws relatively short with premolars in a nearly continuous series. Lower jaws weak with teeth

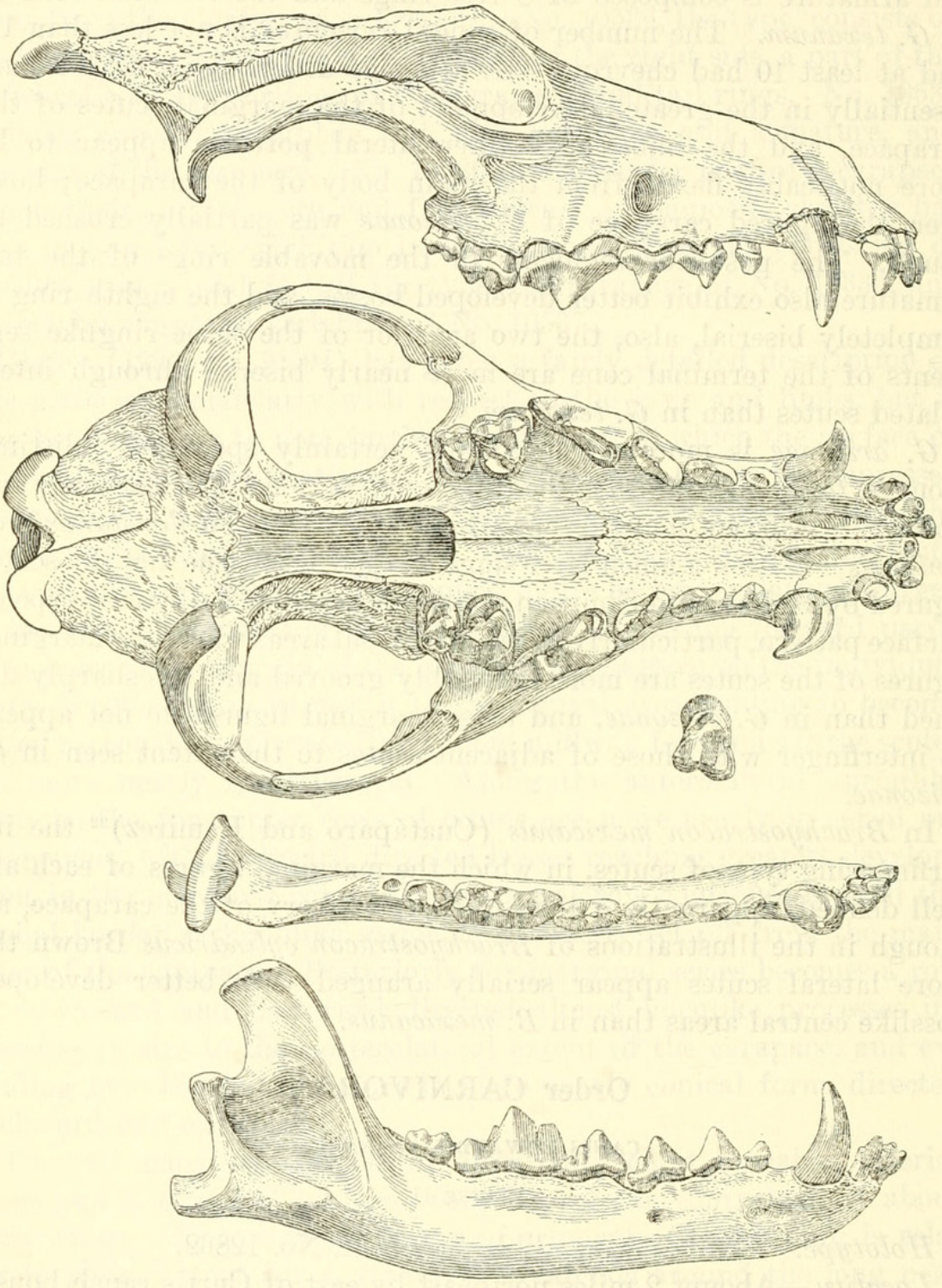

FIGURE 41.—*Canis edwardii*, new species: Skull and right ramus of mandible (U.S.N.M. No. 12862), type specimen; lateral and ventral views of skull, lateral and occlusal views of mandible. A less foreshortened view of the occlusal surface of M^1 is included with the ventral view of the skull. ×½. Curtis ranch Pleistocene, Arizona.

relatively large. Distance between lower molars and condyle relatively short. Coronoid small and backward projecting. Angle large, well separated from condyle and projecting markedly backward.

Description.—The skull and jaw of *Canis edwardii* (fig. 41) are intermediate in size between those of a gray wolf and of a coyote, about equaling specimens of the red wolf, *Canis rufus*, from Missouri and Arkansas. The skull is badly crushed, obscuring its form, particularly in the cranial region. The jugal appears relatively light and the rostrum somewhat shortened with the premolars more crowded than is usual in *Canis rufus*. The teeth are comparable in size to those in the red wolf and resemble them in structure more closely than they do those of any other species of canids. The deuterocone of the upper carnassial is distinctly developed as in *Canis rufus*. Also, as in *Canis rufus* the cusps of the lingual portion of M^1 are relatively well developed, and the paracone and metacone less inflated than in *Canis lupus*. M^2, though not so large relatively as is usual in *Canis rufus*, shows a well developed lingual portion with a prominent hypocone. The cingulum anterolingual to the protocone, however, is not so prominent in the fossil.

The lower jaw is also relatively a little shortened and the premolars are in a closely continuous series. The cheek teeth appear relatively large in proportion to the size of the jaw when comparison is made with *Canis rufus*, and the distance between the molars and the condyle is appreciably shorter. The angle is larger and placed lower with respect to the condyle, whereas the coronoid is relatively small and with the angle projects backward more than in the red wolf specimens examined.

Limb material that Gidley considered as associated with the skull, No. 12862, and on which he commented with respect to the presence of an entepicondylar foramen in the humerus (1922, p. 121), surely does not belong to a dog. The various elements are clearly felid in all respects. The association must have been quite accidental.

Measurements in millimeters of upper and lower teeth of Canis edwardii *(No. 12862)*

Measurement	Upper dentition	Lower dentition
Approximate length of dentition from I1 to M2	115	113
Length of cheek teeth from P1 to M2	77	82
Length of premolars from P1 to P4	60	47. 5
Length of molars from M1 to M2	22. 5	36
Anteroposterior diameter of P3	15	13. 5
Transverse diameter of P3	6. 2	6. 0
Anteroposterior diameter of P4	24. 0	15. 4
Transverse diameter of P4	11. 7	7. 4
Anteroposterior diameter of M1	14. 5	25. 0
Transverse diameter of M1	20. 5	9. 8
Anteroposterior diameter of M2	8. 4	11. 3
Transverse diameter of M2	12. 8	8. 5

SPILOGALE PEDROENSIS, new species

FIGURES 42, 43.

Holotype.—Right ramus of mandible, U.S.N.M. No. 14682, including the canine, P_4 and M_1.

Paratype.—Left maxillary portion, U. S. N. M. No. 12869, with P^4 and M^1.

Locality.—Gidley's rodent locality, about 2 miles northeast by east of Curtis ranch house, San Pedro Valley, Ariz.

Horizon.—Curtis ranch, early Pleistocene.

Specific characters.—Size near *Spilogale ambigua*. P^4 and M^1 with lingual portions not greatly expanded anteroposteriorly. Mandible with symphyseal portion projecting markedly downward and lower margin of ramus irregular. Lower canine robust. Anterior style and posterior transverse crest on P_4 not well developed. M_1 slender, particularly across protoconid and metaconid, and talonid basin well open lingually.

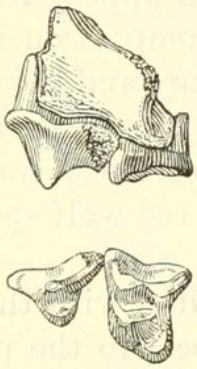

FIGURE 42.—*Spilogale pedroensis*, new species: Left maxillary portion with P^4 and M^1 (U.S. N.M. No. 12869), lateral and occlusal views. ×2. Curtis ranch Pleistocene, Arizona.

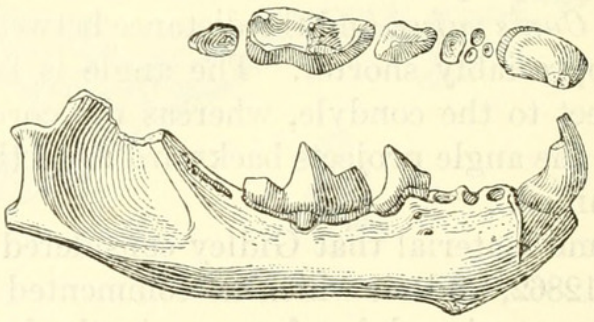

FIGURE 43.—*Spilogale pedroensis*, new species: Right ramus of mandible (U.S.N.M. No 14682), type specimen, lateral and occlusal views. ×2. Curtis ranch Pleistocene, Arizona.

Description.—The lower jaw (type) of *Spilogale pedroensis* (fig. 43) is about the size of that in male individuals of *Spilogale gracilis* or *Spilogale ambigua* now living in Arizona,[23] being distinctly smaller than that in *Spilogale arizonae*. The horizontal ramus of No. 14682 is distinctive in exhibiting so irregular a lower margin. The symphyseal portion extends markedly downward, and posterior to this the lower margin or profile of the jaw is concave as far as the prominent convexity or angulation directly below the alveolus for M_2. A second jaw portion, No. 14683, of *Spilogale pedroensis* with somewhat smaller teeth, probably a female, does not show so marked an angula-

[23] A. H. Howell, Revision of the skunks of the genus *Spilogale*. North Amer. Fauna 26, pp. 1–55, 10 pls., 1906.

tion below M_2. In specimens of *S. ambigua* of equivalent size and maturity the lower margin of the jaw usually exhibits an even convexity almost to the angle, or is but slightly irregular. The type mandible of *S. pedroensis* is further characterized by a short posterior portion as the distance between the carnassial tooth and the condyle is relatively long.

The lower carnassial in the type is distinctly narrower across the protoconid-metaconid portion than in *S. ambigua* or other recent species of *Spilogale* having teeth of about the same size. The talonid portion, however, is not noticeably different in width although the basin appears somewhat more open lingually than in *S. ambigua*, with no suggestion of a cuspule intermediate between the metaconid and entoconid. The canine tooth, on the other hand, is relatively robust and wider than in *S. ambigua*, *S. gracilis*, or even *S. arizonae*. In P_3 the anterior style and posterior transverse crest, arising from the cingulum, are not so well developed as in the recent species of Arizona.

The maxillary portion designated as the paratype, U.S.N.M. No. 12869 (fig. 42), retains only the carnassial and molar. These teeth occlude very well with those in lower jaw No. 14683, presumed to be a female. They compare favorably in size with those in female skulls of *Spilogale ambigua*. In P^4 the anterior style is weak and the deuterocone shelf is not so expanded anteroposteriorly as in Recent species of comparable size. The width of the tooth across the deuterocone is also less. The molar is markedly less expanded anteroposteriorly through the lingual portion than in any of the recent material examined, although the length of the buccal portion is nearly equal to that in specimens of *S. ambigua*. The transverse width of the molar is comparable to that in the living form.

Comparison with other species of *Spilogale* described from the Pleistocene is limited to that with *Spilogale marylandensis* Gidley and Gazin[24] from Cumberland Cave. *Spilogale pedroensis* is readily distinguished from the Cumberland Cave form in exhibiting a much slenderer lower carnassial, particularly through the talonid portion. The longitudinal profile of the lower margin of the ramus, however, is similar in the two jaws, although the symphyseal portion is more abrupt in *S. marylandensis*. P_4 in *S. marylandensis* is more nearly oval in outline, as viewed from above, than in the Curtis ranch form.

Spilogale pedroensis is distinct from species of *Brachyprotoma* in the less crowded premolars, smaller and narrower P_4, and in the relatively more elongate talonid and better developed metastylid on M_1. M^1 in *Brachyprotoma pristina* Brown, as represented in Cumberland Cave, shows a more expanded lingual portion than in *S. pedroensis*,

[24] J. W. Gidley and C. L. Gazin, New Mammalia in the Pleistocene fauna from Cumberland Cave, Maryland. Journ. Mamm., vol. 14, pp. 343–357 (351–352), figs. 1–9 (4), 1933.

although this portion of the tooth is not so developed as it is in the Recent species of *Spilogale.*

Measurements in millimeters of upper and lower teeth of Spilogale pedroensis.

Measurement	No. 12869		No. 14682		No. 14683	
	P^4	M^1	P_4	M_1	P_4	M_1
Anteroposterior diameter	5. 8	4. 5	3. 4	6. 8	3. 4	6. 2
Greatest transverse diameter	3. 4	6. 3	2. 0	2. 9	2. 0	[1] 2. 8

[1] Approximate.

FELIS sp., near FELIS LACUSTRIS Gazin

FIGURE 44

A relatively small cat, smaller than a modern puma but distinctly larger than a lynx, is represented by portions of a skeleton, No. 16618. These were found beneath the scapula of a mastodon and in close proximity to the skull of *Canis edwardii.* The material includes several vertebrae, a few foot bones and certain of the limb bones, among which are a complete humerus (fig. 44), femur and tibia.

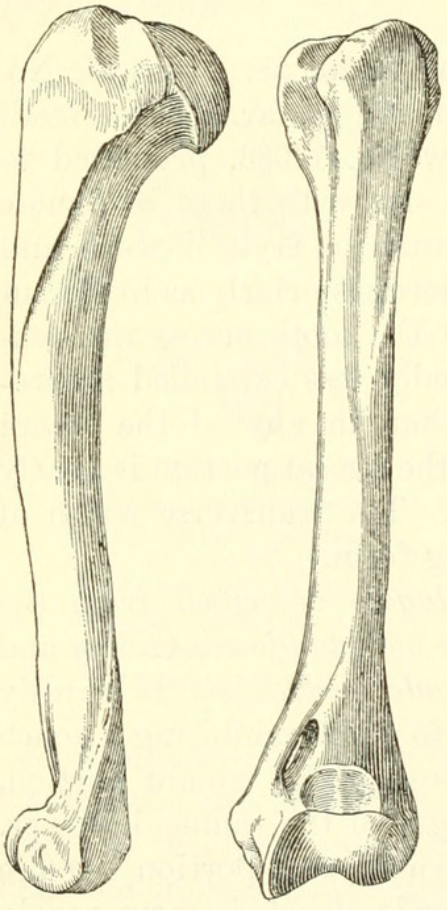

FIGURE 44.—*Felis* sp., near *F. lacustris* Gazin: Left humerus (U.S.N.M. No. 16618), lateral and anterior views. ×½. Curtis ranch Pleistocene, Arizona.

In the Pleistocene record there appears to be a dearth of cat material representing a form comparable to the smaller Curtis ranch type. The limb elements, however, compare favorably with those of *Felis lacustris* [25] from the earlier Hagerman lake beds of Idaho. The limb bones of the Hagerman skeleton, found subsequent to the description of *F. lacustris*, are for the most part incomplete, but the astragalus, the proximal and distal portions of the humerus and tibia, and the distal portion of the femur are nearly identical in proportions to those in the Curtis ranch cat. It should be noted, however, that the lower jaws associated with the Hagerman skeleton indicate an animal somewhat less robust than do the type specimen and certain other jaws referred to *F. lacustris.*

Felis hillanus [26] from the Blanco of Texas cannot be compared directly with the Curtis ranch form but the metacarpals in Cope's

[25] C. L. Gazin, Journ. Mamm., vol. 14, No. 3, pp. 251–254, 1933.

[26] E. D. Cope, 4th Ann. Rept. Geol. Surv. Texas, for 1892, pp. 55–57, 1893.

form are about the same length but not so slender as those in the Hagerman material. The second metatarsal in *F. hillanus* appears to be relatively small for a cat having a manus of the size indicated. The metatarsal as figured is much shorter than in *F. lacustris*.

FELIS sp., near FELIS ATROX Leidy

FIGURE 45

Included in the early Pleistocene material are an unassociated fourth lower premolar, calcaneum, and proximal portion of a third metatarsal, representing a cat of considerable size. The elements are much larger than those in modern puma and jaguar skeletons in the collections of the National Museum, and are of the true felid and not of the saber-tooth type. Comparison with material of *Felis atrox*, as described and figured by Stock,[27] shows the fourth premolar to be about equal in size to those somewhat smaller than average in specimens of *F. atrox*. The calcaneum and metatarsal have proportions of about two-thirds those of the maximum in *F. atrox*, being slightly smaller than the smallest indicated from Rancho La Brea. In this respect the large cat from the Curtis ranch horizon appears to be comparable to the form in the Cumberland Cave fauna, also considered as near *F. atrox*. The Cumberland Cave calcaneum, however, is somewhat more robust than that from Curtis ranch.

The lower premolar (fig. 45) is much larger than P_4 in a lower jaw from the Pleistocene of Florida referred to *Felis veronis*,[28] and consequently larger than would be expected in *Felis angustus*,[29] inasmuch as the upper carnassials in the types of these are of about the same size.

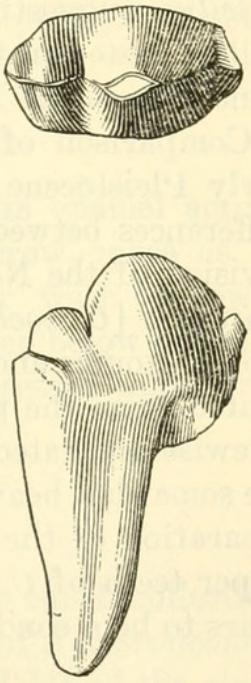

FIGURE 45.—*Felis* sp., near *F. atrox* Leidy: Fourth lower premolar (U.S.N.M. No. 12865), lateral and occlusal views. ×1. Curtis ranch Pleistocene, Arizona.

Order RODENTIA

CITELLUS COCHISEI Gidley

In the collection from Gidley's rodent locality is a right maxillary portion of a ground squirrel with all the cheek teeth, except for a part of P^3. The upper dentition was made the type, No.

[27] J. C. Merriam and Chester Stock, Carnegie Inst. Washington Publ. 422, pp. i–xvi, 1–231, 1932.

[28] O. P. Hay, Proc. U. S. Nat. Mus., vol. 56, pp. 108–109, 1919.

[29] Joseph Leidy, Proc. Acad. Nat. Sci. Philadelphia, 1872, p. 39.

10490, of *Citellus cochisei*, and a left lower jaw, No. 10491, with the incisor and first two cheek teeth, was referred. A second lower jaw showing the alveoli for the cheek teeth and a portion of M_1 was added to the collection in 1936.

The teeth in *C. cochisei* differ from those of *C. bensoni* in being more compressed anteroposteriorly with more emphasis on the development of transverse crests such as in typical *Citellus* and *Cynomys* rather than as in *Otospermophilus*. The form is close in size to such species as *Citellus columbianus* of the Northwest and *Citellus eversmannii* of Siberia, larger than forms belonging to the subgenus *Ictidomys*, common in Cochise County, Ariz., today.

The protocone in upper cheek teeth is not so compressed anteroposteriorly as in recent material belonging in the subgenus *Citellus*, but moderately so, such as in material of *Citellus mexicanus*, although the teeth are larger and relatively much wider than in this species. Moreover, as noted by Gidley, the valley between the protoloph and metaloph does not appear to extend so far lingually as in Recent *Citellus*, suggestive of *Cynomys* but with less development of the valley posterior to the metaloph; also, the teeth are more brachydont than in the Recent prairie dog.

Comparison of *C. cochisei* with *Citellus tuitus* Hay[30] from the early Pleistocene at Anita, Ariz. was not made by Gidley, but the differences between the forms were summarized by Howell[31] in his revision of the North American ground squirrels: "Compared with *tuitus*, it [*C. cochisei*] differs in having the protocone of the upper molars stouter and less hypsodont; the metaloph on M^1 and M^2 is separated from the protocone by a wide sulcus; on M^3 the protoloph is likewise separated from the protocone by a wide sulcus; M^1 and M^2 are somewhat heavier than in *tuitus* but M^3 is relatively shorter." The separation of the protocone from the protoloph or metaloph in the upper teeth of *C. cochisei*, indicated in the foregoing statement, appears to be a condition entirely due to wear.

Cf. PEROGNATHUS sp.

A lower jaw without cheek teeth, Amer. Mus. No. 27791, collected by Gidley at the Curtis ranch locality in 1924, was referred by Wood (1935 p. 107) to *Perognathus*.

DIPODOMYS GIDLEYI Wood

A species of *Dipodomys* in the Curtis ranch fauna was recognized by Wood (1935, pp. 156-159, fig. 74) on the basis of a right lower jaw, Amer. Mus. No. 21848, with cheek teeth P_4 to M_3 preserved but in a fragmentary condition. Among other characters it was noted that

[30] O. P. Hay, Proc. U. S. Nat. Mus., vol. 59, pp. 627–628, 1921.
[31] A. H. Howell, North Amer. Fauna 56, pp. 215–216, 1938.

the anterior surface of P_4 is not grooved as in *P.* ? *minor* although this tooth is less worn than in the Benson jaw, and M_3 is not so reduced as in *P.* ? *minor*. There is no statement as to whether the teeth are rooted, but it is probable that they were not. Hence, it is possible that the Curtis ranch jaw, Amer. Mus. No. 27790, which Wood referred to *P.* ? *minor* may represent *D. gidleyi* or a closely related species. The two teeth in Amer. Mus. No. 27790 are well worn so that the absence of a groove on the anterior surface of P_4 is not significant.

DIPODOMYS sp.

The American Museum lower jaw, No. 27790 from Curtis ranch, which Wood (1935, pp. 155–156, fig. 73) referred to the Benson species, *P. minor*, includes P_4 and M_1. These teeth are well worn, but M_1 is not rooted so that its representing the Benson species seems unlikely. Were the extent of individual variation in material of *D. gidleyi* known, it seems possible that this specimen might be shown to belong rather to *D. gidleyi*. The difference in pattern of P_4 in Amer. Mus. No. 27790 and Amer. Mus. No. 21848, the type of *D. gidleyi*, as illustrated can be attributed largely to difference in wear.

NERTEROGEOMYS,[32] new genus

Generic characters.—Near *Geomys*, but P^4 exhibits enamel across the posterior wall and anterior column of P^4_4 narrow, more as in *Thomomys*. Upper incisors grooved and anterior wall of lower molars without enamel as in *Geomys*. Mental foramen below anterior extremity of masseteric crest. Rostrum more depressed anteriorly with respect to plane of cheek teeth.

Genotype.—Geomys persimilis Hay.

NERTEROGEOMYS PERSIMILIS (Hay)

A small pocket gopher is represented in the Curtis ranch collection by the rostral portion of a skull, No. 10492, the type of *Nerterogeomys persimilis*, having all the cheek teeth except P^4 and M^3 of the right side. To this was referred a right lower jaw, No. 10493, with the first three cheek teeth. A more fragmentary lower jaw with only P_4 was added to the collection in 1936.

Nerterogeomys persimilis was originally described by Gidley as *Geomys parvidens*, but since this was preoccupied by *G. parvidens* Brown the name *G. persimilis* was proposed by Hay (1927, p. 136) for the Curtis ranch gopher.

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[32] νέρτερος, lower, below + *Geomys*, in allusion to its stratigraphic position.

The skull portion of *Nerterogeomys persimilis* is near that of *Geomys texensis* in size but with a shorter and somewhat shallower rostrum and the ventral surface anterior to the cheek teeth not extending so far above the plane of the cheek teeth. The upper incisors are slightly smaller but bisulcate as in *Geomys texensis*. The cheek teeth are also a little smaller and relatively narrower than in Recent *Geomys*. The anterior column of P^4 is much narrower than in *Geomys* material, suggesting *Thomomys*, and the reentrants between the columns of this tooth are more open than in *Geomys*, though not so wide open as in *Thomomys*. Of particular interest is the presence of enamel across the posterior wall of P^4 as in *Thomomys*, but not *Geomys*. According to Merriam[33] enamel occurs on a portion of the posterior wall of this tooth in the Mexican and Central American forms *Heterogeomys*, *Macrogeomys*, *Zygogeomys*, and some *Orthogeomys*. Enamel was also noted on the posterior wall of P^4 in *Plesiothomomys ? orientalis* (Simpson)[34] from the Pleistocene of Florida, and as in *N. persimilis* the rostral portion of *P. ? orientalis* was observed to be somewhat depressed.

The lower jaw of *N. persimilis* appears to be more robust than that of *N. ? minor*, and the masseteric ridge is much better defined, but as in that species the mental foramen is situated below the anterior extremity of the masseteric crest rather than in front of it as in modern *Geomys* and *Thomomys*. The lower cheek teeth in *N. persimilis* are small and relatively narrow as in *N. ? minor* but the anterior column of P_4 appears smaller and more nearly circular in outline. The anterior surface of the lower molars is without enamel, comparable in this respect with *Geomys* and differing from *Thomomys* and *Plesiothomomys*.

BAIOMYS BRACHYGNATHUS (Gidley)

The type and only specimen of this species is a right lower jaw, No. 10501, with all the teeth present and well worn. The form seems most nearly comparable to *Baiomys taylori* as indicated by Gidley, but with a more reduced last lower molar. The last molar is reduced in material of *Reithrodontomys* as well as *Onychomys*, and although the form seems clearly distinct from *Onychomys* the differences from *Reithrodontomys* are not so obvious.

Jaws of *Reithrodontomys megalotis* are comparable in size to those of *Baiomys taylori* but with a somewhat more reduced last lower molar and slightly better developed anterior portion of the first lower cheek tooth, with the anterior pair of cusps more sharply separated from the second pair lingually. Also, the lower incisor is more curved or

[33] C. H. Merriam, North Amer. Fauna 8, p. 79, 1895.

[34] G. G. Simpson, Amer. Mus. Nov., No. 328, pp. 6–7, 1928. See also J. W. Gidley and C. L. Gazin, U. S. Nat. Mus. Bull. 171, p. 59, 1938.

less procumbent in *R. megalotis* than in *B. taylori*, and with the depth of the jaw below the first tooth somewhat greater to accommodate an incisor of greater curvature. Moreover, the coronoid process is smaller.

In the Curtis ranch jaw the last tooth is reduced much as in *R. megalotis* but the anterior portion of the first lower cheek tooth more nearly resembles that in *Baiomys*, and although the teeth show considerable wear, the anterior portion of the first seems to be somewhat shorter than in either form. The length of the anterior portion of the lower jaw, a character stressed by Gidley, cannot be certainly determined because the bone is partially broken away from around the incisor. The beveled portion of the incisor is much closer to the cheek teeth than in other forms but this may have been brought about by a backward sliding of the incisor, since the posterior end of the incisor is not now covered, although the tooth seems quite secure at the present time. In spite of this, the incisor is definitely more procumbent than in *Reithrodontomys* and slightly more so than in *Baiomys taylori*. The lower margin of the fossil jaw is not entire across the incisor below the first cheek tooth and the coronoid process is not preserved.

ONYCHOMYS PEDROENSIS Gidley

The Curtis ranch *Onychomys* is now represented by eight jaw portions, including two that were obtained in 1936; however, none have more than two cheek teeth, and in only one is the incisor complete. The type is a left lower jaw, No. 10506, with an incomplete incisor and the first and third cheek teeth.

The jaws are noticeably deeper and more robust than in *Onychomys leucogaster ruidosae* and the teeth a little larger, much larger than in *O. bensoni*. Structurally, the teeth are very close to those in *O. l. ruidosae*, and relatively higher crowned than in *O. bensoni*. The masseteric ridge, as indicated by Gidley, extends farther forward than in the Recent form and the last cheek tooth is less reduced; the talonid portion, however, is more restricted than in *O. bensoni*.

SIGMODON CURTISI Gidley

In addition to the type, No. 10510, which includes both rami of the mandible with all the cheek teeth and a nearly complete incisor on the right, the large Curtis ranch *Sigmodon* is represented by three lower portions with two to three cheek teeth each and a left maxillary fragment with all the cheek teeth. The upper dentition and two of the lower jaws were added to the collection in 1936.

Sigmodon curtisi is a heavy jawed form distinctly larger than *S. medius* of the Benson fauna, comparing favorably in size of teeth with the modern cotton rat, *Sigmodon hispidus*. The anterior lobe of

the first lower cheek tooth is relatively wider than in *S. medius*, resembling the modern form in this respect. Gidley noted that the cheek teeth were less hypsodont than in the living species, that the valleys of the reentrant folds were more widely open and the lophs more compressed. Although these characters are evident, the extent to which they are exhibited is not so noticeable as in *S. medius*. As in *S. medius* the posterior reentrant on the lingual side of the second tooth is much deeper than in Recent *Sigmodon* and the posterior portion of the lingual wall of the third tooth makes a sharp right angle with the enamel of the lingual reentrant; however, the lingual wall of this tooth does not appear to be notched as it is, though weakly so, in the type of *S. medius*.

The upper dentition added to the collection in 1936 is in an early stage of wear, and the teeth appear noticeably more hypsodont than the upper teeth belonging to the type of *S. medius*. In this respect they approach more closely teeth in modern species, although the reentrant valleys appear more widely open than in these. The anterior lobe of the first upper cheek tooth, unlike that in the lower dentition of *S. curtisi*, is narrower than in modern material observed, approaching more closely the relative proportions seen in *S. medius*. The upper teeth of *S. curtisi* are otherwise similar to those in the modern cotton rat, particularly *S. sanctae martae* of Colombia.

SIGMODON MINOR Gidley

A small species of *Sigmodon* is represented in the Pleistocene collection by no less than ten lower jaws and a maxillary portion. Four of the lower jaws were obtained by the 1936 expedition. The type, a left ramus, No. 10512, and seven of the referred jaws include all the cheek teeth.

Sigmodon minor is considerably smaller than its contemporary, *Sigmodon curtisi*, but less widely separated from the earlier *S. medius*. There is an appreciable variation in the size of the jaws and teeth, and although size of teeth is not in every case correlated with size of jaw, one heavy jawed specimen, No. 16611, has slightly larger teeth than the smallest of the Benson lot; however, the average of the teeth is distinctly less and all of the *S. minor* jaws exhibit relatively narrower teeth than in *S. medius*. The degree of hypsodonty and the pattern of the lower teeth of *S. minor* correspond closely to those in *S. medius* and the two forms differ in nearly the same respects from the living species.

The upper teeth in No. 10513 are also smaller than those belonging to the type of *S. medius*, and the anterior lobe of the first is a little narrower, as noted in several, but not all, of the lower dentitions. Gidley noted also that the external reentrants in the first upper tooth

were of the normal modern type. The difference from *S. medius* in this respect is not obvious as the teeth in No. 10513 show very little wear and are fractured, hence not easily compared with those of the *S. medius* specimen.

ONDATRA sp.

A second left upper molar in the Curtis ranch collection was referred by Gidley to *Neofiber*, probably because of its small size, but since the enamel folds terminate at the lower end, with the formation of small pockets, suggesting a rooted type of tooth, the specimen probably represents a form of *Ondatra*. The tooth is nearly as small as that in *Ondatra idahoensis* [35] material from the late Pliocene of Idaho, but appears to be a little more hypsodont.

A poorly preserved lower jaw, including a portion of the second cheek tooth was found at the Curtis ranch locality in 1936. Except for its smaller size the specimen resembles jaws of *Ondatra zibethica;* however, the jaw seems relatively shallow and the anterior margin of the ascending ramus extends forward as a ridge to a point nearer the anterior end of the tooth row.

Order LAGOMORPHA

LEPUS sp., near LEPUS CALIFORNICUS Gray

A portion of the right mandibular ramus, U.S.N.M. No. 16619, including P_3 to M_1, collected in 1936, is from a lagomorph very near *Lepus californicus eremicus* in size and proportions of the teeth. The anterior wall of the posterior column of the lower cheek teeth seems somewhat more crenulated than in the modern form. P_3 appears relatively broad posteriorly and does not exhibit so flattened a lingual wall.

Cf. SYLVILAGUS sp., near SYLVILAGUS FLORIDANUS (Allen)

A fragmentary right ramus of the mandible with P_3 and P_4, No. 10528, which Gidley referred to as Species No. 3 and compared with *Lepus californicus eremicus*, is relatively small and more nearly resembles material belonging to *Sylvilagus floridanus*. P_3 in this specimen exhibits an unusually deep fold from the middle of the posterior wall of the anterior column forward into the anterior column, more pronounced than shown in Gidley's figure of this specimen (1922, fig. 13).

[35] R. W. Wilson, Carnegie Inst. Washington Publ. No. 440, pp. 132–135, 1933.

Order PROBOSCIDEA

STEGOMASTODON ARIZONAE Gidley

Stegomastodon arizonae has for a type the greater part of a skeleton, No. 10707, including the basal portion of the skull with both tusks and the cheek teeth. To this were referred two other skeletal portions. One of these is of an older individual, No. 10556, and includes the basal portion of the skull with the cheek teeth and tusks, and the lower jaws as well as other portions of the skeleton. The third specimen, No. 10917, includes only a portion of a hind limb and an associated lower jaw without teeth.

Both Gidley (1926, pp. 86–91) and Osborn (1936, pp. 678–682) have given appreciable space to the description and discussion of this material. The form is clearly of the stegomastodont type and on the basis of the lower molars appears, as indicated by Gidley and Osborn, to be more progressive than the type of *Stegomastodon mirificus*. Osborn further notes that the third lower molar with seven and a fraction crests is also somewhat more progressive than that in *Stegomastodon texanus* of the Blanco beds, but less progressive than the *S. aftoniae* type from Iowa.

Order PERISSODACTYLA

EQUUS sp.

The Curtis ranch collection includes a number of isolated upper and lower cheek teeth, portions of jaws, foot bones and fragments of limb bones belonging to *Equus*. The form represented is not of great size, comparing favorably in this respect with material of *Equus semiplicatus* Cope from Texas or *Equus laurentius* Hay from Hay Springs, Nebr. I hesitate to refer the Curtis ranch material to any one of the numerous species of Pleistocene horses because of the great need for revision in this group and also because I regard the stage represented at Curtis ranch as somewhat earlier than the Pleistocene horizons represented at Rock Creek, Tex., and Hay Springs, Nebr. A few comparisons, however, are made with specimens representing certain of the forms which have been named.

The upper molars compare favorably with the dimensions given by Cope [36] for *E. semiplicatus*, to which species the Curtis ranch material may belong, although the protocone in the Arizona teeth is not so elongate as in *E. semiplicatus*. The size of the protocone is noticeable in both Cope's [37] and Gidley's [38] figures of the San Diego, Tex., skull referred by Gidley to *E. semiplicatus*.

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[36] E. D. Cope, 4th Ann. Rept. Geol. Surv. Texas, for 1892, p. 80, 1893.

[37] E. D. Cope, *ibid*, pl. 22, fig. 3.

[38] J. W. Gidley, Bull. Amer. Mus. Nat. Hist., vol. 14, pp. 129–130, fig. 21, 1901.

Horse teeth found in deposits at Pleistocene Lake Cochise, not far from the San Pedro Valley, were regarded by Gidley [39] as representing three species. I doubt, however, that more than one is represented and this may well be *Equus pacificus* or a large *E. occidentalis*. These specimens average much larger than the teeth from Curtis ranch, and the Pleistocene stage represented may be much later.

The Curtis ranch teeth do not differ appreciably in size from material Hay [40] described as *Equus laurentius* from Hay Springs, Nebr., although the patterns exhibited are not much alike. The Curtis ranch upper teeth have somewhat more concave walls between the outer styles and the enamel plates in the walls and lakes are in general either more arcuate or trend somewhat more oblique than in the Hay Springs paratype. Typical *E. laurentius*, and in particular *E. nevadanus* from Manhattan, Nev., make a marked approach to the type of teeth seen in *E. caballus*. The Curtis ranch teeth, though clearly of the *Equus* type, do not seem to be so far removed from the *Plesippus* stage as does much of the better known Pleistocene material.

A few upper teeth, apparently from one individual, No. 11597, found near a powder mill a couple of miles south of the Benson locality seem to represent *Equus* rather than *Plesippus* and may be from the Curtis ranch level although the occurrence is geographically nearer to the Benson locality. These teeth are of about the same size and show somewhat the same type of enamel pattern seen in upper teeth from Curtis ranch proper.

Order ARTIODACTYLA

Camelid sp.

A camel of considerable size is present also in the Curtis ranch fauna. The material representing this form consists of a right maxillary portion, No. 12870, with P^3 to M^3, and the proximal and distal portions of a fused radius and ulna. P^2 is lacking in the dental formula of this animal, as was probably true of the Benson dentition, also the cheek teeth are very similar to those in the older form, but appear a little larger. The difference in size may be due principally to the greater wear suffered by the Benson teeth. In the Curtis ranch specimen the teeth are not in an early stage of wear, nevertheless the length of the series including P^3 to M^3 is seen to be about 200 mm. This is estimated because M^3 is not complete posteriorly.

The dentition in No. 12870 is comparable in size to that indicated for *Gigantocamelus fricki* Barbour and Schultz [41] from Lisco, Nebr.,

[39] Kirk Bryan and J. W. Gidley, Amer. Journ. Sci., vol. 11, pp. 481–484, 1926.

[40] O. P. Hay, Proc. U. S. Nat. Mus., vol. 44, pp. 584–591, fig. 27, 1913.

[41] E. H. Barbour and C. B. Schultz, Bull. Univ. Nebraska State Mus., vol. 2, No. 2, p. 21, 1939.

and probably to that of *Megatylopus? spatula* (Cope)[42] from the Blanco formation, as well as to the larger of the teeth from Hay Springs, Nebr., and American Falls, Idaho, referred to species of *Camelops*.

A camel of marked size, though possibly not so large as the Curtis ranch form, was described by Hay [43] as *Procamelus coconinensis* from Anita, Ariz., a Pleistocene occurrence of relatively early date as indicated by the association of *Hypolagus*. The material of the camel is very fragmentary and I am uncertain as to whether this form should be referred to *Camelops* or to the *Megatylopus-Paracamelus* group, probably the latter. The type of the large Anita camel, the greater portion of an upper molar, is rather well worn, and, in addition to being a little smaller than teeth in the larger San Pedro Valley camels, shows much more acute external styles, particularly that on the outer wall of the anterior lobe between the parastyle and mesostyle. Foot bones in the Anita collection, however, indicate some individuals of very considerable size, so that were adequate material known it might be shown that the Curtis ranch or possibly the Benson form could not be distinguished from that occurring at Anita.

TANUPOLAMA cf. LONGURIO (Hay)

FIGURE 46

In addition to the giant type of camel there is in the Curtis ranch fauna a representative of the llamalike group, *Tanupolama* Stock.[44] The material includes portions of the right and left ramus of the mandible, No. 10636, with a representation of nearly all the teeth. There are also fragments of the jaws and right maxilla of a second and immature individual, No. 10635, with poorly preserved teeth.

The more mature lower jaw (fig. 46) exhibits the first and second incisor, the alveolus for I_3, an erupting canine, and P_4 to M_3. P_2 and P_3 are missing from the formula but the caniniform P_1 with its posteriorly directed hook was found unemerged in the jaw. The first of the cheek tooth series, undoubtedly P_4, is seen in both right and left mandibular portions. The tooth is relatively small but noticeably hypsodont and not sharply constricted anteriorly. This tooth is partially broken down in both rami so that the character of its crown is not entirely evident. There is a shallow fold on the posterior portion of the outer wall, giving the tooth a slightly bilobed appearance; a sharp enamel reentrant is seen on the anterior portion of the lingual wall, disappearing downward, however; and at the stage of wear represented a prominent enamel fold extends forward from the pos-

[42] E. D. Cope, 4th Ann. Rept. Geol. Surv. Texas, for 1892, pp. 70–73, pl. 21, figs. 1–2, 1893.

[43] O. P. Hay, Proc. U. S. Nat. Mus., vol. 59, pp. 622–624, pl. 122, figs. 4–6, pl. 123, fig. 5, 1921.

[44] Chester Stock, Carnegie Inst. Washington Publ. 393, pp. 29–37, pls. 1–6, 1928.

terior wall. The molars have the characteristic anteroexternal styles, and on M_3 a marked style extends lingually from the anterointernal angle of the tooth.

The species *Tanupolama longurio* was described by Hay[45] in 1921 as a species of *Procamelus* from the Pleistocene fissure deposit at

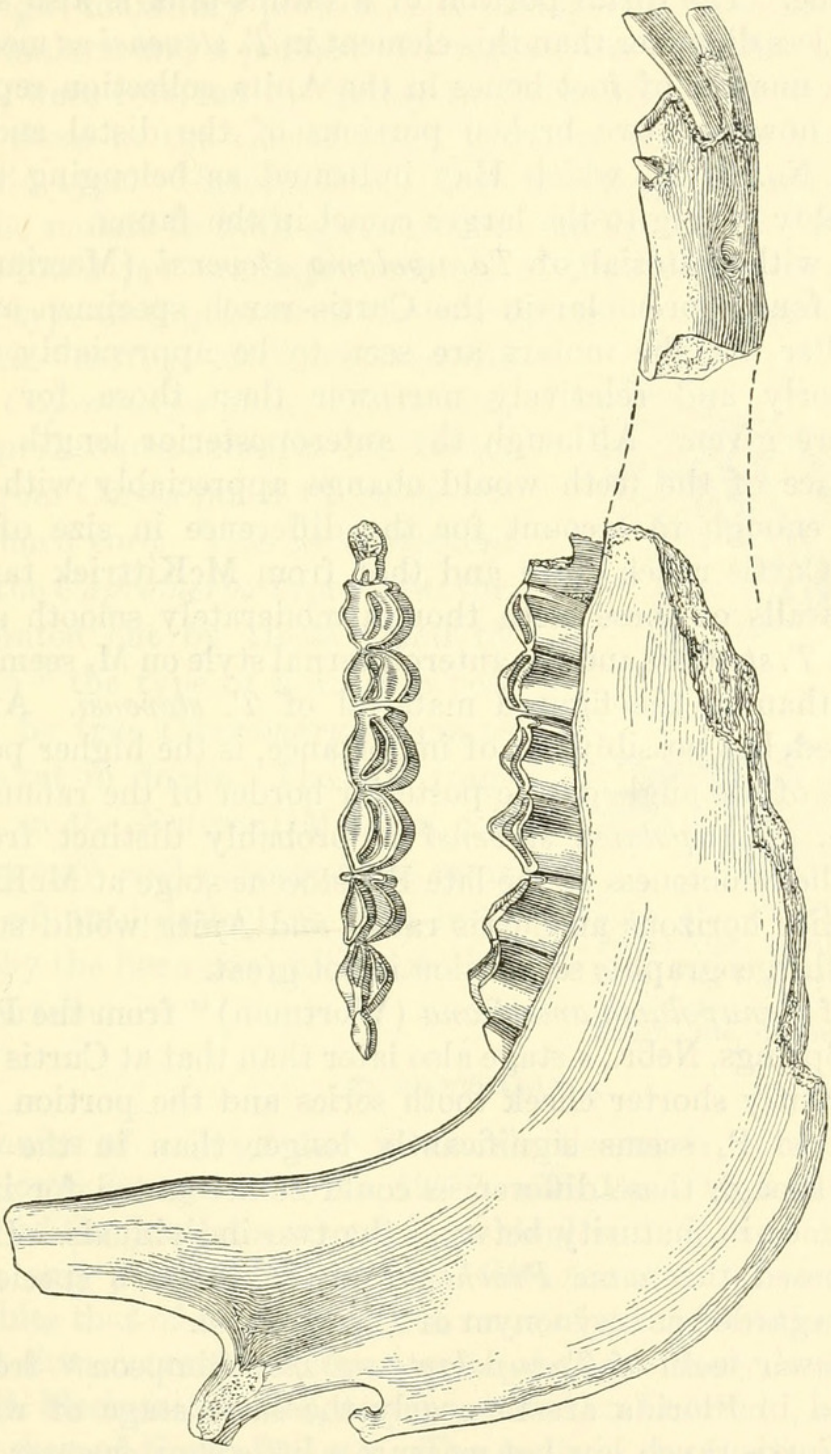

FIGURE 46.—*Tanupolama* cf. *longurio* (Hay): Right ramus of mandible (U.S.N.M. No. 10636), lateral and occlusal views. ×½. Length of anterior portion determined from left ramus. Curtis ranch Pleistocene, Arizona.

Anita, Ariz. From his description and from an examination of the material it is evident that a species of *Tanupolama* is represented. The material described by Hay did not include skull or jaw remains but the cervical vertebra and foot material indicate a llamalike animal with long and slender neck vertebrae and long, slender limbs

[45] O. P. Hay, Proc. U. S. Nat. Mus., vol. 59, pp. 624–626, pl. 120, fig. 8; pl. 123, figs. 3–4; pl. 124, fig. 4, 1921.

and feet, entirely comparable with characters indicated for *Tanupolama.* The type, U.S.N.M. No. 10166, an incomplete posterior cannon bone, measures about 44 by 40 mm. at the proximal end, a somewhat smaller diameter than the figures given by Stock for *T. stevensi*, and the incomplete length is about 290 mm., approximately two-thirds the entire bone. The distal portion of a radius-ulna is also seen to be of slightly less diameter than this element in *T. stevensi* as measured by Stock. A number of foot bones in the Anita collection represent *T. longurio;* however, two broken portions of the distal end of a cannon bone, No. 10174, which Hay indicated as belonging to this species, probably belong to the larger camel in the fauna.

Compared with material of *Tanupolama stevensi* (Merriam and Stock)[46] the fourth premolar in the Curtis ranch specimen appears slightly smaller but the molars are seen to be appreciably longer anteroposteriorly and relatively narrower than those for which dimensions are given. Although the anteroposterior length of the occlusal surface of the teeth would change appreciably with wear, possibly not enough to account for the difference in size of teeth between the Curtis ranch form and that from McKittrick tar pits. The lingual walls of these teeth though moderately smooth appear less so than in *T. stevensi* and the anterointernal style on M_3 seems more outstanding than in the figured material of *T. stevensi.* Another character noted, but possibly not of importance, is the higher position of the process of the angle on the posterior border of the ramus from Curtis ranch. *Tanupolama stevensi* is probably distinct from *T. longurio*, as the remoteness of the late Pleistocene stage at McKittrick from the earlier horizons at Curtis ranch and Anita would suggest, even though the geographic separation is not great.

The type of *Tanupolama americana* (Wortman)[47] from the Pleistocene at Hay Springs, Nebr., a stage also later than that at Curtis ranch, has an apparently shorter cheek tooth series and the portion of the jaw anterior to P_4 seems significantly longer than in the Curtis ranch jaw, although these differences could be accounted for in part by the difference in maturity between the two individuals. In 1929 Frick[48] proposed the name *Prochenia* for Wortman's species, but this must be regarded as a synonym of *Tanupolama.*

The type lower teeth of *Tanupolama mirifica* Simpson[49] from the Seminole field in Florida are in nearly the same stage of wear as those in the Curtis ranch jaw but measure a little shorter anteroposte-

[46] J. C. Merriam and Chester Stock, Carnegie Inst. Washington Publ. 347, pp. 37–42, figs. 1–4, 1925.

[47] J. L. Wortman, Bull. Amer. Mus. Nat. Hist., vol. 10, art. 7, pp. 133–134, fig. 21, 1898.

[48] Childs Frick, Nat. Hist., vol. 29, p. 107, 1929.

[49] G. G. Simpson, Bull. Amer. Mus. Nat. Hist., vol. 56, art. 8, pp. 593–596, figs. 17–19. 1929.

Gazin, C. Lewis. 1942. "The late Cenozoic vertebrate faunas from the San Pedro Valley, Ariz." *Proceedings of the United States National Museum* 92(3155), 475–518. https://doi.org/10.5479/si.00963801.92-3155.475.

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