THE PEARCE-SELLARDS *Series*

NUMBER 15

New Early Miocene Formation and Vertebrate Local Fauna, Big Bend National Park, Brewster County, Texas

by

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MARY R. DAWSON

AUGUST, 1969

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Illustrations

New Early Miocene Formation and Vertebrate Local Fauna, Big Bend National Park, Brewster County, Texas

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ABSTRACT

The early Miocene Delaho (new) Formation is a locally derived sequence of basin fill sediments now severely deformed by later Tertiary normal faulting. These sediments contain the Castolon local fauna comprising seventeen mammalian taxa. Three genera are new. Age of the Castolon local fauna is considered middle Arikareean, and differences between it and other Arikareean faunas are caused in part by ecological bias.

INTRODUCTION

The first identifiable vertebrate fossils of Miocene age from western Texas were discovered in 1963 by Dr. John A. Wilson, Messrs. Ruben Frank and William Huie, in Big Bend National Park (Figs. 1, 2). Cretaceous, Paleocene, and Eocene vertebrates are known from other regions of the park and have been collected by Wilson and others for many years (Wilson, *in Maxwell* et al., 1967: 157–169). The collection of vertebrate remains herein reported is designated the Castolon local fauna, and all specimens are from the lower member, Delaho (new) Formation. Stratigraphy and structure (summarized in Fig. 2) were interpreted by James B. Stevens, Leporidae were studied by Mary R. Dawson, and the remainder of the fauna studied by Margaret S. Stevens.

Collections in Big Bend National Park were made under provisions of a permit issued to the Bureau of Economic Geology, The University of Texas at Austin, by the U. S. Department of the Interior. All specimens are curated in The University of Texas Bureau of Economic Geology collections, and specimen numbers not preceded by abbreviations belong to these collections. This study was aided by NSF grants G13270, GP-1050, the University Research Institute, and the Geology Foundation, The University of Texas at Austin. All measurements are in millimeters and the following abbreviations

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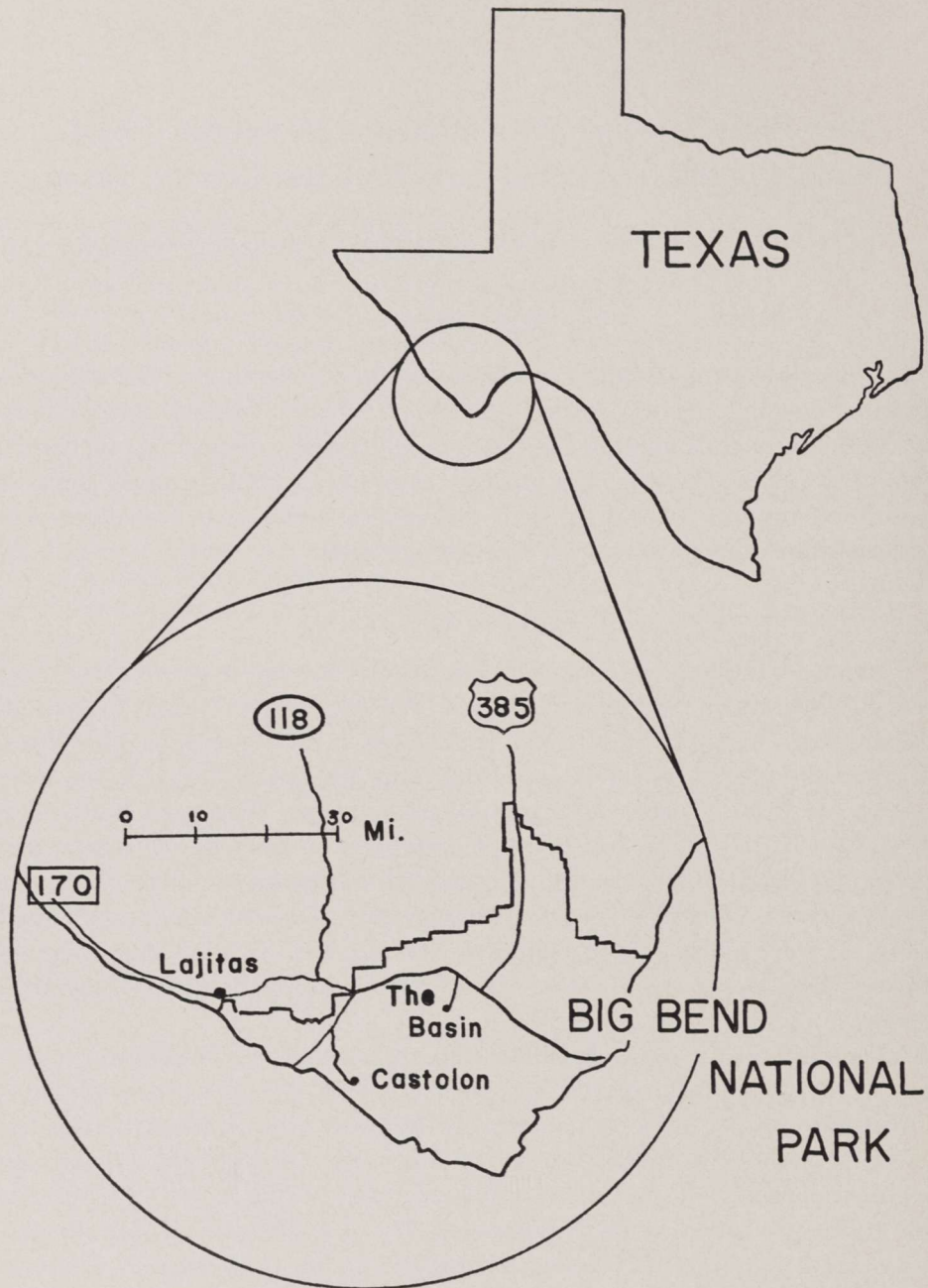
Fig. 1. Map of Texas and detail of Castolon area, Big Bend National Park.

are used: AC, Amherst College; AMNH, American Museum of Natural History; CV, coefficient of variation; FAM, Frick Collections, American Museum of Natural History; md, maximum diameter; *, measurement approximate; **, measurement estimated; N, number of specimens in sample; OR, observed range; $\bar{X}$, mean; s, standard deviation.

[4]

103° 28'

Teo

Tmds

Blue Creek

15
8
12
14
3
14
18
Big Windmill
3
32
Kg

Mule Ears Overlook

Teo

14

7

Kg

Tmds

Cerro Castellan

11

Teo

Kg

CASTOLON

UNITED STATES

12

16

8

Tmds

Rancho de Roman de la Ho
spring
2
3
2
4

Qral

Teo

5

Tmds

1

Tao

Tmdc

9

Tmds

5

16

6

7
8
9

Qral

REPUBLIC of MEXICO

10

6

Teo

12

11

8

13

10

RIO GRANDE

Smoky Creek

N

TRUE NORTH
11°
MAGNETIC NORTH

Approx. Mean Declination, 1966

0   1/4   1/2   3/4   1 Mile

29° 05'

EXPLANATION

Qral

Alluvium

Recent alluvium in stream channels

UNCONFORMITY

Tmdc
Tmds

Delaho Formation

Tmdc, Smoky Creek Member, sandstone, conglomerate; Tmds, lower member, siltstone, sandstone, conglomerate

UNCONFORMITY

Teo

Chisos, South Rim Formations, tuffs, flows, sediments

UNCONFORMITY

Kg

Aguja and Javelina Formations, sandstone and clay

5

Fossil locality

2

Measured section

QUATERNARY — RECENT

TERTIARY { MIOCENE — ARIKAREEAN / EOCENE – OLIGOCENE – GULFIAN } — CRETACEOUS

Fig. 2. Generalized geologic map of Castolon area, Big Bend National Park, Brewster County, Texas.

ACKNOWLEDGMENTS

LOCALITIES

Fossil localities shown in Fig. 2 bear the following catalogue numbers: loc. 1, 40918; loc. 2, 40635 (type locality of Delaho Formation); loc. 3, 40726; loc. 4, 40715; loc. 5, 40694; loc. 6, 40923; loc. 7, 40693; loc. 8, 40871; loc. 9, 40849; loc. 10, 40879; loc. 11, 40620; loc. 12, 40723; loc. 13, 40736; loc. 14, 40725; loc. 15, 40724; loc. 16, 40686; and loc. 17, 40823.

SYNOPSIS OF FAUNA

Class Reptilia
    Order Chelonia
        Family Testudinidae
            ?*Geochelone* sp.
Class Mammalia
    Order Insectivora
        (unstudied)
    Order Lagomorpha
        Family Leporidae
            Archaeolagus buangulus M. R. Dawson, sp. nov.
            Archaeolagus, cf. *A. acaricolus*

Order Rodentia
   Family Geomyidae
      Gregorymys sp.
   Family Heteromyidae
      ?*Mookomys* sp.
   Rodentia, gen. et sp. indet.
Order Carnivora
   Family Mustelidae
      ?*Paroligobunis* sp.
   Family Canidae
      ?*Nothocyon*, cf. *N. lemur*
   Canidae, gen. et sp. indet.
Order Perissodactyla
   Family Rhinocerotidae
   Moschoedestes delahoensis M. S. Stevens, gen. et sp. nov.
Order Artiodactyla
   Family Merycoidodontidae
      Hypsiops leptoscelos M. S. Stevens, sp. nov.
      Merychyus sp.
   Family Camelidae
      Priscocamelus wilsoni M. S. Stevens, gen. et sp. nov.
   Camelidae, gen. et sp. indet.
      Stenomylus sp.
   Family Hypertragulidae
      Nanotragulus, cf. *N. matthewi*
   Family ?Nothokemadidae
      Delahomeryx browni M. S. Stevens, gen. et sp. nov.

GEOLOGY

by J. B. STEVENS

The geology of Big Bend National Park has been described by Maxwell et al. (1967). At the time their report was under preparation little was known of the post-volcanic and pre-pedimentation sediments. They were regarded as "older alluvium" and it was only late in their study that part of the older alluvium was found to contain Miocene fossils. Part I of this paper is concerned with the oldest known post-volcanic sediments, herein described as the Delaho Formation.

Sediments belonging to the Delaho Formation are known only from the area along the Rio Grande southwest of the main body of the Chisos Mountains, Brewster County, Texas. Most of the lower member of the Delaho Formation occurs in the area covered by Fig. 2. The Smoky Creek (upper) Member of the formation is more widely distributed and crops out over a wide area extending for an unknown distance south and east into Mexico.

The stratigraphic section for the area, following that of Maxwell et al. (1967), is given in Fig. 3. Two of the lithologies, the Tule Mountain Trachyandesite Member of the Chisos Formation, and the Burro Mesa Riebeckite Rhyolite Member of the South Rim Formation are easily identified in the field and are not duplicated in or near the area studied. There is a thick sequence of tuffs between the Alamo Creek Basalt and the Bee Mountain Basalt Members of the Chisos Formation which have not been described in detail, or named. The tuffs of this interval, late Eocene to early Oligocene in age, are poorly to moderately indurated, and are important as suppliers of detritus for younger sediments. The Delaho Formation, however, is mainly derived from volcanic rocks younger than this interval of tuffs.

Structural Geology

Maxwell et al. (1967) give a detailed account of the structural elements and tectonic setting of Big Bend National Park. Udden (1907) was the first to study the area and coined the term 'sunken block,' which is applied to a graben in which the Chisos Mountain intrusives and volcanics are approximately centered. Big Bend National Park lies almost entirely within the sunken block.

The sunken block is bounded on the northeast by the Sierra del Carmen, referred to by Maxwell et al. (1967) as a west-dipping monocline broken by longitudinal normal faults. The western and southwestern boundary of the

SYSTEM	SERIES	Stage	Lithologic Units		
QUATERN-ARY	RECENT		Alluvium		
TERTIARY	MIOCENE	Arikareean	Delaho Formation	Smoky Creek Member	
				Lower member	
	OLIGOCENE	Chadronian ?	BIG BEND PARK GROUP	South Rim Formation	Burro Mesa Riebeckite Rhyolite Member
					Wasp Spring Flow Breccia Member
	EOCENE and	Duchesnean		Chisos Formation	Tule Mtn. Trachyandesite Member
					Mule Ear Spring Tuff Member
		Uintan ?			Bee Mtn. Basalt Member
					Alamo Creek Basalt Member
CRETACEOUS	GULFIAN	Maestrichtian	Javelina Formation		
		Campanian	Aguja Formation		

Fig. 3. Upper Cretaceous and Tertiary formations, Castolon area, Big Bend National Park, Brewster County, Texas.

block in the area is a northwest trending fault line scarp 1,500 feet high, into which Santa Elena Canyon is cut. The scarp faces east along the principal fault of the Castolon-Terlingua Abaja Fault Belt (Maxwell et al., 1967). They give the stratigraphic throw on this fault at Santa Elena Canyon as approximately 2,900 feet, and say that it increases to about 3,900 feet south of the village of Santa Helena, Mexico, where the San Carlos Trail passes over the scarp.

Udden (1907), Baker (1928, 1935), and Maxwell et al. (1967) have emphasized the importance of the general northwest trend of the principal

[9]

Q

Quartzarenite

95

Subarkose

Sub-
litharenite

75

A

Arkose   Lithic
          Arkose   Feldspathic   Litharenite
                    Litharenite

25

F   3:1   1:1   3:1   RF

B

25

F   3:1   1:1   3:1   RF
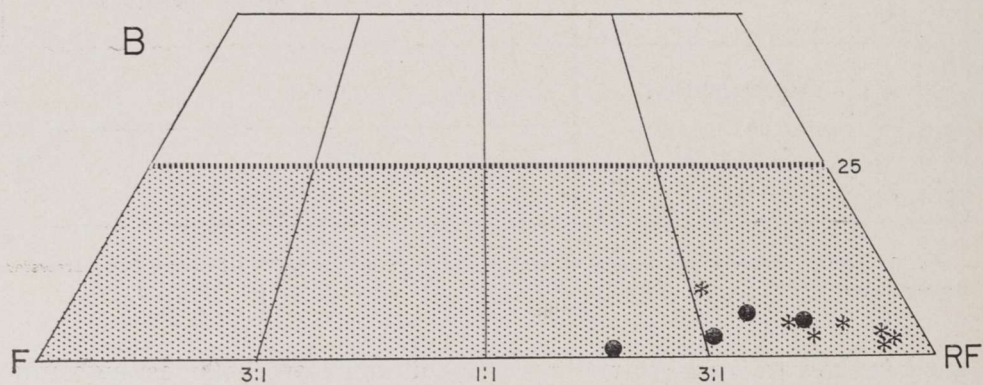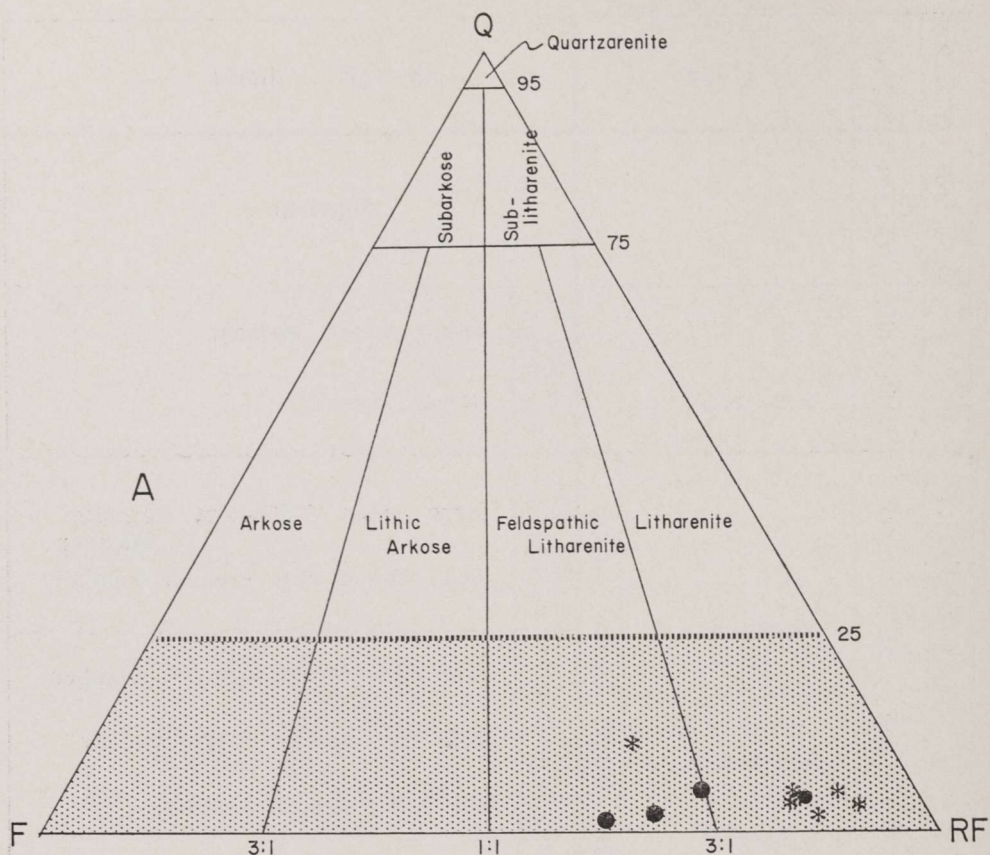
Delaho Formation

*   Smoky Creek Member

●   Lower Member

          Quartz — Poor

structures in and around the sunken block. The authors cited above have attributed this trend to the Laramide movements that produced the major part of the folding in the area. The major period of normal faulting is younger than the Delaho Formation, but the faults also have a northwest trend.

The fault that passes immediately to the east of Big Windmill has stratigraphic throw in excess of 2,000 feet in that area, and brings the lower member of the Delaho Formation in contact with the Cretaceous Javelina Formation. Throw on this fault diminishes to the northwest and southeast, and it is a high angle normal fault, down-thrown to the southwest. The fault passing immediately northeast of Cerro Castellan has about 1,200 feet of displacement in this area. It, and the major faults belonging to the Castolon-Terlingua Abaja Fault Belt, are high angle normal faults, down-thrown to the northeast. This makes the area shown in Fig. 2 the most deeply dropped part of a complexly faulted graben, which is tilted to the southeast, so that the lower member of the Delaho Formation is exposed to the northwest and the Smoky Creek (upper) Member to the southeast.

DELAHO[1] (new) FORMATION

General description.—The Delaho Formation is named after the Roman de la Ho ranch, located at a spring approximately 2 miles southeast of Castolon, Big Bend National Park, Brewster County, Texas. The ranch is shown on the Army Corps of Engineers Emory Peak Quadrangle (1931, special edition, grid zone 'E', 1599:1400;/49; 1/62500).

The Delaho Formation is divided into two members. The lower member is not given a formal name. The upper is named the Smoky Creek Member for exposures near the mouth of Smoky Creek, a minor tributary of the Rio Grande.

Lower member, Delaho Formation.—This member rests unconformably on rocks of the Chisos and South Rim Formations, and there is probably some angularity between it and the two older formations. The lower member of the Delaho Formation at the type section is a sandy silt with minor lenses of silty sand and conglomerate. The sand in the siltstone and conglomerate is a quartz-poor volcanic arenite (Fig. 4) and its quartz, occuring in minor quantity, is probably of volcanic origin. Feldspars rarely exceed 25 per cent of any sample, and sanidine is the principal *K* feldspar. *K* feldspar and quartz-bearing volcanic rock fragments are dominant rock fragment varieties.

[1] De la Ho, Spanish. Delaho Formation and Smoky Creek Member approved by the Geologic Names Committee, United States Geological Survey.

Fig. 4. Plot of sandstone composition of the two members of the Delaho (new) Formation, based on a sandstone classification diagram proposed by R. L. Folk (1968). A, composition calculated on number of grains; B, composition based on sum of the long dimensions of grain types. Q-pole includes quartz and quartzite. F-pole includes feldspar and coarse-grained igneous rock fragments, RF-pole includes all other rock fragments.

Trachytic and basaltic rock fragments combined form about 10 per cent of the rocks examined in thin section. Most dark volcanic rock fragments are heavily stained by limonite. Fragments of largely unrecrystallized volcanic glass are found in minor quantities. Heavy minerals are opaque minerals, sodic hornblende, biotite, and oxyhornblende.

Four cements are present in the lower member of the Delaho Formation in the following order of appearance: a zeolite; fine calcite, possibly caliche; and a coarsely crystalline or sparry calcite. Near faults, opal precedes most or all of the calcite cement.

Pebbles of riebeckite rhyolite, probably derived from Burro Mesa Riebeckite Rhyolite Member of the South Rim Formation, form more than 20 per cent of the pebble fraction of the lower member. Pebbles of this lithology are uncommon in the Smoky Creek Member. A second pebble lithology, a pink to gray thoroughly welded tuff with chatoyant sanidine phenocrysts, is present in minor amounts in the lower member, but is not known in the Smoky Creek Member.

Smoky Creek (new) Member, Delaho Formation.—This member rests disconformably on the lower member of the Delaho Formation, and on the Chisos and South Rim Formations. The Smoky Creek Member is a coarser sediment than the lower member, as may be seen in MS 1, and sandy siltstones are minor constituents.

There is little difference in thin sections taken from the two members of the Delaho Formation. Some samples of Smoky Creek Member contain more dark volcanic rock fragments than light; microcline forms a very minor component. Heavy minerals are less common, but when present are the same in the two members.

Conglomerates of the Smoky Creek Member are coarser than those of the lower member, come in thicker units, and have bedding best seen at a distance. Pebbles of Tule Mountain Trachyandesite, of minor importance in the lower member, are dominant in the Smoky Creek Member. Sandstones have well developed festoon cross bedding sets from 1–4 feet thick, and planar bedding is also common, but usually found in sets less than 1 foot thick. No detailed study of cross bedding directions was undertaken but, making allowance for dip of beds, many of the sets appear to have been directed to the south or southwest.

MS 2, type locality, Delaho Formation, downstream from and at the Roman de la Ho ranch, Fig. 2.

Segment	Thickness (feet)	Cumulative thickness (feet)

Fault contact with South Rim Formation

3. Sandy siltstone, sand fine, moderately sorted, very angular; calcite cemented; quartz-poor

[12]

feldspathic volcanic arenite; pink-buff; massive
indistinct bedding _____ 24.5'   467.2'

2. Covered _____177.0'   442.7'

1. Sandy siltstone; sand medium at base, fine at
top, moderately to poorly sorted, very angular;
moderately calcite cemented; quartz-poor volcanic
arenite; pink-buff; massive indistinct bedding _____265.7'   265.7'

Recent stream alluvium
   MS 3, lower member, Delaho Formation, 1 2/5 mi. NE Cerro Castellan.

Segment	Thickness (feet)	Cumulative thickness (feet)

Pediment gravel

9. Sandy silt with lenses of sandy pebble conglomerate
2–6 ft., increasing upward in thickness and frequency;
sand coarse, very angular; pebbles angular to near
very angular at top; silt calcite cemented, conglom-
erates sparry calcite cemented, later opal near
joints; sand, quartz-poor volcanic arenite; pebbles
derived from Chisos and South Rim Formations,
Burro Mesa Riebeckite Rhyolite dominant; silts
light pink-buff, conglomerates brown-buff;
massive indistinct bedding _____196.1'   1,076.8'

8. Medium sandy silt with minor lenses of coarse
pebble conglomerate 1–3 ft. thick; sand and
pebbles very angular; sandy silt calcite cemented,
conglomerate sparry calcite cemented; sand, quartz-
poor volcanic arenite; pebbles derived from Chisos
and South Rim Formations; sandy silt, light pink-buff,
conglomerates brown-buff; massive indistinct bedding ____207.3'   880.7'

7. Covered _____116.9'   673.4'

6. Sandy silt with lenses of silty pebble conglomerate,
1–3 ft. thick; sand coarse, angular; pebbles angular
to subangular; calcite cement; sand, quartz-poor
chatoyant sanidine-bearing volcanic arenite; pebbles
derived from Chisos and South Rim Formations; light
pink-buff; massive indistinct bedding _____198.0'   556.5'

5. Silty sand, with large pebbles, persistent layers of
conglomerate 1–4 ft. thick; sand coarse, angular;
pebbles angular, near subangular; sparry calcite
cement, opal cement near joints; sand, quartz-poor
volcanic arenite, pebbles, volcanic rock fragments
from Chisos and South Rim Formations, with
welded tuff dominant; light pink-buff; massive
indistinct bedding _____114.1'   358.5'

4. Covered .... 103.9'   244.4'
3. Poorly exposed silty sand with large pebbles;
   lenses of sandy silt toward top, sand coarse to
   medium upward .... 30.9'   140.5'
2. Large pebble conglomerate dominant; coarse
   sandstone lenses increasingly common upward; sand
   bimodal, fine and coarse modes; sand very angular,
   pebbles angular; sparry calcite cement; sand, quartz-
   poor sanidine-bearing volcanic arenite; pebbles
   derived from Chisos and South Rim Formations; con-
   glomerate light gray-buff; sandstone light yellow-
   buff; massive indistinct bedding .... 40.7'   109.6'
1. Large pebble conglomerate, minor lenses of poorly
   sorted sandstone, 0.5–1.5 ft. thick; sand coarse,
   bimodal in conglomerate, very fine and coarse
   modes; sand very angular, pebbles angular; sparry
   calcite cement; sand, quartz-poor sanidine-bearing
   volcanic arenite; pebbles derived from Chisos and
   South Rim Formations, Burro Mesa Riebeckite
   Rhyolite dominant; conglomerate light gray to
   light gray-buff; sandstone light buff; massive
   indistinct bedding .... 68.9'   68.9'
Unconformity

Burro Mesa Riebeckite Rhyolite Member, South Rim Formation
        MS 1, Smoky Creek Member, Delaho Formation, approx.
                2 mi. N. mouth Smoky Creek

Segment	Thickness (feet)	Cumulative thickness (feet)
Fault contact with Chisos Formation		
4. Sandstone, minor lenses of sandy silt, 1–4 ft. thick; sand medium, moderately sorted, sand with silt more angular; calcite cemented, sandy silts poorly cemented; quartz-poor sanidine-bearing volcanic arenite; yellow-buff; thick bedded, cross bedded	362.4'	1,090.0'
3. Large pebble conglomerate with minor lenses of pebbly sandstone and medium sandy silt .3–2 ft. thick; sand coarse; pebbles and cobbles average about 5.0 ϕ, max. size about —8.5 ϕ; sand, pebbles very angular; pink caliche and sparry calcite cement; sand quartz-poor volcanic arenite, pebbles derived from Chisos and South Rim Formations, Tule Mt. Trachyandesite dominant; conglomerates light red-brown, finer lenses pink-buff to light pink-buff; bedding massive	69.7'	728.3'

[14]

2. Poorly exposed large pebbly sandstone; lenses of pebbly conglomerate up to 16 ft. thick near base, coarse lenses thinner, less frequent upward; sand medium; pebble size decreases upward from mean of 5.0 ϕ, max. of —8.0 ϕ at bottom, to mean of 4.24 ϕ, max. of —5.5 ϕ at top; pink caliche cemented, white sparry calcite cement near joints; sand angular to subangular, pebbles very angular at bottom, near subangular at top; sandstone, quartz-poor volcanic arenite; pebbles derived from Chisos and South Rim Formations, Tule Mt. Trachyandesite dominant in lower part, less common upward; conglomerates red-brown, sandstones pink-buff; cross bedding and planar bedding common toward top of segment .... 513.0′   658.6′

1. Large pebble conglomerate, lenses of silty large pebbly coarse sandstone 0.5–4 ft. thick, increasing in thickness and frequency upward; sand bimodal, coarse and fine modes; pebbles range to —9.25 ϕ; sand very angular, pebbles very angular; moderately sparry calcite cement; sandstone, quartz-poor sanidine-bearing volcanic arenite; pebbles volcanic rock fragments from Chisos and South Rim Formations, Tule Mt. Trachyandesite dominant; conglomerates red-brown, sandstone lenses yellow-brown-buff; indistinct massive bedding .... 145.6′   145.6′

Fault contact with lower member, Delaho Formation

Age of Delaho Formation.—The sandy siltstones of the lower member of the Delaho Formation have yielded a vertebrate local fauna. We consider this local fauna to be early Miocene, Arikareean. The Smoky Creek Member is younger, but so far no identifiable vertebrate remains have been found in it.

PART II

SYSTEMATIC DESCRIPTIONS
excluding Lagomorpha
by M. S. STEVENS
Class Reptilia
Order Chelonia
Family Testudinidae Gray
?*Geochelone* sp.
(Fig. 5, A–B)

Material.—40635–33, carapace and plastron.

Description.—The carapace is approximately 170 mm. long and 135 mm. wide. Slight crushing makes neurals 7–8 appear narrow in the illustration (Fig. 5, A). Costal plates 2, 4, 6, 7, and 8 narrow proximally whereas costals 3 and 5 narrow distally. Neural 1 is rectangular, neurals 2–8 are hexagonal. Emphasis has been placed on shape of neurals in descriptions of early Miocene tortoises, but specific neurals may be 4, 6, or 8-sided in the same population (Auffenberg, written communication, March, 1966). This is especially true in Oligocene and early Miocene species. The edges of peripherals 8–10 are upturned. The pygal bone, somewhat concave internally, projects downward as does the posterior margin of peripheral 11.

The plastron (Fig. 5, B) is about 143 mm. long and the plastral lip is damaged anteriorly but probably was not deeply notched. It is deeply excavated posteriorly, and 32.6 mm. wide. The posterior lobe of the plastron is wide, with little notching in the region of the femoral and anal scutes, and the ziphiplastron is not pointed posteriorly.

Discussion.—This tortoise has more resemblance to *Geochelone* than to *Gopherus*. It is, however, somewhat aberrant. Specific assignment is deferred pending study of the specimen by D. Bramble of the University of California, Berkeley.

Class Mammalia
Order Insectivora

The insectivore material from the Castolon local fauna is being studied by Bryan Patterson of Harvard University.

Order Rodentia
Family Geomyidae Gill
Subfamily Entoptychinae Miller and Gidley
Gregorymys sp.
(Fig. 6, A–F; Table 1)

[16]
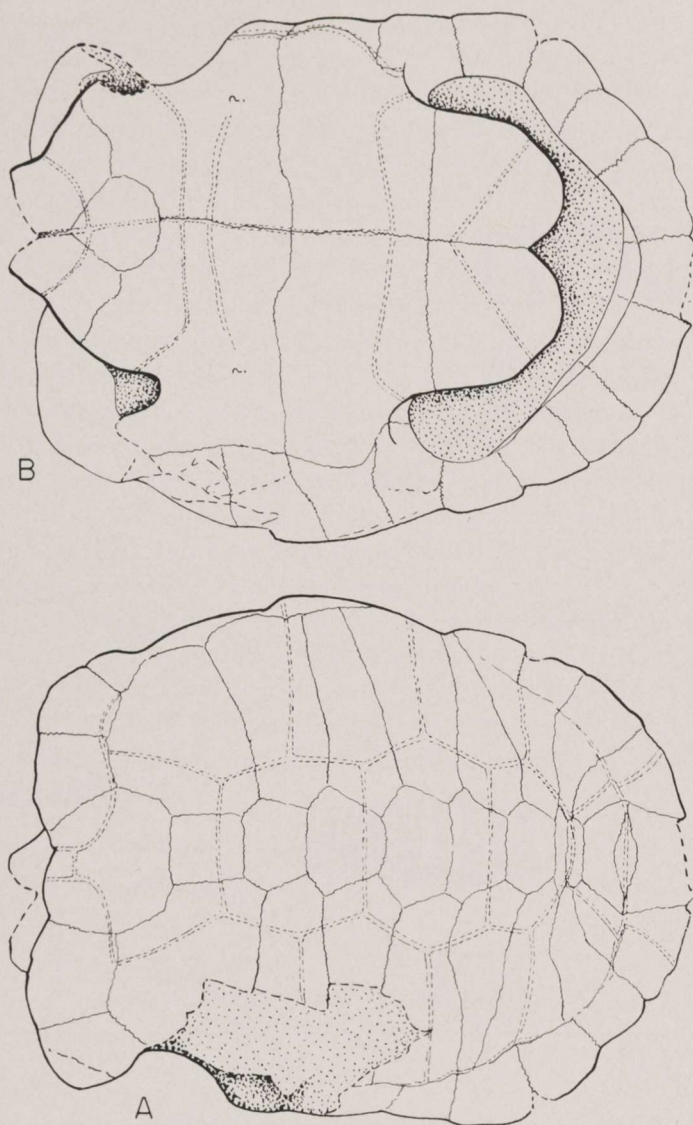
Fig. 5. A, B, ?*Geochelone* sp., 40635–33. A, carapace, dorsal view; B, plastron, ventral view. All × ½.

Material.—40635–39, left mandible with P_4-M_3 and 40635–38, right mandible with P_4-M_2.

Description.—A partial incisor with orange enamel is present in 40635–38. It is sub-triangular in cross-section. P_4 has two large divergent roots; M_1-M_3 have a single, broad root (Fig. 6, F). Enamel extends down toward the roots of P_4 on its anterior and posterior sides, a feature observed in most entoptychines. On M_1-M_3 the enamel extends much farther down the posterior side of the tooth than elsewhere. Placement of enamel is known to vary within

[17]
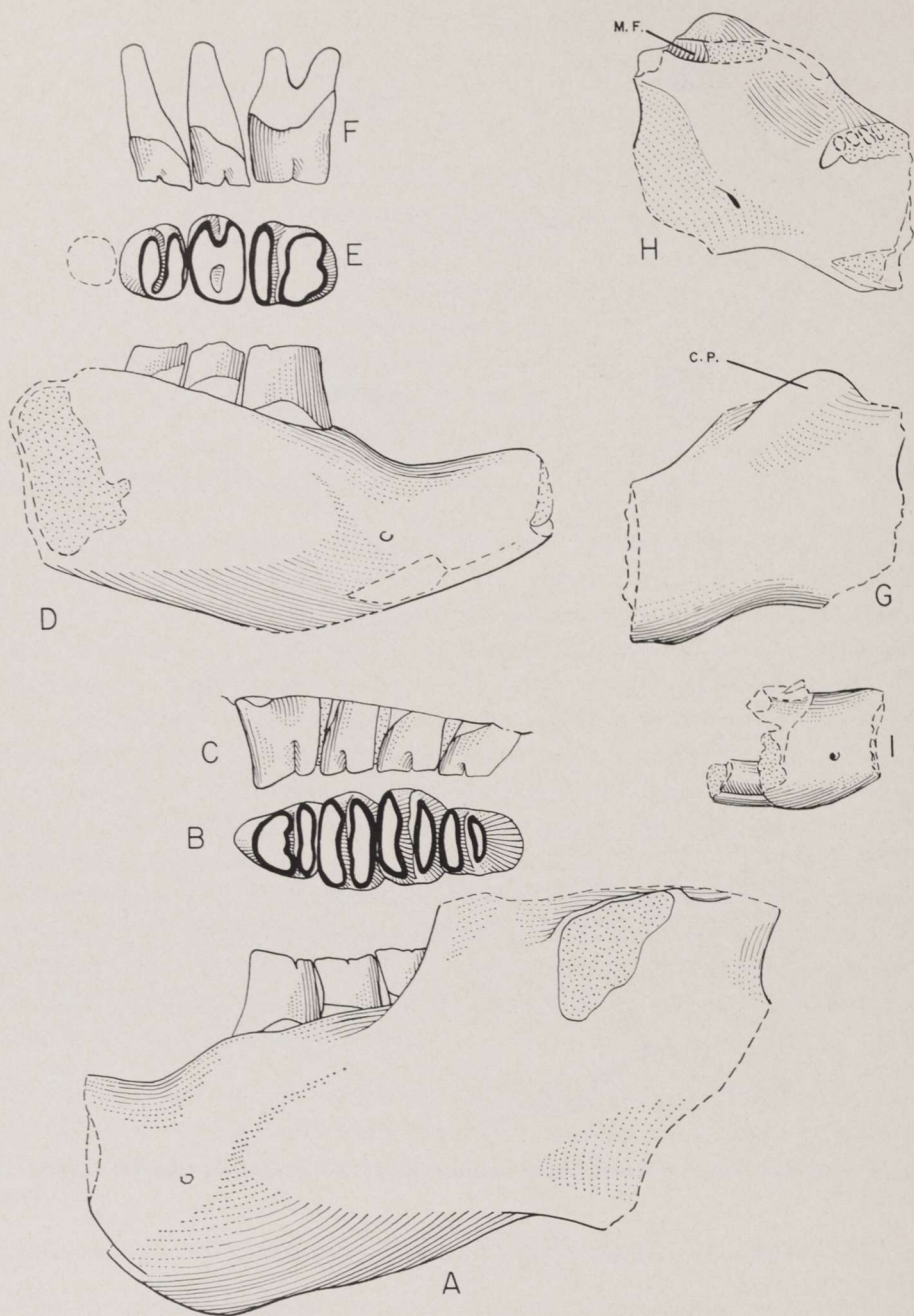
Fig. 6. A–F, Gregorymys sp. A, mandible, 40635–39; B, occlusal view, P_4–M_3; C, lingual view, P_4–M_3. D, mandible, 40635–38; E, occlusal view, P_4–M_2; F, lingual view, P_4–M_2. G–H, ?Mookomys sp., 40635–53; G, labial view, posterior portion of mandible (c. p., capsular process); H, lingual view, mandible (m.f., mandibular foramen). I, Rodentia, gen. et sp. indet., 40635–60, diastemal portion of mandible (anterior to right). All $\times$ 6.

the subfamily but the Castolon species resembles more closely the genera *Gregorymys* and *Entoptychus* in this feature than *Pleurolicus*. Wear during the animal's lifetime would not have interrupted the occlusal enamel pattern as it did in *Entoptychus*. Crowns of the teeth are composed of two transverse lophids, with the protolophid of P_4 apparently composed of at least three cusps. The position of the anteroconid (see Wood, 1935:79 for cusp nomenclature) is slightly different on the two P_4's. A shallow notch is present between the anteroconid and protoconid of P_4 of 40635–38. No anterior cingulum occurs on P_4, but both known premolars are worn. The shallow sulcus between lophids deepens toward the lingual side of each cheek tooth. Thus, the lophids first unite at the labial border, and the sulcus retreats medially with continued wear. It is more deeply incised in P_4 than in M_1-M_3, but is not as deep as in *Entoptychus*. The sulcus is very slightly basined labial to the midline in all teeth. This produces an isolated enamel lake when wear has all but removed the sulcus. This lake is very shallow and would be quickly removed. Enamel lakes are known to occur in *Gregorymys* and *Entoptychus*. There is no indication of an H-pattern on the teeth.

The two jaws show size dimorphism similar to that seen in jaws of the living gopher, *Thomomys bottae*. The shallow masseteric fossa ends below the anterior edge of P_4 and the pit located between M_3 and the base of the coronoid process is very shallow. The capsular process (knob at the base of the lower incisor) is large, and the mandibular foramen is located posterodorsal to the base of M_3.

Discussion.—The subfamily Entoptychinae contains the early Miocene genera, *Pleurolicus* Cope (1879), *Gregorymys* Wood (1936), *Grangerimus*

TABLE 1

Measurements of *Gregorymys* sp.

	Anteroposterior diameter		Proto-lophid width^{md}	Meta-lophid width^{md}	Crown height, max. observable, lingual
	(Alveolar)	(Crown)			
P_4 40635–39	2.38	1.57	1.62	1.64	2.23
40635–38	2.05	1.64	1.58	1.81	1.86
M_1 40635–39	1.00	1.16	1.83	1.96	1.81
40635–38	1.10	1.35	1.90	1.86	1.75
M_2 40635–39	1.00	1.32	2.00	1.81	1.64
40635–38	.93	1.21	1.71	1.60	1.64
M_3 40635–39	1.44	1.30	1.58	1.24	1.64
P_4–M_3 (alveolar)			(40635–39)	6.63	
			40635–38	6.19	

Wood (1936), and *Entoptychus* Cope (1879). The Castolon species appears closest to forms of *Gregorymys*, in that its teeth are moderately high crowned, are rooted, have isolated enamel lakes, and have no interruption of enamel pattern. The Castolon form is too specialized to belong to *Pleurolicus* and too generalized to belong to *Entoptychus*. The species from the Delaho Formation is perhaps the smallest *Gregorymys* known. Specific designation is, however, deferred pending study of additional material.

Family Heteromyidae Allen and Chapman
?Subfamily Perognathinae Wood
?*Mookomys* sp.
(Fig. 6, G–H)

Material.—40635–53, posterior part of left mandible and associated tibia, femur, and other bone fragments.

Description.—The jaw is characteristically heteromyid with a high, slit-like mandibular foramen that bends gently over the base of the incisor. The capsular process is inflated and the base of the angular process is large, thus distinguishing the specimen from the early Miocene genus, *Florentiamys* Wood (1936a:46). A very shallow depression occurs between M_3 and the ascending ramus. Little information can be gained from the teeth except that the roots of part of M_2 and those of M_3 are similar in shape to those in Recent *Perognathus*.

The limb elements resemble in size those of Recent *Perognathus hispidus* but are longer and more slender. The tibia, represented by approximately two-thirds its length, includes the fused distal end of the fibula and this union is higher on the shaft than in *P. hispidus*.

Discussion.—Arikareean heteromyid genera are *Heliscomys* Cope (1873), *Mookomys* Wood (1931), *Proheteromys* Wood (1935), and *Florentiamys* Wood (1936a), discussed above. *Heliscomys* is apparently the stem genus of the family and is confined mainly to the Orellan (middle Oligocene) (Wood, 1935:18; Wilson, 1949a:114). Two species, however, of *Heliscomys* are known from the Arikareean; *H. woodi* McCrew (1941:55) and *H. schlaikjeri* Black (1961:4). *Mookomys* is close to *Heliscomys* but has more progressive features in its dentition. It probably gave rise to Recent *Perognathus* (Wood, 1935; Wilson, 1949a). What is known of the Castolon species closely resembles *Perognathus* and it therefore seems probable that it is more closely allied to *Mookomys*, the *Perognathus* ancestor, than to the more generalized *Heliscomys* or *Proheteromys*.

Rodentia, gen. et sp. indet.
(Fig. 6, I)

A third species of rodent in the Castolon local fauna, a very small mouse, is represented by the diastemal portion of a right mandible, 40635–60. The fragment contains part of the incisor and the mental foramen.

[20]

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Order Carnivora Bowdich
Family Mustelidae Swainson
?*Paroligobunis* sp.
Fig. 7, F–G)

</div>

Material.—40635–29, an unerupted P_2 in a mandible fragment.

Description.—The tooth is unworn but fully formed, and has a simple apex with no accessory cusps (Fig. 7, F–G). Its posteromedial portion is broadly expanded and slight posteroexternal and posteromedial cingula occur. The tooth is 4.74 mm. wide, and 6.8 mm. long but the anterior portion of the tooth lacks enamel.

Discussion.—The Castolon specimen resembles either P_2 or P_3 of *Paroligobunis simplicidens* (Peterson, 1906), but is about one-third smaller than P_2. A second, smaller species referred by Loomis (1932) to *Paroligobunis, P. petersoni*, from the Marsland Formation near Van Tassell, Wyoming, has a smaller P_2 which lacks the posterior expansion observed in the premolars of *P. simplicidens*, and *Brachypsalis*, and thus appears unrelated to this group. The Castolon P_2 differs from that of the Middle John Day, *Oligobunis crassivultus* (Cope), AMNH 6903, by slightly larger size, higher crown, greater posteromedial expansion and more prominent ridge from apex to posterior margin. The Castolon specimen closely resembles P_2 of *Brachypsalis modicus* Matthew, AMNH 17209, from the Snake Creek, though the tooth is shorter, and lower crowned.

<div align="center">

Family Canidae Gray
?*Nothocyon*, cf. *N. lemur* (Cope)
(Fig. 7, A-C)

</div>

Holotype.—*Nothocyon lemur*, Cope, 1879a.

Material.—40635–66, lower jaw fragment with a partial P_2, P_3 lacking its apex, alveoli for P_4, and M_1 lacking its posterior edge of enamel; 40879–2, a partial mandible with a fragment of M_1; and possibly 40918–35, a mandible fragment with premolar alveoli.

Description.—Only 40635–66 is suitable for description. The apex of P_3 is broken, but the tooth was high and lacks accessory cusps. The trigonid of M_1 is elevated and the large metaconid is slightly posteromedial to the protoconid (Fig. 7, A–C). Its talonid is basined and slight traces of anteroexternal and external cingula occur. The anteroposterior diameter of P_3 is 4.45 mm., and it is 2.07 mm. wide. M_1 is 8.2°° mm. long, 3.57 mm. wide at the talonid, its trigonid and talonid length (taken as in Hall, 1927, Fig. 1) are 5.04 and 3.16°° mm., respectively. Its height, from apex of protoconid to base of enamel is 5.15 mm. P_3-M_1 is 17.3°° mm., jaw depth below P_3, 7.06 mm., depth below M_1, 8.36 mm., and the ratio of length of trigonid of M_1 to talonid is 62.7%.

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[21]

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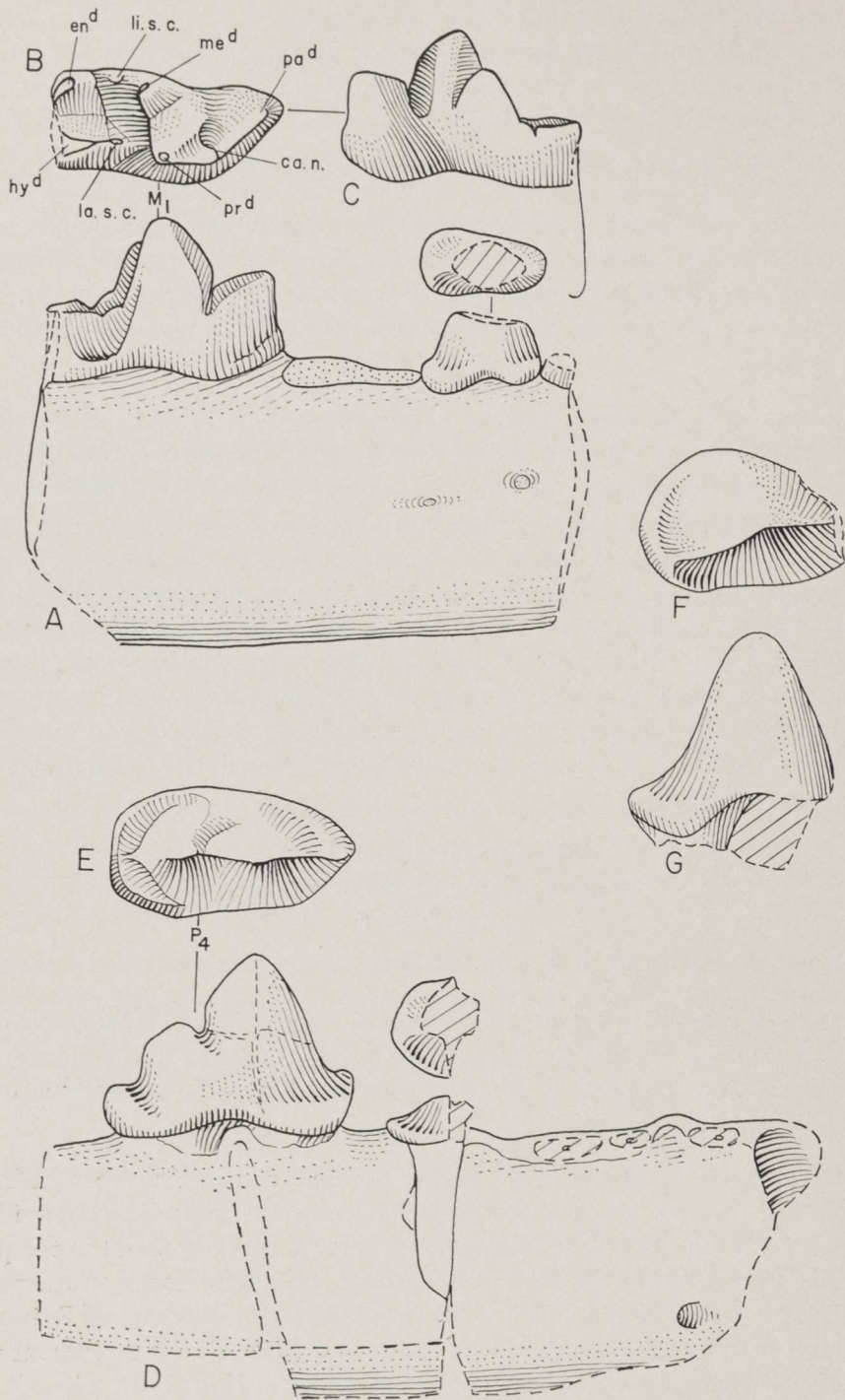
Fig. 7. A–C, *?Nothocyon*, cf. *N. lemur*, 40635–66; A, labial view, mandible with fragment of P_2, a partial P_3, M_1; B, occlusal view, M_1 (ca. n., carnassial notch; en^d, entoconid; hy^d, hypoconid; la. s. c., labial subsidiary cusp; li. s. c., lingual subsidiary cusp; me^d, metaconid; pa^d, paraconid; pr^d, protoconid); C, lingual view, M_3. D–E, Canidae, gen. et sp. indet., 40635–67; D, labial view, mandible with partial P_3–P_4; E, occlusal view, P_3–P_4. F–G, *?Paroligobunis* sp., 40635–29; G, labial view; F, occlusal view. All $\times$ 4.

Discussion.—Specimen 40635–66 is indistinguishable from *Nothocyon lemur*, AMNH 6892, figured by Cope (1884:70; Fig. 7, 7a).

<center>Canidae, gen. et sp. indet.</center>
<center>(Fig. 7, D–E)</center>

Material.—40635–67, a partial right jaw with alveoli for P_1-P_2, a partial P_3, and P_4.

Description.—P_4 is short, high, and broad with prominent accessory cusps (Fig. 7, D–E). Premolars are closely spaced, and the jaw is not robust. P_4 is 7.74 mm. long, 4.14 mm. wide, and 6.07 mm. high. The alveolar length of P_2-P_4 is 20.7 mm.

<center>Order Perissodactyla Owen</center>
<center>Family Rhinocerotidae Owen</center>
<center>*Moschoedestes delahoensis*[1] M. S. Stevens, gen. et sp. nov.</center>
<center>(Fig. 8, A–D; Table 2)</center>

Holotype.—40694–2, both mandibles lacking ascending rami.

Referred.—40726–1, associated upper and lower dentitions.

Type locality.—Loc. 5.

Moschoedestes.—The characters of the genus are those of the type species, *M. delahoensis.*

Diagnosis.—A rhinoceros of larger size, and much higher crowned cheek teeth than *Menoceras cooki.*

Description.—The subadult mandible (Fig. 8, A–B) is intermediate in size between jaws of *Menoceras cooki* (Peterson) from the Harrison Formation of Agate, Nebraska, and *Diceratherium armatum* Marsh, from the Middle John Day of central Oregon. It contains alveoli for ? DI_1, erupting I_2, alveolus for P_1 (?DP_1), P_2-P_3, erupting P_4 exposed under DP_4, M_1-M_2, and fragments of erupting M_3. I_1 is represented by an alveolus; whether for the deciduous or permanent tooth is unknown. The tusk, I_2, is moderately long, narrow and semiprocumbant, and similar to an equilateral triangle in section. No enamel occurs on its dorsomedial surface. The diastema is very short, little more than the length of the occlusal surface of M_1. A similar short diastema is characteristic of *Menoceras cooki*. The length of the diastema would probably not have greatly increased with maturity. Jaws of Recent rhinoceroses in the American Museum of Natural History at the same stage of tooth replacement do not differ greatly from adults of their species with respect to depth of jaw and length of diastema. P_1, perhaps deciduous, is represented by a single root fragment in its alveolus. Peterson (1920:434) states that in *M. cooki* P_1 is absent, but in young animals a DP_1 persists until all cheek teeth are

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[1] *Moschos*, μόσχος, a young twig, and *edestes*, ἐδεστης, an eater; *delahoensis*, from the Rancho de Roman de la Ho.
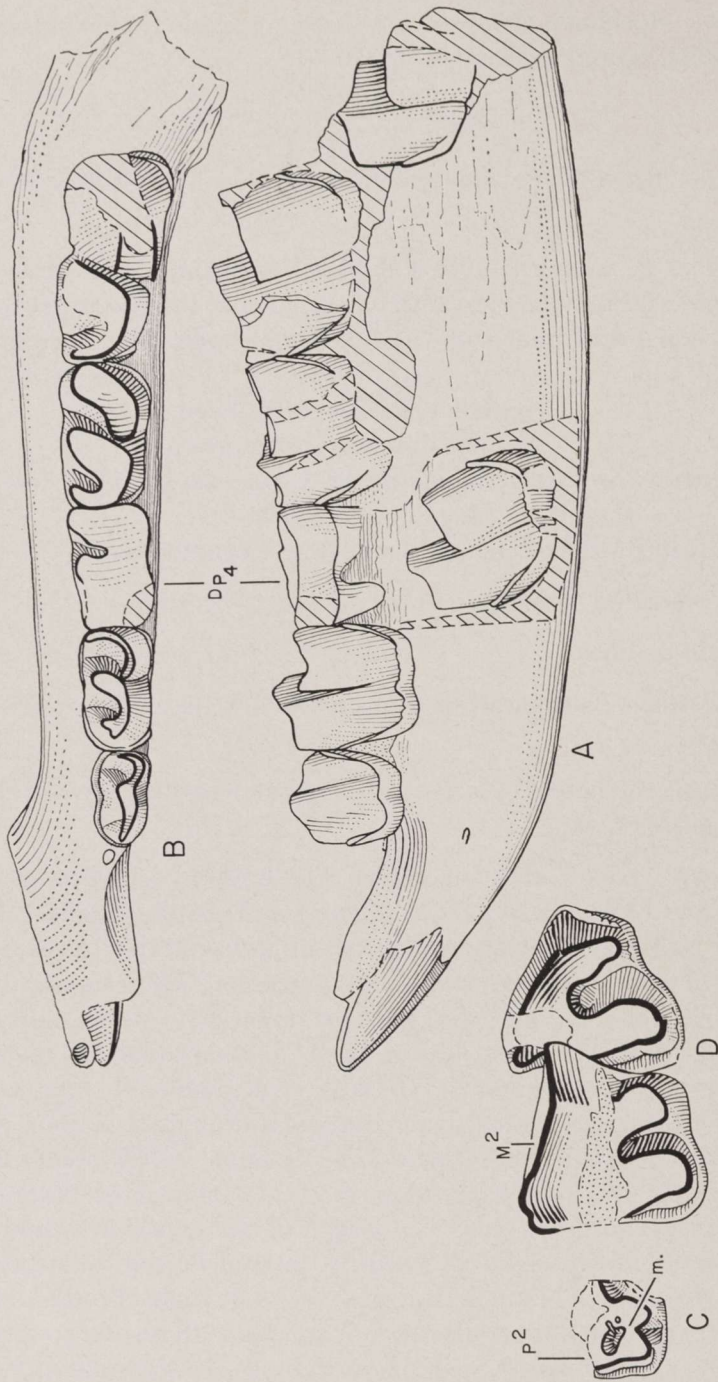
<center>[23]</center>

Fig. 8. A–D, *Moschoedestes delahoensis* M. S. Stevens, gen. et sp. nov. A–B, 40694–2, holotype; A, mandible; B, occlusal view, dentition. C–D, 40726–1; C, P^2 (m., mure); D, M^2–M^3 (M^2 restored). All $\times$ ½.

erupted. P_2-M_3 are sub-hypsodont. The crown height of P_2-P_4 is only a little less than the depth of the jaw below them. These are much higher crowned premolars than found in *M. cooki* and the species of *Diceratherium*. The height of M_1-M_2 is about two-thirds the depth of the mandible below them. Cingula are continuous and very prominent on P_2-P_4. Anterior and posterior cingula are present on M_1-M_2, and an anterior cingulum is known for M_3.

The dentition of the referred specimen is worn, extremely fractured and crushed. The best preserved teeth are LP^2, LM^2 and LM^3. M^2-M^3 are of the generalized rhinocerotid type. No antechrochet, crista or crochet is present on M^2. There is a slight crochet on M^3, which may have been larger when the tooth was less worn.

Discussion.—The only other early Miocene rhinoceros hitherto known to have sub-hypsodont teeth is *Menoceras cooki*. The Castolon species certainly is not *M. cooki* though it resembles it in its trend toward hypsodonty, short mandibular diastema, and curving ventral mandibular border. It differs from *Diceratherium* in the much shorter diastema, much higher crowned teeth, and shallower, ventrally curving mandible, but resembles it in development of cingula. The Castolon species differs from the *Diceratherium*-like *Floridaceros whitei* Wood of the Thomas Farm local fauna in the same way as from *Diceratherium*. Cingula are reduced in *Floridaceros* (Wood, 1964).

Peterson (1920:434–435) and Wood (1927:57–59) agree that *Menoceras cooki* probably was derived from *Caenopus*. *Moschoedestes* may also have come from *Caenopus* or something related to the *Caenopus-Subhyracodon* radiation.

Proportions of crown height to depth of mandible in *Moschoedestes* is similar to that in Pliocene *Teleoceras*, and also to the mandible referred to *Aphelops* sp. by Stock and Furlong (1926:49). *Moschoedestes*, however,

TABLE 2

Measurements of *Moschoedestes delahoensis*,
M. S. Stevens, gen. et sp. nov., 40694–2

	Anteroposterior diameter	Transverse diameter	Height of crown	Depth of jaw below tooth
P_2	26.0	16.2	30.6	34.4
P_3	33.1	21.8	39.2	38.8
P_4	38.8	—	40.4	46.4**
M_1	43.9	26.2*	38.1*	52.1*
M_2	47.9*	—	40.5	60.0
P_2–M_3				236.0**
P_2–M_2				186.0
Length of symphysis				85.4
Minimum width of symphysis				52.2

probably is not the long sought ancestor of *Teleoceras* as early species of that genus have lower crowned teeth than the Castolon species. No limbs are known for *Moschoedestes*. Its relationship, if any, to *Aphelops* sp. is unclear.

The mandible of *Moschoedestes delahoensis* also resembles, in a general way, that of the Recent African black rhinoceros where moderately high crowned teeth, short mandibular diastema and ventrally curving mandible are adaptations associated with browsing on shrubby xerophytes. *Moschoedestes* was probably similarly adapted, and lends support for relatively xeric conditions in the Big Bend region in the early Miocene.

Order Artiodactyla Owen
Family Merycoidodontidae Thorp
Subfamily Phenacocoelinae Schultz and Falkenbach
Hypsiops leptoscelos[1] M. S. Stevens, sp. nov.
(Fig. 9, A–C, F–I; Table 3)

Holotype.—40635–8, associated skull, mandibles, left pes, left innominate bone, and greater part of left tibia.

Referred.—40635–26, skull, jaws; 40635–6, anterior part of skull, jaws; 40635–1, lower jaws, right humerus lacking proximal end, left femur and tibia, astragali; 40635–25, anterior part of skull, jaws, articulated right femur, tibia and pes; 40635 24, skull, right femur, left humerus lacking proximal end, lumbar and sacral vertebrae, articulated left calcaneum and astragalus; and 40635–81, skull, jaws.

Type locality.—Loc. 2.

Diagnosis.—A small *Hypsiops* with higher crowned teeth and much more slender limbs than *H. luskensis*.

Description.—The skulls and jaws of the Castolon species are very similar to that of *H. luskensis* from the Harrison Formation (of Schultz and Falkenbach, 1950:122) of Niobrara County, Wyoming. Teeth differ from those of *H. luskensis* by being relatively higher crowned and in other details. P^2 and P^3 of *H. leptoscelos* have extremely large posterior crescents (see Fig. 9, F–H, for cusp nomenclature, modified from Loomis, 1925:586). This produces a very large internal shelf that enters into the grinding surface with wear. No shelf, only a small conule is present in *H. luskensis* (FAM 44853A). Cingula on upper and lower teeth are much more developed than in *H. luskensis* (an exception is 40635–24). An enclosed lake or basin, absent in *H. luskensis*, occurs on the posteroexternal border of P$_2$ and P$_3$ of *H. leptoscelos* (Fig. 9, G and I). This is formed by posterior union of the posterior intermediate crest and the posterior crest.

Four nearly complete skulls of *H. leptoscelos* are known, but all are some-

[1] *Leptus*, λέπτος, thin, fine; and *scelos*, ὀκέλος, the leg.
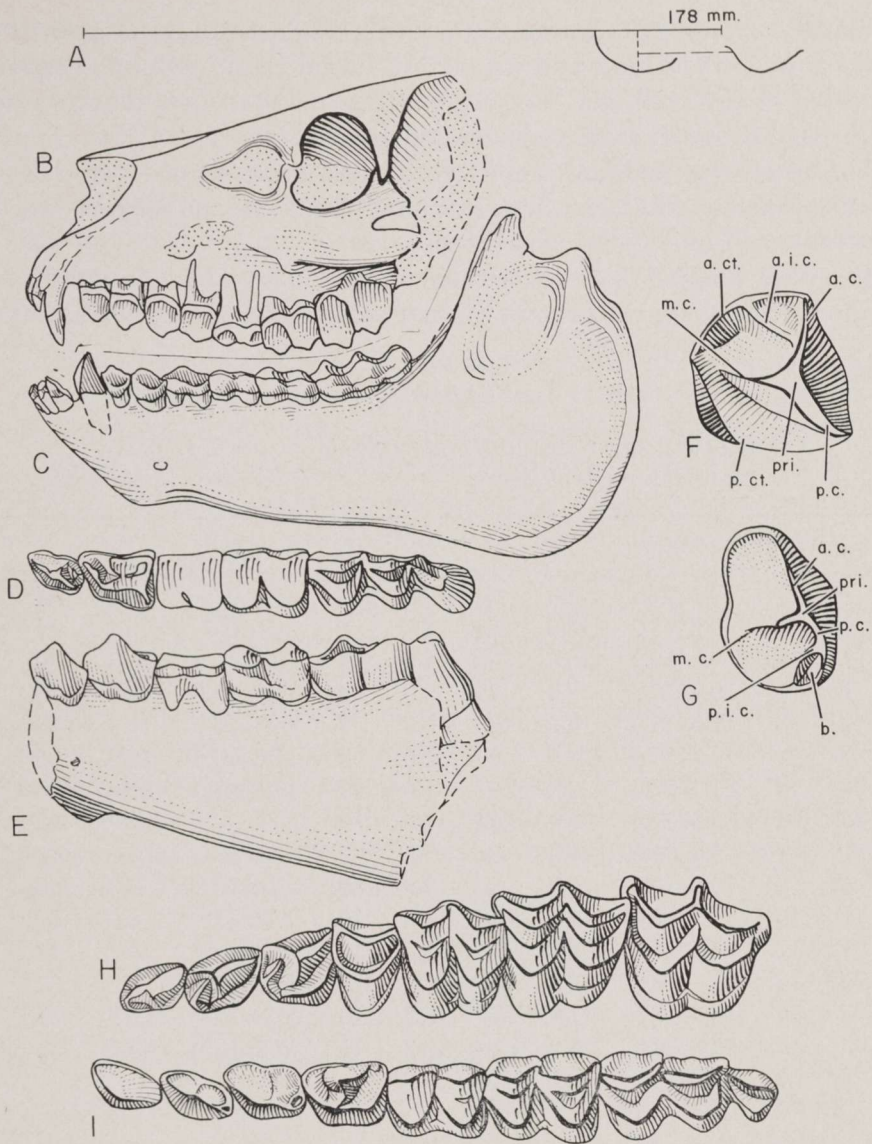
Fig. 9. A–C, F–I, *Hypsiops leptoscelos* M. S. Stevens, sp. nov. A, basal length of skull, 40635–8, holotype, and cross-sections through auditory bulla taken as Schultz and Falkenbach (1950, p. 97, chart 1), basal length approximate, × ½; B, lateral view of skull anterior to cranium, 40635–6, × ½; C, lateral view, mandible, 40635–26, × ½; F, LP³, 40635–8, holotype (a. c., anterior crest; a. ct., anterior crescent; a. i. c., anterior intermediate crest; m. c., median crest; p. c., posterior crest; p. ct., posterior crescent; pri., primary cusp), × 2; G, Lp₃, 40635–8, holotype (a. c., anterior crest; b., basin; m. c., median crest; pri., primary cusp; p. c., posterior crest; p. i. c., posterior intermediate crest), × 2; terminology modified from Loomis (1925: 386, Fig 1). H–I, Lp¹–Lm³ and Lp₁–Lm₃, 40635–8, holotype, occlusal view, × 1. D–E, *Merychyus* sp., 40823–1; D, lateral view, mandible, × 1; E, occlusal view, P₃–M₃, × 1.

what crushed. An undistorted partial skull, 40635–6, is illustrated. The most complete skull is 40635–26, but it is flattened, has worn teeth and the auditory bullae are not preserved. The type specimen, 40635–8, is a cranium lacking

premaxilla and canines, but having a young adult dentition (Fig. 9, H–I), most of the skull, bullae, and mandibles. Facial fossae are not completely preserved in any skull, but bone around their margins show that they were deep. Auditory bullae are large and semidepressed (Fig. 9, A).

Numerous lower jaws are preserved, the best being 40635–1, –8, and –26. The axial skeleton is known from specimen 40635–24, and all vertebrae are relatively small and lightly constructed.

Specimen 40635–8 includes an innominate bone which is lightly constructed. The two humeri known are not complete but their distal ends are

TABLE 3

Statistical data on *Hypsiops leptoscelos* M. S. Stevens, sp. nov.

		Anteroposterior diameter					Transverse diameter			
	N	OR	$\overline{X}$	s	CV	N	OR	$\overline{X}$	s	CV
P^1	7	8.5–9.3	9.0	.29	3.4	7	5.2–6.3	5.9	.44	7.7
P^2	9	9.6–12.0	10.6	.84	8.1	9	8.0–9.6	8.8	.61	7.2
P^3	9	9.8–12.2	10.6	.69	6.6	9	10.1–11.3	10.8	.39	3.7
P^4	9	9.4–10.2	9.9	.28	3.0	9	12.6–14.6	13.5	.53	4.1
M^1	8	12.6–15.5	14.2	.86	6.3	7	15.4–16.7	16.1	.48	3.1
M^2	9	17.4–20.1	18.5	1.00	5.6	9	17.6–19.6	18.6	.62	3.4
M^3	10	21.1–27.0	23.8	1.97	8.5	11	17.6–23.0	20.0	1.30	6.7
P^1–M^3	5	85.9–95.8	89.9	4.04	4.7					
P_1	9	9.3–10.9	10.2	.51	5.2	9	5.1–6.5	5.6	.49	8.9
P_2	9	10.0–10.6	10.2	.20	2.0	9	5.4–6.2	5.8	.28	4.9
P_3	10	11.2–12.8	11.9	.54	4.6	10	7.6–8.6	8.0	.37	4.8
P_4	11	12.0–14.3	12.9	.71	5.6	11	8.4–10.9	9.7	.77	8.1
M_1	14	12.7–14.9	13.8	.68	5.0	13	10.2–12.3	11.3	.57	5.2
M_2	10	15.6–18.5	17.0	.94	5.7	10	11.3–13.4	12.8	.61	4.9
M_3	12	22.8–28.5	26.2	1.54	6.0	11	12.5–13.8	13.2	.53	4.1
P_1–M^3	5	93.3–95.5	93.9	.90	1.0					

	N	OR	$\overline{X}$
Transverse diameter, tibia	3	20–22	21.3
Length, femur	2	153–155	154
Transverse diameter, head of femur	2	20–21	20.5
Minimum diameter, femur shaft	1	14	——
Transverse width, distal end, femur	2	29–31	30
Length, tibia	2	154–159	156.5
Minimum diameter, shaft, tibia	2	12–12	12
Transverse width, distal end, tibia	3	19–22	21
Length, calcaneum	3	47–51	49
Anteroposterior diameter, calcaneum	3	19–20	19.7
Length, astragalus	2	26–27	26.5
Transverse diameter, distal end, astragalus	2	15–15	15

much smaller than those of *H. luskensis*. The same is true for the radius. Only one femur and two tibiae of *H. luskensis* are available for comparison, and those of *H. leptoscelos* are much more slender. The femur of *H. luskensis* is 16 per cent longer than that of *H. leptoscelos*, 40635–1, and is much more robust. Its head is 20 per cent larger, width of the distal end across medial and lateral condyles is about 26 per cent greater and the minimal width of the shaft is 35 per cent greater. The femur of *H. luskensis* is longer than the associated tibia by 12 per cent, whereas those of *H. leptoscelos* are the same length or slightly shorter than associated tibiae.

Discussion.—The subfamily Phenacocoelinae contains *Phenacocoelus* Peterson (1906), *Hypsiops* Schultz and Falkenbach (1950), *Submerycochoerus* Schultz and Falkenbach (1950), and *Pseudomesoreodon* Schultz and Falkenbach (1950), all from the early and middle Miocene. The Castolon species differs from all other species of the subfamily except *Phenacocoelus kayi* Schultz and Falkenbach, and *Hypsiops luskensis* Schultz and Falkenbach in overall size. Toothrow length of *H. leptoscelos* is similar to that of *P. kayi*, holotype, FAM 33660A, but the teeth of *H. leptoscelos* are much higher crowned with more prominent cingula. Similarly, all other species of *Phenacocoelus* have much more brachyodont teeth. The Castolon species is closest to *Hypsiops luskensis* in general morphology, but again, the Castolon form has higher crowned teeth. *H. leptoscelos* has the highest crowned teeth of the genus with the possible exception of the larger *H. breviceps* (Douglass). *H. leptoscelos* and *P. kayi* both have relatively long and light limbs. *H. leptoscelos* is not ancestral to any other *Hypsiops* except possibly *H. breviceps* of the late Arikareean of Montana.

Subfamily Merychyinae Simpson
Merychyus sp.
(Fig. 9, D–E; Table 4)

Material.—40823–1 and 40694–1, mandibles.

Description.—Both mandibles contain worn LP_3-LM_3 (Fig. 9, D–E). The

TABLE 4

Measurements of teeth of *Merychyus* sp.

	Anteroposterior diameter			Transverse diameter		
	N	OR	X	N	OR	X
P_3	1	8.43	———	1	5.59	———
P_4	2	9.40–9.70	9.55	2	7.23–7.81	7.52
M_1	2	9.41–9.54	9.48	1	7.94	———
M_2	2	11.37–12.92	12.15	1	9.96	———
M_3	2	20.84–21.37	21.11	2	8.67–9.12	8.90
M_1–M_3	2	40.52–42.87	41.70			

jaws are much smaller than those of *Hypsiops leptoscelos*, lack basins on the posteroexternal side of P_3 and have shorter and relatively wider P_4's. *Mery-chyus* sp. is not unlike *M. crabilli* Schultz and Falkenbach (1947) from the Harrison Formation, *M. calaminthus* Jahns, from the Tick Canyon Formation (Jahns, 1940), or small individuals of *M. minimus* Peterson (1906) from the Marsland Formation, in size. Since only jaw fragments of this small oreodont have been recovered from the Delaho Formation, specific designation is deferred.

<div align="center">

Family Camelidae Gray

Subfamily Camelinae Zittel

Priscocamelus wilsoni[1] M. S. Stevens, gen. et sp. nov.

(Fig. 10, A–I; Fig. 11, A–C; Table 5)

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Holotype.—40849–1, mandibles lacking angle and coronoid.

Referred.—40635–40, partial palate with DP^4, M^1-M^3, right jaw with M_1-M_3; 40849–2, maxilla with P^1-P^4, partial M^1-M^3, metatarsal and astragalus; 40635–102, immature individual, partial skeleton, metapodials, jaws and maxilla fragment with teeth; 40823–2, partial skeleton, hind limbs; 40879–1, left mandible with P_3-M_3, alveoli for anterior premolars and canine, associated P^4, M^2-M^3, phalanges; 40693–11, M_1-M_3, metapodials; 40620–26, metapodial fragments; 40849–5, metapodials; and 40635–2, partial skeleton.

Type locality.—Loc. 9.

Priscocamelus.—The characteristics of the genus are those of the type species, *P. wilsoni.*

Diagnosis.—Differs from ?*Oxydactylus wyomingensis* (Loomis) by relatively shorter rostrum, hence shorter diastemas between first and second premolars, and slightly shorter metapodials.

Description.—Holotype contains RI_3, both canines, LP_1, right and left P_2-M_3. I_3 is large, procumbant and spatulate (Fig. 10, A–B). Canines are very large, elongate, trenchant and recurved. A very short diastema, three-fourths the length of P_1, occurs between the canine and P_1. P_1 resembles the canine, but is much smaller. Behind P_1 another diastema, the length of P_2, extends to P_2. These diastemas are relatively shorter than in some specimens of *Poebrotherium* Leidy. P_2 is long and transversely compressed, and its paraconid is slightly medially directed. P_3 and P_4 are very long and narrow, and have anteromedially directed paraconids and posteriorly open lakes, formed by entoconid and hypoconid.

Associated upper and lower teeth, specimens 40879–1, 40635–40 and –102, have been recovered. The longest tooth of the molar series is M^2, the shortest is M^1. M^2-M^3 are widest across their anterior pair of crescents; M^1 is slightly

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[1] *Priscus,* ancient, former, and *camelus,* a camel; *wilsoni* for Professor John Andrew Wilson of The University of Texas at Austin.
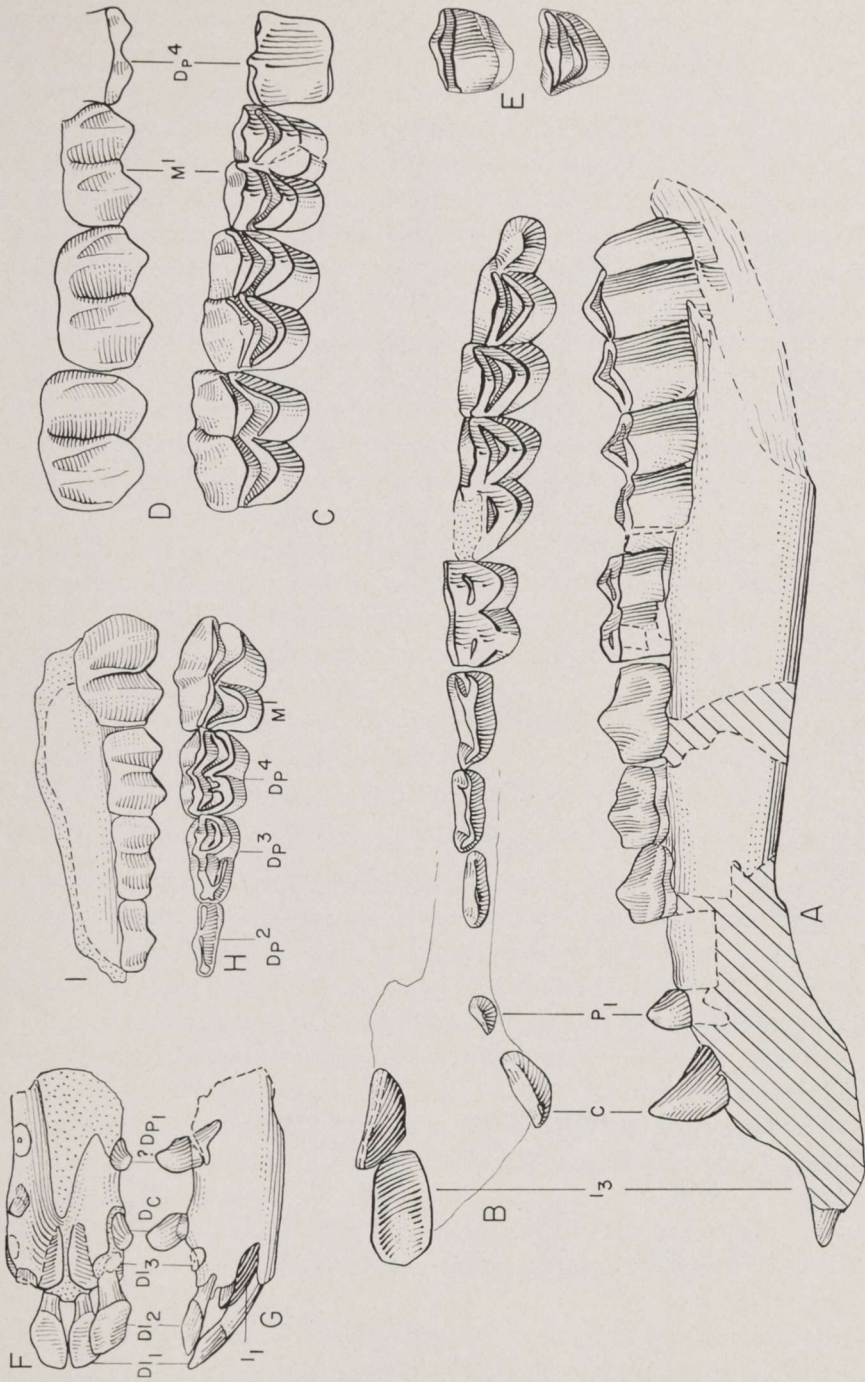
Fig. 10. A–I, *Priscocamelus wilsoni* M. S. Stevens, gen. et sp. nov. A, B, lateral view of mandible, occlusal view of RI$_3$, C–M$_3$, 40849–1, holotype; C–D, DP^4, M^1–M^3, occlusal and labial views (DP^4 reversed), 40635–40; E, occlusal and lingual view of P^4, 40879–1; F–G, symphysis of mandible with milk teeth, 40635–14; H–I, maxilla fragment with milk teeth, 40636–15. All × 1.

[31]
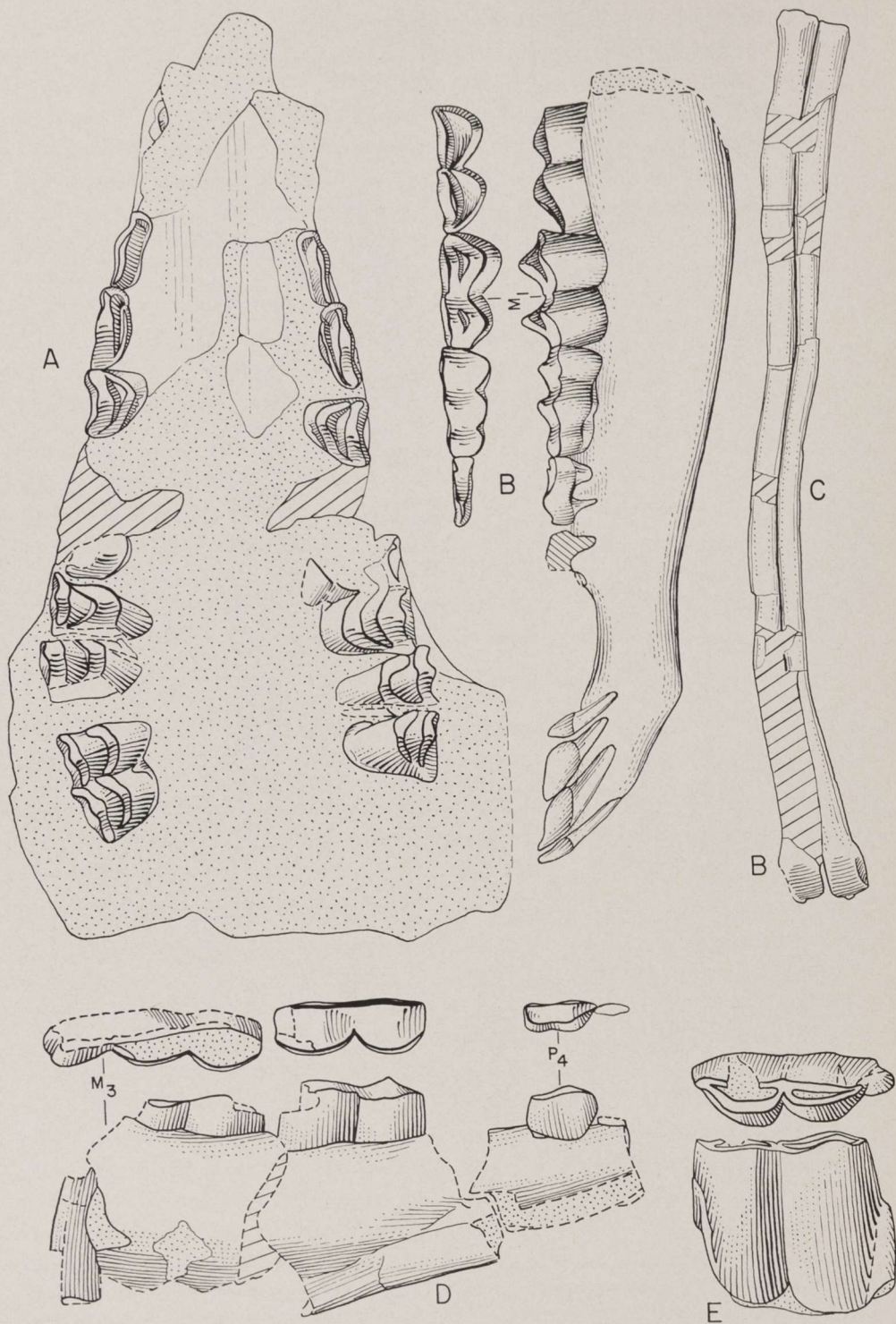
Fig. 11. A–C, *Priscocamelus wilsoni* M. S. Stevens, gen. et sp. nov. A, maxilla with dentition, P^1–P^4, M^2–M^3, 40849–2, $\times$ 1; B, juvenile mandible, incisors, canine, and premolars are deciduous, 40635–102, $\times$ 1; C, metatarsal, anterior view, 40849–2, $\times$ ½. D–E, *Stenomylus* sp. D, mandible with P_4, M_2–M_3, 40620–10, $\times$ 1; E, LM^3, lingual and occlusal views, 40620–10, $\times$ 1.

wider across its posterior pair (Fig. 10, C–D). Parastyles and mesostyles are prominent, especially at depth, so that these features appear to be more prominent on worn, than on unworn teeth. M^1-M^3 are sub-hypsodont.

Specimen 40849–2 has premolars preserved in addition to molars (Fig. 11, A). P^1 is small and is separated from P^2 by a diastema about equal to the length of P^3. This is relatively much shorter than the corresponding diastema in most individuals of *Oxydactylus* Peterson, and is in keeping with the short diastema of the mandible of this species. Spacing of canines and the anterior premolars is known to vary greatly in camelids (Loomis, 1928), and though there is similar variation in these features in *P. wilsoni*, its diastemas are nevertheless consistently short. P^2 is long, narrow, with a rudimentary but continuous internal cingulum. P^3 is similar to P^2, but longer and has a well developed, cresent-like internal cingulum, notched at its anteromedial edge (Fig. 11, A). On P^2-P^3 the prominent anterior style forms a small cusp.

Three partial milk dentitions, specimens 40635–14, –15, and –102, have been referred to *Priscocamelus wilsoni* (Fig. 10, F–1; Fig. 11, B).

A number of metapodials or metapodial fragments are associated with dentitions. These dentitions are very similar to each other and represent but one species, but the metapodials show considerable individual variation in length. The metatarsal of 40849–2 (Fig. 11, C), is very long and slender. Those of 40693–11, 40620–26, 40849–5, and 40823–2, are long, but slightly more robust. The metatarsal of 40635–102, a very young individual with only M^1_1-M^2_2 of its permanent dentition erupted, are short (Table 5). None of the metapodials are fused at any part of their length.

Discussion.—Priscocamelus wilsoni is similar to the much earlier *Poebrotherium* in many characteristics. These include elongated, unreduced premolars, short diastemas between the first and second premolars, and shallow mandibles. It differs from *Paratylopus primaevus* Matthew, a poorly known late Oligocene derivative of *Poebrotherium*, mainly by greater hypsodonty, larger general size, and metapodial elongation. *Paratylopus*, however, appears to have a deeper mandible than is known for *Priscocamelus*, and for this reason *Priscocamelus* may be more directly derived from *Poebrotherium*.

Morphology of teeth and metapodials of *Priscocamelus wilsoni* imply relationship to the central line of camelid radiation discussed by McKenna (1966). *P. wilsoni* differs most notably from all late Arikareean and early Hemingfordian *Oxydactylus, sensu stricto*, by much shorter rostrum and much shallower mandible.

Priscocamelus wilsoni is very similar to ?*Oxydactylus wyomingensis* (Loomis). The depth of the mandible of 40635–102, which is approximately the same individual age as the immature type specimen of ?*O. wyomingensis*, is the same as that of adult jaws known for its species, specimens 40849–1 and 40879–1, etc., indicating that the depth of the jaw below M_1-M_2 does not increase significantly after eruption of these teeth. Length of the rostrum of

[33]

the immature mandible would, however, lengthen when the milk incisors and premolars were replaced, as the rostrum of 40635–102 is shorter than that of adult mandibles of its species. Mandibular depth of the immature type specimen of ?*O. wyomingensis* would similarly not have greatly increased had that individual reached maturity, but its rostrum would have lengthened with replacement of its deciduous incisors and premolars. These changes are consistent with those produced by ontogeny of Recent camels in the AMNH collections. *P. wilsoni* has a shorter rostrum than ?*O. wyomingensis*, as the C-M₃ diameter of adult specimens of *P. wilsoni* is less than this diameter on the immature mandible of the type specimen of ?*O. wyomingensis*.

The metatarsal of the immature type specimen of ?*O. wyomingensis* is comparable in length to those of adults of *P. wilsoni*. It is not known how much, if any, the metatarsal of ?*O. wyomingensis* would have lengthened had the animal reached maturity, and Loomis (1936: 64) states that the epiphysis on the metatarsal is already fused. It is known that in the immature specimen, 40635–102, which is only slightly younger than the type specimen of ?*O. wyomingensis*, there would have been considerable metatarsal lengthening with maturity. Adult metatarsals recovered for *P. wilsoni* indicate that they are comparable or slightly shorter than those of the juvenile type specimen of ?*O. wyomingensis*.

Priscocamelus wilsoni could, morphologically, be ancestral to ?*Oxydactylus wyomingensis*, however, doubt is expressed in the literature concerning the age of the specimen from Wyoming. Though Loomis (1936: 59) states that the type specimen of ?*O. wyomingensis* comes from "the sandstone beds which are generally designated in this region as lower Harrison," Macdonald (1963: 231) considers the specimen as having the same stratigraphic position (that is "40 feet above the top of the typical Oligocene" Loomis, 1936: 59) as specimens from the Sharps Formation. The Sharps Formation overlies Oligocene (Brule) deposits and is very early Miocene in age (Harksen, et al., 1961). Camelid material from the Sharps Formation is markedly smaller than the type specimen of ?*O. wyomingensis*, as based on size of M¹ and M², and is not "slightly larger than the type" as Macdonald (1963: 231) states. The material from the Sharps Formation also has a more massive and deeper mandible. It appears that this material should not be referred to *Oxydactylus* cf. *wyomingensis*, but may instead represent a miotylopine, to which it agrees in size and in "reduction in the size of the styles" on the molars (Macdonald, 1963). Metapodials have not been reported from the Sharps Formation. If ?*Oxydactylus wyomingensis* is late Arikareean in age (lower Harrison, *sensu* Loomis, 1936) then *Priscocamelus wilsoni* is probably directly ancestral to it. If ?*O. wyomingensis* is earlier, then *Priscocamelus wilsoni* represents a generalized collateral species that persisted in the Southwest until at least the middle Arikareean.

Priscocamelus wilsoni has no close relationship to *Gentilicamelus stern-*

bergi (Cope), questionably from the middle division of the John Day Formation. *P. wilsoni* may be closely related to ?*Paratylopus cameloides* (Wortman), from the upper division of the John Day Formation, but *P. wilsoni* is smaller, has much shorter rostrum (see Wortman, 1898; Dougherty, 1940) and longer metapodials. *P. wilsoni*, ?*Paratylopus cameloides*, and ?*Oxydactylus wyomingensis* appear to represent a closely related group of species which have in common shallow mandibles, sub-hypsodont dentitions, upper molars with prominent styles, unreduced premolars, and elongated metapodials. They differ from each other in rostral morphology. Generic assignment of the John Day and Wyoming forms has never been satisfactorily demonstrated. Harksen, et al. (1961: 678) consider ?*O. wyomingensis*, and Repenning and Vedder (1961: 237) consider ?*Paratylopus cameloides*, as referable to *Oxydactylus*. Perhaps better taxonomic treatment would be to consider them as species of *Priscocamelus*. *Oxydactylus* can be derived from

TABLE 5

Measurements of *Priscocamelus wilsoni*, M. S. Stevens, gen. et sp. nov.

	Anteroposterior diameter				Transverse diameter		
	N	OR	X̄		N	OR	X̄
P^1	1	4.0	....		1	2.1	....
P^2	1	11.1	....		1	4.5	....
P^3	1	12.3	....		1	5.6	....
P^4	2	10.0–11.2	10.6		2	8.9–9.1	9.0
M^1	2	14.2–16.3	15.2		2	12.1–12.7	12.4
M^2	3	16.5–19.3	18.3		3	13.0–14.6	13.9
M^3	3	18.6–18.7	18.7		3	14.4–15.4	14.9
$\bar{C}$	1	9.4	....		1	4.5	....
P_1	1	5.8	....		1	3.5	....
P_2	1	9.4	....		1	3.7	....
P_3	3	10.6–11.8	11.4		4	4.3–4.7	4.5
P_4	5	11.4–13.8	12.5		5	5.6–6.4	5.8
M_1	5	13.6–15.1	14.3		5	8.5–9.6	9.1
M_2	2	16.8–17.8	17.3		6	9.6–11.1	10.7
M_3	5	22.8–24.3	23.5		6	8.8–10.8	9.8
P^2–P^4			33.2	P_2–P_4			34.7
P^2–M^3			76.3[1]	P_2–M_3			92.6
P^1–P^2 diastema			13.5	$\bar{C}$–P_1 diastema			2.6, 4.2
Length of metatarsal (adult)							262°, 246°
Length of metatarsal (juvenile)							157

[1] P^2-M^3, estimated by ratio of the corresponding measurement in *Paratylopus primaevus*, P^2–P^4 to P^2–M^3; this is very close to the length of LP^2–LM^3 of specimen 40849–2 as the teeth are preserved in matrix.

the early and middle Arikareean *Miotylopus* (Schlaikjer, 1935) as proportions of their mandibles and rostrums are very similar. Morphology of molars, however, of priscocamelines, with their prominent styles, are more *Oxydactylus*-like than the molars of miotylopines. Though no metapodials are known
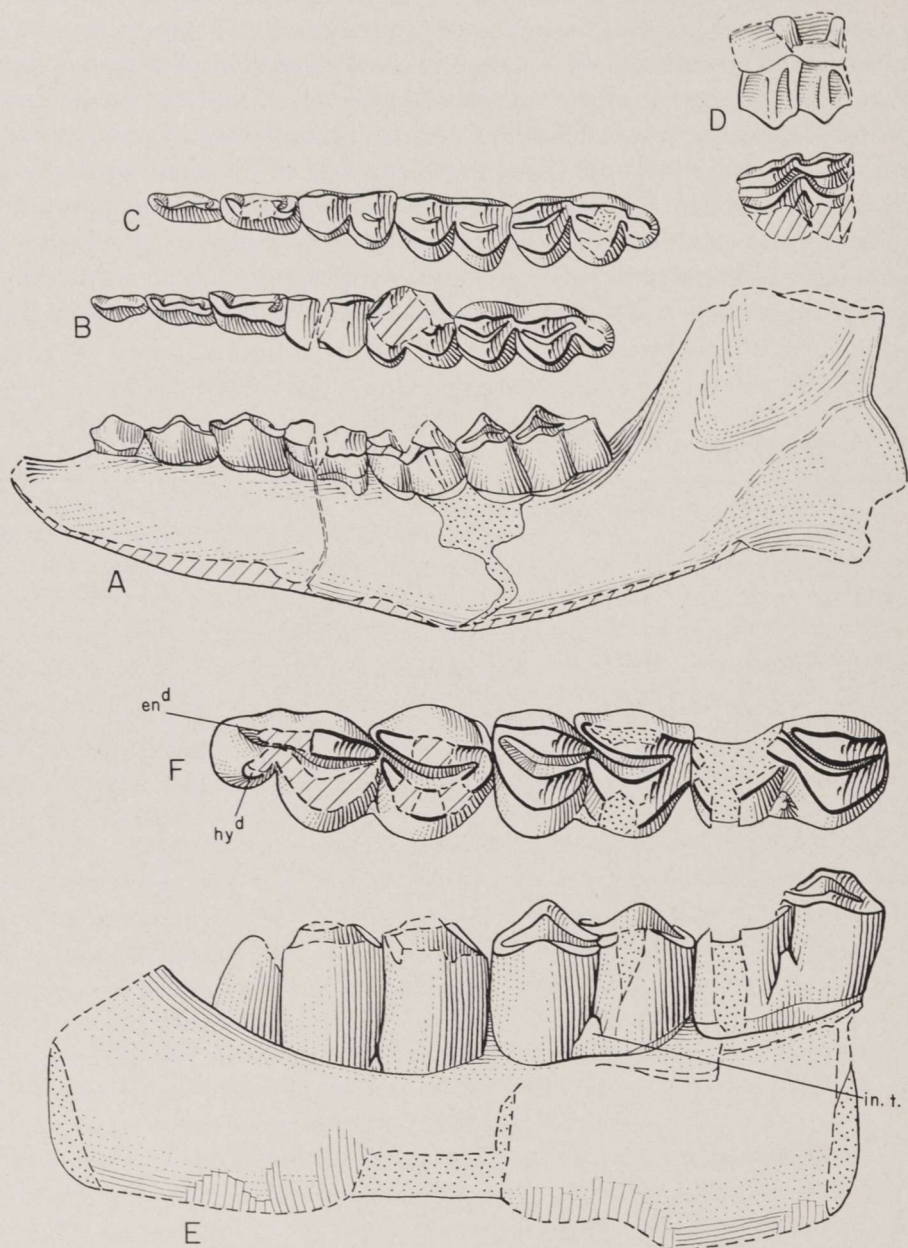
Fig. 12. A–D, Camelidae, gen. et sp. indet. A, view of mandible; B, occlusal view of P$_2$–M$_3$, 40871–1; C, occlusal view of another dentition, P$_3$–M$_3$, 40620–20; D, RM^3, occlusal and labial views, 40871–1, × 1. E–F, *Delahomeryx browni* M. S. Stevens, gen. et sp. nov. E, mandible fragment; F, occlusal view, M$_1$–M$_3$, 40620–7, holotype (en^d, entoconid; hy^d, hypoconulid; in. t., intercolumnar tubercle), × 2.

for *Miotylopus,* those of priscocamelines are again very *Oxydactylus*-like. Thus, there is evidence that priscocamelines may be, instead, the ancestral group.

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Camelidae, gen. et sp. indet.

(Fig. 12, A–D; Table 6)
</div>

Material.—40635–60, mandible with P_2, roots of P_3, part of M_1, M_2, and part of M_3; 40620–20, mandible with P_3-M_3; and 40871–1, mandible with P_2-M_3, M^3, and metapodial fragments, etc.

Description.—This species is much smaller than *Priscocamelus wilsoni,* its posterior lakes of P_3-P_4 open posteromedially instead of posteriorly, P_2-P_4 are much more reduced relative to length of P_2-M_3, and it has much more brachyodont teeth (Fig. 12, A C). P_1 is lacking in the mandibles but specimen 40871–1 has the posterior part of its alveolus preserved (Fig. 12, A). The P_1-P_2 diastema is short, though relatively longer than in *Priscocamelus.* M^3 is incomplete (Fig. 12, D), but smaller than M^3 of *Priscocamelus wilsoni.* It has prominent para- and mesostyles and ribs. M_3 has a simple hypoconulid as in camels.

Discussion.—The three mandibles closely resemble certain *Poebrotherium*-like camels, from Gering and Harrison deposits, in the Frick Collection (for example FAM 36487). Assignment of the Castolon species is therefore deferred pending description of material in manuscript.

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TABLE 6

Measurements of Camelidae, gen. et sp. indet.
</div>

	Anteroposterior diameter			Transverse diameter		
	N	OR	X̄	N	OR	X
M^3	1	14.3	—	—	———	———
P^2	2	7.2–8.5	7.9	2	3.2–3.4	3.3
P_3	2	9.9–9.9	9.9	2	3.6–4.1	3.8
P_4	2	10.8–10.9	10.0	2	4.8–5.3	5.1
M_1	1	14.1	——	2	8.4–8.7	8.6
M_2	2	15.6–16.3	15.9	2	9.7–10.0	9.9
M_3	3	19.6–20.5	20.1	2	8.8–10.1	9.5
P_2–M_3				(40871–1)	70.0*	
P_2–P_4				(40871–1)	27.4	
M_1–M_3				(40871–1)	49.2	

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Subfamily Stenomylinae Frick

Stenomylus sp.

(Fig. 11, D–E; Table 7)
</div>

Material.—40620–10, fragments of lower jaw with P_4, M_2-M_3, associated M^3

Description.—P$_4$ is large, has a smooth lingual margin and is not hypsodont. M$_2$ is wide relative its anteroposterior diameter. M$_3$ lacks enamel on its lingual side and parts of the occlusal surface. Its hypoconulid, just beginning to show wear, is not expanded posteriorly. M$_2$-M$_3$, though hypsodont are not very high crowned (Fig., 11, D). M$_3$ is nearly as long as M^3 and higher crowned. M^3 is not enlarged posteriorly; its shape, and that of M$_3$, are more nearly square instead of the rhomboid shape third molars attain in more advanced stenomylines (Fig. 11, E).

Discussion.—*Stenomylus* sp. is smaller and more primitive than the type specimen of S. *gracilis* (Peterson, 1906, p. 41) and S. *crassipes* (Loomis, 1910: 319), from the Harrison Formation. It is nearer the size of the small S. *hitch-cocki* (Loomis, 1910: 298) from lower in the same formation, but the mandible is much wider, more massive, and contains broader and relatively lower crowned teeth.

Stenomylus material from New Mexico in the Frick Collection, AMNH, exhibit much variation. Because of this the fragments from Big Bend National-al Park will not be assigned to a species, or a new species erected.

TABLE 7

Measurements of *Stenomylus* sp. 40620-10

	Anteroposterior diameter	Transverse diameter	Crown height
P$_4$	9.6 (absolute)	4.2	6.4 (labial)
M$_2$	21.0* (occlusal)	7.5	18.2 (lingual)
M$_3$	28.7 (absolute)	7.7*	29.8 (labial)
M^3	29.7 (absolute)	9.8	26.3 (labial)
Depth of jaw below middle of M$_2$			22.2

Family Hypertragulidae Cope
Nanotragulus, cf. *N. matthewi* Cook, 1943
(Fig. 13, A–F; Table 8)

Holotype.—*Nanotragulus matthewi* Cook, 1934

Material.—40635–13, M^2-M^3; 40635–76, M^3; 40918–37, M^2-M^3; 40918–36, M^2; 40635–77, P^4; 40620–2, mandible fragment with M$_1$-M$_3$; 40918–18, mandible fragment with M$_1$-M$_2$; 40918–9 jaw fragment with M$_1$-M$_2$; 40918–28, jaw fragment with M$_3$; 40726–2, jaw fragment with M$_3$; 40635–57, jaw fragment, M$_1$-M$_2$; 40635–74, P$_4$.

Description.—The internal crescent of P^4 has a slight cleft (Fig. 13, F). The upper molars are large, agreeing well in size and hypsodonty with M^2-M^3 of *Nanotragulus matthewi*. M^2-M^3 have less prominent parastyles than in *N. matthewi*. Cingula and styles on the molars are variously developed but never prominent.
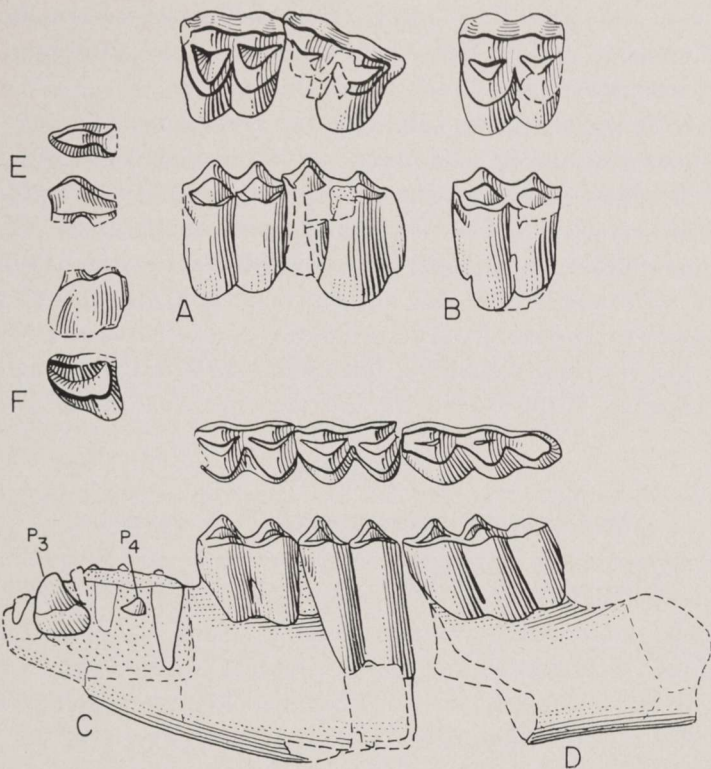
[38]

Fig. 13. A–F, *Nanotragulus*, cf. *N. matthewi*. A, M^2–M^3, lingual and occlusal views, 40635–13; B, M^2, lingual and occlusal view, 40918–36; C, mandible fragment with unerupted P_3–P_4, M_1–M_2, 40918–18; D, mandible fragment with M_3, 40726–2; E, LP_4, labial and occlusal view, 40635–74; F, RP^4, labial and occlusal view, 40635–77. All × 2.

The continuous M_1-M_3 series is known from 40620–2, but M_1 and M_3 are damaged. The best mandible is 40918–18, containing M_1-M_2 and the anterior part of the jaw, including roots for DP_4, the anterior one for DP_3, and erupting P_3 (Fig. 13, C). The labial part of the jaw was removed to show P_3. It is short, caniniform and has a continuous external cingulum not observed in other nanotragulines where the tooth is known. External styles occur on M_1, but these are absent on M_2-M_3. Anterior cingula are absent on M_1 and M_3, variable on M_2 but usually present.

Discussion.—The genus is in need of revision. Six species have been described; *N. loomisi* Lull (1922), the genotypic species from the Harrison Formation (of Lull, 1922), near Spanish Mines, Wyoming, and from the Sharps Formation of western South Dakota (Macdonald, 1963); *N. ordinatus* (Matthew) (1907) from the Harrison Formation (Macdonald, 1963: 155) of South Dakota; *N. matthewi* Cook (1934) from the Harrison Formation near Agate, Nebraska; *N. intermedius* Schlaikjer from the Harrison Formation (of Schlaikjer, 1935) of Goshen County, Wyoming, and from the Sharps

Formation; *N. albanensis* Frick (1937) from the Harrison Formation of Sioux County, Nebraska; and *N. lulli* Frick from the Lower Rosebud (of Frick, 1937) near American Horse Creek, South Dakota.

The Castolon species differs from all other species except *N. matthewi* and *N. ordinatus* in size, and it resembles *N. matthewi* more in details that can be compared. It differs with less prominent parastyles and ribs and an M^3 with less posterior expansion. The Castolon species differs from *N. ordinatus,* based on a mandible, by having a P_3 with a labial cingulum, slightly shorter M_3 relative to the length of M_1-M_2, and less developed cingula and styles. The Castolon species is distinct from *N. ordinatus. N. ordinatus* and *N. matthewi,* both from the Harrison formation, represent similar sized animals and may be a single species. If this is true, the Castolon species is probably distinct.

TABLE 8

Measurements of *Nanotragulus,* cf. *N. matthewi*

	Anteroposterior diameter			Transverse diameter		
	N	OR	X	N	OR	X
M^1	1	–6.2	____	1	4.1	____
M^2	3	7.1–7.3	7.2	3	6.5–7.5	7.0
M^3	1	8.2	____	1	6.1	____
M_1	4	6.0–6.6	6.2	4	3.4–4.4	4.0
M_2	3	6.0–7.3	6.8	3	3.8–4.2	3.9
M_3	3	9.8–10.0	9.9	3	3.2–4.1	3.6

Family ?Nothokemadidae White
Delahomeryx browni[1] M. S. Stevens, gen. et sp. nov.

[1] *Delaho,* formation from which the specimens were recovered; *meryx* μη′ρυέ, a ruminating animal; *browni,* specific name in honor of Mr. Perry Brown, Superintendent of Big Bend National Park during the time the Castolon local fauna was collected.

(Fig. 12, E–F)

Holotype.—40620–7, partial mandible with M_1-M_3.

Referred.—40635–52, jaw fragment with M_3.

Type locality.—Loc. 11.

Delahomeryx.—The characters of the genus are those of the type species, *D. browni.*

Diagnosis.—Much smaller than *Nothokemas floridanus* (Simpson) with relatively broader and lower crowned teeth.

Description.—Teeth of 40620–7, though damaged, resemble those of *Nothokemas* White. M_1 has united anterolingual and posterolabial crescents. This

results in wear progressing beyond the sulcus which divided these crescents. On the less worn M_2-M_3, union has not occurred but the crescents are closely appressed. Similar union, however, occurs in lower molars of a number of species of different artiodactyl families. The posterior edge of M_3 has an entoconid which overlaps the hypoconulid in characteristic *Nothokemas* fashion (Fig. 12, F). Intercolumnar tubercles are large on M_1-M_2, reduced on M_3, and originate from the protoconid. The teeth are relatively broader than in *Nothokemas* and more brachyodont, and thus are more like those of hypertragulines than camels.

Discussion.—Delahomeryx is smaller and more primitive than *Nothokemas*. It has larger intercolumnar tubercles, less developed union of anterolingual and posterolabial crescents, relatively wider and more brachyodont teeth, but similar hypoconulid division.

Certain resemblances between *Nothokemas* and *Oxydactylus* led Simpson to describe the original material from the Thomas Farm as *O. floridanus* (Simpson, 1932, p. 35). Later workers (McKenna, 1966; Maglio, 1966; Patton, 1967) consider it an oxydactyline derivative. Taking into account the generalized nature of *Priscocamelus wilsoni* the dichotomy must be very remote. If *Delahomeryx* is correctly allied with *Nothokemas*, the family may be of remote hypertraguloid ancestry.

The M_1 of *Delahomeryx browni* is 11.9 mm. long, 7.5 mm. wide; M_2, 14.4 mm. long, 8.9 mm. wide, and the two M_3's are 19.9 mm. and 21.1 mm. long, and 9.9 mm. and 9.5 mm. wide.

PART III

SYSTEMATIC DESCRIPTIONS
Lagomorpha
BY M. R. DAWSON

Order Lagomorpha
Family Leporidae Gray
Subfamily Archaeolaginae Dice
Archaeolagus buangulus[1] M. R. Dawson, sp. nov.
(Fig. 14, D; Table 9)

Holotype.—40918–2, partial left jaw, P_3-P_4.

Referred.—40635–23, partial left jaw, broken M_1, M_2.

Type locality.—Loc. 1.

Diagnosis.—Anteroexternal fold of P_3 very shallow; P_3 relatively short anteroposteriorly as in *A. acaricolus*, shorter anteroposteriorly than in *A. ennisianus*. Size larger than *A. acaricolus*.

Description.—Two species of *Archaeolagus* occur in the Castolon local fauna. The larger, dentally more primitive form, represents a new species, and the smaller seems to be nearest to a species previously known only from southern California. Both the Castolon species appear to be in the group of species of *Archaeolagus* having P_3 relatively short anteroposteriorly (Dawson, 1958, p. 38). The larger Castolon leporid, *A. buangulus*, (Fig. 14, D) has a very shallow, cement-free anteroexternal fold on P_3. On P_4-M_2 the trigonid and transversely narrow talonid are united by a lingual bridge. The lower incisor extends back to below the middle of P_3, where it is about mid-depth of the jaw.

Although inadequately known, this leporid clearly represents a species of *Archaeolagus* that is more primitive than other described archaeologines with the exception of *Archaeolagus* sp. from the upper Sespe (Wilson, 1949: 57). *Archaeolagus* sp. is smaller than *A. buangulus* and has only the faintest indication of an anteroexternal groove on P_3. A very gradual series of steps from a paleolagine type of P_3 to that of an archaeolagine can be traced from *Paleolagus philoi* of the Sharps Formation through the upper Sespe *Archaeolagus* sp. to *A. buangulus*.

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[1] *Bu-* prefix meaning large, and *angulus*, bend; combination refers to the type locality in the Big Bend area of Texas.
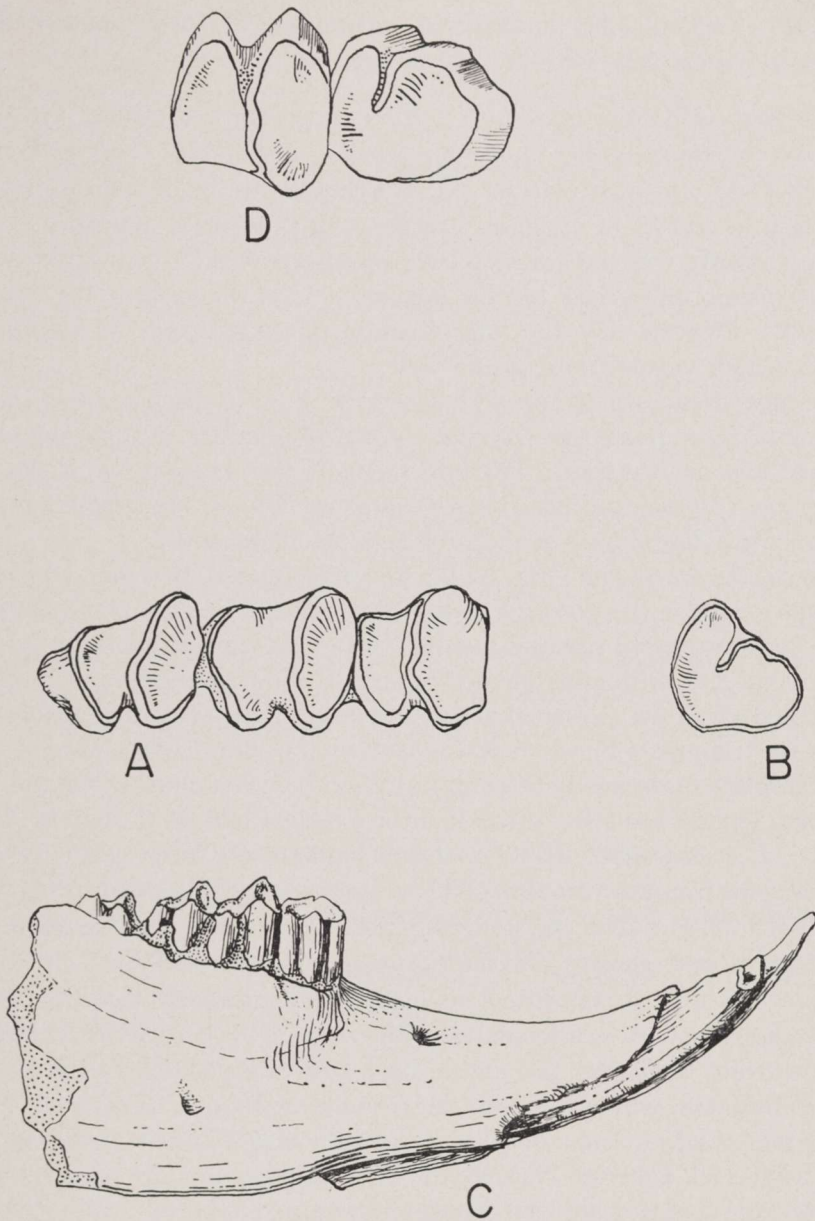
Fig. 14. A–C, *Archaeolagus*, cf. *A. acaricolus*, 40635–3; A, occlusal view of RP_4–RM_2, $\times$ 8; B, occlusal view of LP_3, $\times$ 8; C, lateral view of right jaw, $\times$ 4. D, *Archaeolagus buangulus* M. R. Dawson, sp. nov., 40918–12, occlusal view of LP_3–LP_4, holotype, $\times$ 8.

Archaeolagus, cf. *A. acaricolus* Dawson, 1958
(Fig. 14, A–C; Table 9)

Holotype.—Archaeolagus acaricolus Dawson, 1958.

Material.—40635–47, left maxilla with incomplete P^3, P^4-M^3, partial left and right mandibular rami, LP_3, RP_3-RM_2.

Description.—Although not found in direct occlusal relationship, the maxilla and jaws appear referable to one species of *Archaeolagus*. The occlusal surfaces of P^4-M^2 are poorly preserved, but they show the pattern in the adult condition to consist of a single, straight-walled internal hypostria crossing from one-third to one-half of each occlusal surface. On P^3 the occlusal surface is incompletely preserved, but the opposite end of the tooth in the maxillary tuberosity suggests that the only element of pattern was an internal hypostria, which was shorter than on P^4-M^2.

The most diagnostic of leporid lower teeth, P_3 (Fig. 14, B), shows that this is a primitive archaeologine having a relatively shallow but distinct anteroexternal fold on that tooth. The fold seems to lack cement. On P_4-M_2 (Fig. 14, A) the trigonid and transversely narrower talonid are tapered buccally and are joined lingually by a bridge of cement and dentine.

The slender lower jaw (Fig. 14, C) has an elongated diastema. One mental foramen occurs in the posterior half of the diastemal region and a more ventrally and posteriorly situated mental foramen is approximately in line with the talonid of P_4. Although the medial surface of the rami is somewhat broken over the shaft of the incisor, that tooth seems to have extended back to a line below the trigonid of P_3, where it was at about mid-depth of the jaw.

Incomplete materials limit comparison with *A. buangulus*, but the larger Castolon leporid has a less distinct anteroexternal fold on P_3 than in *Archaeolagus*, cf. *A. acaricolus*. In level of development the latter seems closest to *A. acaricolus* from the Miocene of Tick Canyon in southern California (Dawson, 1958: 39–41). The one known maxilla of *A. acaricolus* has more worn cheek teeth with shorter internal hypostriae than in 40635–47. In the two known jaws of *A. acaricolus*, P_3 is les tapered anteriorly than in 40635–3. *Archaeolagus*, cf. *A. acaricolus* also differs from *A. acaricolus* in having a dorsoventrally shallower jaw and a more posterior position of the posterior mental foramen, which is below the trigonid of P_4 in *A. acaricolus*. Part of the former condition may be due to the somewhat crushed condition of the jaws from Tick Canyon. Neither the Tick Canyon leporid nor the smaller leporid from Castolon are well enough represented to permit evaluation of individual variation. Until the limits of such variation can be assessed, it seems desirable not to give separate taxonomic designation to this Castolon leporid.

Discussion.—The only previously reported lagomorph from the Miocene of Texas was one tooth of "?*Palaeolagus* sp." from the lower part of the Oakville Formation in the Texas Coastal Plain (Wood and Wood, 1937: 139). Reexamination of the specimen in question, AMNH 30089, shows that it is not *Palaeolagus* but rather represents a rather poorly known group of North American lagomorphs with relatively low-crowned, rooted teeth, that are

currently referred to as ?*Desmatolagus* (Dawson, 1965: 14–18). ?*Desmatolagus* is not closely allied to *Archaeolagus* and thus does not contribute phylogenetic or stratigraphic clues relative to the Castolon leporids.

The two species of *Archaeolagus* from Castolon show slightly different levels of development of the archaeolagine pattern of P_3, the larger *A. buangulus* being more primitive. Dental advance of a smaller leporid relative to a contemporary larger leporid seems to occur fairly commonly in the Oligocene and early Miocene. The condition is shown especially well by species of *Paleolagus* and the dentally more primitive *Megalagus* through the Oligocene, as well as appearing in the Castolon leporids.

Similarity in level of development of the smaller Castolon leporid to *Archaeolagus acaricolus* suggests an age for the Castolon local fauna approximately equivalent to that of Tick Canyon. Both Castolon leporids are more advanced dentally than those from the early Miocene of the Sharps Formation of South Dakota. *Archaeolagus*, cf. *A. acaricolus* is slightly less progressive dentally than *A. primigenius* from the Rosebud Formation and is relatively even less advanced than the leporid known from deposits in Martin Canyon, Colorado (Dawson, 1958: 44–45), that are near the Nebraskan Marsland in age. An assessment of the Castolon leporids as presenting a level that is post-Sharps, pre-Rosebud, and near Tick Canyon seems justified. The age indicated would be approximately equivalent with the late

TABLE 9

Measurements of the Castolon Leporidae

	Archaeolagus buangulus M. R. Dawson, sp. nov.		*Archaeolagus*, cf. *A. acaricolus*
	40918–12	40635–23	40635–3
P_3, Anteroposterior diameter	2.5	------	2.0
Width trigonid	2.1	------	1.8
Width talonid	2.5	------	2.3
P_4, Anteroposterior diameter	2.7	------	2.1
Width trigonid	2.8	------	2.4
Width talonid	2.4	------	2.0
M_1, Anteroposterior diameter	------	------	2.2
Width trigonid	------	------	2.3
Width talonid	------	2.5	1.9
M_2, Anteroposterior diameter	------	3.0	2.3
Width trigonid	------	2.8	2.3
Width talonid	------	2.4	2.0
P_4–M_2	------	------	6.9
Depth of jaw at M_1	------	------	8.5

early Miocene. The age determination must, of course, be utilized in the realization that there is a considerable geographic distance from the Big Bend area to the Great Plains and Pacific Coast. How this geographic factor might bear on level of development of leporids at any one time is uncertain at present.

AGE AND INTERPRETATION OF THE CASTOLON LOCAL FAUNA
BY M. S. STEVENS

The age of the Castolon local fauna is early Miocene (Arikareean), but it is difficult to date more precisely relative to other Arikareean local faunas because of its geographic location. Its taxa represent sampling of a different early Miocene ecological province than previously known in detail. The Castolon assemblage lacks similarity to the early and middle Arikareean faunas of the Gering and Monroe Creek Formations of the High Plains, because their faunas are poorly known and what is known represents different taxa. Mammalian genera shared with other Arikareean faunas of North America are *Archaeolagus, Gregorymys, ?Mookomys, ?Paroligobunis, ?Nothocyon, Hypsiops, Merychyus, Stenomylus,* and *Nanotragulus.* The Castolon assemblage contains three new genera; *Moschoedestes, Priscocamelus,* and *Delahomeryx.* Condition of the specimens representing *?Mookomys, ?Paroligobunis,* and *Stenomylus* is so poor that specific assignment is impossible. The specimens from the Delaho Formation referred to *Nothocyon* are indistinguishable from *N. lemur,* but identification based on isolated mandibles of dogs often results in improper taxonomic treatment. The Castolon *Nanotragulus* is referred to *N. matthewi,* but again this is tentative as noted in the discussion of this species. One of us, (MRD) in the discussion of the Castolon leporids, indicates that *Archaeolagus,* cf. *A. acaricolus* is at a similar level of development as *A. acaricolus* of the Tick Canyon local fauna, regarded as late Arikareean in age. The stage of evolution of most species of the Castolon local fauna indicates, that they are slightly more generalized than comparable species from the late Arikareean Harrison Formation of Nebraska. Other species in the fauna appear to be endemics. The possibility exists that the Castolon leporid, *A.* cf. *acaricolus,* is advanced because it is associated with evolving xeric climatic conditions in the Southwest (Axelrod, 1967: 273–277), and that *A. acaricolus* is found essentially unchanged in the slightly later Tick Canyon local fauna, of southern California.

Perhaps the stage of evolution of *Priscocamelus wilsoni* is the most useful indicator of age for the fauna. This species is more generalized than any oxydactyline camel from the Harrison Formation. If *?Oxydactylus wyomingensis* is from deposits equivalent to those of the Harrison Formation, then *Priscocamelus wilsoni* probably is ancestral to it. The fauna from the early Arikareean Sharps Formation is difficult to compare to the Castolon assemblage because it is significantly older, and because it represents a different ecological association.

Taxa from the middle Arikareean Wewela local fauna, from Turtle Butte, South Dakota (Skinner, et al., 1968), also lack similarity to those of the Castolon assemblage, even though the two faunas are probably equivalent in time. The Wewela local fauna is thought to indicate "warm, perhaps quite humid conditions with streams and lakes" (Skinner, et al., 1968: 429). The Castolon assemblage appears to lack species that preferred moist conditions, indicating that such environments were not prevalent.

The Castolon local fauna shows little resemblance to assemblages from the Arikareean and early Hemingfordian John Day sequence. Only ?*Nothocyon,* cf. *N. lemur* and the camel, *Priscocamelus,* are at all comparable. The canid adds nothing that would delimit an age for the Castolon assemblage, but the camel is more generalized than that from the upper division of the John Day Formation.

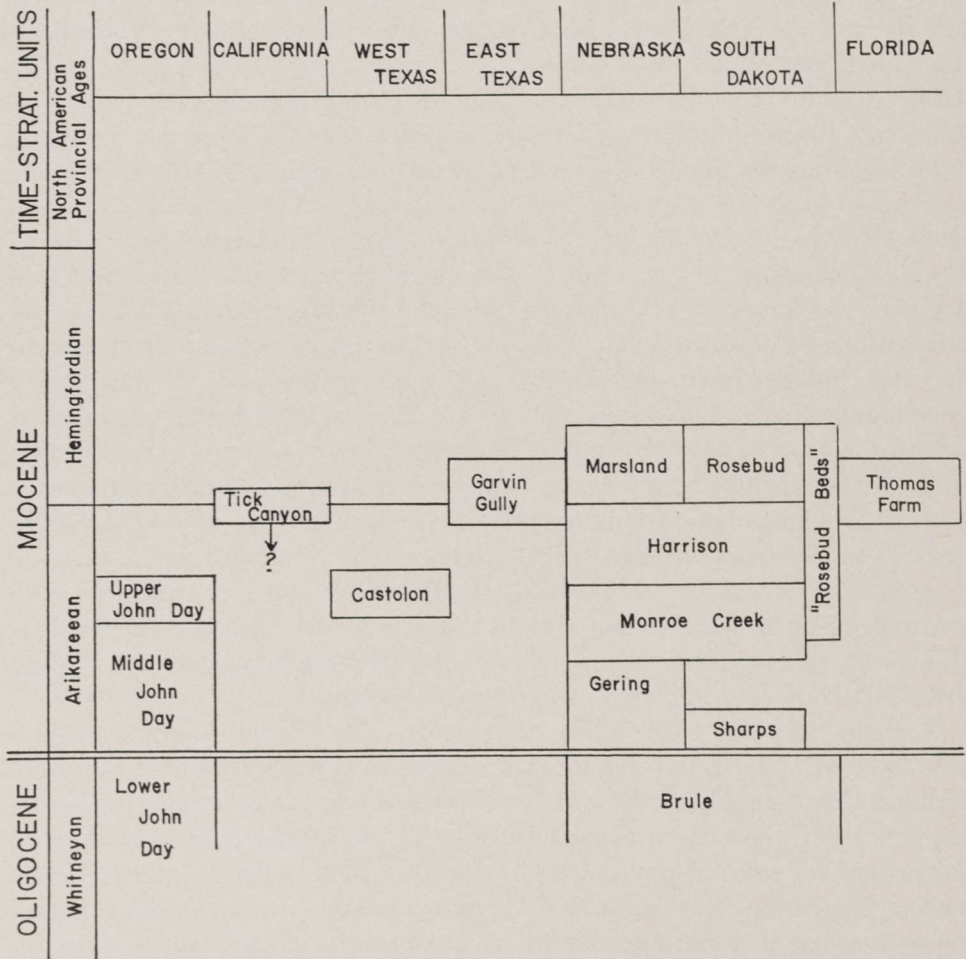Little resemblance is shown between the Castolon assemblage and the late

TIME-STRAT. UNITS	North American Provincial Ages	OREGON	CALIFORNIA	WEST TEXAS	EAST TEXAS	NEBRASKA	SOUTH DAKOTA	FLORIDA
MIOCENE	Hemingfordian							
MIOCENE	Arikareean	Tick Canyon ?			Garvin Gully	Marsland / Rosebud	"Rosebud Beds" / Thomas Farm	
MIOCENE	Arikareean		Castolon			Harrison		
MIOCENE	Arikareean	Upper John Day				Monroe Creek		
MIOCENE	Arikareean	Middle John Day				Gering / Sharps		
OLIGOCENE	Whitneyan	Lower John Day				Brule		

Fig. 15. Generalized correlation chart showing middle Tertiary vertebrate horizons.

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Arikareean Garvin Gully local fauna from east-central Texas (Quinn, 1955; Wilson, 1957, 1960, 1962), or to the Thomas Farm local fauna of Florida (Simpson, 1932; White, 1942). This is due to different, more humid, ecological conditions and to significant age differences. The only similarity between these and the Castolon assemblage is through *Delahomeryx*, if its nothokemid affinities are correctly interpreted.

The Castolon local fauna has a greater affinity with faunas of the High Plains than to those more peripheral to this area. It may represent in part the sampling of a stage in a faunal shift which progressed from the Southwest toward the High Plains as a xeric trend spread toward the interior of North America. The Castolon assemblage is interpreted as being slightly earlier than that from the Harrison Formation of Nebraska, approximately equivalent to the Middle Arikareean Monroe Creek and Wewela taxa from the high Plains (Fig. 15). All fossil localities in the lower member of the Delaho Formation are regarded as approximately the same age as remains of most Castolon local fauna mammals are recovered from them.

Perhaps most notable in the Castolon local fauna is the absence of the otherwise ubiquitous Equidae, which are present in the John Day, Sharps, Wewela, Monroe Creek, Harrison, Garvin Gully, and Thomas Farm assemblages. Arikareean horses contemporaneous with the Castolon assemblage may not have been well adapted to the sub-humid or semi-arid Madro-Tertiary Geoflora in which the Castolon local fauna is thought to have lived. The assemblage is largely artiodactyl, and, though this may be an accident of recovery, a wide variety of ungulate species indicates a savanna situation (Bourliére, 1963, table 7).

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