

THE GEOLOGY AND PALEONTOLOGY
OF THE ELK MOUNTAIN
AND TABERNACLE BUTTE
AREA, WYOMING

PAUL O. MCGREW

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PAUL O. MCGREW

WITH THE COLLABORATION OF JACK E. BERMAN, MAX K. HECHT,
JOHN M. HUMMEL, GEORGE GAYLORD SIMPSON, AND
ALBERT E. WOOD

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INTRODUCTION

PAUL O. MCGREW

THE COLLECTIONS DESCRIBED in the present report were obtained during three brief trips to the vicinity of Tabernacle Butte at the northern end of the Green River Basin, Wyoming. In 1950 a party made up of George Gaylord Simpson, Anne Roe Simpson, George O. Whitaker, Malcolm C. McKenna, Creighton Peet, and Paul O. McGrew spent 10 days collecting in exposures of the upper part of the Bridger formation in the area. A few hours were spent in Morrow Creek exposures some 12 miles to the south of Tabernacle Butte, but without success in the finding of mammals. In 1951 McGrew, with four students, spent three weeks in the area and collected the mammalian fauna from the Morrow Creek as well as additional specimens from the upper Bridger of Tabernacle Butte and related localities. Again, in 1952, G. G. Simpson, Paul McGrew, Laura McGrew, and Creighton Peet spent a few days at the various localities, with rather indifferent results, although a few new elements were added to the fauna.

During the summer of 1954 Jack E. Berman (then a graduate student at the University of Wyoming, presently with the Gulf Oil Corporation, Denver, Colorado) carried on geologic studies in the vicinity of Elk Mountain and Tabernacle Butte and made a detailed map. In 1957 John M. Hummel (then also a graduate student at the University of Wyoming, presently with the Mountain Fuel Supply Company, Rock Springs, Wyoming) mapped the area to the east, which includes our locality 15. The pertinent data of these two maps are combined and reproduced herein.

Because of the varied nature of the faunas it was decided that a more valuable treatment would be obtained if specialists were invited to study the various faunal groups. Hence this Bulletin contains studies of the primates by G. G. Simpson, of the rodents by Albert E. Wood, of the remaining mammals by Paul O. McGrew, of the reptiles and amphibians by Max Hecht, and of the geology by Paul O. McGrew, Jack E. Berman, and John M. Hummel.

The collections, made jointly by the American Museum of Natural History and the University of Wyoming, are divided between those two institutions. In the present studies reference to the institutions containing the various specimens is as follows:

A.M.N.H., the American Museum of Natural History

U.S.N.M., United States National Museum, Washington, D.C.

U.W., University of Wyoming, Laramie

Y.P.M., Yale Peabody Museum, New Haven, Connecticut

During the progress of the work assistance was obtained from several sources. Dr. R. W. Brown of the United States National Museum identified fossil seeds found at the mammal localities. Dr. Loris Russell, National Museum of Canada, identified the invertebrate fossils. Mr. John Arambel permitted the use of a cabin near the fossil localities and extended many other courtesies. The Research Council of the University of Wyoming provided funds for McGrew to spend two weeks at the American Museum to make necessary comparisons. Dr. Joseph Gregory of Yale University made available various insectivore types housed in their collections. The geologic map (fig. 1) was compiled and drafted by Mrs. Laura McGrew. Figures 2-13 were drawn by Mr. Michael Insinna; figures 14-27, by Albert E. Wood. To all these individuals and institutions thanks are expressed. Other acknowledgments will be found in the individual reports.

It has long been recognized that remnants of the Bridger formation occur at the northern end of the Green River Basin. It was not until 1947, however, that fossil mammals demonstrating their middle Eocene age were found. In that year David Love of the United States Geological Survey found specimens at Tabernacle Butte. These were identified by C. L. Gazin as *Antiacodon* sp., *Palaeosyops* sp., *Hyrachyus* sp., *Hyopsodus* sp., and *Glyptosaurus* sp.

Except for the collection and identification of this small assemblage of mammals, no paleontological work had been done in the

area until the work culminating in this report was begun in 1950.

FOSSIL LOCALITIES AND FAUNAL LISTS

On the south side of Elk Mountain and Tabernacle Butte the Bridger formation conformably overlies the Morrow Creek member of the Green River formation. Here only the upper part of the Bridger is represented. To the north Morrow Creek lithology gives way to the fluvial lower part of the Bridger formation. All mammal localities in the Bridger formation discussed in this report are from the upper Bridger except for localities 9 and 10 which are in the Morrow Creek several miles south of Elk Mountain.

BRIDGER FORMATION

In the vicinity of Tabernacle Butte and Elk Mountain, mammals were found in the Bridger formation at 11 localities (see fig. 1). A rather large concentration was found at locality 5, with 18 species of mammals and numerous reptiles represented. Locality 13 produced five species of mammals, and locality 15, four. These concentrations appear to be the result of prolonged weathering and the accumulation of bones and teeth on the surface, although a few specimens were found *in situ*. Attempts to quarry the most prolific locality (5) did not prove profitable. At other localities only single, isolated specimens were found.

Following is a list of localities and the species found at each:

- Locality 1
Helohyus validus
- Locality 2
Telmatherium cultridens
- Locality 2a
Uintatherium sp.
- Locality 2b
Uintatherium sp.
- Locality 3
Manteoceras manteoceras
- Locality 5
Peratherium knighti, new species
Peratherium sp.
Nyctitherium velox
Diacodon bacchanalis, new species
Hyopsodus lepidus
Orohippus, small species
Orohippus, large species

- Manteoceras manteoceras*
- Hyrachyus* cf. *eximius*
- Uintasorex parvulus*
- Washakius insignis*
- Paramys delicatior*
- Paramys* near *excavatus*
- Leptotomus* sp.
- Microparamys wyomingensis*, new species
- Reithroparamys delicatissimus*
- Sciuravus nitidus*
- Taxymys lucaris*
- Eorhinophrynus septentrionalis*, new species
- Megophryinae, indet.
- Diplasiocoela, indet.
- Crocodylia, indet.
- Xestops* sp.
- Dimetopisaurus wyomingensis*, new species
- Peltosaurus* sp.
- Parasaniwa* sp.
- Saniwa grandis*
- Saniwa* sp.
- Palaeoxantusia fera*
- Thinosaurus stenodon*
- Teiidae, indet.
- Lestophis* sp.
- Rhineura* sp.
- Coniophis carinatus*, new species
- Coniophis platycarinatus*, new species
- Calamagrus primus*, new species
- Boavus* sp.
- Paraepicrates brevispondylus*, new species
- Dunnophis microechinis*, new species

Locality 6

- Hyrachyus* cf. *eximius*

Locality 7

- Thinocyon* sp.

Locality 8

- Helohyus* sp.

Locality 13

- Hyopsodus lepidus*
- Orohippus*, small species
- Washakius insignis*
- Sciuravus nitidus*
- Tillomys senex*
- Saniwa grandis*

Locality 15

- Peratherium innominatum*
- Hyopsodus lepidus*
- Orohippus*, small species
- Washakius insignis*
- Xestops* sp.
- Rhineura* sp.

Locality 22

- Hyopsodus lepidus*
- Thinosaurus stenodon*

The Bridger localities are rather widely scattered, and, because of the discontinuous

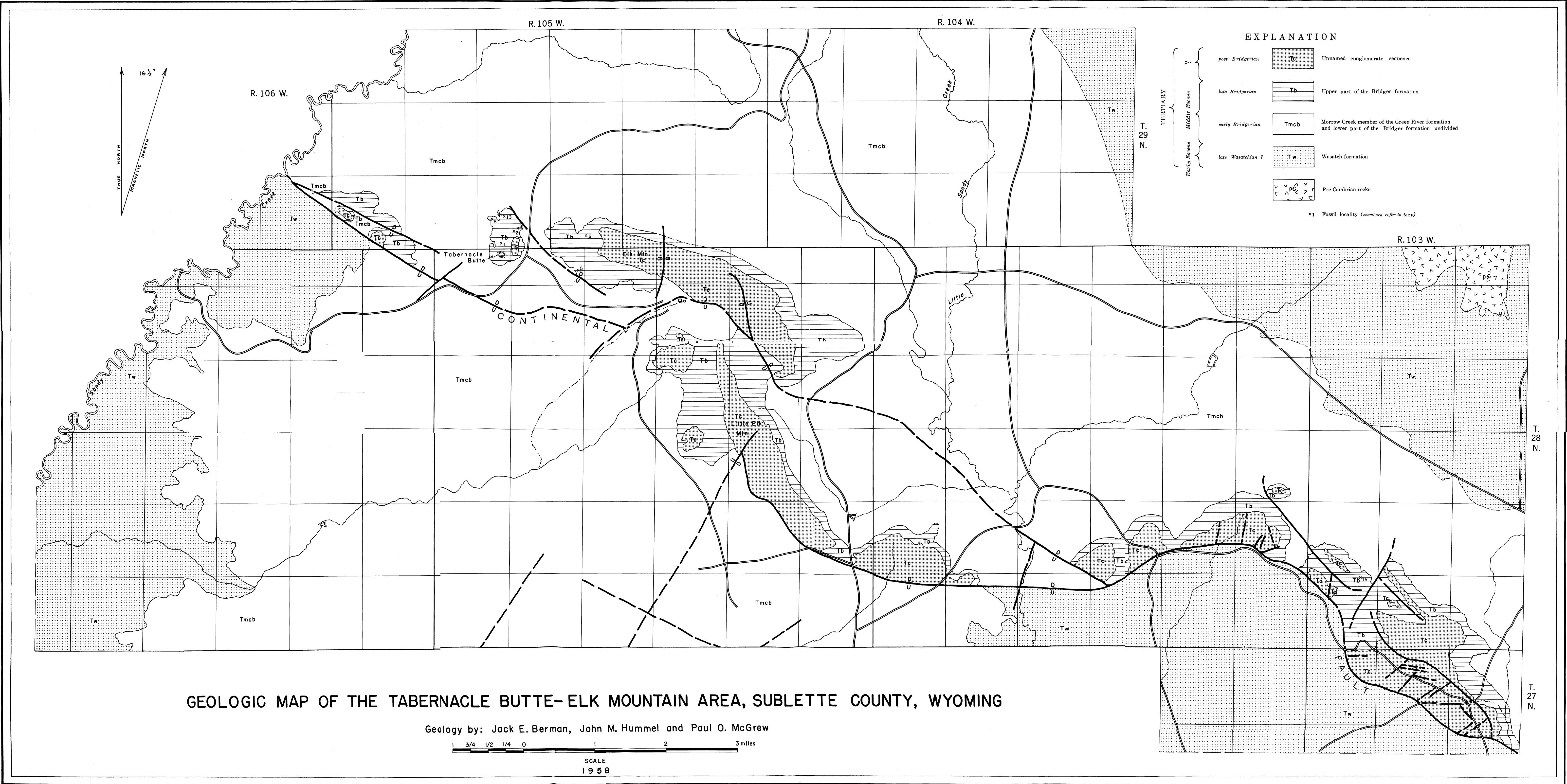


FIG. 1. Geologic map of the Elk Mountain and Tabernacle Butte area, Sublette County, Wyoming, showing localities at which fossil collections were made.

nature of the beds and because of faulting, it has not been possible to correlate them stratigraphically with any degree of confidence. The localities almost certainly range through at least 140 feet of the Bridger formation and possibly more. Mammals that are probably diagnostic of late Bridgerian were found in the lowermost and uppermost localities, so there appears to be no significant age difference between them.

There is no correlation between lithology and presence of fossils. Unidentifiable fragments were found almost throughout the formation. Localities 5, 7, 15, and 22 are in channel deposits; localities 1, 6, and 13 are in a very fine bentonitic matrix; and localities 2, 3, and 8 are in tuffaceous clays. These are the three main lithologic types to be found in the formation.

Locality 5 contains a great preponderance of small mammals, that is, the size of *Hyopsodus lepidus* and smaller, although four *Orohippus* teeth, a jaw of *Hyrachyus*, and a jaw of *Manteoceras* were also found there. Localities 13 and 15 contained no fragments of mammals larger than *Orohippus*. The larger mammals, except for those found at locality 5, were found as isolated specimens.

Nearly all material from the Bridger formation is extremely fragmentary, with jaws containing more than two or three teeth being rare. The only skull found was that of *Telmatherium cultridens* at locality 2.

MORROW CREEK MEMBER OF THE GREEN RIVER FORMATION

Mammals are rare or absent in nearly all the Morrow Creek exposures examined, although turtle and crocodile bones were everywhere abundant. By persistent search we found one isolated jaw of *Leptotomus parvus* (locality 9) and a couple of miles distant a small lens of siltstone containing the rest of our Morrow Creek mammalian fauna (locality 10). Of the mammals from locality 10 none was larger than *Hyopsodus lepidus* except for *Hyrachyus*, of which an astragalus was found. Insectivores, primates, rodents, and *Hyopsodus* make up the great bulk of the fauna. The faunal list of the Morrow Creek localities where mammals were found is as follows:

Locality 9

Leptotomus parvus, new species

Locality 10

Diacodon edenensis

Notharctus gracilis

Omomys carteri

Shoshonius? laurae, new species

Paramys delicatus

Thisbemys sp.

Sciuravus nitidus

Hyrachyus sp.

Hyopsodus lepidus

Melanosaurus sp.

CORRELATION OF MAMMALIAN FAUNAS

UPPER PART OF THE BRIDGER FORMATION

Although there are some 250 feet of rocks in the upper part of the Bridger formation in the vicinity of Tabernacle Butte, there is no evidence that significant evolution took place during this period of deposition. The fossils appear to represent a single time unit, and the rocks are not divisible into faunal zones.

Of 27 species of mammals from the Bridger formation of the region, 10 are known only from the upper, or Twin Buttes, member of the formation in its type area in the Bridger Basin. Fifteen of the species are new, too incomplete for accurate identification, known to occur throughout the type Bridger, or, for other reasons, not significant in close correlation. Certain species, such as *Telmatherium cultridens*, *Manteoceras manteoceras*, *Hyopsodus lepidus*, and *Hyrachyus eximius*, belong to groups the histories of which are well known and which are especially important in correlation. The presence of these species offers rather conclusive evidence of the late Bridgerian age of the Bridger formation in the Tabernacle Butte area.

Following is a list of the species and their significance in correlation:

Peratherium innominatum: Known previously only from the lower Bridger. The evolution of didelphids was so slow, and so little is actually known of the geologic distribution of species of *Peratherium*, that this occurrence is probably of no real value in correlation.

Peratherium knighti: Same as above.

Peratherium sp.: Same as above.

Nyctitherium velox: The genus is known from Wasatchian and Bridgerian deposits, but little

interpretable difference occurs among the described species. Although *N. velox* has been reported only from the upper Bridger, the species is not well defined, and thus its presence in the Tabernacle Butte fauna is probably not significant.

Diacodon bacchanalis: This is the first known occurrence of a tiny leptictid in middle Eocene deposits. So little is known of the development and diversity of leptictids in the Eocene that at the present time this form is of little or no importance in correlation.

Thinocyon sp.: The P⁴ known from Tabernacle Butte could equally well be referred to *T. velox* of the lower Bridger or *T. medius* of the upper Bridger.

Uintasorex parvulus: Not known to be of correlative significance within the Bridger.

Washakius insignis: A species most common in upper Bridger deposits but also known from the lower Bridger. Not significant.

Paramys delicatior: Known from both upper and lower Bridger.

Paramys near *excavatus*: Closest to early Eocene species, although closely related species occur in the Uinta. Probably not significant.

Leptotomus sp.: Not significant.

Microparamys wyomingensis: Not significant.

Reithroparamys delicatissimus: Known from both upper and lower Bridger. Not significant.

Sciuravus nitidus: Known from both upper and lower Bridger.

Taxymys lucaris: Known only from the upper Bridger.

Tillomys senex: Known only from the upper Bridger.

Hyopsodus lepidus: Known only from the upper Bridger.

Orohippus, small species: The isolated teeth of this species are probably not significant.

Orohippus, large species: This species is so advanced in size and the development of lophs and mesostyles that it is almost certainly indicative of late Bridgerian.

Telmatherium cultridens: A species more advanced than any known from the early Bridgerian.

Manteoceras manteoceras: An advanced species known only from late Bridgerian deposits.

Hyrachyus eximius: A late Bridgerian species.

Uintatherium sp.: Probably not significant.

MORROW CREEK MEMBER OF THE GREEN RIVER FORMATION

Evidence for dating the Morrow Creek fauna is not so conclusive as that for the Bridger fauna. Of the nine mammal species known from the Morrow Creek, seven are

not significant in close correlation, one suggests late Bridgerian, and one suggests early Bridgerian. Stratigraphically the Morrow Creek underlies the upper Bridger and is obviously earlier in time.¹ The fauna of the Morrow Creek is as follows:

Diacodon edenensis: Because this is the only large diacodont known from middle Eocene deposits, the occurrence is not significant.

Notharctus gracilis: This species occurs in both upper and lower Bridger.

Omomys carteri: Known from both upper and lower Bridger.

Shoshonius? laurae: This genus has been known previously only from Wasatchian deposits; however, closely related forms appear in both Bridgerian and Uintan deposits. It is probably not significant. (See description for discussion.)

Paramys delicatus: Known from both upper and lower Bridger.

Leptotomus parvus: Known only from the lower Bridger.

Thisbems sp.: Approaches most closely lower Bridger species of the genus.

Sciuravus nitidus: Known from both upper and lower Bridger.

Hyopsodus lepidus: The P₄ found in the Morrow Creek appears to be diagnostic for this species, and the species appears to be diagnostic of the late Bridgerian.

Hyrachyus sp.: Known only from an astragalus that is not significant.

ENVIRONMENT

Morrow Creek sediments were believed by Bradley (1926) to represent a member of the lacustrine Green River formation. The unit varies from quite definitely lacustrine sediments in the central part of the Green River Basin to at least partially fluvial sediments in the region of Tabernacle Butte. In general the Morrow Creek represents deposition during the waning stages of Lake Gosiute.

Individual beds within the Morrow Creek, in the area studied, are discontinuous laterally, with silts, sands, and calcareous shales grading into one another, so that few beds can be traced for any appreciable distance. Some of the beds of shale, probably repre-

¹ During the field season of 1957 a number of mammals were found in beds north of Tabernacle Butte (lower Bridger of the present report) which interfinger with the Morrow Creek. These mammals strongly support the conclusion that the Morrow Creek is early Bridgerian in age.

senting periods of widespread submergence, could probably be traced over wide areas.

Some of the Morrow Creek sediments were obviously deposited in stream channels. They are cross-bedded and contain a rather high proportion of materials apparently derived from the Wind River Mountains to the north, and some rather coarse volcanic debris and numerous clay balls so typical of stream-channel deposits. The great abundance of crocodiles and turtles and the general lithologic character suggest conditions of deposition not very different from those of the Bridger formation as exposed in the Bridger Basin.

The presence of mammals near Farson, some 25 miles south of the northern limit of the Morrow Creek exposures, provides definite evidence that unsubmerged lands extended far into the basin at times during Morrow Creek deposition. Altogether the evidence suggests a rather extensive, heavily forested swampland, with numerous braided waterways. The occasional beds of calcareous shale containing abundant impressions of the fish *Knightia* indicate periodic, perhaps widespread submergence.

A shift from the heavily forested, strongly paludal environment to the somewhat more open flood-plain environment of the Bridger appears to be reflected in the faunas of the two units.

Crocodiles, abundant in the Morrow Creek, are rare in the Bridger of the Tabernacle Butte area. Sixty per cent of the identifiable mammal bones found in the Morrow Creek are of primates and rodents, while in the Bridger these elements make up only 14 per cent of the fauna. *Hyopsodus* makes up 23 per cent of the Morrow Creek fauna, while in the Bridger some 71 per cent of the mammals are of this genus. *Orohippus* was not found in the Morrow Creek but was present in three of the Bridger localities. The largest mammal known from the Morrow Creek is *Hyrachyus*, represented by a single astragalus. In the Bridger, fragments of *Hyrachyus*, titanothere, and uintatheres are not uncommon.

The fauna of the Morrow Creek is not sufficiently large to make this comparison completely valid, and its character might have been affected by purely local conditions. It is, however, strongly suggestive and fits with the general lithologic picture.

GEOLOGY

PAUL O. MCGREW, JACK E. BERMAN, AND JOHN M. HUMMEL

THE TABERNACLE BUTTE AREA is located in the southeast corner of Sublette County, Wyoming, about 15 miles from the southwest flank of the Wind River Mountains and 25 miles north of the village of Farson. The area mapped is included within T. 27, 28, and 29 N., R. 103, 104, 105, and 106 W.

The area lies within the northeastern portion of the Bridger Basin. The Bridger Basin, as herein defined, is that part of the Green River Basin that is located north of the Uinta Mountains, west of the Rock Springs uplift, and that is drained principally by the Green River and its tributaries.

STRATIGRAPHY

Only Tertiary sedimentary rocks are exposed in the vicinity of Tabernacle Butte. The closest known pre-Tertiary sedimentary outcrops are found at Steele Butte, about 25 miles to the northwest. Pre-Cambrian crystalline rocks crop out, however, a short distance to the north.

WASATCH FORMATION

The oldest rocks exposed near Tabernacle Butte belong to the fluvial Wasatch formation.

The lithology of the Wasatch formation is best displayed in the western part of the area along Sandy Creek. There in the stream cuts, it consists of 6- to 10-foot bands of reddish violet and light green mottled mudstone, alternating with bands of buff-orange and green mottled mudstone of similar thickness. Those rocks have a characteristic earthy appearance and contain angular grains of quartz and feldspar scattered throughout. Within the mottled beds are extensive thin lentils of buff, buff-gray, and buff-green, arkosic, cross-bedded sandstones and grits. Elsewhere within the area, the Wasatch formation forms varicolored flats and badlands. It conspicuously supports little vegetation.

The maximum exposed thickness of the Wasatch formation in the vicinity of Tabernacle Butte is only about 80 feet. The thickness there probably totals a few hundred feet, but the lower part is not exposed.

MORROW CREEK MEMBER OF THE GREEN RIVER FORMATION AND LOWER BRIDGER

The Morrow Creek member of the Green River formation, defined by Bradley (1926), conformably overlies the Wasatch formation in the southern part of the area, but the contact is not clear cut. Berman picked the contact at a 2-foot bed of light green, soft, calcareous, ostracodal mudstone.

The Morrow Creek member consists of paludal and lacustrine near-shore sediments. Green to gray-green, hard, silty shale and mudstone, which alternates with buff siltstone and fine-grained rusty sandstone, comprise the bulk of the lithology. Thin beds of paper shale, arkoses, and some tuffs occur throughout. Thin-bedded buff to brown, hard, dense limestones are common. Differential erosion produces small ledges at the outcrops wherever these limestones are present. Chippy fragments and poor bedding characterize the Morrow Creek member, not only within the area but beyond. Facies changes occur quite rapidly. The member supports a good stand of vegetation.

The thickest Morrow Creek exposure near Tabernacle Butte totals 156 feet. This section probably constitutes about one-half of the thickness of the member. Bradley (1926) reported 324 feet of Morrow Creek in the vicinity of Steamboat Mountain, about 28 miles northwest of Rock Springs.

The Morrow Creek member is widespread throughout the Bridger Basin. Bradley (1926), Nace (1939), and Donovan (1950) reported its occurrence. Bradley (1926) stated that the member can be traced westward to the town of Green River. He later reported Morrow Creek from the Washakie Basin. Excellent outcrops can be seen east of U. S. Highway 187, about 9 miles north of Farson.

North of Tabernacle Butte and Elk Mountain the lithology of the Morrow Creek changes rapidly to green and gray, arkosic, tuffaceous clay, containing lenses of sandstone and arkose. This obviously represents a peripheral, fluvial facies that was deposited

contemporaneously with and interfingers with the Morrow Creek. The depositional environment of the fluvial facies is like that of the Black's Fork member of the Bridger formation in the southern part of the Green River Basin, and it seems best to regard the deposits as the lower unit of the Bridger formation in this area.¹

UPPER PART OF THE BRIDGER FORMATION

The upper Bridger conformably overlies the Morrow Creek member of the Green River formation in the southern parts of the area and overlies conformably lower Bridger sediments in the northern parts of the area. The lower contact of the upper Bridger can easily be recognized by the abrupt color change from the buffs, greens, and dark grays of the Morrow Creek and lower Bridger to the white and pale shades of the upper Bridger.

The upper part of the Bridger formation, at Tabernacle Butte, comprises flood-plain deposits of white to gray-white, fine-grained, fairly soft and friable tuffaceous sands that alternate with beds of pale yellow, pink, and buff bentonitic claystones and mudstones. Lentils of blue-gray, cross-bedded, soft, and friable tuffaceous grits, which represent stream-channel deposits of reworked tuffs, interrupt the fairly well-bedded, flood-plain sediments at random. The formation maintains only sparse vegetation and frequently develops into badlands. Lithologically there is a striking resemblance to the Twin Buttes member of the Bridger formation in the vicinity of Lone Tree, Wyoming.

The upper Bridger section at Tabernacle Butte aggregates a thickness of 357 feet. This section is thought to represent the maximum development of the Bridger formation in the northeastern portion of the Bridger Basin.

POST-BRIDGER CONGLOMERATE

The boulder conglomerate that disconformably overlies the Bridger formation in the vicinity of Tabernacle Butte is herein designated the post-Bridger conglomerate.

The conglomerate is a buff-gray massive

unit which shows neither sorting nor alignment of the fragments. The majority of the fragments consist of granites and basic igneous rocks. Gneiss, schist, and metaquartzites are also abundant. The fragments range in size to boulders with a diameter of 3 feet. Lentils of cross-bedded sandstone and pebble conglomerate are common. The matrix varies from arkosic sandstone to sandy marl and is often tuffaceous.

The post-Bridger conglomerate cannot, at the present time, be correlated with similar units elsewhere. Exposures are too limited to make direct surface correlation possible.

STRUCTURE

The principal structural feature in the vicinity of Tabernacle Butte is a fault zone which trends north 60 degrees west across the area as a series of connected, nearly parallel, high-angle, normal faults. Slip along the fault zone varies from 250 to 300 feet. The faults are downthrown on the north side and dip 65 degrees to 75 degrees to the north. The main fault zone is interrupted at several places by nearly north to south trending, vertical, transverse faults. This fault zone was named the "continental fault" by Nace in 1929.

It is thought that the continental fault zone extends only about 2 miles west of Sandy Creek, although Water Hole Draw may possibly reflect a farther westward extension. To the east the fault is known to extend some 15 miles beyond Oregon Butte, which makes a total length of the fault zone of at least 50 miles.

In the vicinity of Tabernacle Butte and Elk Mountain the youngest beds offset by the faults are those of the undated post-Bridger conglomerate. On the Lander-Farson highway in T. 27 N., R. 102 W., the continental fault cuts beds of Miocene age. The age of the faulting is, therefore, not older than Miocene.

In general, the beds near Tabernacle Butte are little disturbed, except on the north side of the fault zone where dips of 15 degrees were recorded. Those dips have resulted from tilting on the downthrown side. Perched erratic blocks which show dips of about 35 degrees were noted at several localities but are attributed to gravity slumping.

¹ Mammal collections made since this paper was written demonstrate the early Bridgerian age of the fluvial facies.

AMPHIBIANS AND REPTILES

MAX K. HECHT

AMONG THE COLLECTIONS from Tabernacle Butte is an array of fragments of jaws, vertebrae, and skull bones which clearly are of groups closely allied to living groups of amphibians and reptiles. Unfortunately comparative osteological studies and collections are incomplete, and therefore a part of the collection cannot be definitely identified at the present time. This type of collection clearly shows the need for comparative studies on single elements and regions of the reptile and amphibian skeletons. Some rather complete studies have been made which compare skeletons of various living groups, but, as complete skeletons are rare in the fossil record, it is desirable that comparative studies be made of the upper and lower jaws, vertebrae, and other regions that are more often preserved. Such a study is essentially what has been undertaken here in the identification of the various elements. The following discussion includes studies on the remains of frogs, crocodilians, lizards, and snakes.

AMPHIBIA

ANURA

OPISTHOCOELA

RHINOPHRYNIDAE

EORHINOPHRYNUS, NEW GENUS

GENOTYPE: *Eorhinophrynus septentrionalis*, new species.

KNOWN DISTRIBUTION: As for the genotype.

DIAGNOSIS: An anuran belonging to the family Rhinophrynidae but distinguished from the only known living species by the longer neural arch and low distinct neural spine.

Eorhinophrynus septentrionalis, new species

TYPE LOCALITY: Locality 5.

HORIZON: Late Bridgerian, middle Eocene.

FORMATION: Bridger.

TYPE: A.M.N.H. No. 3818.

DIAGNOSIS: As for the genus.

DESCRIPTION: A single complete atlas (A.M.N.H. No. 3818; pl. 50, figs. 1-3), hav-

ing a centrum length of 3 mm. (measured from the ventral lip of the cotyle to the point between the condylar sockets). The anterior surface of the centrum bears two cup-shaped condylar facets which make up most of the border of the neural canal. The position of these facets indicates that the occipital condyles must have been nearly vertical or at approximately 70 degrees. These facets almost meet ventrally where they form a clear ridge which curves posteriorly. This inward curving of the facets leaves a narrow groove at the ventral anterior face of the centrum (between the two condylar facets). The height of the condylar facets is about 3 mm. Dorsally the facets are widely separated by an indentation of the neural arch. The height of the atlas is 2.8 mm. as measured in frontal view from the base of the centrum to the top of the neural arch.

The neural arch is elongated, bearing a low neural spine and measuring 5 mm. in length. At its anterior margin the neural spine is indented. Above the indented margin a low crest begins which is very obscure for the first quarter of the neural arch. This low crest becomes increasingly distinct and elevated posteriorly. The neural arch slopes gently away anteriorly but flattens posteriorly into concavities which rise at the margins. There are minor irregular ridges on the surface of the arch.

On the ventral surface of the neural arch there is an elongated, ventrally directed ridge, henceforth called the subneural zygapophyseal ridge. The ridge, viewed ventrally, is about four times longer than it is wide. It comes to a sharp point or keel. On the left side it bears a clear articular surface and may represent a modified postzygapophyseal structure. The entire structure is higher anteriorly than posteriorly and rises sharply at the level of the posterior boundary of the centrum.

The posterior portion of the ventral surface of the neural arch bears a Y-shaped groove. The two arms of the Y begin at the base of the subneural zygapophyseal ridge. The two arms meet midway and form a single canal

which lies in the mid-ventral surface of the neural arch. On each side of this canal there are small, facet-like surfaces which appear to have made contact with the prezygapophyses of the more posterior vertebrae.

RELATIONSHIPS: The two condylar facets of this complete atlas clearly indicate a modern type of amphibian. The vertically oriented condylar facets and the lack of an odontoid-like process (precluding urodeles and apodans) clearly indicate an anuran. The posterior surface of the centrum of the atlas is concave and therefore precludes the more advanced anuran families with procoelous vertebrae (i.e., Bufonidae, Pseudidae, Leptodactylidae, Palaeobatrachidae, Atelopidae, Hylidae, Ranidae, Rhacophoridae, and Microhylidae). The presence of this posterior central concavity indicates that the atlas belongs to a member of the Ascaphidae (name preferred by Ritland, 1955), Discoglossidae, Pipidae, Rhinophrynidae, or Pelobatidae (which may not have the true procoelous condition). The fossil atlas may be distinguished by its nearly vertical condylar facets and its elongate neural arch. Only one family, the Rhinophrynidae, combines the primitive condition of the posterior central condition with the advanced feature of a vertically oriented condylar facet. The ventral surface of the centrum of this atlas most closely resembles the condition in the Discoglossidae and Rhinophrynidae. The elongate neural arch and its posterior overhang appear to be new adaptations to a fossorial habit.

A single living species, *Rhinophrynus dorsalis*, belongs to the Rhinophrynidae. Only two atlases were available for study. The smaller specimen had a shorter overhang of the neural arch than the larger specimen. In the larger specimen there is a well-developed, subneural zygapophyseal ridge which is most similar to that of the fossil. The neural arch of the living species does not extend beyond the centrum by more than a central length and bears at best only a weak neural spine. The fossil atlas is about three-quarters of the width of the largest recent *Rhinophrynus* atlas and differs in the greater overhang of the neural arch and the distinct, low, but well-developed neural spine.

The functional significance of the neural arch in the fossil presents an interesting prob-

lem, because the overlap with the more posterior vertebrae would certainly limit the movement of the neck region. This restriction possibly indicates a burrowing form of anuran in which the head is used as a ramrod in the burrowing process. As the living *Rhinophrynus* is a burrowing type, the elongated neural arch of the fossil indicates an even more specialized burrowing species.

It should be noted that the present interpretation of the systematic position of the Rhinophrynidae is in disagreement with that of Noble (1931) but in accord with that of Walker (1938). A comparison of the atlantal segment clearly indicates close resemblance to that of the Discoglossidae, Ascaphidae, and some pelobatids. Perhaps the best resemblance is with that of the discoglossids. It therefore appears that the rhinophrynids are actually primitive anurans which have independently attained certain advanced features as adaptations to their specialized burrowing habit.

ANOMOCOELA

PELOBATIDAE

MEGOPHRYINAE

An incomplete sacrum (A.M.N.H. No. 3832; pl. 57, figs. 6-9) clearly indicates the presence of members of this group, the Megophryinae, from locality 5. This distinctive fragment is an incompletely preserved sacrum which clearly bears a cotyla on the anterior surface of the sacrum and a single condyle on its posterior surface. The hatchet-shaped, laterally expanded, sacral diapophysis indicates a pelobatid (in the sense of Zweifel, 1956, and Taylor, 1941). The lack of any sign of fusion between the urostyle and the sacrum clearly precludes all members of the Pelobatinae (which include the living American members of the genus *Scaphiopus*), with the possible exception of *Macropelobates* of the Oligocene of Mongolia (Noble, 1924). The fossil in hand can easily be distinguished from *Macropelobates* by the distinctly different sacral diapophyses, which are not so extensively developed in an anterior-posterior direction nor so greatly webbed as is the Mongolian fossil. The Wyoming pelobatid bears particular resemblance to the genus *Eopelobates* as described by Zweifel (1956).

DIPLASIOCOELA

An incompletely preserved sacrum (A.M.N.H. No. 3833), about 2 mm. in length, from locality 5, clearly indicates a diplasiocoel frog, one of the most morphologically advanced groups of frogs. Two living diplasiocoel families are found today in the New World, Ranidae and Microhylidae.

REPTILIA

CROCODILIA

Only scattered, fragmentary, unidentifiable remains of this order are available for study. These fragments include isolated teeth and osteoscutes and occur abundantly in the Morrow Creek exposures and occasionally in the upper Bridger.

SQUAMATA

LACERTILIA

ANGUIDAE

DIPLOGLOSSINAE

Xestops sp.

The genus *Xestops* is indicated by the presence of osteoscutes and is known from two localities (localities 5 and 15). Although over two dozen osteoscutes are available for study from these collections, two rather complete and representative osteoscutes (A.M.N.H. No. 3834) from locality 5 can be described as examples. These are rectangular in form and measure 7.5 by 5.2 mm. and 8.2 by 4.1 mm., respectively. These osteoscutes are beveled on the anterior surface so as to enable each osteoscuter to slip over the anterior osteoscuter. The osteoscutes are also beveled outward on the left lateral surface and inward on the right lateral surface. These beveled surfaces allow free movement in three directions in the osteodermal armor of the lizard. This arrangement of the armor is characteristic of the Diploglossinae and not of the members of the Gerrhonotinae or Glyptosaurinae. The ornamentation of the exposed portion of the osteoscuter is most similar to that of the Glyptosaurinae and Gerrhonotinae and therefore bears little resemblance to the exposed surface of the usual diploglossine osteoscuter. The rectangular form of the osteoscuter resembles that in the fossil genera *Peltosaurus*, *Glyptosaurus*, and *Melanosaurus*. There is a distinct keel on these osteoscutes which runs

approximately diagonally across the osteoscuter. In lizards these keels usually run lengthwise and in a straight line. This diagonal arrangement of the keel in *Xestops* would indicate that the osteoscuter and the overlying epidermal scutes were set at an angle and not in a straight row. It is obvious from the above analysis that in some respects these osteoscutes are not characteristic of the assigned subfamily. It therefore appears that this genus may be a primitive member of this subfamily, with certain features, such as the form of the osteoscuter, shared with members of other closely related subfamilies.

DIMETOPISAURUS, NEW GENUS

GENOTYPE: *Dimetopisaurus wyomingensis*, new species.

KNOWN DISTRIBUTION: As for the genotype.

DIAGNOSIS: An anguid lizard that differs from other members of the family in the following combination of characters: (1) the presence of a non-fused frontal, with a well-marked, ventral, olfactory process; (2) frontal ornamented on its dorsal surface with tiny, mound-like osteoderms which are completely fused with one another; (3) epidermal scute impressions on the dorsal surface of the frontal, clearly indicating the presence of a frontoparietal and interparietal; (4) frontal making an extensive contribution to the orbital border between prefrontal and postfrontal; and (5) obscure impressions, indicating a possible divided frontal epidermal scute.

Dimetopisaurus wyomingensis, new species

TYPE LOCALITY: Locality 5.

HORIZON: Late Bridgerian.

DIAGNOSIS: As for the genus.

DESCRIPTION OF HOLOTYPE: A single frontal (A.M.N.H. No. 3819; pl. 51) which is almost complete and measures 19.2 by 8.8 mm. Its dorsal surface is almost completely covered by small, tubercle-like mounds which are fused osteoderms and are similar in form to those found in the gerrhonotine genus *Peltosaurus*. At its external lateroposterior border there is a deep incision in the frontal which is not covered by osteoderms. This incision marks the area of overlap by the postfrontal bone. At the external latero-anterior border there is a small incision, also not cov-

ered by osteoderms, which marks the area of overlap with the prefrontal bone. The latter incision, the incision of the prefrontal bone, is much smaller in dorsal view than it is in lateral view. With the exception of the areas of overlap by the above-mentioned bones, the entire surface of the frontal is covered by osteoderms.

On the osteodermal surface are imprinted a series of faint grooves, which in anguillid lizards are usually indicative of the overlying epidermal scutes. At the anterior end of the frontal there is a V-shaped groove which probably marks the prefrontal scute border. Posteriorly there is an arc-like groove extending from the orbital border (about one-third of the total distance from the posterior frontoparietal suture) to the internal border of the frontal (about one-quarter of the metopic suture length as measured from the frontoparietal suture). The entire arc-like groove occupies about 40 degrees. This groove approaches the midline where it joins a second groove which arises from the midline slightly anterior to the arc itself. The latter groove, properly called the interparietal groove, arises from the metopic suture at a point slightly anterior to the one-quarter mark from the frontoparietal suture. The interparietal groove extends posteriorly and reaches the frontoparietal suture about one-fifth of the total distance from the metopic suture and the supraorbital border of the frontoparietal suture. Alongside the metopic suture there is a third groove which is very obscure and shallow and is parallel and external to the metopic suture. The osteoderms alongside the groove are slightly raised and enlarged. This latter groove may represent the impression of the border of the divided frontal epidermal scute. Therefore it may be concluded that the grooves on the dorsal surface of the frontal apparently demark the areas occupied by the epidermal scutes which are called the prefrontal, frontal, frontoparietal, and interparietal epidermal scutes.

In lateral external view the olfactory processes are clearly visible and complete. They are short, robust, and form a gutter for the olfactory tracts. Also visible in external lateral view are the incisions that mark the areas of overlap of the prefrontal and postfrontal bones. It is clear that the area of overlap with the prefrontal bone is much

larger than the area of overlap with the postfrontal bone. The area of overlap of the prefrontal occupies only the anterior half of the orbital area. The postfrontal bone occupies almost the entire orbital border of the frontoparietal epidermal scute and is confined to the posterior one-third of the orbital border of the frontal.

In sagittal view the mesial border of the frontal is a straight suture in which the differentiation between the osteodermal and bony layers is clearly visible. External to the metopic suture can be clearly seen the internal surface of the olfactory processes which hang perpendicularly ventral to the frontal roof of the braincase and reach a vertical depth of 3.5 mm.

In ventral view the olfactory process which is complete rises from low mounds posteriorly to form high crests in the anterior half of the frontal. The general conformation of the olfactory process follows the orbital border of the frontal so that the posterior base of the olfactory ridge rises in the posterolateral border of the frontal and turns gradually mesiad. Midway forward the olfactory crests occupy the exterior half of the frontal and form the wall of the orbit. At its greatest height, as viewed ventrally, the olfactory process bears a complex, notch-like, articular surface. This notch is perhaps the articulation point for the palatine. It is conceivable that the notch is an articulation point for the prefrontal, but this interpretation is contradicted by the position of the prefrontal incision which abuts laterally against the olfactory process and not frontally as would be indicated by the notch.

RELATIONSHIP TO OTHER ANGUILLID GENERA: The presence of the metopic suture or the non-fused frontal clearly differentiates *Dimetopisaurus* from the non-diploglossine genera, such as *Peltosaurus*, *Gerrhonotus* (*sensu lato*), *Abronia*, *Glyptosaurus* (*sensu lato*), and *Melanosaurus*. The osteodermal ornamentation of the frontal clearly indicates similarity to the pattern found on the frontal of *Peltosaurus* and little similarity to the osteodermal ornamentation found on typical diploglossines. The condition of the frontal and the presence of a distinct frontoparietal epidermal scute resemble the condition in *Ophisaurus* (*sensu lato*), *Ophiodes*, *Diploglossus* (*sensu lato*, including *Celestus*), and

Xestops. The impression of the interparietal epidermal scute on the frontal differentiates the fossil from the diploglossine genera *Diploglossus* and *Xestops*, because in these forms this scute is generally above the parietal bone. The impression of the interparietal epidermal scute on the frontal clearly indicates relationship to *Ophiodes* and *Ophisaurus*. In both the latter genera the prefrontal and postfrontal bones are in contact or almost in contact. As a result, in both these genera the frontal contribution to the supraorbital border is reduced or completely obliterated. On the other hand the postfrontal and prefrontal are widely separated in *Dimetopisaurus*. The fossil genus *Dimetopisaurus* can be easily distinguished from the European genus *Anguis* by the completely different arrangement of the epidermal scutes and the relationship of the frontal to prefrontal bones.

From the above discussion it appears that in most respects this frontal is most similar to the frontals of *Ophisaurus* and *Ophiodes*. The presence of a *Peltosaurus*-like ornamentation may be primitive for the Gerrhonotinae, Diploglossinae, and perhaps for the whole Anguidae. Thus this frontal represents the remains of a form that may be considered as belonging to the ancestral stock of the Diploglossinae. The possibility that the genus *Dimetopisaurus* is ancestral to other of the anguid subfamilies is not determinable at this time. This interpretation hinges on what is the primitive condition of the frontal in the Anguidae. If the presence of a metopic suture is primitive and not a secondary development, then we must consider the frontal condition in *Dimetopisaurus* primitive. If the presence of a metopic suture is secondary, then *Dimetopisaurus* must be considered more advanced than *Peltosaurus* and is already on the *Ophisaurus* line of development. At the present time I believe that it is best to consider *Dimetopisaurus* a primitive member of the Diploglossinae.

GERRHONOTINAE

Peltosaurus sp.

Several incomplete dentaries and osteoscutes are known from locality 5. While these remains are very fragmentary, their size and form appear to be closest to those of the ge-

nus *Peltosaurus*. It is admitted that this identification is tentative, but it would not be unexpected to find this well-known and abundant genus in these collections.

Melanosaurus sp.

Part of a maxilla and several osteoscutes (A.M.N.H. No. 3836) are known from a single locality, locality 10 (Morrow Creek). These remains are apparently closest to the genus *Melanosaurus* as indicated by the size and arrangement of the osteoscutes on the maxilla, the size and form of the teeth, and the size and ornamentation of the trunk osteoscutes. There are distinct differences between the type of *Melanosaurus* and the fossil in hand. One of the most distinct differences is found in the teeth. The teeth of the specimens in hand are chisel-shaped and striated, which is most unlike the more pestle-like teeth of *Melanosaurus maximus*.

This incomplete material may indicate the presence of a new species or a closely allied genus.

It will be noted that the author does not follow McDowell and Bogert (1954) in their assignment of the genus *Melanosaurus* to the Xenosauridae. The trunk osteoscutes of *Melanosaurus* are identical with those of the Glyptosaurinae and strongly resemble the osteoscutes of their close allies, the Gerrhonotinae. The interpretation of Camp (1923) and that of McDowell and Bogert (1954) of the badly crushed type of *Melanosaurus maximus* is open to question and is dependent on Camp's reconstruction. The "paroccipital epiphysis" of Barrows and Smith (1947) has been clearly demonstrated in *Xenosaurus*, but the existence of a homologous structure in *Melanosaurus* and *Shinisaurus* is yet to be conclusively demonstrated. The existence of the paroccipital process in the type of *Melanosaurus* should be questioned. The crushing of the appropriate region of the skull is so bad that the fragment of bone labeled as the paroccipital process may represent another bone. In the only prepared skull of *Shinisaurus* there is even less evidence of this process. A tiny ossicle on one side of the skull is all that can possibly be identified as the paroccipital process. The skull has not been prepared so as to demonstrate clearly the presence or absence of this process. Other

features of *Shinisaurus*, such as the type of skull osteodermal ornamentation, general skull conformation, and teeth, indicate to me that the two forms may not be so closely related as the taxonomic allocation of McDowell and Bogert implies. The lack of trunk armor in *Xenosaurus* and *Shinisaurus* differentiates these genera from *Melanosaurus*, *Glyptosaurus*, and the Gerrhonotinae. Two striking differences between *Melanosaurus* and the Glyptosaurinae are the nature of the osteodermal armor of the skull and the form of the teeth in the glyptosaurus.

VARANIDAE

Parasaniwa sp.

A single fragment of a left maxilla (A.M.N.H. No. 3820; pl. 50, figs. 4, 5) from locality 5 bears two teeth which closely resemble those of the type of *Parasaniwa wyomingensis* Gilmore (a fragment of a dentary from the Lance formation, upper Cretaceous). There are some minor differences in the shape of the teeth and in the smaller size of the fossil in hand. This fragment probably represents at least another species, but the description of the new form is better relegated to a time when more complete material is available.

Saniwa grandis (Marsh)

Among the many vertebrae that are clearly varanoid and most probably remains of the genus *Saniwa* is an almost complete vertebra (A.M.N.H. No. 3837) from locality 13, which clearly resembles Marsh's *Thinosaurus grandis*. The large size of the vertebra and the oblique dorsally turned condyle clearly indicate a varanoid. This allocation is further substantiated by the presence of caudal vertebrae with clear indications of the attachment of the haemal spine to the posterior ventral surface of the centrum. This species is clearly separable from other members of the genus *Saniwa* and the living *Varanus* by the presence of distinctly formed and characteristic zygantra. This outstanding feature of *Saniwa grandis* perhaps indicates the need for reconsideration of the validity of Marsh's genus *Thinosaurus*.

Saniwa sp.

Among the abundant vertebrae of the ge-

nus *Saniwa* from locality 5 are specimens (A.M.N.H. No. 3813) from the anterior and posterior thoracic region and the caudal region. Many species of *Saniwa* have been described, but it is difficult to evaluate the status of these species and even more difficult to allocate the specimens. Only the species discussed above, *S. grandis*, is readily identifiable.

Also among the remains of *Saniwa* is an almost complete dentary (A.M.N.H. No. 3814; pl. 50, figs. 6, 7) from locality 5. This dentary compares favorably in all respects to other dentaries allocated to this genus, but is unusually small in size (being less than one-third of the length of the other known dentaries).

XANTUSIIDAE

Palaeoxantusia fera Hecht

REVISED GENERIC AND SPECIFIC DIAGNOSIS: A xantusiid lizard distinguished from the smaller members of the genus *Xantusia* by its larger size, more robust dentary, its distinct spleniodentary depression, and groove for the adductor mandibulae externus superficialis; from *Klauberina riversiana*, by its smaller size and its lack of the secondary lateral internal cusps and slightly lower tooth counts; from *Lepidophyma*, by its smaller size and heavier form, fewer teeth which lack secondary cusps, and by the presence of a deeper depression on the spleniodentary; and from *Cricosaura*, by its larger size and fewer teeth.

Hecht (1956) clearly indicates the basis for the present familial assignment. A second incomplete specimen is available from the type locality (locality 5) and is undoubtedly identical with the type (fig. 2). The second specimen (A.M.N.H. No. 3821) is composed of the posterior portion of the spleniodentary which includes the last four teeth.

AGAMIDAE

Thinosaurus stenodon Marsh

Two fragments bearing acrodont teeth are available from localities 5 and 22. The smaller fragment is composed of three teeth set on a fragment of bone, apparently the dentary. This fragment (A.M.N.H. No. 3822) is about 3 mm. in length as measured from the anterior point on the base of the anterior tooth

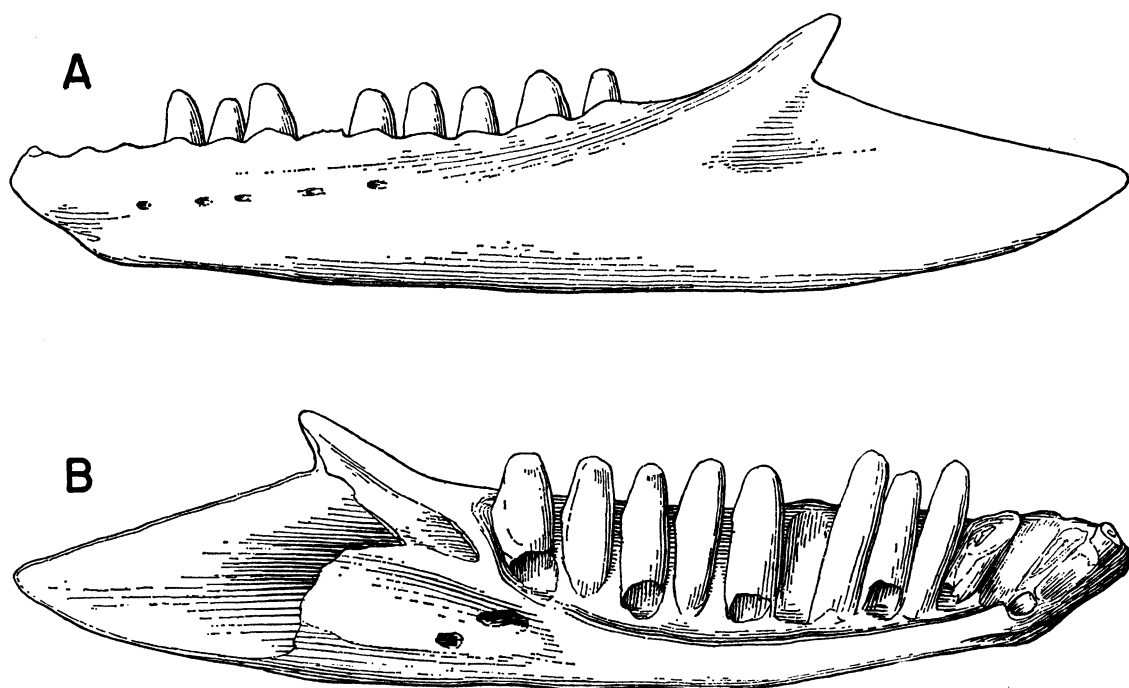


FIG. 2. *Palaeoxantusia fera* Hecht. Type, A.M.N.H. No. 3815, left dentary. A. External lateral view. B. Internal lateral view. $\times 15$.

to the posterior point of the base of the third tooth. The second fragment (A.M.N.H. No. 3823; pl. 54, figs. 6, 7) is composed of five teeth on a large piece of dentary bearing an open Meckelian groove. These teeth are much larger than those discussed above. Three teeth on this fragment occupy a space measuring between 5.5 and 6 mm. Gilmore (1928) describes the teeth of this genus as being subacrodont, although our specimens are more nearly acrodont. This discrepancy may be due to a slight difference in terminology. Otherwise these specimens compare favorably with the photographs and description of Gilmore (1928).

TEIIDAE

Only fragmentary remains are available of this family. Some badly broken dentaries (A.M.N.H. No. 3812) from locality 5 bear tricuspid teeth with an indication of a long, but missing, splenial. These characteristics are good evidence that they belong to a member of this family.

AMPHISBAENIDAE

RHINEURINAE

In the Tabernacle Butte collections there

is a large series of isolated amphisbaenid vertebrae which are characterized by the low neural arches, lack of zygosphenes and zygantra, round diapophyses, and elliptical condyles and cotyles. Vanzolini (1951) divided the Amphisbaenidae into three subfamilies, Amphisbaeninae, Trogonophinae, and Rhineurinae. Comparative material of all the genera of these three groups is sparse. Comparisons are further complicated by the fact that most fossil amphisbaenids are described from the remains of the skull, with little or no associated vertebrae. Despite this lack, it appears that all the vertebrae in this collection belong to the Rhineurinae. There are apparently at least two distinct groups of vertebrae.

Lestophis sp.

The first group is clearly referable to the genus *Lestophis* as diagnosed and referred to by Gilmore (1938). Vanzolini (1951) does not refer to or list *Lestophis* of Marsh (1885) or Gilmore (1938). Vanzolini lists "*Glyptosaurus*" *anceps* Marsh as *incertae sedis*. This form was referred to by Gilmore as *Lestophis*. Taylor (1951) follows Gilmore (1938) and recognizes *Lestophis* as an amphisbaenid ge-

nus of the middle Eocene. Gilmore (1938) points out that Marsh erroneously considered that this genus belonged to the Serpentes. He further points out the characteristic sculpturing on the neural arch which is composed of longitudinal ridges on each side of the superior median ridge. The characteristic longitudinal ridges on the neural arch of *Lestophis* are also found on the anterior vertebrae of modern *Rhineura floridana*. There are marked similarities between the two sets of vertebrae, but the size and the length to width proportions clearly indicate that these specimens belong to the genus *Lestophis*.

The larger incomplete vertebra (A.M.N.H. No. 3824; pl. 57, figs. 1-5) fits the description of the specimen of *Lestophis anceps* Marsh that was at one time referred to the genus *Ototrion* by Gilmore (1928). The second, smaller, vertebra (A.M.N.H. No. 3825) is about half of the size of the specimen referred to *L. anceps* but apparently is *L. crassus* Marsh as described and diagnosed by Gilmore (1938). Both specimens are from locality 5. In most respects this small vertebra is similar to that of other rhineurines, except that it bears a prominent haemal carina. There are marked similarities between the two species of *Lestophis*, although there are proportional differences. These differences may be due to regional differentiation in the column of *Lestophis*.

Rhineura sp.

Abundant vertebral remains of the genus *Rhineura* are known from two localities, 5 and 15. Various size categories and regions of the body are represented by A.M.N.H. No. 3811 from locality 5. It is impossible to determine at this time the specific allocation, because little is known of the vertebrae of the many fossil forms (described by previous authors), and less is known of the vertebral variation and ontogenetic variation within the single living species, *Rhineura floridana*.

SERPENTES

Snakes are represented in fossil collections most abundantly by vertebrae and more rarely by skull elements. In ophidian classification skull elements are usually more diagnostic than the vertebral features. Unfortunately the Tabernacle Butte collections have no skull elements but abundant verte-

bral remains. The entire problem of the identification of ophidian vertebrae is complicated by gradients within the vertebral column which change imperceptibly from the cervical to thoracic and caudal regions. The problem is further complicated by ontogenetic changes in vertebral form and the fact that most fossil ophidian vertebral remains are not associated in columns. Despite these difficulties, various workers have made progress with the study of ophidian vertebrae.

Owen (1849-1884), Rochebrune (1880, 1881), Simpson (1933), Gilmore (1938), Hoffstetter (summarized in 1955a, 1955b), and Johnson (1955) have attempted to analyze the morphological differentiation in the vertebral column of the snake. Johnson (1955) was the first to attempt to show on a quantitative basis the existence of diagnostic familial characters in the vertebrae. Actually the existence of such characters was already indicated by earlier workers on a qualitative and less quantitative basis. Johnson also demonstrated parallelism in different groups of snakes in vertebral adaptation to similar modes of life. Acquaintance with Mosauer's study (1935) on the trunk myology is essential for a functional interpretation of vertebral form and for any attempt to interpret fossil material.

Ophidian vertebrae can usually be recognized by the procoelous condition of the centrum, the rounded, well-developed condylus and cotyla, the well-developed zygosphenes and zygantra, the well-developed diapophyses, the usual presence of an accessory process or tubercle under or alongside the prezygapophyseal facet, and the usual presence of hypapophyses in some region of the vertebral column. As a result it is usually not difficult to recognize such vertebrae except in the case of certain burrowing lizards in which there is a distinct parallelism to the vertebral form of burrowing snakes.

The greatest part of the ophidian column is composed of what is generally called thoracic vertebrae. It is not surprising that most of the fossil remains are of this region. These can generally be divided into three subregions in an articulated vertebral column, yet it is often very difficult to show conclusively that an isolated ophidian vertebra is anterior, middle, or posterior thoracic.

The classification of snakes here followed

is not that of Romer (1956). It is difficult to see the utility of the family Aniliidae as erected by Romer, which is certainly a composite unnatural assemblage of primitive, burrowing, boid-like snakes. Any similarities between the Xenopeltinae, Aniliinae, Loxoceminae, and Uropeltinae are either the result of convergence or merely primitive features held in common with all boid-like primitive snakes. Placing these subfamilies in a single family, the Aniliidae, implies a monophyletic assemblage. Such an arrangement is very improbable, and it seems more reasonable to recognize these groups as subfamilies of the Boidae or as distinct families of a larger superfamily, the Booidea. The last two arrangements would not imply that these groups are closer to one another than they are to the primitive Boidae. For the purpose of the present study the classification followed is the more conservative one. The subfamilies of the Aniliidae of Romer (1956) are treated as families, with the exception of the Loxoceminae which are regarded as a distinct subfamily of the Boidae.

Romer (1956) places the fossil genera *Calamagrus* and *Ogmophis* in the Boinae, but these are here regarded as members of the Erycinae, although this group may also be an artificial category.

ANILIIDAE

CONIOPHIS MARSH, 1892

GENOTYPE: *Coniophis precedens* Marsh, from the Lance, upper Cretaceous, from "Peterson Quarry," Niobrara County, Wyoming.

DIAGNOSIS: An aniliid snake that differs from the genus *Anilius* by lacking a distinct low neural spine, by having the more reduced accessory process, and by lacking a posterior notch in the neural arch border and thus forming a straight line posteriorly; differing from *Cylindrophis* by lacking the posterior notch in the neural arch border and by having a very reduced neural ridge and neural mound.

Coniophis carinatus, new species

TYPE LOCALITY: Locality 5.

DIAGNOSIS: Differing from the other species in this genus by the presence of a sharp ridge at the dorsalmost point of the neural

arch and three distinct low mounds at the posterior boundary of the neural arch, with a low cuneate haemal keel.

DESCRIPTION OF HOLOTYPE: An incomplete mid-thoracic vertebra (A.M.N.H. No. 3826; pl. 52) which is broken on the right side so that the right prezygapophysis and diapophysis and a portion of the cotyle are missing. Centrum short, about 5.1 mm. long or about five-eighths of the prezygapophyseal width (about 8 mm.). In ventral view the centrum is triangular in form, with a cuneate haemal keel which is very flattened posteriorly and becomes narrower and more distinct anteriorly. The haemal carina extends from the condylus to the cotyla. The broken cotyla is clearly ellipsoidal in form. The condylus is well developed and directed posteriorly, bearing at its ventral border a deep channel which clearly delimits the condylar ventral border from the ventrum of the centrum. The neural arch is broad, short, and low, with two distinct mounds which lie on each side of the middorsal posterior mound of the neural ridge. These two lateral mounds clearly indicate the lateral edges of the zygantrum. A sharp neural ridge extends from the posterior border of the upward-flaring zygosphenes to the anterior border of the median neural mound. The zygosphenes is well developed and is approximately 3 mm. in width. It flares upward so that its highest point is at the same level as the highest point of the neural arch. The zygosphenes is heavy, although not so massive as it is in boid snakes. The neural canal is relatively small, between 1.2 and 1.5 mm. in diameter. The relative size of the neural canal indicates an adult specimen. The prezygapophyseal facets are large and long and attain a width of 2.7 mm. Extending beyond the limits of the prezygapophyseal facets is a weakly developed accessory process which attains a length of 0.6 mm. The neural arch gradually slopes posteriorly to form the postzygapophyses, with no evidence of an interzygapophyseal ridge. The postzygapophyseal width is about 7.8 mm., and the interzygapophyseal width is about 7.2 mm. The diapophyses are badly eroded, but the general form is rectangular, about 2.8 mm. in length and 1.8 mm. in width. Two clear mounds can be seen on the diapophyses, and the general axis of the dia-

pophysis is set at a sharp angle (about 20°) from the vertical.

REFERRED MATERIAL: Several specimens of this species are known from the type locality. Included among these is one tiny vertebra which is less than 2.2 mm. long. In this vertebra the mounds of the neural arch are clearly developed, indicating that the mounds are not merely ontogenetic changes as in some living colubrids. This species is also known from another collecting point on Elk Mountain. A single specimen of this species was collected by the American Museum expeditions in the Huerfano, middle Eocene, Colorado.

Occurring sympatrically at the two Elk Mountain localities is another species of this genus.

***Coniophis platycarinatus*, new species**

TYPE LOCALITY: Locality 5.

DIAGNOSIS: Differing from the other species in the genus by the lack of the mounds on the posterior dorsal surface of the neural arch, and by the lack of any distinct haemal carina on the ventral surface.

DESCRIPTION OF HOLOTYPE: An incomplete mid-thoracic vertebra (A.M.N.H. No. 3827; pl. 53, figs. 1, 2) in which the condyle is broken. Centrum was probably short (reconstruction based on referred material), attaining a length of about 4 mm. or about six-tenths of the prezygapophyseal width which equals about 6.1 mm. In ventral view the centrum is subtriangular in form, with an obscure haemal carina so flattened as to afford little distinction from the ventral surface of the centrum. From the referred material it is apparent that the condylus is directed posteriorly and slightly upward. The condylus is well rounded, bearing at its ventral border a deep channel which clearly delimits its ventral border from the ventral surface of the centrum (as determined from referred material). The neural arch is broad, short, and low, with a slight rise on the posterior lateral surfaces which indicate the lateral edges of the zygantrum. The posterior middorsal region of the neural arch bears no mound or prominence. There is an obscure line or ridge which extends from the posterior border of the neural arch to the posterior border of the upward-flaring zygosphenes. The zygosphenes,

broken on the right side, is well developed and approximately 2.5 mm. in width. It flares upward so that its highest point is at the same level as the highest point of the neural arch. The zygosphenes is well built and heavy, although proportionately not so heavy as in the large boids. The neural canal is relatively small, being about 1.2 mm. in diameter. The relative size of the neural arch indicates a vertebra of an adult specimen. The prezygapophyseal facets are large and long and attain a width of about 2.2 mm. Extending beyond the limits of the prezygapophyseal facets is a weakly developed accessory process which attains a length of about 0.4 mm. The neural arch gradually slopes posteriorly to form the postzygapophysis, with no evidence of an interzygapophyseal ridge. The postzygapophyseal width is about 5.2 mm., and the interzygapophyseal length is about 5.3 mm. The diapophyses are rectangular in outline but auriculiform in appearance. In the upper part of the auricle there is a large mound which bears at its base a large lobe. The diapophyses are approximately 1.9 mm. in length and 0.9 mm. in width.

REFERRED MATERIAL: This species is known from the same localities as *Coniophis carinatus*. It is not known from the Huerfano, middle Eocene, of Colorado. Several specimens of this species are known from the Bridger collections of Marsh in the Yale University collections. The data from these collections are inadequate.

RELATIONSHIPS OF *Coniophis*: In the last review of fossil North American snakes (Gilmore, 1938) the genus *Coniophis* was allocated to no family and was stated to be known from a single specimen. Later workers continued this allocation. The small series of vertebrae now available from several middle Eocene localities required a reevaluation of the relationships of these fossils, the consideration of whether or not they were of serpent origin, and, if so, to what group they could best be compared.

These vertebrae are characteristically ophidian, as indicated by the presence of a well-developed zygantrum and zygosphenes, the presence of accessory processes (Mosauer, 1935, fig. 5), and the procoelous condition of the centrum. These fossil vertebrae can be distinguished from those of members of the

families Colubridae, Elapidae, Hydrophiidae, and Viperidae (*sensu lato*) by the following combination of characters: (1) the fossils lack a distinct neural spine; (2) the accessory process is poorly developed, barely protruding beyond the postzygapophyseal facet; (3) the lack of hypapophyses in the mid-thoracic region; (4) the haemal carinae are barely visible and at best are developed as low mounds on the ventral surface of the centrum; (5) the general form of the vertebrae is square in outline and not longer than broad; and (6) the posterior border of the neural arch does not have a well-developed, but at best only a slight, indentation. These vertebrae can be distinguished from those of the Boidae by the following characteristics: (1) the lack of a well-developed neural spine; (2) the presence of an upward-flaring zygosphenes; (3) the lack of a posterior notch in the neural arch; (4) the lack of a well-developed haemal carina; and (5) the outline of the vertebrae, square and not broader than long. The fossil vertebrae can be distinguished from those of the monotypic Xenopeltidae by the presence in the xenopeltids of a well-developed, high, ridge-like, haemal carina, prominent accessory processes, well-developed posterior notch in the neural arch, and prominent neural ridge. The fossil vertebrae are similar to the mid-thoracic vertebrae of the families Typhlopidae, Leptotyphlopidae, and Aniliidae, which they resemble in the following respects: (1) the depressed neural arch; (2) the lack of the neural spine; (3) the lack of a well-developed haemal carina; and (4) the almost straight border of the posterior region of the neural arch. The fossil genus *Coniophis* can be distinguished from the blind snakes, Leptotyphlopidae and Typhlopidae, by the following characteristics: (1) the lack of the large accessory process (present in the blind snakes); (2) the lack of the round diapophyses; and (3) the presence of an upward-flaring zygosphenes. There remains only one family of snakes with vertebrae that resemble the fossil vertebrae, i.e., the Aniliidae. In this family there are three living genera: *Cylindrophis* and *Anomochilus* of the Indo-Malayan region, and *Anilius* of South America. Only the vertebrae of *Anilius* and *Cylindrophis* were available for study. The verte-

brae of *Anilius* are characterized by the presence of a low neural ridge and small but distinct accessory processes. The neural ridge is completely lacking in *Cylindrophis*. The accessory process is much smaller in *Cylindrophis* than it is in *Anilius*. At the posterior end of the neural arch, above the zygosphenes, there is a low distinct mound in *Cylindrophis*. The fossil vertebrae most closely resemble those of *Cylindrophis* but are distinguished by three distinct mounds on the posterior border of the neural arch.

Several fossils have been ascribed to the Aniliidae. Rochebrune (1880) assigned *Scytalophis* to this family, but the figures clearly indicate a boid snake as Hoffstetter (1955a, 1955b) has concluded. In 1901 Smith Woodward described *Dinilysia patagonica* from the Cretaceous of South America. The plates of this paper do not depict details of the morphology of the vertebrae clearly, yet it can be determined that this fossil genus differs from all aniliids by the presence of large and distinct neural spines. Also, as noted by McDowell and Bogert (1954), there are definite lacertilian features in the skull of *Dinilysia*. If these are correctly interpreted, then in this respect *Dinilysia* is certainly a most primitive snake and belongs in a family of its own (Romer, 1956). As a result it may be concluded that no fossils up to this time have been correctly assigned to the Aniliidae.

Certain features of the fossil vertebrae that belong to the genus *Coniophis* are clearly adaptations to a fossorial existence. The lack of neural spines or the reduction of the neural spine is clearly an adaptation to burrowing in snakes and in certain lizards. The reduction of the accessory process is an indication of fossorial habit, although this generalization is contradicted in the primitive but isolated Typhlopidae and Leptotyphlopidae. In the burrowing elapid *Micruroides*, there is little evidence of the neural spine, and the accessory process is much reduced for an elapid, although it is larger in proportion than the accessory process of the Aniliidae. Similar adaptations can be noted in the burrowing African colubrid *Miodon*. Johnson (1955, p. 380) indicates that in burrowing snakes the prezygapophyseal width is generally reduced, which implies a general reduction in the entire area. Actually such an implication is mis-

leading, because the primary reduction is in the accessory process to which the Muscalis levator costae are attached. In the semi-burrowing *Micrurus* the neural spines are low. In both *Micruroides* and *Micrurus* the characteristic elapid hypapophyses are reduced in size, particularly posteriorly. Therefore burrowing adaptations in snakes and many lizards result in similar morphological changes in the vertebrae. As stated above, the Leptotyphlopidae and Typhlopidae, which are obligate burrowers, are the only snakes in which the reduction of the accessory process does not take place. This remarkable exception can perhaps be explained by the fact that these two families are the only burrowing snakes that lack enlarged ventral scales. Whether the similarity of the vertebrae in these two families is an indication of close relationship or of convergence (the latter interpretation is indicated by McDowell and Bogert, 1954) can be answered only by a functional analysis of locomotion in the blind snakes and a more complete fossil record.

An evaluation of the distinguishing features of the genus *Coniophis* indicates that its closest relative is perhaps the Indo-Malayan genus *Cylindrophis*. Studies of vertebral variability within the latter genus are not available. If the differences between living species of snakes are taken as criteria for evaluation of the differences between fossil forms, then we can assume that there are three species in this genus: *Coniophis precedens*, *Coniophis carinatus*, and *Coniophis platycarinatus*. These three forms may be compared as follows:

The genus *Coniophis* was placed by Hoffstetter (1955b) in the family Coniophidae. Determination of the family affinities of this vertebra from the illustrations gives certain impressions of uniqueness that, on examination of the type, do not hold. This impression was held by myself until the type of *Coniophis precedens* (pl. 53, figs. 3-7) was made available by David Dunkle. Although the illustration portrays the general impression of the vertebra and is on the whole accurate, there are certain inaccuracies. The mid-neural mound and the post-neural notch are not portrayed accurately.

The temporal and geographic range of *Coniophis* adds interesting distributional data to the family Aniliidae. If the allocation is correct, then the appearance of this family is now known from the late Mesozoic, and the form represented is most closely related to the tropical Old World forms.

BOIDAE

ERYCINAE

Hoffstetter (1955a) resurrected this fossorial or semifossorial subfamily which can easily be distinguished from the other subfamilies in the Boidae (Boinae, Pythoninae, Tropicophinae, Sanziniinae, and Loxoceminae). Hoffstetter states that the vertebrae are diagnostic, but he believes them to be most similar to those of Boinae. These vertebrae are very easily distinguished from those of the Tropicophinae and the Sanziniinae. In the subfamily Erycinae, Hoffstetter places the Old World genus *Eryx*, the New World genera *Lichanura* and *Charina*, and the fossil

	<i>C. precedens</i>	<i>C. carinatus</i>	<i>C. platycarinatus</i>
Horizon	Upper Cretaceous	Middle Eocene	Middle Eocene
Development of neural ridge	No ridge development	Distinct ridge from base of zygantrum to middle mound	No ridge
Development of haemal carina	Well-developed haemal carina but not flattened posteriorly and not reaching condylar lip	Carina reaching condylar lip, flattened posteriorly	Flattened carina and obscure along entire length
Zygantral mounds	None present	Well-developed, distinct, zygantral mounds	None or obscure
Middorsal neural arch mound	Present and distinct	Present, distinct, midway between two zygantral mounds	Not present or obscure

genera *Helagrus*, *Cheilophis*, *Ogmophis*, *Calamagrus*, and possibly *Lithophis*. Romer (1956) has apparently a totally different concept of this subfamily, and of the above genera he retains only *Eryx* and *Lichanura* in this subfamily. The others are either placed in other subfamilies of the Boidae or, as in the case of the two fossil genera *Cheilophis* and *Helagrus*, placed in Ophidia, *incertae sedis*. It seems to me that the classification of Hoffstetter is more natural.

Among the several collections at hand are some vertebrae that clearly belong to this subfamily. These vertebrae may represent several different species, but it seems best at this time to consider all these as members of a single species of the genus *Calamagrus*. If the generic allocation is correct, then this is the first Eocene representative of the *Calamagrus-Ogmophis* complex.

CALAMAGRUS COPE, 1873

***Calamagrus primus*, new species**

TYPE LOCALITY: Locality 5.

DIAGNOSIS: An Eocene species of the genus *Calamagrus* distinguished from other species of the genus by its thin neural spine and reduced knob of the neural spine, convexly projecting zygosphenes, and oval, depressed cotyla.

DESCRIPTION OF HOLOTYPE: A nearly complete, anterior, mid-thoracic vertebra (A.M.N.H. No. 3828; pl. 54, figs. 1-5) in which the centrum is relatively short, attaining a length of about 2.6 mm. In ventral view the centrum bears a low, distinct, haemal keel which runs from the lower lip of the cotyla to the tip of the condylus. The condylus is well rounded, oval in form, and projects directly posteriorly. In ventral view the sides of the centrum drop sharply from the haemal keel to the lateral ridges which extend from the base of the diapophysis to the short neck of the condylus. The sides of the centrum extend laterally dorsad to the prominent, projecting, interzygapophyseal ridge which runs from the prezygapophysis to the postzygapophysis. The cotyla is oval in shape, with its greatest diameter (1.7 mm.) extending across the width of the socket. Above the cotyla is the neural canal which is trapezoidal in form. Above the neural canal is a well-developed zygosphenes which is not a thick

shelf as in the larger boids but is relatively thin. The zygosphenes attains a width of 2.2 mm. The prezygapophyses are set at a very slight angle and are quite elongate in form, being one-third longer than their greatest width. The prezygapophysis does not bear a protruding accessory process. The prezygapophyseal width as measured from the tips of the facets is about 4.4 mm.

The neural arch is moderately high and sloping but bears at its peak a short, low, neural spine. The neural spine begins as a low sloping ridge at the base of the zygosphenes and midway up the neural arch rises sharply. The neural spine is thin and bears at its crest a slightly widened area or knob. The posterior portion of the neural spine overhangs the notch in the posterior border of the neural arch. In dorsal view the zygosphenes form a gentle sinuous curve which is convex in the middle. Lateral to each neural spine are slight mounds which indicate the lateral limits of the zygantrum. The zygantrum is deep and well developed. The postzygapophyseal width is 4.5 mm., and the interzygapophyseal width 3.2 mm. Beneath the prezygapophysis is the large abraded diapophysis which is oblong in form and is apparently a single mound with a single articular surface. The diapophysis attains a height of 1.5 mm. and a maximum width of 0.7 mm.

REFERRED MATERIAL: Specimens of this form are known from locality 5. Most of these vertebrae are not so complete as the holotype and are probably more posterior in the vertebral column. These mid-thoracic vertebrae generally have much more flattened haemal carinae and are nearly twice the size of the type. Further collections and larger series may prove that certain apparently minor differences actually indicate the presence of several species in the middle Eocene.

RELATIONSHIPS: The Oligocene *Calamagrus* (*sensu lato*) apparently bears its greatest resemblance to the living California boas, *Lichanura* and *Charina*, particularly the latter. The fossil genus differs from *Lichanura* by the presence of large accessory processes, reduced neural spines, and the greater width of the vertebrae in the living genus. The development of the accessory process is much greater in the Old World genus *Eryx* than in

any members of the genus *Calamagrus*. The Oligocene *Calamagrus* are most similar to *Charina* in respect to the general outline of the vertebra (in which the interzygapophyseal length is about three-fifths to two-thirds of the prezygapophyseal width), the length of the neural spine, the development of the knob of the neural spine, and the non-protruding nature of the accessory process. The Eocene form is apparently more primitive than the Oligocene and Recent forms, because of the presence of longer, thinner, neural spines and the poor development of the knob of the neural spine.

BOINAE

Boavus sp.

There are abundant remains of the genus *Boavus* in the collection (A.M.N.H. No. 3809). A complete review of the genus is necessary before specific determination can be made.

PARAEPICRATES, NEW GENUS

GENOTYPE: *Paraepicrates brevispondylus*, new species.

KNOWN DISTRIBUTION: As for the genotype.

DIAGNOSIS: A boid genus with short, broad, and high vertebrae but distinguished from other boid genera with similar vertebral form by its very short-based neural spine which ascends gradually to its full height; by the shallow posterior notch in the neural arch; by the reduced accessory processes, which are merely tiny nubbins; by its moderately thick zygosphenes; and by the overhang of the neural spine at the posterior border of the neural arch.

Paraepicrates brevispondylus, new species

TYPE LOCALITY: Locality 5.

HORIZON: Late Bridgerian, middle Eocene.
FORMATION: Bridger.

DIAGNOSIS: As for the genus.

DESCRIPTION OF HOLOTYPE: A complete mid-thoracic vertebra (A.M.N.H. No. 3829; pl. 55) in which the centrum is very short and attains a length of about 4.2 mm. In ventral view the centrum bears a low, obscure, cuneate, haemal carina which terminates just short of the ventral border of the condylus as a distinct mound. The condylus is round

in form and directed backward without any distinct neck. In ventral view the sides of the centrum drop gently from the flattened haemal carina into a shallow groove which extends from the base of the diapophysis to a short distance from the condylus. Above these grooves is an obscure ridge which extends from the diapophysis to the condylus. Viewed ventrally, the centrum extends laterally and dorsad to the level of the zygapophyses.

In ventral view the zygapophyses are extensive and almost meet in the middle of the vertebra, thus leaving a very narrow interzygapophyseal space. In frontal view the cotyla is almost circular in form, with a diameter of about 2.8 mm. Above the cotyla is the neural canal which has the form of an equilateral arch. Above the neural canal is a well-developed, thick zygosphenes. The zygosphenes attains a width of 3.8 mm. In dorsal view the zygosphenes offers a concave border. The prezygapophyses are set at a distinct angle and are quite elongate, with the greatest width about three-fifths of the greatest length of the prezygapophyseal facet. The prezygapophysis bears a tiny accessory process which is 0.3 mm. long. The prezygapophyseal width (as measured across the vertebra from the tips of the facets) is about 9.6 mm.

The neural arch is rather high and sharply sloping but bears at its peak a short-based neural spine which has been broken off. The cross section of the neural spine indicates that a thin triangular spine occupied the posterior half of the neural arch. At the base of the neural spine is a gradually ascending crest which begins obscurely at the base of the zygosphenes. Lateral to the base of the neural spine is a distinct elongate mound which lies directly above the upper lateral corners of the zygantrum. These elongate zygantral mounds extend almost to the base of the zygosphenes. Lateral to the zygantral mounds are less prominent mounds which are directly above the postzygapophyses. The zygantrum is deep and well developed. The postzygapophyseal width is about 9 mm., and the interzygapophyseal width is about 5.3 mm. Beneath the prezygapophysis is the large, abraded diapophysis which is roughly oblong in form. The diapophysis is appar-

ently a single mound, with a single articular surface, although this too is not certain. The diapophysis attains a height of 1.5 mm. and a maximum width of about 1.3 mm.

RELATIONSHIPS: A complete array of all the living Boidae is not available for study, but it is clear that the fossil belongs to that group of boid snakes with short, broad, and high vertebrae (in this group the interzygapophyseal width is between 56% and 70% of the prezygapophyseal width). Among the genera with this characteristic form is a group that differs from *Paraepicrates* by having more prominent accessory processes, massive zygosphenes, deep postneural notch, and longer-based neural spine which rises sharply vertically to its full height. This group includes such genera as *Python*, *Boa*, *Constrictor*, *Corallus*, *Eunectes*, *Boavus*, *Sanzinia*, and *Neurodromicus*¹ (of Vanzolini, 1952). The vertebra of *Paraepicrates* is shorter than that in most of the forms included in the above list of genera and in this respect is most similar to that of *Madtsoia*, *Epicrates*, *Scytalophis*, and *Loxocemus*. The genus *Paraepicrates* can easily be distinguished from *Madtsoia* by the latter's heavy gigantic zygosphenes and heavy, high, sharply rising neural spine. *Paraepicrates* bears a strong resemblance to the Mexican genus *Loxocemus* but differs by having a much thicker zygosphenes, which is also concave in the fossil, whereas it is slightly convex in *Loxocemus*. Other points of difference are: the interzygapophyseal space is greater in *Loxocemus* than in the fossil, although the former is comparatively shorter in length; and the shorter neural spine rises sharply and more abruptly in *Loxocemus* than in *Paraepicrates*. There are certain similarities between *Paraepicrates* and the genus *Scytalophis* (Oligocene of France). From the plates in Rochebrune (1880) it is difficult to determine accurately important details, but it is apparent that vertebral proportions are similar to those of *Paraepicrates*. On the other hand the notch in the postneural arch and the confor-

mation of the neural spine are distinctly different. Within the genus *Epicrates*, vertebrae of three species are available for comparison: *E. striatus* of Cuba, Hispaniola, and the Bahamas; *E. cenchris* of southern Central America and South America; and *E. inornatus* of Hispaniola and Puerto Rico. Of the above three species *Epicrates striatus* represents the closest match to the fossil species. It is similar in vertebral proportions, in the presence of a short-based, thin, triangular, neural spine which starts as a low ridge at the base of the zygosphenes, and in other general features of the vertebra. *Paraepicrates* is distinctly different in its deeper notch in the postneural arch and its wide interzygapophyseal space. In general vertebral proportions *Paraepicrates* is least like *Epicrates cenchris* which has the longest vertebrae of the three species. *Epicrates inornatus* is most similar to *Paraepicrates* in vertebral proportions, having a short, wide vertebra, but differs in its long, low, neural spine, its heavily developed, prominently rising, zygantral mounds (which are found on each side of the neural spine), and a narrow interzygapophyseal space which differs in form and relative position from the afore-mentioned fossil. In summary it may be stated that *Paraepicrates* most closely resembles the genus *Epicrates*, although there are some distinct points of resemblance with *Loxocemus*. These resemblances are anomalous, as the genus *Loxocemus* was formerly placed in the subfamily Pythoninae and is now placed by Romer as a distinct subfamily in the Aniliidae. (It appears to me that the most reasonable allocation would be as a distinct group within the Boidae.) Therefore it is not unreasonable to assume that the similarities to each of the two genera may be the result of convergence due to physiological advantages gained by short, wide, vertebral form.

INCERTAE SEDIS

DUNNOPHIS,¹ NEW GENUS

GENOTYPE: *Dunnophis michroechinus*, new species.

KNOWN DISTRIBUTION: As for the genotype.

DIAGNOSIS: An ophidian genus, probably burrowing in habit and related to some of the

¹ *Neurodromicus* of Cope has been shown by Hoffstetter (1953) not to be a fossil and considered by him a living form. This conclusion has been corroborated by examination of the type. The name (*Neurodromicus*) applied by Vanzolini to his Floridian Miocene boids is therefore incorrect. This unhappy state is being rectified in a study of the fossil snakes of Florida by Walter Auffenberg.

¹ This genus is named in honor of the late Dr. Emmett Reid Dunn.

members of the Booidea, which can be distinguished from other snakes by the following combinations of vertebral characters: (1) presence of a low neural spine which is restricted to the posterior third of the neural arch from which it rises sharply; (2) presence of a distinct, deeply incised, posterior notch in the neural arch; (3) presence of elongated, prezygapophyseal facets but with no accessory processes; (4) absence of carinae or hypapophyses on the ventral surface of the mid-thoracic vertebrae; and (5) squarish vertebral outline which is just slightly longer than broad in dorsal outline.

***Dunnophis microechinis*, new species**

TYPE LOCALITY: Locality 5.

FORMATION: Bridger.

DIAGNOSIS: As for the genus.

DESCRIPTION OF HOLOTYPE: A complete mid-thoracic vertebra (A.M.N.H. No. 3830; pl. 56, figs. 1-5) in which the centrum is slightly smaller than the maximum prezygapophyseal width. The centrum attains a length of about 3.6 mm., and in ventral view the centrum bears a smooth rounded surface, with no evidence of a carina or process. The ventral surface of the centrum is sharply demarcated laterally from the lateral exterior walls of the neural arch by two deeply incised grooves which run from the border of the cotyla directly under the diapophyses. These grooves curve gently under the diapophysis and turn internally and posteriorly until they reach the lateral borders of the lip of the condylus. In ventral view the zygapophyses are not large and leave a wide interzygapophyseal space between them.

In frontal view the cotyla is oval in shape, being wider than high and about 2.2 mm. in its greatest diameter. The cotyla is deep and about 1.4 mm. in its greatest height. Above the cotyla is the neural canal which is trapezoidal in form. Above the neural canal there is a well-developed but very thin zygosphene which is about 1.8 mm. in width. In dorsal view the zygosphene offers a concave border. The prezygapophyses, in frontal view, are horizontal but in dorsal view are quite elongate, being almost twice as long as wide. The prezygapophysis bears no evidence of an accessory process. The prezygapophyseal width (as measured across the vertebra from the tips of the facets) is about 4 mm.

The neural arch is low and gently sloping but bears a small, short, knobbed, neural spine which is restricted to the posterior third of the dorsal portion of the neural arch. The neural arch is about 2.8 mm. as measured from the anterior border of the zygosphene to the anterior point of the notch in the postneural arch. Of the above distance 0.8 mm. is occupied by the base of the neural spine. The height of the neural spine is about one-third of its base, although it shows some signs of slight abrasion. The area in front of the base of the neural spine is flat, and the spine rises sharply from the neural arch. The area lateral to the spine bears only the faintest of indications of a zygantral mound. The distance between the tips of the postzygapophyses (the postzygapophyseal width) is about 4.6 mm. The interzygapophyseal distance (the distance between the tips of the prezygapophyses and postzygapophyses) is about 4.6 mm.

In dorsal view the neural arch shows a deeply incised posterior notch which begins its anteriorly oriented incision at the level above the zygantrum. The neural spine does not overhang the notch of the postneural arch.

In lateral view, beneath the prezygapophysis, a large, prominent, high mound or diapophysis can be seen, which is slightly auriculiform in outline and bears a single globose articulating surface. The diapophysis attains a height of 1.1 mm. and a maximum width of about 0.7 mm.

In posterior view the condylus is oval in outline, well rounded, and facing posteriorly dorsad. Above the condylus is a large neural canal which has parallel sides at its base but a highly arched roof. Above the neural canal are two long, deeply incised zygantra which extend from the posterior borders of the postzygapophyses to a point deep under the most anterior point of the posterior notch in the neural arch.

REFERRED MATERIAL AND RELATIONSHIPS: The genus *Dunnophis* is known from two localities (locality 5 and locality 13) and from four badly broken specimens (other than the type). It is also known from specimens in the Peabody Museum from Marsh's Bridger collections. Most of the available specimens are clearly mid-thoracic vertebrae, but one vertebra probably represents a more anterior

thoracic, and another, more complete specimen represents a caudal vertebra (A.M.N.H. No. 3831; pl. 56, figs. 6-10).

The vertebrae are clearly ophidian in origin, as indicated by the presence of a well-developed zygantrum and zygosphenes, procoelous centrum, and well-developed posterior notch in the neural arch. The accessory processes are not present, but a weak nubbin is present on the under side of the prezygapophyseal facet of one specimen which may represent the homologous structure. While some lizards (i.e., Teiidae) have the procoelous condition of the centrum, zygosphenes, and zygantrum or posteriorly restricted and reduced neural spine, no type is known to me with the above features and with lymphapophyses on the caudal vertebrae and distinct grooves on the lateral ventral exterior surface of the centrum.

The array of vertebral characters that demark *Dunnophis* makes it difficult to place the genus in any of the known families of snakes. It may represent a new family. The reduced neural spine and the lack of ventral processes on the centrum may indicate a partially burrowing type. If this assumption is correct, it is not surprising that the accessory processes are not developed. It seems clear that, until more material is obtained, definitive allocation is not possible.

CONCLUSIONS

The collections from Tabernacle Butte present an interesting array of herpetological forms. All the faunal elements indicate close relationship to modern faunal elements that are primarily tropical or subtropical in distribution. Perhaps two genera in the fauna, *Eorhinophrynus* and *Palaeoxantusia*, can be considered indicators of xeric environments. Hartweg and Oliver (1940) indicate that *Rhinophrynus* is typically adapted to dry plains habitats. This burrowing frog disappears for long periods of dry weather and reappears spontaneously after heavy rains. The relatives of *Palaeoxantusia* are more varied in habitat preference, but many of its closest relatives are secretive inhabitants of drier situations (Stebbins, 1954; Hartweg and Oliver, 1940). On the other hand such forms as the aniliid snakes, crocodylians, amphisbaenids, megophryine pelobatids, and *Dimetopisaurus* can be considered not xeric elements

but indicators of more moist environment.

In the fauna there is a notable abundance of fossorial or semi-fossorial forms such as *Eorhinophrynus*, the aniliid snakes, the erycine snakes, and the amphisbaenids. The living close relatives of the aniliid snakes and the amphisbaenid lizards are primarily burrowers in leaf mold and loose moist soil (Tweedie, 1953; Carr, 1940; Smith, 1943; Johnson, 1955). These forms are generally associated with at least locally moist conditions. This is particularly true of the rhineurine amphisbaenids because of their limited ability to retain water (Bogert and Cowles, 1947).

It may be concluded from the herpetofaunal elements that the environment had a mixture of xeric and humid factors, which perhaps can be explained as an alternation of wet and dry seasons or perhaps long-term cyclic or other periodic changes. Another more probable interpretation indicates rather narrow ecological zonation in the area, with consequent mixture of fossil faunas during deposition.

Zoogeographically the herpetofauna from Tabernacle Butte shows a mixture of typically Old World and New World elements. The fossil megophryine frog and aniliid snake are indicators of tropical Old World forms. The presence of xantusiid, rhineurine, and teiid lizards, the rhinophrynid frog, and the close relatives of the California burrowing boas indicate Recent New World elements.

ACKNOWLEDGMENTS

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MAMMALIA

MARSUPIALIA

PAUL O. MCGREW

DIDELPHIDAE

Peratherium cf. *innominatum* Simpson

U.W. No. 984 is a small jaw with P_3 - M_4 from locality 15. It corresponds in size with the smallest Eocene didelphid, *Peratherium innominatum*, the type of which is from the lower Bridger of Bridger Basin.

Peratherium sp.

A.M.N.H. No. 55694, from locality 5, is a lower jaw containing M_2 , the trigonid of M_3 , and M_4 . It is large for an early Tertiary didelphid, M_3 measuring 3.1 mm. This size corresponds rather closely with that of *Peratherium comstocki* from the Graybull. Because of the considerable time difference and because of the excellent possibility that upper molars would demonstrate significant differences, it does not seem desirable to refer the Tabernacle Butte specimen to that species.

Peratherium knighti,¹ new species

TYPE: A.M.N.H. No. 55684, right maxillary with M^{1-3} .

HYPODGM: Type; A.M.N.H. No. 55690, lower jaw fragment with M_4 and talonid of M_3 ; A.M.N.H. No. 55691, jaw fragment with M_4 and talonid of M_3 ; A.M.N.H. No. 55692, jaw fragment with M_4 ; A.M.N.H. No. 55693, M_2 or M_3 ; A.M.N.H. No. 55695, M_2 or M_3 .

HORIZON AND LOCALITY: Late middle Eocene, locality 5, Tabernacle Butte.

DIAGNOSIS: Length of M^{1-3} , 5.9 mm. Styler cusps low and on extreme external border of molars. Three principal styler cusps, one opposite apex of paracone, one slightly posterior and external to the V between paracone and metacone, and one opposite the apex of the metacone, the latter two very close together. Paraconule and metaconule well defined on M^{2-3} , less so on M^1 .

DISCUSSION: The details of the lower molar structure in related didelphid genera are closely similar, as can be appreciated by a

¹ For Dr. S. H. Knight who has encouraged investigations in vertebrate paleontology at the University of Wyoming.

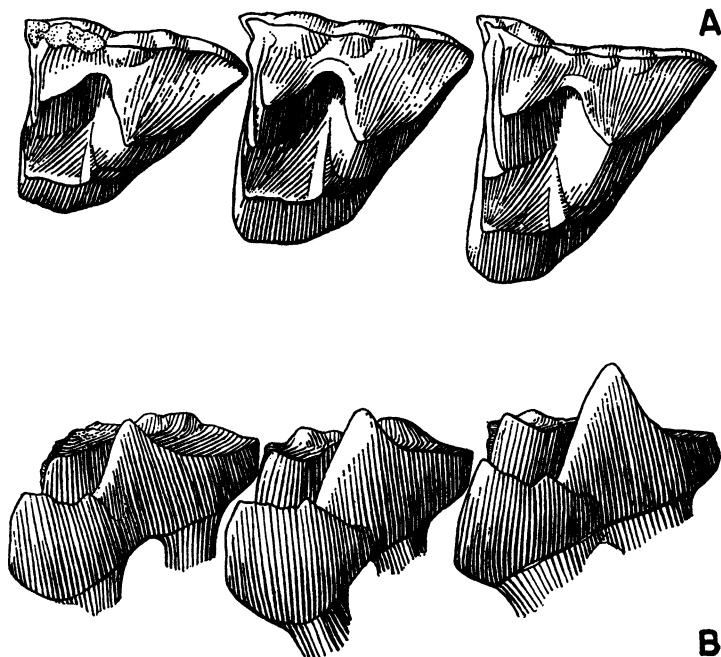


FIG. 3. *Peratherium knighti*, new species. Type, A.M.N.H. No. 55684, right M^{1-3} . A. Crown view. B. Internal view. $\times 15$.

TABLE 1
MEASUREMENTS (IN MILLIMETERS) OF TEETH OF *Peratherium*

Type	<i>Peratherium knighti</i>					<i>Peratherium</i> sp.	<i>Peratherium</i> <i>innominatum</i>
	A.M.N.H. No. 55690	A.M.N.H. No. 55691	A.M.N.H. No. 55693	A.M.N.H. No. 55692	A.M.N.H. No. 55695	A.M.N.H. No. 55694	U.W. No. 984
M ¹⁻³							
Length	6.0	—	—	—	—	—	—
M ¹							
Length	2.0	—	—	—	—	—	—
Width	1.7	—	—	—	—	—	—
M ²							
Length	2.1	—	—	—	—	—	—
Width	2.0	—	—	—	—	—	—
M ³							
Length	2.1	—	—	—	—	—	—
Width	2.2	—	—	—	—	—	—
M ₁							
Length	—	—	—	—	—	—	1.5
M ₂							
Length	—	—	—	—	—	3.1	1.6
M ₃							
Length	—	2.3	2.3	2.3	2.3	3.1	1.6
M ₄							
Length	—	—	—	—	—	—	1.5
M ₁₋₄							
Length	—	—	—	—	—	—	5.6
M ₂₋₃							
Length	—	—	—	—	—	—	3.0
M ₂₋₄							
Length	—	—	—	—	—	8.3	—

study of the several living South American marmosine opossums. The structure of the lower molars does not reflect important differences in the upper molars. Unfortunately Paleocene and Eocene didelphids are known principally from lower dentitions. For this reason any attempt to interpret the taxonomy of early Tertiary didelphids is a difficult task. At present, size is about the only criterion that can be used for the separation of species known only from lower dentitions. Possibly lower premolars would be significant were more available for study. Taxonomic differences appear to be strikingly reflected in the structure of the upper molars.

Peratherium knighti is clearly distinct from other species that are known from upper molars in the arrangement and relative prominence of the styler cusps. The styler cusps are lower than in other species and occur on the extreme external border of the teeth. There is no cusp corresponding to cusp C of

Peratherium fugax and *Peratherium marsupium*.

The Tabernacle Butte collections contain *Peratherium* jaws of three very distinct size groups, the middle one of which corresponds so closely in size with the type of *Peratherium knighti* that it is safe to include these specimens in the hypodigm of that species. Except for the difference in size, however, I am unable to detect any structural differences between the lower molars of *Peratherium knighti* and those of the other species.

INSECTIVORA

LEPTICTIDAE

PAUL O. MCGREW

Diacodon edenensis,¹ new species

TYPE: A.M.N.H. No. 55685, fragment of right lower jaw with M₁₋₃.

¹ For Eden Valley, in which our collection of Morrow Creek mammals was made.

HYPODIGM: Type only.

HORIZON AND LOCALITY: Morrow Creek member of the Green River formation; locality 10.

DIAGNOSIS: Approximate size of *Diacodon tauri-cinerei* and *Diacodon septentrionalis*. Molars less compressed anteroposteriorly and cusps relatively lower than in those species. Ridge between hypoconid and base of protoconid higher. Paraconid ridge narrow

and extending to anterior base of metaconid. Paraconid not cusperate. Trigonid with distinct forward tilt.

DISCUSSION: Leptictids are fairly well known from pre-Bridgerian and post-Bridgerian rocks, but interestingly enough only one specimen, *Hypictops syntaphus*, has been described from middle Eocene deposits, which is rather surprising when one considers the rather abundant microfauna from the Bridger Basin.

In size *Diacodon edenensis* is not significantly different from *Diacodon tauri-cinerei* and *Diacodon septentrionalis*. It is quite different from *Diacodon septentrionalis* in the lower trigonids and in the more elevated ridge between the hypoconid and the posterior base of the protoconid on the molars. The ridges formed by the paraconids appear to be unique for the genus in that they extend internally to the anterior base of the metaconids, in this respect resembling *Leptacodon*. The paraconid ridge is low and narrow, showing no tendency to be bulbous as in *Diacodon tauri-cinerei* and especially in the Oligocene members of the Leptictidae. The protoconid and metaconid are subequal, with the metaconid slightly the higher of the two cusps.

The talonid of M_1 is as wide as the trigonid,

TABLE 2

MEASUREMENTS (IN MILLIMETERS) OF TYPE OF *Diacodon edenensis*, A.M.N.H. No. 55685

M_{1-3}	
Length	7.1
M_1	
Length	2.4
Width of trigonid	1.9
Width of talonid	1.9
M_2	
Length	2.4
Width of trigonid	1.9
Width of talonid	1.7
M_3	
Length	2.5
Width of trigonid	1.8
Width of talonid	1.3
Depth of jaw under M_3	3.8

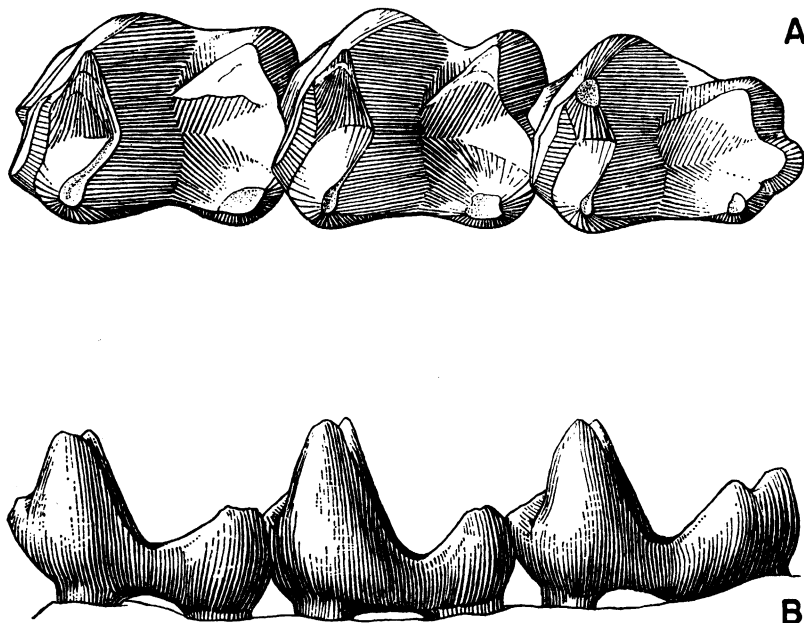


FIG. 4. *Diacodon edenensis*, new species. Type, A.M.N.H. No. 55685, right M_{1-3} . A. Crown view. B. Internal view. $\times 15$.

but on M_2 the talonid is slightly narrower, and on M_3 it is much narrower. The hypoconulid is distinct and median on all molars, but it is a prominent cusp only on M_3 . The hypoconid is heavier than the entoconid on all molars.

Comparison with *Hypictops syntaphus* is made difficult by the fact that the type of that species, and the only known specimen, is a maxillary with heavily worn dentition. *Diacodon edenensis* is smaller but probably not significantly so.

***Diacodon bacchanalis*,¹ new species**

TYPE: A.M.N.H. No. 55687, fragment of left lower jaw with M_{2-3} .

HYPODIGM: Type; A.M.N.H. No. 55688, an isolated M^1 , and A.M.N.H. No. 55686, M_2 in jaw fragment.

HORIZON AND LOCALITY: Late middle Eocene, Tabernacle Butte, locality 5.

DIAGNOSIS: Size very small (see table 3). Talonid of M_3 smaller than trigonid. Hypoconulids internal.

DISCUSSION: Although all the teeth known of this species are rather heavily worn, the leptictid characters are clear. The species is

¹ In reference to the rendezvous of the early mountain men that took place in the vicinity of Tabernacle Butte in the 1830's.

TABLE 3

MEASUREMENTS (IN MILLIMETERS) OF TYPE OF *Diacodon bacchanalis*, A.M.N.H. No. 55687

M_2		
Length		1.5
Width of trigonid		1.2
Width of talonid		1.1
M_3		
Length		1.6
Width of trigonid		1.1
Width of talonid		0.8

similar in size and general structure to *Diacodon minutus* from the Wyoming Paleocene but is plainly distinct. In *Diacodon minutus* the talonid of M_3 is the same width as the trigonid, while in the new species the talonid is much narrower than the trigonid. This condition is found in the larger species of *Diacodon*. In other species the hypoconulid is median, whereas in *Diacodon bacchanalis* the hypoconulid is somewhat internal. The paraconids are low and extend far internally, more so than in other known species except *Diacodon edenensis*. The paraconids of *Diacodon minutus* are also internal. In the new species, also as in *Diacodon minutus*, the metaconid is the largest cusp on the trigonid of M_2 , while on M_3 the protoconid and metaconid are subequal.

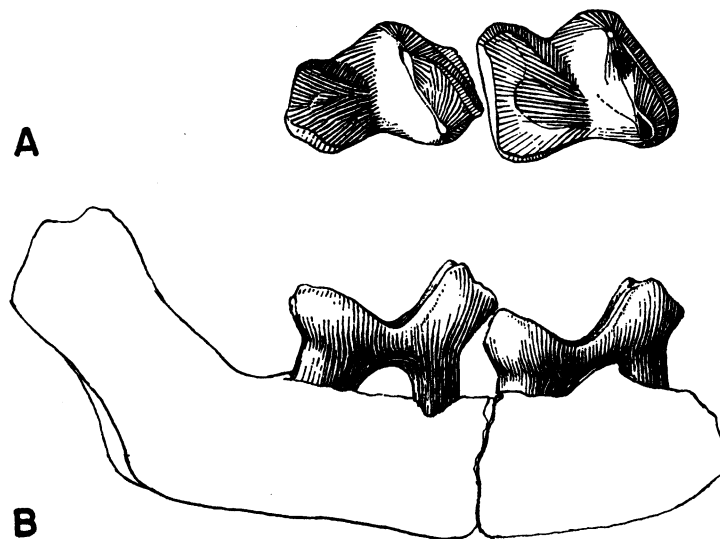


FIG. 5. *Diacodon bacchanalis*, new species. Type, A.M.N.H. No. 55687, fragment of left lower jaw with M_{2-3} . A. Crown view. B. Internal view. $\times 25$.

Because of its very small size and diacodont characters, the isolated M^1 almost certainly represents this species. This tooth is simply a miniature of M^1 of the larger species of *Diacodon*. The hypocone is somewhat larger than that of *Diacodon minutus* but of the same relative size as in the Eocene species. Other characters of M^1 are so like those of the other species that further discussion is not necessary.

NYCTITHERIIDAE

PAUL O. MCGREW

Nyctitherium velox Marsh

Two specimens, A.M.N.H. No. 55659, a left P^4 , and A.M.N.H. No. 55658, a left lower molar, probably M_2 , both from locality 5, are referable to this species. *Nyctitherium velox* appears to differ significantly from other species referred to this genus in the possession of a strong external cingulum along the entire length of each lower molar. Except for the presence of this cingulum, *Nyctitherium velox* is very like the specimen referred by Matthew to *Nyctitherium celatum*. *Nyctitherium velox* and *Nyctitherium celatum* differ in some rather important ways from the types of *Talpavus nitidens* (referred by Matthew to *Nyctitherium*) and *Nyctitherium priscus*. The former species differs from the latter in the greater separation of the paraconid from the metaconid, the lower entoconid relative to the hypoconid, the sharply enclosed talonid basin in contrast to the open basins of *Talpavus nitidens* and *Nyctitherium priscus*, the more internally located hypoconulid, and the sharper external angle on the protoconids and hypoconids. There is some probability that the latter species should be separated generically from *Nyctitherium*, in which case Marsh's name *Talpavus* (now considered a synonym of *Nyctitherium*) should be recognized. The entire group of small insectivores described by Marsh is in need of a critical revision.

The P^4 in our collection has a very prominent hypocone, strong styles, and other characters that could hardly belong with any known middle Eocene mammal other than *Nyctitherium*. It is quite molariform, with a high, pointed paracone and a lower, but strong metacone. A prominent spur extends postero-externally from the paracone and is



FIG. 6. *Diacodon bacchanalis*, new species. A.M.N.H. No. 55688, isolated M^1 . Crown view. $\times 15$.

continuous with a low external cingulum that is confined to the portion of the tooth behind the paracone. Anterior to the paracone is a strong, cusped parastyle protruding far forward. The protocone is V-shaped, with the apex rising as a sharp cusp. The hypocone is large, protrudes far back, and appears as a large shelf. It is very low, actually at about the same level as the middle of the external roots. There is a strong anterior cingulum.

There is much doubt, in my opinion, that all species referred to *Nyctitherium* actually belong to one genus and, further, that all genera referred to the Nyctitheriidae belong to a single family. Much more, and better-preserved, material, particularly upper dentitions, will doubtless be required to settle these points. The similarity of the dentition of *Nyctitherium velox* to that of certain bats seems altogether too great not to be significant, but here again more material is needed for study.

SORICIDAE?

GEORGE GAYLORD SIMPSON

Genus and species indeterminate

Figure 7

A.M.N.H. No. 55689, from locality 5, is a fragment of a right lower jaw with parts (but not the ends) of the angular and coronoid processes and alveoli for M_3 and M_2 except the anterior wall of the latter. Incomplete as it is, the specimen is of special interest because of its extremely small size. Differences of proportion make over-all size comparison uncertain, but this animal seems to have been at least as small as the smallest living mam-

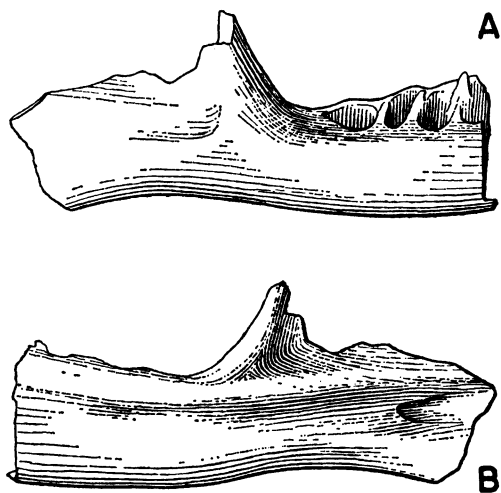


FIG. 7. Genus and species indeterminate. A.M.N.H. No. 55689, fragment of right lower jaw. A. Internal view. B. External view. $\times 15$.

mals (*Suncus etruscus* and allies) and was probably still smaller. This may be the smallest known mammal, as we are not acquainted with any other fossil of comparable size.

The most peculiar feature of the fragment, apart from its size, is the presence of a strong ledge running posteriorly from the end of the alveolar border above the dental foramen. The medial face of the base of the coronoid process is strongly excavated above this ledge, which suggests a primitive phase in development of a still deeper pocket in this position in recent shrews (in *Suncus*, among others) and may warrant reference to the Soricidae. Some and perhaps all recent soricid molars have, however, crests on the roots and basal face similar to those described by Butler (1948) in erinaceids. These leave a plain mark on the alveolar partitions (as in Butler, 1948, fig. 12), not seen on the fossil. However, the projecting part of the partition between the alveoli of M_3 has been eroded and that of M_2 is somewhat broken, so that the absence of this feature is not certain, nor is it certain that it occurred in all soricids. The family reference of the fossil is questionable. It almost certainly represents a new genus and species, but proposal of names with so inadequate a type would be indefensible.

PRIMATES

GEORGE GAYLORD SIMPSON

Apart from a few isolated teeth too uncertain in affinities to warrant description, the collections include representatives of five primates, an adapid, and two omomyids from the Morrow Creek, and an omomyid and an anaptomorphid from the Bridger. One of the omomyids is definable as a new species.

ADAPIDAE

Notharctus gracilis (Marsh)

Several fragmentary specimens from locality 10 (A.M.N.H. Nos. 55670 and 55671), in the Morrow Creek member, represent a single species of *Notharctus*. Mr. Peter Robinson, who has made a detailed study of Bridger *Notharctus*, kindly examined these specimens and identified them as *Notharctus gracilis*. They do not seem to be specifically separable from forms that occur in both lower and upper Bridger.

ANAPTOMORPHIDAE

Gazin (1958) has recently suggested dividing the Anaptomorphidae of authors into Omomyidae and Anaptomorphidae. As he notes, the supposed families still include many phyletic lines of doubtful mutual affinities, and the most natural grouping is far from clear, but Gazin's division into two families is here followed.

Uintasorex parvulus Matthew

This genus and its sole species were originally based on a fragment with P_4 and broken M_1 , referred by Matthew to the Insectivora and by some later authors to the Primates *incertae sedis*. Gazin (1958) has recently identified and described a number of other specimens and demonstrated with sufficient probability that this is a true primate (one of the smallest, if not the very smallest, known). Its position as between Omomyidae and Anaptomorphidae is doubtful, but Gazin is followed in placing it tentatively in the latter group, where it is very distinctive. It also somewhat resembles the *Utahia-Stockia-Ourayia* group, placed by Gazin in the Omomyidae.

Our specimen (A.M.N.H. No. 55664) is a partial left lower jaw, with M_{1-3} , from lo-

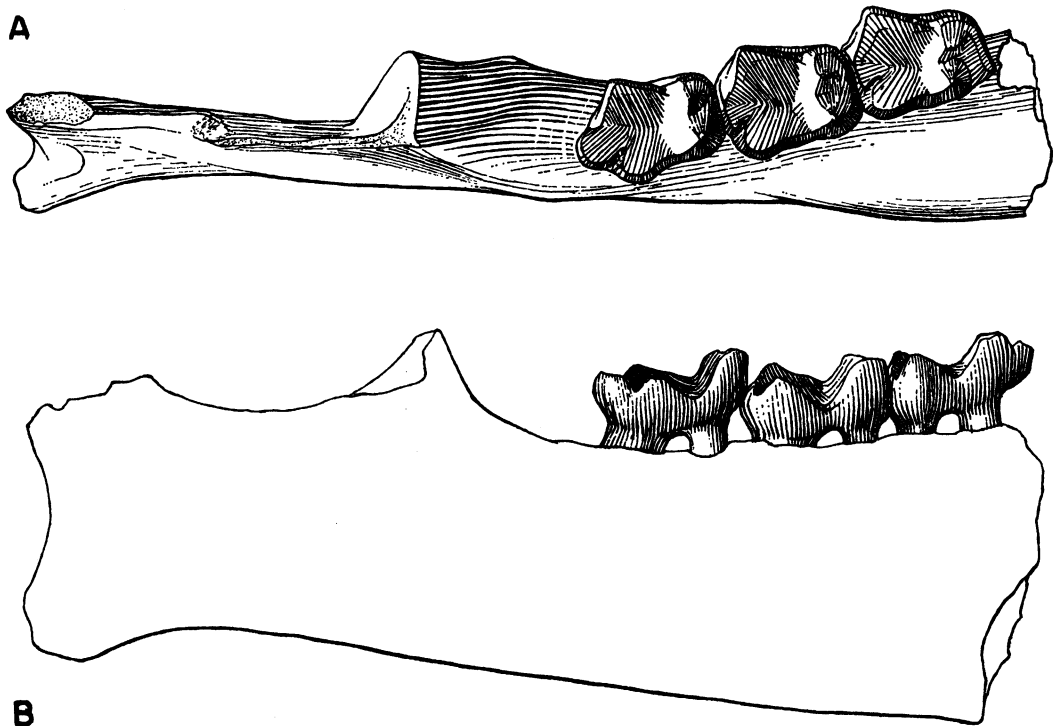


FIG. 8. *Uintasorex parvulus* Matthew. A.M.N.H. No. 55664, left lower jaw with M_{1-3} .
A. Crown view. B. Internal view. $\times 15$.

cality 5. The measurements given in table 4 are all close to those given by Gazin for other specimens of this species. Gazin noted that specimens from the Green River were smaller than the two then known from the Bridger and suggested that the former might represent a distinct taxon "of probably no more than subspecific importance." The present specimen from the Bridger, but from

a widely separate locality, is closest to the Green River specimens in size, but the differences could well be due to chances of sampling rather than any taxonomic factors.

TABLE 4
MEASUREMENTS (IN MILLIMETERS) OF *Uintasorex parvulus*, A.M.N.H. No. 55664

M_{1-3}	
Length	3.7
M_1	
Length	1.2
Width	0.9
M_2	
Length	1.1
Width	1.0
M_3	
Length	1.3
Width	0.9

OMOMYIDAE
***Omomys carteri* Leidy**
A.M.N.H. No. 55673, a fragment of left lower jaw, with crowns of P_3 and M_1 , agrees closely with specimens of *Omomys carteri* from the Bridger. Our specimen is from locality 10, in the Morrow Creek member. *Omomys carteri* is recorded from both lower and upper Bridger, and no difference between earlier and later populations has been established.
***Shoshonius? laurae*,¹ new species**
TYPE: A.M.N.H. No. 55672, left lower jaw with M_{1-3} .
HYPODIGM: Type only.
HORIZON AND LOCALITY: Morrow Creek member, locality 10.

¹ For Mrs. Laura McGrew, who cheered and aided us in the field.

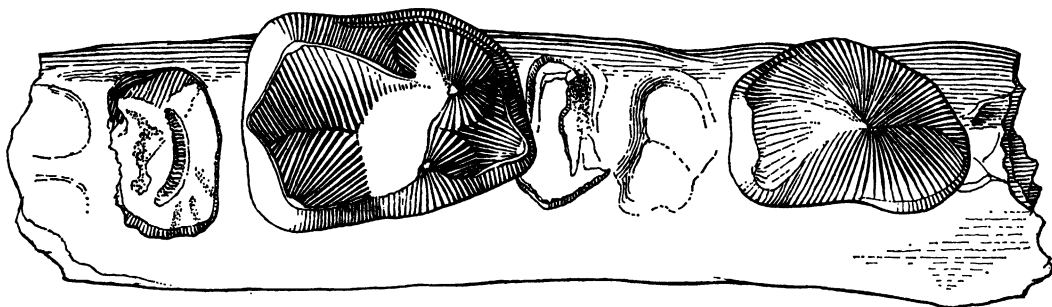


FIG. 9. *Omomys carteri* Leidy. A.M.N.H. No. 55673, fragment of left lower jaw with crowns of P_3 and M_1 . Crown view. $\times 15$.

DIAGNOSIS: Closely similar to *Shoshonius cooperi*, but talonid of M_3 more symmetrical, with more distinctly incipient third lobe, and with hypoconulid vaguely twinned. Somewhat smaller than *Washakius insignis*, with third lobe of M_3 definitely less developed.

DISCUSSION: This interesting primate strikingly resembles *Shoshonius*, *Washakius*, and *Dyseolemur*, notably in the presence of a strong metastylid, which sharply distinguishes those three genera from other supposed anaptomorphids. It unquestionably

belongs to that group of Eocene primates, and there is little doubt that it represents a new species. The generic sequence is, however, somewhat anomalous, and there is some question as to the position of this species in that sequence.

In the lower dentition, as far as known, the only clear-cut difference between *Shoshonius* and *Washakius* is in the talonid of M_3 . In *Shoshonius* there is no distinct third lobe, and the hypoconulid is single and asymmetrical. In *Washakius* the third lobe is dis-

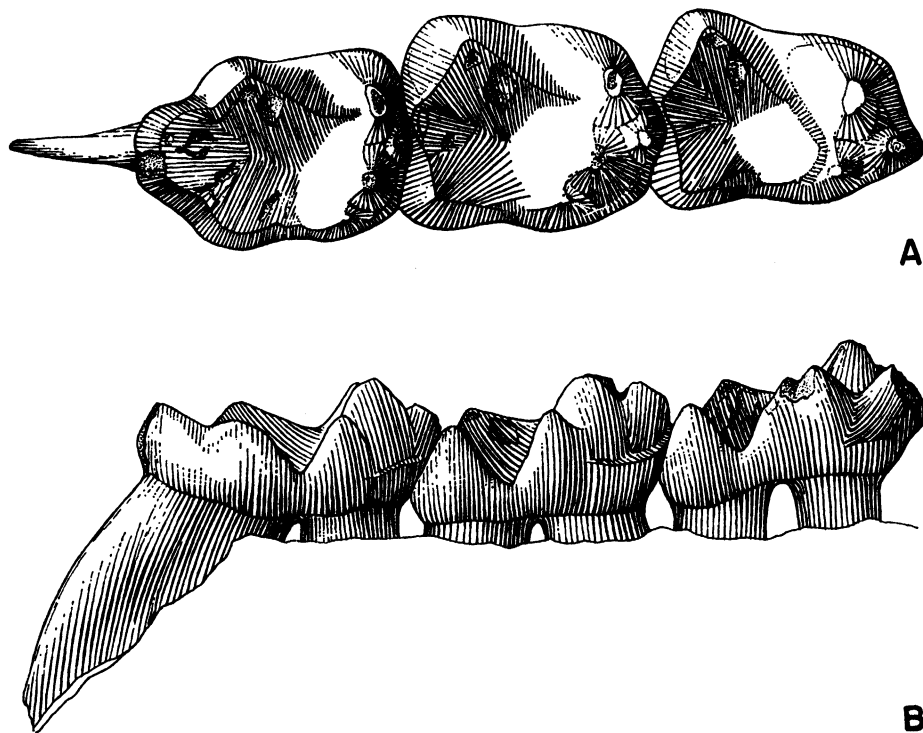


FIG. 10. *Shoshonius? laurae*, new species. Type, A.M.N.H. No. 55672, left M_{1-3} . A. Crown view. B. Internal view. $\times 15$.

TABLE 5

MEASUREMENTS (IN MILLIMETERS) OF TYPE OF *Shoshonius? laurae*, A.M.N.H. No. 55672

M ₁₋₃	
Length	6.8
M ₁	
Length	2.1
Width	1.7
M ₂	
Length	2.0
Width	1.9
M ₃	
Length	2.5
Width	1.7

tinct and large, and the hypoconulid, although asymmetrical, is distinctly twinned. *Dyseolemur* (see Gazin, 1958) is hardly distinguishable from *Shoshonius* in M₁₋₃, but the talonid of M₃ may be even a little less developed and a little more symmetrical in *Dyseolemur*. If these were the only teeth known, *Dyseolemur* would probably be considered a synonym of *Shoshonius*, although it is much later in time (Uintan as against late Wasatchian). Both those genera, although based on clearly valid species, would also be doubtfully separable from *Washakius*, intermediate between them in age (Bridgerian).

The upper teeth referred to the three

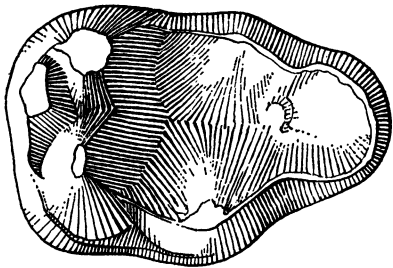


FIG. 11. *Washakius insignis* Leidy. A.M.N.H. No. 55667, isolated left M₃. Crown view. ×25.

genera complicate the problem. The upper molars of *Shoshonius* have strong mesostyles, absent in *Washakius* and *Dyseolemur*. This fact would seem to validate *Shoshonius* as a good (i.e., a conveniently separable) genus and would probably exclude it from the ancestry of the later forms. In spite of small distinctions noted by Gazin (1958), the known upper teeth of *Dyseolemur* (M²⁻³) hardly seem generically separable from those of *Washakius*. *Dyseolemur* thus has the extraordinary characteristic that it nearly combines the lower dentition of *Shoshonius* with the upper dentition of *Washakius*. Directly associated upper and lower teeth are not known in any of these genera. It is possible that the anomalies are due to incorrect ascription of upper or lower teeth to one or more of them, although the indirect evidence

TABLE 6

MEASUREMENTS (IN MILLIMETERS) OF TEETH OF *Washakius insignis*

	A.M.N.H. No. 55668	A.M.N.H. No. 55666	A.M.N.H. No. 55667
P ⁴			
Length	—	2.2	—
Width	—	2.9	—
M ¹			
Length	—	2.5	—
Width	—	3.6	—
M ²			
Length	2.3	2.1	—
Width	3.8	3.9	—
M ³			
Length	2.0	2.1	—
Width	3.5	3.7	—
M ₂			
Length	—	—	2.0
Width	—	—	2.1

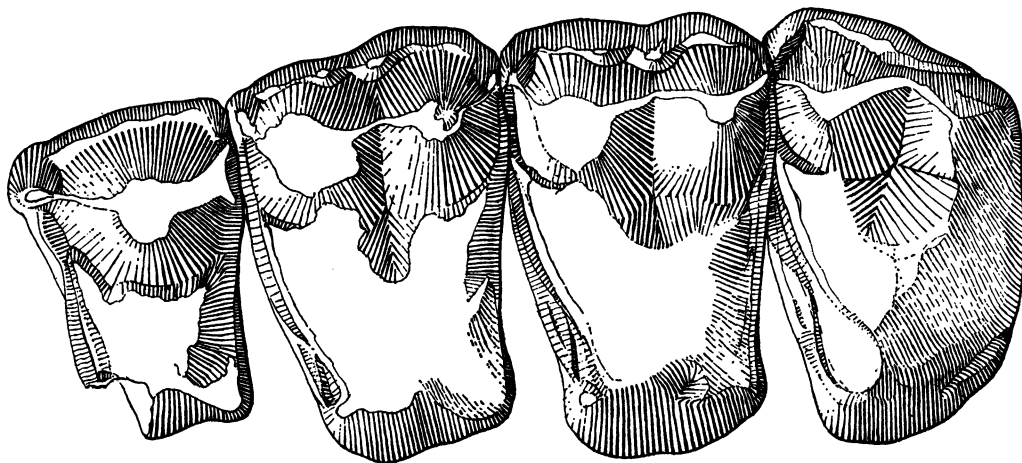


FIG. 12. *Washakius insignis* Leidy. A.M.N.H. No. 55666, left P⁴—M³. Crown view. $\times 15$.

for the associations seems fairly good. Even if only upper or only lower teeth are considered, the time sequence of *Shoshonius cooperi* to *Washakius insignis* to *Dyseolemur pacificus* almost certainly does not represent a single phylum. It would involve a highly improbable reversion between *Shoshonius* and *Washakius* in the upper molars or between *Washakius* and *Dyseolemur* in the lower molars.

The lower molars of *Shoshonius? laurae* could be referred to any one of the three manifestly related genera. They are in part intermediate between those of *Shoshonius cooperi* (of which the type is an upper dentition) and those of *Washakius insignis* (based on the lower dentition). On the whole, they seem to me somewhat nearer those of *Shoshonius cooperi* in structure, although in age they may be nearer those of *Washakius insignis*. *Shoshonius cooperi* is known only from the Lost Cabin, and the Morrow Creek member cannot be that old.

In size, the type of *Shoshonius? laurae* is

within the probable range of both *Shoshonius cooperi* and *Dyseolemur pacificus*.

Washakius insignis Leidy

Several specimens indicate the presence of an animal close to *Washakius insignis* Leidy, 1873, including upper teeth that would previously have been referred to *Hemicodon pygmaeus* Wortman, 1904. Gazin (1958) has shown that the two supposed species, although hitherto placed in different genera, are almost certainly synonymous. Although our various specimens differ slightly in dimensions and structural details from those previously known, the differences all seem too slight for taxonomic significance. The specimens are as follows:

A.M.N.H. No. 55665, right lower jaw with roots of incisors and worn crowns of C—M₂; locality 5. This specimen confirms the formula $\frac{2.1.3.3}{1.1.3.3}$,

as correctly stated by Matthew (1915), rather than $\frac{2.1.3.3}{1.1.3.3}$, as given by Wortman (1904).

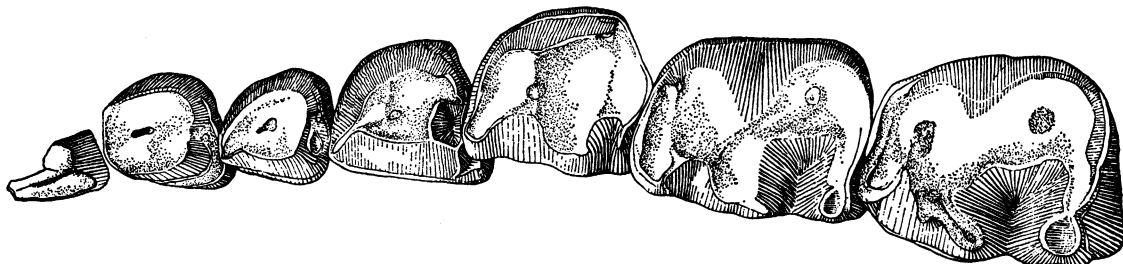


FIG. 13. *Washakius insignis* Leidy. A.M.N.H. No. 55665, right C—M₂. Crown view. $\times 12$.

A.M.N.H. No. 55666, part of left maxilla with P^4-M^3 ; locality 5.

A.M.N.H. No. 55667, isolated left M_3 ; locality 13.

A.M.N.H. No. 55668, part of right maxilla with M^{2-3} ; locality 5.

A.M.N.H. No. 55669, isolated M_2 ; locality 13.

A.M.N.H. No. 56033, left lower jaw with P_3-M_3 ; locality 15.

RODENTIA

ALBERT E. WOOD

Rodents are present in both the Morrow Creek member of the Green River and the Bridger at Tabernacle Butte. The material from the Morrow Creek consists of six specimens, referable to *Paramys delicatus*, *Leptotomus parvus*, new species, *Thisbemys*, new genus, and *Sciuravus nitidus*. The first and last of these indicate merely a Bridger age, but *L. parvus* and probably the species herein described of *Thisbemys* are present only in the lower Bridger, being replaced by distinct but descendent species in the upper Bridger.

There are a larger number of specimens from the Bridger. These include *Paramys delicatior*, *P. near excavatus*, *Leptotomus* sp., *Reithroparamys delicatissimus*, *Microparamys wyomingensis*, new genus and new species, *Sciuravus nitidus*, *Taxymys lucaris*, and *Tillomys senex*. These unfortunately give very little useful information as to the precise age of the Tabernacle Butte Bridger. *Paramys delicatior*, *Reithroparamys delicatissimus*, and *Sciuravus nitidus* range through the Bridger, although *R. delicatissimus* is not known from the upper part of the upper Bridger. The specimens of *Leptotomus* are too fragmentary for certain identification and are within the range of variation both of *L. parvus* and of the upper Bridger species. *Paramys* aff. *excavatus* and *Microparamys wyomingensis* are previously unknown forms that cannot be tied in to any definite point of time. *Taxymys lucaris* and *Tillomys senex* suggest an upper Bridger age, but the weight of this support is weakened by the fact that both genera are known from a very small number of individuals, the number of species is limited, the variability is unknown, and their absence from the lower Bridger may be due to accidents of collecting or be an artifact of our classification.

As is true to date of all North American

middle Eocene deposits, only two families of rodents are represented at Tabernacle Butte, the Paramyidae and the Sciuravidae. The former are in general more primitive, and presumably gave rise to the sciuravids, a group that may have considerable phylogenetic significance.

The present study was assisted by a grant from the Marsh Fund of the National Academy of Sciences. The measurements of all specimens are given in tables 7 and 8.

PARAMYIDAE

The rodents referred to this family are in the course of extensive revision by the present author, and the bases for the determinations are included in that study. It is, however, necessary to establish certain forms in the present paper, to permit their being discussed.

At least five genera of paramyids are present, representing three of the four subfamilies that occur in the middle Eocene. These genera are *Paramys*, *Leptotomus*, and *Thisbemys* of the Paramyinae, *Microparamys* of the Microparamyinae, and *Reithroparamys* of the Reithroparamyinae. The subfamilies are not discussed here.

Paramys delicatus Leidy

Figure 14

Two teeth are referable to this Bridger species. The specimen (A.M.N.H. No. 55605), from the Morrow Creek member, locality 10, consists of an isolated right P_4 and an isolated right M_2 , very probably from the same animal. The premolar is unworn, and the molar is very slightly worn. In size, the teeth fall within the range of those of *P. delicatus*, though the premolar is a little smaller than the mean of that species. Both teeth show the numerous minor irregularities in the enamel surface that are characteristic of unworn teeth of this species, but that are removed by wear, leaving little or no trace of their former presence.

The premolar differs slightly from that of the holotype in the forward position of the metaconid. The anterior cingulum is short, extending from the protoconid as in the holotype. At the end of the cingulum is a very small basal cuspule, presumably of cingular origin and not a paraconid (see below under

TABLE 7
MEASUREMENTS (IN MILLIMETERS) OF UPPER TEETH OF RODENTS
FROM TABERNACLE BUTTE

	<i>Paramys delicatior</i> A.M.N.H. No. 55675	<i>Leptomys</i> sp. A.M.N.H. No. 55676	<i>Leptomys</i> sp. A.M.N.H. No. 55678	<i>Microparamys wyomingensis</i> A.M.N.H. No. 55683	<i>Microparamys wyomingensis</i> A.M.N.H. No. 55681	<i>Thisbemys</i> sp. A.M.N.H. No. 55674	<i>Reithroparamys delicatissimus</i> A.M.N.H. No. 55682	<i>Sciuravus nitidus</i> A.M.N.H. No. 55602	<i>Sciuravus nitidus</i> A.M.N.H. No. 55604	<i>Sciuravus nitidus</i> A.M.N.H. No. 55607	<i>Sciurus nitidus</i> A.M.N.H. No. 55608	<i>Sciurus nitidus</i> A.M.N.H. No. 55611	<i>Taxymys lucaris</i> A.M.N.H. No. 55679
P⁴													
Anteroposterior	—	—	3.88	—	2.65	3.60	—	1.97	2.03	—	—	—	1.52
Width of protoloph	—	—	4.78	—	3.05	4.05	—	2.38	2.67	—	—	—	2.00
Width of metaloph	—	—	4.58	—	2.92	4.48	—	2.27	2.67	—	—	—	2.00
M¹													
Anteroposterior	—	3.68	—	—	—	—	—	—	2.22	2.00	—	—	1.77
Width of protoloph	—	5.63	—	—	—	—	—	—	2.65	2.57	—	—	2.10
Width of metaloph	—	5.10	—	—	—	—	—	—	2.75	2.59	—	—	1.95
M²													
Anteroposterior	3.25	—	—	2.42	2.55	—	—	—	—	—	2.28	2.32	1.81
Width of protoloph	4.05	—	—	2.86	3.10	—	—	—	—	—	2.30	2.27	2.15
Width of metaloph	3.98	—	—	2.95	2.78	—	—	—	—	—	2.42	2.42	2.00
M³													
Anteroposterior	3.55	—	—	—	—	—	3.17	2.20	—	—	—	—	—
Width of protoloph	3.70	—	—	—	—	—	3.08	2.26	—	—	—	—	—
Width of metaloph	3.77	—	—	—	—	—	3.08	2.24	—	—	—	—	—

Paramys near *excavatus* for a discussion of such cusps). One striking feature is the presence of an interrupted crest running parallel to and just in front of the posterior cingulum. This is similar to, but not identical with, the crest that progressively develops in the upper Eocene *Rapamys*. It does not appear to be identical in location and relationships with the similar crests either in the holotype of *P. delicatus* or in Y.P.M. No. 13384, also referable to *P. delicatus*. It is probable that such crestlets are individual variants in this species, both as to location and as to presence or absence. It is also probable that the den-

tine does not extend up into these ridges, so that, with wear, all trace of them would be removed.

The molar agrees very closely with that of the holotype. In this tooth the subsidiary crest runs from the entoconid out into the talonid basin, as in the holotype and in Y.P.M. No. 13384.

This species is known from both lower and upper Bridger and hence indicates merely a Bridgerian age for the Morrow Creek.

Paramys delicatior Leidy

Figure 15

This rather rare species is represented in the Bridger by a single specimen (A.M.N.H. No. 55675), consisting of left M²⁻³ from locality 5. Most of the material in museum collections that has been referred to *P. delicatior* is actually referable to *Thisbemys*, described below.

The two teeth of the present specimen show the typical triangular arrangement,

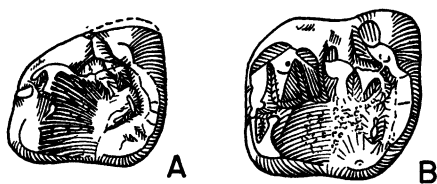


FIG. 14. *Paramys delicatus* Leidy. A.M.N.H. No. 55605, right P₄ and M₂. Crown view. $\times 5$.

TABLE 8
MEASUREMENTS (IN MILLIMETERS) OF LOWER TEETH OF RODENTS
FROM TABERNACLE BUTTE

	<i>Paramys delicatus</i> A.M.N.H. No. 55605	<i>Paramys near excavatus</i> A.M.N.H. No. 55680	<i>Leptomys parvus</i> A.M.N.H. No. 55600	<i>Leptomys sp.</i> A.M.N.H. No. 55678	<i>Reithroparamys delicatissimus</i> A.M.N.H. No. 55677	<i>Sciuravus nitidus</i> A.M.N.H. No. 55601	<i>Sciuravus nitidus</i> A.M.N.H. No. 55603	<i>Sciuravus nitidus</i> A.M.N.H. No. 55606	<i>Sciuravus nitidus</i> A.M.N.H. No. 55610	<i>Tillomys senex</i> A.M.N.H. No. 55609
P ₄ -M ₃	—	—	15.3	—	—	9.25	9.65	—	—	—
P ₄										
Anteroposterior	4.08	—	3.63	—	2.86	2.32	—	—	—	—
Width of metalophid	3.30	—	2.93	—	1.82	1.53	—	—	—	—
Width of hypolophid	3.85	—	2.96	—	2.47	1.76	—	—	—	—
M ₁										
Anteroposterior	—	2.97	3.41	—	—	2.22	2.28	—	2.27	—
Width of metalophid	—	2.71	3.10	—	—	1.72	1.98	—	—	—
Width of hypolophid	—	2.94	3.25	—	—	2.00	2.20	—	—	—
M ₂										
Anteroposterior	4.56	—	3.69	—	—	—	2.24	—	2.23	2.05
Width of metalophid	4.11	—	3.44	—	—	1.90	2.12	—	2.08	1.75
Width of hypolophid	4.40	—	3.37	—	—	—	2.33	—	2.18	1.92
M ₃										
Anteroposterior	—	3.30	4.33	—	—	2.53	—	2.85	—	2.02
Width of metalophid	—	2.92	3.31	—	—	2.02	—	2.20	—	1.78
Width of hypolophid	—	2.82	3.03	—	—	1.99	—	2.03	—	1.78
I ₁										
Anteroposterior	—	—	3.35	3.53	—	—	2.22	—	2.05	—
Transverse	—	—	2.27	2.40	—	1.60	1.55	—	1.40	—

with protoloph and metaloph converging on the protocone. In M² the posterior cingulum is enlarged to form an incipient hypocone, though this cusp never seems fully developed in any paramyid. The protoconule is small, and there is a single, large metaconule. Minor irregularities are present on the surface of the crown, but they have been nearly worn away in this specimen, and not much additional wear is needed to eliminate them entirely. On the third molar, the hypocone is entirely absent, a characteristic of the paramyids. The metaloph is directed more nearly anteroposteriorly than in M², owing to the backward rotation of the metacone. This process has not been carried so far as in some other paramyids, however, so that the cen-

tral basin is fairly small in this species.

A portion of the palate is preserved. The maxillary-palatine suture crosses the palate near the front of M² and then swings back along the alveolar border, there being only a very narrow sliver of maxillary between the alveoli and the palatine. The posterior palatine foramina lie well within the palatine, and are multiple, which may be an individual variation. As in paramyids in general, the posterior border of the palatine is thickened to form a distinct process, overhanging slightly along its anterior face. There is a groove in the palatine, between M³ and the internal nares, which extends posterolaterally to the temporal fossa. The maxillary ends in a sharp point, lateral to this groove, be-

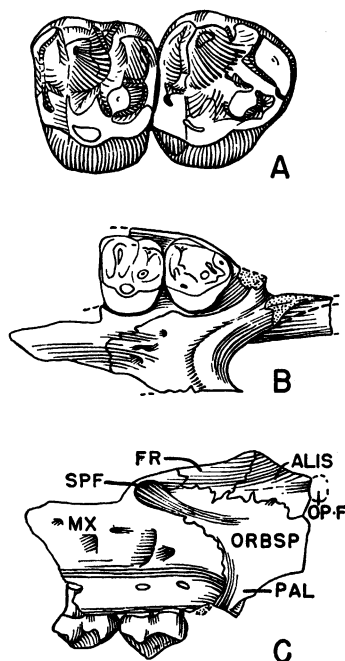


FIG. 15. *Paramys delicatior* Leidy. A.M.N.H. No. 55675. A. Left M^{2-3} . Crown view. $\times 5$. B. Palate. $\times 2\frac{1}{2}$. C. Orbit. $\times 2\frac{1}{2}$. Abbreviations: alis, alisphenoid; fr, frontal; mx, maxillary; op. f, optic foramen; orbSP, orbitosphenoid; pal, palatine; spf, sphenopalatine foramen.

hind M^3 . There are five fair-sized foramina in the orbital part of the maxillary, which cannot readily be named and which are not present, or at least are very much smaller, in *Paramys delicatus*, as represented by A.M.N.H. No. 12506. There is a large foramen, which seems to be the sphenopalatine, in the frontal just above the maxillary suture. In *P. delicatus* an identical-appearing foramen lies in the dorsal part of the maxillary. The orbitosphenoid is larger than in *P. delicatus*, and the optic foramen (broken off in the present specimen, but apparently just behind the preserved portion) is well to the rear. The alisphenoid apparently extended dorsal to the posterior part of the orbitosphenoid, forward of the optic foramen and as far forward as the rear of M^3 , a striking difference from the situation in *P. delicatus*. These are rather notable differences to occur between two otherwise apparently closely related species.

This species of *Paramys* is found through-

out the Bridger and hence does not serve to determine a precise level for the Tabernacle Butte Bridger.

Paramys near *excavatus*

Figure 16

Two isolated lower molars from the Bridger, locality 5 (A.M.N.H. No. 55680), one either M_1 or M_2 and the other M_3 , belong to *Paramys* but cannot be referred to any hitherto known Bridger species. The anterior molar is unworn; the M_3 , badly worn. In both size and the structural pattern of the unworn tooth, this form is very suggestive of *Paramys excavatus*, not known later than the Lost Cabin. However, the *P. excavatus* line seems to have survived through the Bridger, as a probable descendant is known from the upper Eocene, and hence it would not be surprising to find the group represented in the Bridger. The present material does not, however, warrant the erection of a new species.

The unworn tooth (fig. 16) exhibits a very simple paramyid pattern, with only a trace of the irregularities of the enamel surface. The metaconid is at the antero-internal corner, a short distance forward of the protoconid. An incomplete crest unites them along the anterior margin of the tooth. There is a slight enlargement near the center of the cingulum. A low ridge runs from the protoconid for a short distance into the talonid basin,



FIG. 16. *Paramys* near *excavatus*. A.M.N.H. No. 55680, left M_1 or M_2 . Crown view. $\times 5$.

and there is also a low crest along the buccal margin, leading to the indistinct mesoconid. This latter is very near the margin of the tooth. The talonid basin is large and is bounded posteriorly by a long, uniform crest running from the hypoconid to the entoconid. These two cusps are only slight swellings of the crest. The crest itself lies very near the rear of the tooth.

The worn third molar agrees, as far as can be determined, with the unworn tooth.

The interpretation given above of the anterior part of the tooth is different in some

respects from that which Schaub uses. Schaub (see especially Stehlin and Schaub, 1951, pp. 195-198) considers that if, in sciurids, a small cuspule is present in the region here considered the anterior cingulum, it is a paraconid, and that therefore such sciurids are more primitive than any known paramyids. While it is possible that this interpretation is correct, the complete absence of such a cusp in the earliest rodents, and its appearance in Oligocene sciurids, suggest strongly that it is a neomorph, and that the paraconid was completely lost during the unknown Paleocene part of rodent history. It is, of course, impossible to decide finally between these two points of view until the Paleocene history of rodents is unraveled, which is unfortunate, because such a difference of opinion must strongly alter the resulting over-all interpretations of the direction of rodent evolution.

This species is within the size range of *Reithroparamys delicatissimus*, but it cannot be referred to that form because it does not show any trace of the prominent transverse crest extending from the entoconid into the talonid basin, which is a characteristic feature of *Reithroparamys*.

As this is a previously undescribed species of *Paramys*, it cannot give any precise indications of age. *Paramys excavatus*, however, is a lower Eocene species, which suggests that the Tabernacle Butte Bridger may be early rather than late Bridgerian. The presence of a closely related form in the Uintan reduces the weight of this argument.

LEPTOTOMUS MATTHEW

DIAGNOSIS: Large genus; molar cusps high, basins reduced; P_4 not reduced; moderately wide molars; little or no crenulation in lower cheek teeth, although some present in earliest members of genus; ridge from entoconid progressively develops, extending out across talonid basin; protoconid tends to move in towards the center of the trigonid, squeezing the trigonid basin; little or no development of accessory crests in upper molars; metaconules normally single; lower incisors narrow; compressed, convex anteriorly, expanding posteriorly to a point about two-thirds of the distance from the anterior face; enamel extends laterally to the widest point of incisors; mandible with no symphyseal flange;

hind limbs large; ungual phalanges high and compressed.

Leptotomus parvus, new species

Figure 17

HOLOTYPE: A.M.N.H. No. 12519, right and left jaws with P_4 - M_3 and incisors, left P^4 - M^3 , and a fragment of the skull roof, from Grizzly Buttes, Bridger B₂, Bridger Basin, Wyoming.

DIAGNOSIS: Small and primitive member of the genus; typical *Leptotomus* type of incisors, approaching the *Paramys* type in some specimens with partially flattened anterior faces; progressively acquiring more *Leptotomus* characters in higher levels of Black's Fork; P^4 small; M_{2-3} with incomplete metalophulid; protoconule of all cheek teeth minute.

RANGE: Bridger B (Black's Fork member), Bridger Basin, Wyoming, and Morrow Creek member, locality 9, Wyoming.

DISCUSSION: This species is represented in the Morrow Creek, locality 9, by A.M.N.H. No. 55600, a lower jaw with all the teeth (fig. 17). All measurements on this specimen differ from the mean of the species by less than three times the standard deviation, if enough data are available for the standard deviation to be computed.

The present specimen is very similar in tooth pattern to the holotype of *L. parvus*. The metalophids of all the lower cheek teeth are a little longer, and there is a small mesostylid on M_1 . There are numerous minor irregularities of the molar enamel, which would be quickly worn away. M_1 shows peculiar wear of the metaconid, apparently indicating an individual abnormality of the upper teeth.

The lower incisor shows the typical *Leptotomus* pattern, with a narrow anterior face, the tooth widening gradually to or beyond its middle, and with the enamel continued to the wide point of the tooth (fig. 17B). The enamel is thin and the pulp cavity slender.

This specimen agrees with the extensive series (15 or more specimens) of *L. parvus* from the lower Bridger in size and pattern and is significantly smaller in nearly all measurements than the upper Bridger species of *Leptotomus*. It also is more primitive in tooth pattern, and therefore indicates a

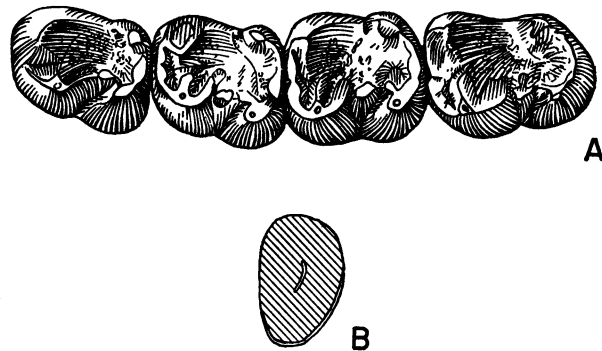


FIG. 17. *Leptotomus parvus*, new species. A.M.N.H. No. 55600. A. Left P₄-M₃. Crown view. $\times 5$. B. Incomplete left I₁, cross section. $\times 5$.

Black's Fork age for the Morrow Creek Member.

Leptotomus sp.

Figure 18

Two specimens from the Bridger of Tabernacle Butte clearly belong to *Leptotomus*. These include A.M.N.H. No. 55678, a partial lower incisor and an upper premolar, perhaps associated; and A.M.N.H. No. 55676, a first upper molar; both are from locality 5. These specimens are so fragmentary that positive specific identification is impossible. They fall within the range of variation both of *L. parvus* and of a still undescribed species from the upper Bridger. In view of the associated fauna, it is probable that these are of Twin Buttes age, but this material does not definitely indicate such an age.

The upper premolar (A.M.N.H. No. 55678; fig. 18A) shows a broad external cingulum which has pushed the paracone and metacone away from the external margin of the tooth. The anterior cingulum ends buccally

in a prominent cusp. The metaconule is a single rounded cusp, and the protoconule is practically non-existent. The hypocone is beginning to differentiate from the posterior cingulum. The latter is continuous across the posterior margin of the tooth.

The upper molar referred here is badly worn. The pattern suggests that of M¹, and the fact that the maxillary-palatine suture crosses the palate opposite its center clinches the argument. As is frequently the case in *Leptotomus*, the antero-external corner of the tooth is expanded by a broad cingulum shelf. There has been extensive interdental wear, particularly along the anterior face of the tooth, where the enamel has been entirely worn through, exposing the dentine, a most unusual situation (fig. 18B).

The lower incisor agrees in all significant features with that of *L. parvus*, described above. Such agreement carries no stratigraphic significance, as there appears to have been no change in the incisor between *L. parvus* and its Twin Buttes descendant.

MICROPARAMYS, NEW GENUS

GENOTYPE: *Paramys minutus* Wilson, 1937, from the Bridger.

DIAGNOSIS: Very small paramyids, lower tooth row ranging from 5 to 8 mm. in length; lower incisor with rounded anterior face, widest point well back of front; anterior cingulum of lower molars showing a tendency to be separate from protoconid; progressively well-developed metastylid extending back from metaconid; upper molars beginning to develop independent hypocone, but both it

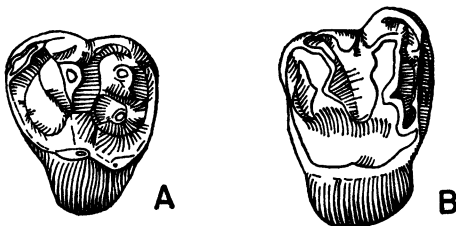


FIG. 18. *Leptotomus* sp. A. A.M.N.H. No. 55678, left P₄. Crown view. $\times 5$. B. A.M.N.H. No. 55676, right M₁, anterior end to the right. Crown view. $\times 5$.

and metaloph incompletely developed; swelling from protocone extends into central basin, as typically in paramyids; infraorbital foramen large.

REFERRED SPECIES: *Microparamys nanus*, Sparnacian of Belgium; *M. wyomingensis* from Tabernacle Butte; and several still undescribed forms.

RANGE: Eocene of North America and lower Eocene of Belgium.

***Microparamys wyomingensis*, new species**

Figure 19

HOLOTYPE: A.M.N.H. No. 55683, an isolated left M², locality 5.

REFERRED SPECIMEN: A.M.N.H. No. 55681, an isolated right M² and a left P⁴, locality 5.

DIAGNOSIS: Hypocone small, but present; metaconule beginning to shift its attachment from protocone to hypocone; metaloph near posterior cingulum; anterior cingulum strong and with a cusplule at its lingual margin; protoconule far forward, and at least sometimes united with anterior cingulum rather than with protocone; protocone sending a low swelling to central basin; premolar with large parastyle and weak hypocone; size large for *Microparamys*.

RANGE: Upper Bridger of Tabernacle Butte.

DISCUSSION: The structural features of these specimens are largely indicated in the diagnosis. All teeth have a well-developed incipient hypocone, being far advanced towards a quadrate type of tooth. The anterior and posterior cingula are strong and crest-like, giving a suggestion of a four-crested tooth. In the premolar, the parastyle is essentially independent of the cingulum. The swelling from the protocone into the central basin, between the protoloph and metaloph, is a typically paramyid feature, not present in sciuravids. The protoloph and metaloph are made up of a series of cusps, loosely united, rather than being dominated by their lophate features, as in sciuravids. There is no trace of a mesocone, a cusp generally present, or at least suggested, in the sciuravids.

It is perhaps poor policy to name a species on three isolated teeth, but this specimen is clearly distinct from any previous reported Eocene rodent. Structurally, this species



FIG. 19. *Microparamys wyomingensis*, new species. A. Holotype, A.M.N.H. No. 55683, left M². Crown view. $\times 5$. B. A.M.N.H. No. 55681, left P⁴. Crown view. $\times 5$.

shows a number of advanced features, generally characteristic of the Sciuravidae, together with primitive ones, more typical of the paramyids. Apparently the animals from which these teeth came were in the process of crossing the border from the paramyids to the sciuravids. In view of the presence of at least one rather progressive sciuravid in the Lysite (*"Sciuravus" depressus*, Loomis), however, *M. wyomingensis* could not be what it seems to be, unless the sciuravids are a composite group, formed by a large number of paramyid lines undergoing similar or identical modifications. While such an interpretation is by no means impossible, it would be more conservative to assume that the sciuravids arose once, in the lower Eocene, and that later forms that closely approximate the sciuravid type are parallelisms. It is almost certain that the sciuravids arose from small paramyids, either *Microparamys* or some of the small species of *Paramys*, so that resemblances of Bridger species of *Microparamys* to *Sciuravus* would be parallelisms in closely related stocks, and quite expectable.

This species adds little to an age determination of the Tabernacle Butte Bridger, as the genus ranges through most of the Eocene, and specimens are too rare to permit any clear interpretation of evolutionary trends. The most that the material could suggest would be Bridgerian age.

THISBEMYS, NEW GENUS¹

GENOTYPE: *Thisbemys corrugatus*, new species.

DIAGNOSIS: Teeth highly corrugated, with the corrugations lasting until the teeth are

¹ This genus was originally given the manuscript name of *Thisbe*, to indicate relationship to *Paramys*, but the name *Thisbe* is preoccupied for a lepidopteran, so *Thisbemys* is proposed as an approximation to the same idea.

well worn; irregularities in enamel typically large enough to be part of crown pattern and not just wrinkling; irregularities progressively increasing in size; M_3 elongate; lower incisor large, typically with flat anterior face, enamel reaching well around lateral side of tooth; pronounced masseteric fossa on mandible; groove between M_3 and ascending ramus; upper cheek teeth with very prominent mesostyles; hypocone developed on molars but absent on premolars.

***Thisbemys corrugatus*, new species**

HOLOTYPE: U.S.N.M. No. 17165, skull and jaws from north of Cedar Mountain, near center of Bridger Basin, from Bridger C.

DIAGNOSIS: Convolutions prominent and arranging into a pattern; prominent lingual gorge between metaconid and entoconid, which is continued as a valley part way across talonid basin; ectolophid elongating; incisor large; prominent hypocone on M^{1-2} , which are quadrate; metaloph of M^{1-2} short; para-style large.

RANGE: Twin Buttes member, Bridger formation of Wyoming.

***Thisbemys* sp.**

Figure 20

One isolated fourth upper premolar (A.M.N.H. No. 55674), from locality 10, Morrow Creek, is referable to this genus. The tooth is unworn and shows the complicated pattern to perfection. The protoconule is small and far forward. The metaconule is large and appears to be giving rise to a small accessory metaconule. The mesostyle is large and forms a prominent bulge at the center of the tooth. There is no trace of a hypocone.

This material is not adequate to permit the positive specific identification of the specimen. It is, however, definitely more primitive than P^4 of *T. corrugatus* in the



FIG. 20. *Thisbemys* sp. A.M.N.H. No. 55674, right P^4 , anterior end to the right. Crown view. $\times 5$.



FIG. 21. *Reithroparamys delicatissimus* (Leidy). A. A.M.N.H. No. 55677, left P_4 . Crown view. $\times 5$. B. A.M.N.H. No. 55682, right M^3 , anterior end to the right. Crown view. $\times 5$.

lesser development of a pattern in the crenulations and their more irregular arrangement, and in these respects approaches the undescribed lower Bridger species of the genus.

***Reithroparamys delicatissimus* (Leidy)**

Figure 21

This species is represented by two isolated teeth (A.M.N.H. Nos. 55677, a left lower premolar, and 55682, a right third upper molar), both from locality 5. Not only does *R. delicatissimus* agree with these specimens in the details of tooth pattern, but it is also the only rodent known from the Bridgerian of the correct size.

The premolar is subtriangular, the protoconid having partially united with the metaconid, so that there is essentially only a single anterior cusp. Partly this is the result of wear, as the protoconid of P_4 of *Reithroparamys* is apt to receive unusual wear at an early stage. But the partial absorption of the protoconid by the metaconid is characteristic of *Reithroparamys delicatissimus*. This presumably is not the retention of a primitive character, as the progressive reduction of the protoconid can be followed through the lower Eocene and Bridger species of the genus. There is a well-developed ectolophid, slightly expanded at its middle to form a mesoconid. As is typical of *Reithroparamys*, the entoconid is distinct from the posterior cingulum, being separated from it by a deep valley. The swelling of the entoconid into the talonid basin is merely suggested, a characteristic feature of this tooth in many lower Bridger specimens of *R. delicatissimus*. This tooth is the smallest known premolar of *R. delicatissimus* but is well within the presumed range of variation for this form.

The third molar, an unworn tooth, is also small for *R. delicatissimus* but is within the known range of variation of the species. It

shows the minor crenulations characteristic of the same tooth of most Bridgerian paramyids. The metaloph is more oblique than in *P. delicatior*, the metacone having apparently shifted backward. There is a large mesostyle. The metaconule is small, and the metaloph an indistinct ridge, separated from the posterior cingulum by a prominent valley. There is a faint suggestion of the beginnings of a hypocone. All these features agree with the situation in A.M.N.H. No. 12561, the best known specimen of *Reithroparamys*. One individual variation in this tooth is the notch in the posterior border between the metacone and the posterior cingulum. This is probably not of any taxonomic significance.

Reithroparamys delicatissimus is predominantly a lower Bridger form, but it occurs rarely in the Twin Buttes member of the Bridger, so that it merely proves a Bridgerian age, though suggesting a lower Bridger one.

SCIURAVIDAE

The Sciuravidae are probably a very important group of rodents phylogenetically. The details of their evolution, however, have not been worked out. In addition to a series of descriptive papers, beginning in 1871, and casual references in other papers, the only partial summaries of the family have been by Matthew (1910) and Wilson (1938 and 1949). Wilson's 1938 paper is largely a review of the Yale collections, and, while his later paper summarizes current knowledge of the sciuravids, it does not add new material. One genus, *Pauromys*, is generally referred to the sciuravids, but Stehlin and Schaub (1951, p. 367) consider it to be a cricetid. It is very possible that this genus is actually intermediate between the sciuravids and the cricetids, but further documentation is needed. There is a considerable quantity of undescribed sciuravid material in various museums, but, until this is described, together with a review of the entire family, it will not be possible to be certain either of the evolutionary trends within the group or of their possible relationships to later forms.

For this reason, the Tabernacle Butte sciuravid material is particularly important as adding to the rather limited published data on the family. No attempt is made here to revise the family, and the specimens are re-

ferred to the already described species, which are interpreted in as broad a manner as possible. Because of this broad interpretation, only rather general age determinations can be based on the sciuravids.

Sciuravus nitidus Marsh

Figures 22-26

This is the commonest rodent species in the Tabernacle Butte material, being represented by three specimens each of upper and lower teeth from the Bridger out of a total of 14 rodent individuals, and by two specimens of upper teeth and one of lowers out of six rodents from the Morrow Creek member of the Green River. There appears to be no difference between the material from the two horizons, although such lack of difference may be partly due to wear, as all the specimens from the Morrow Creek are badly worn. The diminutive third upper premolar is present only as a badly worn and broken stump in A.M.N.H. No. 55602, locality 10, about which nothing can be told except that it was present and its approximate size. The root only is present in A.M.N.H. No. 55604, locality 10.

In both A.M.N.H. No. 55602 and A.M.N.H. No. 55604 P⁴ is present but much worn. The anterior cingulum is well developed, and both protoloph and metaloph curve somewhat forward, at their median ends. The posterior cingulum is short. As in the specimen figured by Wilson (1938, fig. 2), there seems to have been no trace of a hypocone. A peculiar feature is the shape of the lingual root, which bends well forward between the crown and the alveolus.

The first molar is present in A.M.N.H. No. 55604 and as an isolated tooth in A.M.N.H. No. 55607, locality 13, both badly worn. The latter is a little shorter, anteroposteriorly, than any hitherto described M¹ of the genus, but the difference is slight. As far as can be told from the highly worn teeth, they otherwise agree with those figured by Wilson (1938, figs. 1, 2).

The second molar is present as isolated unworn teeth in A.M.N.H. No. 55608, locality 13, and A.M.N.H. No. 55611, locality 5 (fig. 22). This tooth agrees closely with the specimens Wilson figures. These two second molars are not identical, differing in the length



FIG. 22. *Sciuravus nitidus* Marsh. A. A.M.N.H. No. 55611, left M². Crown view. $\times 5$. B. A.M.N.H. No. 55608, left M². Crown view. $\times 5$.

of the protoconule and its relationships to the paracone and in the completeness of the metaloph. One interesting problem is suggested by the metaloph complex. Is this crest made up of metaconule and hypocone, together with a more or less distinct metacone; is there a mesocone and no metaconule; or is the mesocone attached to the hypocone and the metaconule to the metacone? The appearance of the two teeth (fig. 22) suggests that there is a mesocone, but it seems more probable, in view of the complete absence of a mesocone and the universal presence of a strong metaconule directed towards the protocone in the paramyids, that we are here dealing with a form in which the hypocone has newly acquired its marked separation from the protocone, whereas the metaloph still retains its more primitive relationships to the protocone. In other words, the forward bending of the metaloph in figure 22B would be a primitive condition, and the tooth shown in figure 22A would be slightly more specialized. Until considerably more is known of the sciuravids and their evolutionary trends, this conclusion must remain pure speculation.

The only third upper molar in the collection (fig. 23) is associated with the maxilla of A.M.N.H. No. 55602, but comes from the opposite side. It is about the right stage of wear to have come from the same individual. The anterior part of the tooth is very similar to that of the holotype of *S. nitidus* (Wilson, 1938, fig. 1). The posterior portion, however, shows a number of distinctive features. The



FIG. 23. *Sciuravus nitidus* Marsh. A.M.N.H. No. 55602, left M³. Crown view. $\times 5$.

hypocone is merely a swelling of the posterior cingulum, instead of being a separate cusp as in the holotype. The metaloph runs as a distinct ridge across the basin of the tooth, reaching the protocone and separating the basin into two parts. No trace of such a crest is seen in Wilson's figure of this tooth. In the metaloph this tooth resembles M³ of *Mysops parvus*, but it is much more progressive in the development of the hypocone, which again merely indicates how little is known of sciuravid evolutionary trends.

The lower teeth are represented by three jaws and an isolated M₃. In one of the jaws (A.M.N.H. No. 55601, from locality 5) the teeth are slightly worn, whereas in the other two they are badly or very badly worn. One unusual feature in these specimens is the absence of interdental wear, even when the teeth are worn down almost to the roots, as in A.M.N.H. No. 55610, from locality 5, in contrast to the usual condition in rodents, where such wear may amount to as much as 5 per cent or even more of the original tooth length.



FIG. 24. *Sciuravus nitidus* Marsh. A.M.N.H. No. 55601, right P₄-M₃. Crown view. $\times 5$.

The lower premolar of A.M.N.H. No. 55601 is a narrow tooth (fig. 24). The trigonid is much more elevated than that of the molars, standing well above the talonid, a sciuravid character. The metaconid is appreciably forward of the protoconid. The posterior arm of the protoconid nearly reaches the rear side of the metaconid. There may have been a slight anterior cingulum across the front of the tooth, but this section is beveled by wear of P³, so that it is impossible to be sure. The trigonid basin is perched high above the talonid basin, to which it has no outlet. There is no distinct mesoconid, the surface of the ectolophid sloping without break into the talonid basin. The posterior cingulum is broad and short, with a distinct hypoconulid near the hypoconid. The entoconid is elongate transversely and is aligned with the mesial edge of the hypoconulid, although the two would not be connected until the tooth was highly worn. This arrangement of the

posterior margin of the tooth is very suggestive of that in the smaller paramyids, such as *Reithroparamys* and *Microparamys minutus*. If this is indicative of relationship, it is probably with the latter, although the details are still not determined. This tooth is definitely more primitive than is that of *Sciuravus bridgeri* (Wilson, 1938, fig. 3) and is distinct from the holotype (referred by Wilson to *S. nitidus*) of *Sciuravus undans* (A. E. Wood, 1936, fig. 2). It is also more primitive than the corresponding tooth of any other described sciuravids.

In the first molar (fig. 24) there is a heavy anterior cingulum uniting the protoconid and the metaconid. The narrow trigonid basin drains posteriorly along the rear of the metaconids, as in the type of *S. undans* and as in *Tillomys parvidens*. In one or the other of these respects this tooth differs from that of all other illustrated sciuravids. The mesoconid is a prominent swelling of the ectolophid and is readily distinguishable. It is continued mesially by a long, low mesolophid. The entoconid is continued across the tooth to unite with the anterior edge of the hypoconid, as in the type of *S. undans*. The posterior cingulum is long and slender, reaching nearly to the lateral margin of the entoconid. It is enlarged near its buccal margin to form a hypoconulid. This tooth shows one important distinction from that of all other hitherto described sciuravids, in that there is both a complete hypolophid and a mesolophid, although a weak one. In all previously described forms except *Pauromys* (A. E. Wood, 1937, fig. 65), either there is no mesolophid, or the entoconid has united with the mesolophid. In *Pauromys*, the crest from the entoconid runs to the hypoconulid rather than to the anterior side of the hypoconid. It would therefore seem that this specimen of *Sciuravus* is just as probable a cricetid ancestor as *Pauromys* (cf. Stehlin and Schaub, 1951, p. 367) and that it is also in the process of developing, in the North American Eocene, the five-crested pattern found in the contemporary European theridomyids. Therefore, even if the "*Trechomys-Theriodomysplan*" is as fundamental as Stehlin and Schaub consider it, the sciuravids indicate that it has developed twice independently, and, if twice, why not even more often? There is a small

metastylid blocking the lingual end of the talonid basin, as in *S. undans*.

Nothing can be told about M_2 of A.M.N.H. No. 55601, as it is badly damaged. In A.M.N.H. No. 55603, from locality 10, it is present but badly worn. It seems to be similar to the tooth in *S. undans* and quite different from that of *Tillomys* or *Pauromys*, in which the hypolophid connects with the posterior, rather than the anterior, part of the hypoconid (Wilson, 1938, fig. 10; A. E. Wood, 1936, fig. 2).

The last molar is preserved on A.M.N.H. No. 55601. The trigonid is like that of M_1 , but the metaconid is even farther forward. The structures of the talonid basin appear, however, to be unique. The entoconid is continued laterally by a crest, running towards the posterior corner of the hypoconid, but which abruptly turns forward to join the ectolophid between the mesoconid and the hypoconid. The mesoconid does not extend as a mesolophid into the talonid basin, but



FIG. 25. *Sciuravus nitidus* Marsh. A. A.M.N.H. No. 55606, right M_3 . Crown view. $\times 5$. B. A.M.N.H. No. 55610, right I_1 , cross section $\times 5$.

there is a crest arising from the hypolophid that does so. An isolated third molar (A.M.N.H. No. 55606, from locality 13; fig. 25A) shows the conditions before wear. This indicates that there is a prominent mesolophid, extending well into the talonid basin, and that in the unworn tooth the entoconid is only indistinctly connected with the ectolophid. Thus here also we see the initial stages in the development of five-crested teeth.

It is possible that these developments in the structure of the lower molars are sufficiently important to warrant specific separation from *S. nitidus*. There is, however, no adequate basis for determining what to separate from what until the entire family is thoroughly reviewed, which is outside the scope of the present paper.

The lower incisor has a flat or gently rounded anterior face (fig. 25B). The widest point is about a third of the way back and marks the lateral limit of the enamel. The

enamel extends only a very short distance onto the median side. The enamel cap is thin, and the pulp cavity is small and oval.

Small portions of the maxillae are present on A.M.N.H. Nos. 55602 and 55604, both from locality 10. These show that the maxillary-palatine suture crosses the palate near the front of M^1 and then runs posterolaterad, fairly far from the alveoli, as far as the rear of M^1 . The maxillary-palatine suture passes very close to the alveolus of M^2 , being separated from it by a mere sliver of bone (fig. 23). The groove between the point of the maxillary and the palatine is not pronounced. In the preserved portion of the orbit of A.M.N.H. No. 55604 there are no foramina, a condition quite different from what is seen in the specimen of *Paramys delicatior* described above.

The lower jaw is fairly slender, with no particularly outstanding features (fig. 26).

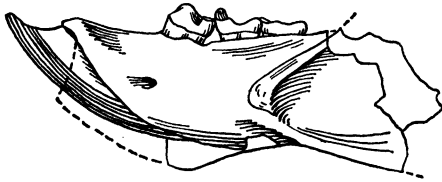


FIG. 26. *Sciuravus nitidus* Marsh. Composite lateral view of lower jaw, based largely on A.M.N.H. 55603, with outlined areas restored from A.M.N.H. Nos. 55601 and 55610. $\times 2\frac{1}{2}$.

The diastema is sharp-crested, the crest running nearly the entire length of the diastema. At its anterior end there is a shallow antero-posterior groove separating the crest from the symphysis. The mental foramen is single, about the middle of the jaw dorsoventrally and beneath the anterior root of P_4 . The masseteric fossa is large, extending to beneath the talonid of M_1 , and ends in a fairly prominent rugosity. In A.M.N.H. No. 55610, from locality 5, the rugosity is turned upward at its anterior end, whereas in the other two specimens it is not. The anterior end of the coronoid process passes the alveolar border behind the rear of M_3 . There is a slight ventral process at the rear of the symphysis, which is larger in A.M.N.H. No. 55610 than in the other two specimens. The larger ventral process, together with the difference in the masseteric rugosity, suggests that this specimen may be a male. The symphysis is

fairly large and rugose, but its shape cannot be determined from any of these specimens.

Taxymys lucaris Marsh

This species is represented by a maxilla, with right P^4-M^2 (A.M.N.H. No. 55679), from locality 5. The teeth are very greatly worn, so that very little of diagnostic value can be determined from them. They agree in size, however, with those of *T. lucaris*, and they agree in the obviously very pronounced separation of the protocone and hypocone. The cingula are strong, and it appears that the hypocone is an enlargement of the posterior cingulum, as in *T. lucaris* (Wilson, 1938, figs. 13, 14), rather than a distinct cusp as in some specimens of *Sciuravus*. P^3 was large and perhaps had an incipient division of its root. As Wilson suggests (1938, p. 300), it is possible that not all the material referred to this species is conspecific.

The palate shows the maxillary-palatine suture beginning at about the rear of P^4 and still leaving a wide maxillary area mesiad of M^2 . There is a very heavy tubercle on the ventral surface of the zygomatic process, which suggests that the anterior part of the masseter was separated from the rest and had a tendinous rather than a diffuse origin, which in turn suggests that we have here the initial stages in the development of the masseteric differentiation which characterized the origin of the specialized rodent types.

This species has not hitherto been reported except from the upper Bridger.

Tillomys senex Marsh

Figure 27

A single specimen (A.M.N.H. No. 55609) from locality 13 is referred to this form. As



FIG. 27. *Tillomys senex* Marsh. A.M.N.H. No. 55609, right M_{2-3} . Crown view. $\times 5$.

with all the sciuravids, the validity and significance of the generic and specific separations are uncertain. This uncertainty is particularly true of *Taxymys*, known only from upper teeth, and *Tillomys*, known only from lowers.

As indicated by Wilson (1938, p. 218), *Til-*

lomys is separable from *Sciuravus* by the transversely elongate mesoconid, the posterior prolongation of the metaconid into a mesostylid or something approaching such a cuspule, and the uniting of the entoconid with the posterior rather than anterior end of the hypoconid, and the uniting only after considerable wear.

The present specimen differs from that figured by Wilson (1938, fig. 10) and from the holotype in the greater transverse elongation of the mesoconid. This is much more prominent on M_2 than on M_3 , and Wilson's figure indicates that such an elongation occurs on this tooth. On both teeth, the trigonid basin is closed posteriorly and lies high above the level of the talonid basin, as is true of the previously described specimens. There is no trace of the ectostylid which features the lateral surface of M_1 in both the holotype and A.M.N.H. No. 11608. There is a distinct hypoconulid on both teeth of the present specimen. Its absence on the other specimens is undoubtedly due to wear.

In some respects, the present specimen is closer to *Tillomys parvidens* (Wilson, 1938, fig. 12) than to *T. senex*, as demonstrated by the transversely elongate mesoconid and the distinct hypoconulid. On the other hand, the size is closer to that of *T. senex*, and the anterior cingulum is firmly united with both protoconid and metaconid as in that species. In view of how little is known of the variability and trends within the sciuravids, any allocation of the present material must be tentative, and it is referred to the genotype as being the better established species.

While *T. senex* is known from the upper Bridger and *T. parvidens* from the lower, not enough is known of the range of either form, nor is the present material sufficiently distinctive, to permit an age determination closer than the Bridger.

CARNIVORA

PAUL O. MCGREW

HYAENODONTIDAE

Thinocyon sp.

A single M^1 of a small creodont (A.M.N.H. No. 55660) was found at locality 7 in a local stream channel, stratigraphically below and just west of locality 13. The specimen is clearly referable to *Thinocyon*, and the size

TABLE 9
MEASUREMENTS (IN MILLIMETERS) OF *Thinocyon*
SP., A.M.N.H. No. 55660

M^1	
Parastyle to metastyle	5.8
Metastyle to protocone	7.0

is that of *Thinocyon velox*. According to Matthew (1909) this species is limited to the lower Bridger, while *Thinocyon medius*, a very slightly larger species, occurs only in the upper Bridger. Matthew did point out, however, that considerable size variation was found and based his distinction between the species on characters other than dental. The tooth from our collection could belong to either of these species.

CONDYLARTHRA

PAUL O. MCGREW

HYOPSODONTIDAE

Hyopsodus lepidus Matthew

Hyopsodus lepidus is by far the most common mammalian species found in the Bridgerian deposits of the Tabernacle Butte region. It is well represented from all localities at which any concentration of mammal bones was found in the Bridger formation. In the Morrow Creek (locality 10) three jaw fragments were found that appear to be referable to this species. Altogether some 35 upper and lower jaw fragments containing two or more cheek teeth were found, along with numerous isolated teeth. All the specimens appear to represent a single species, and the characters agree perfectly with those of *Hyopsodus lepidus* described by Matthew from Bridger C of the Bridger Basin.

In addition to the characters pointed out by Matthew, P_4 appears to be distinctive of the species. This tooth is short anteroposteriorly, the talonid is reduced and trenchant, and the hypoconid is nearly central in position. The trigonid is high, compressed anteroposteriorly, and with well-developed paraconid. In these respects *Hyopsodus lepidus* seems to differ quite consistently from all other species. In other species the talonid of P_4 is longer and tends to be basined, the paraconid is less well developed, and the trigonid is relatively lower.

TABLE 10
MEASUREMENTS (IN MILLIMETERS) OF THE DENTITION OF *Hyopsodus lepidus*

	Number of Specimens	Minimum	Maximum	Mean	Type
P ²	5				
Length		2.3	2.9	2.58	—
Width		1.7	2.3	2.06	—
P ³	6				
Length		2.8	2.9	2.87	2.5
Width		2.7	3.5	3.06	—
P ⁴	6				
Length		2.6	2.8	2.70	—
Width		3.7	4.5	3.97	—
M ¹	6				
Length		3.3	4.0	3.70	3.8
Width		4.5	4.7	4.60	4.6
M ²	8				
Length		3.8	4.3	4.03	4.2
Width		5.1	5.7	5.38	5.3
M ³	8				
Length		2.8	3.6	3.00	3.5
Width		4.1	5.1	4.51	4.5
P ₂	2				
Length		2.0	2.1	2.05	—
Width		1.6	1.6	1.60	—
P ₃	5				
Length		2.4	3.1	2.70	—
Width		1.8	2.5	2.08	—
P ₄	6				
Length		2.7	3.4	2.96	3.0
Width		2.1	2.5	2.28	—
M ₁	8				
Length		3.6	4.4	3.91	3.8
Width		2.6	3.3	2.91	—
M ₂	7				
Length		3.4	4.5	3.81	3.8
Width		3.0	3.8	3.34	—
M ₃	4				
Length		3.8	4.7	4.30	4.6
Width		2.7	3.0	2.85	—

Hyopsodus lepidus had previously been known only from the upper horizons of the Bridger formation. A P₄ from the Morrow Creek is certainly of the *Hyopsodus lepidus* type and must be referred to that species.

PERISSODACTYLA

PAUL O. MCGREW

EQUIDAE

Orohippus, small species

Eight teeth of *Orohippus* were found in the Bridger formation of the Tabernacle Butte

region. Seven of these appear to represent a single species of average size, while one is so large that it must certainly represent a second species. Because species of *Orohippus* are not clearly differentiated, it does not seem desirable at this time to make definite reference to any one species, but rather simply to refer to them as small species and large species.

Specimens referable to *Orohippus*, small species, are U.W. Nos. 1282, 1283, and 1285 from locality 5; U.W. Nos. 1286 and 1287 from locality 13; and U.W. Nos. 1288 and

TABLE 11
MEASUREMENTS (IN MILLIMETERS) OF TEETH OF *Orohippus*

	P ₄		P ₃		P ₂		M ²		M ¹	
	L	W	L	W	L	W	L	W	L	W
Small species										
U.W. No. 1282	—	5.8	—	—	—	—	—	—	—	—
U.W. No. 1283	—	—	6.9	7.1	—	—	—	—	—	—
U.W. No. 1285	—	—	—	—	7.7	4.7	—	—	—	—
U.W. No. 1286	—	—	—	—	—	—	7.4	9.5	—	—
U.W. No. 1287	—	—	—	—	—	—	7.9	9.5	—	—
U.W. No. 1289	—	—	—	—	6.7	4.6	—	—	—	—
U.W. No. 1288	—	—	—	—	—	—	—	—	7.5	8.4
Large species										
U.W. No. 1284	—	—	—	—	—	—	9.0	11.0	—	—

1289 from locality 15. In this species the lophs of the upper molars are quite well developed, but in unworn teeth the conules are distinct and separated from the protocone and hypocone by sharp notches. Rather strong basal cingula are present on all four sides of the upper molars. A parastyle is rather uniformly developed on all the upper molariform teeth; it is small, not projecting, and close to the paracone. Mesostyles on the upper molariform teeth are variable, being quite strong on some and weak on others. The paracones and metacones are also variable but at most only a little crescentic.

The lower teeth have well-developed lophs, but the entoconids remain isolated.

The general characters of this species are distinctly those of a Bridgerian horse, but neither late nor early Bridgerian is specifically indicated.

Orohippus, large species

A single upper molar (U.W. No. 1284) from locality 5 is so much larger than the others, and seemingly so advanced, that it certainly represents a separate species. In addition to the larger size the paracone and metacone are more crescentic and the mesostyles much more prominent. This is certainly an advanced species of *Orohippus*.

BRONTOTHERIIDAE

Telmatherium cultridens (Osborn, Scott, and Speir)

A partial skull (U.W. No. 1290) referable to *Telmatherium cultridens* was collected from locality 2, near the top of Tabernacle Butte.

The top of the skull had weathered away, but the ventral portion of the skull is complete except for a small portion of the premaxillaries. The specimen agrees closely with the type of *Telmatherium cultridens* in nearly

TABLE 12
MEASUREMENTS^a (IN MILLIMETERS) OF
Telmatherium cultridens

P ¹ to occipital condyles, inclusive	405
Width of skull across zygomatic arches	312
P ¹ —M ³ , length	190
P ¹ —P ⁴ , length	78.2
M ¹ —M ³ , length	126.7
P ¹	
Length	16.7
Width	8.8
P ²	
Length	20.3
Width	18.9
P ³	
Length	21.5
Width	25.2
P ⁴	
Length	24.3
Width	30.9
M ¹	
Length	34.6
Width	36.1
M ²	
Length	46.0
Width	44.2
M ³	
Length	46.5
Width	46.4

^a Except for P¹, length measurements are along ectoloph. Width measurements are from outside of parastyle to inside of protocone.

all characters, but the premolars appear to be slightly advanced over those of the type. They are somewhat larger relatively, and the lingual portion is relatively wider. In this respect there is some approach to *Telmatherium validus*, the most advanced species of the genus, known only from Bridger D. In all, however, agreement is closer to *Telmatherium cultridens* from Bridger C or D. The differences from this species are not more than would be expected as individual variations.

***Manteoceras manteoceras* Hay**

A right lower jaw with P_4 - M_3 (U.W. No. 1291) from locality 5 and a complete P^2 (U.W. No. 1441) from locality 3 are referable to this species.

TABLE 13

MEASUREMENTS (IN MILLIMETERS) OF TEETH OF
Manteoceras manteoceras

P^2	
Length	18.4
Width	13.1
P_4	
Length	19.4
Width	13.6
M_1	
Length	26.0
Width	18.0
M_2	
Length	31.2
Width	22.0
M_3	
Length	45.1 approx.
Width	24.0 approx.

The jaw is smaller than the smallest known *Telmatherium* jaw and probably is too large to represent a species of *Mesatirhinus*. It fits well within the size range of jaws of *Manteoceras manteoceras*, and, although most detailed characters of the dentition are obscured by wear, it agrees well with specimens of this species from the upper Bridger.

The P^2 agrees well in size and structure with that tooth in *Manteoceras manteoceras*.

RHINOCEROTIDAE

***Hyrachyus cf. eximius* Leidy**

Three specimens from the Bridger formation of the Tabernacle Butte area are referable to *Hyrachyus* and somewhat doubtfully

to *Hyrachyus eximius*. U.W. No. 1436, a left lower jaw with P_3 - M_3 , is from locality 5, and U.W. No. 1438, a maxillary and premaxillary with I^2 , C, and P^1 - M^3 , along with U.W. No. 1437, an isolated M_3 , is from locality 6.

The measurements of the teeth of these specimens correspond closely with the measurements of *Hyrachyus eximius*, as de-

TABLE 14

MEASUREMENTS (IN MILLIMETERS) OF TEETH OF
Hyrachyus cf. eximius

Upper teeth	
P^1 - M^3 , length	107.1
P^2 - M^3 , length	98.0
P^1 - I^2 , length	48.6
P^2 - I^2 , length	39.4
M^1 - I^2 , length	61.7
Diastema, length	38.0
P^1 , length	10.1
P^2	
Length	11.9
Width	13.5
P^3	
Length	13.9
Width	19.6
P^4	
Length	15.3
Width	22.0
M^1	
Length	20.5
Width	25.6
M^2	
Length	22.0
Width	27.8
M^3	
Length	23.8
Width	27.0
Lower teeth	
M_1 - I_3 , length	65.1
P_3	
Length	14.0
Width	10.2
P_4	
Length	15.0
Width	12.3
M_1	
Length	19.5
Width	13.1
M_2	
Length	22.7
Width	13.9
M_3	
Length	24.4
Width	13.0

scribed by H. E. Wood (1934), and only with that species.

The upper teeth are so heavily worn that detailed characters of the teeth are obscured. As far as can be determined, however, they agree perfectly with the teeth of *Hyrachyus eximius*.

The teeth of the lower jaw, although little worn, occlude perfectly with those of the upper, and there is little doubt that the two specimens represent the same species. The lower molars agree well with those of *Hyrachyus eximius*, but the premolars are quite definitely more advanced. P_3 has a strong postero-internal cingular shelf but no distinct entoconid. On P_4 is a low, but distinct, entoconid. H. E. Wood (1934) described the talonid of P_4 of the type of *Hyrachyus eximius* as "a nearly simple, antero-posterior blade, without trace of an entoconid or of a postero-internal cingulum." It is possible that this difference is of such magnitude that the Tabernacle Butte specimens should be described as a new species. It might, however, be considered as a variant, as I prefer, until additional specimens are available for study.

The astragalus from the Morrow Creek is not specifically identifiable.

ARTIODACTYLA

PAUL O. MCGREW

CHOEROPOTAMIDAE

Helohyus validus Marsh

Jaw fragments with right P_4 and M_{2-3} and left P_1 and M_{1-2} (U.W. No. 1439), all representing one individual, were found at locality 1. Another jaw fragment (U.W. No. 1440) with right M_1 was found at locality 8. Both appear to represent the same species and are

TABLE 15
MEASUREMENTS (IN MILLIMETERS) OF TEETH OF
Helohyus validus

P_3		
Length		7.9
Width		4.0
M_1		
Length		8.5
Width		5.8
M_2		
Length		9.1
Width		7.3
M_3		
Length		10.8
Width		6.9

referable to *Helohyus validus*. *Helohyus validus* and *Helohyus plicodon* are very similar species, but differences can be detected between Marsh's types of the two forms. The differences are not great, and without larger collections it is not possible to be sure that the species are distinct. If both are valid, our specimen clearly belongs with *Helohyus validus*. The type of this species differs from the type of *Helohyus plicodon* mainly in minor details of M_3 . The hypoconulid is connected by low ridges to the entoconid and hypoconid. In *Helohyus plicodon* these ridges are not complete. In M_1 of *Helohyus validus* a ridge extends obliquely forward from the hypoconid to the middle of the posterior slope of the trigonid. This ridge does not appear in the type of *Helohyus plicodon*. P_4 of *Helohyus validus* is shorter and wider than that tooth of *Helohyus plicodon*.

The specimen from locality 8 is of an old individual, and details of tooth structure are obscured by wear. It appears to agree well in all proportions with *Helohyus validus*.

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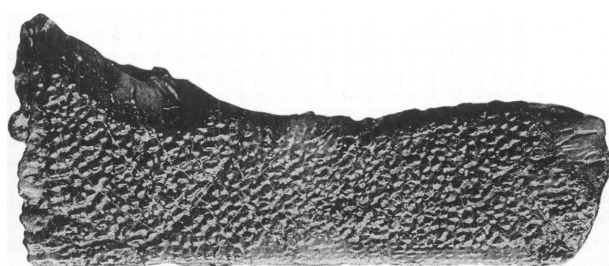
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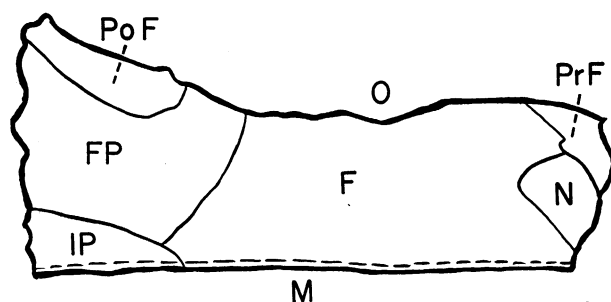
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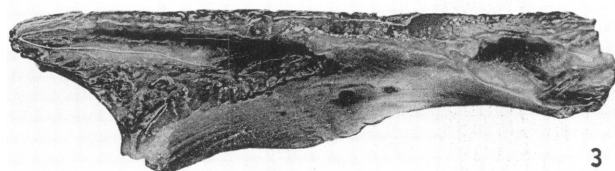
1-3. Type of *Eorhinophrynus septentrionalis*, A.M.N.H. No. 3818, atlas. 1. Dorsal view (right, anterior). 2. Anterior view (top, dorsal). 3. Ventral view (right, anterior). 4, 5. *Parasaniwa* sp., A.M.N.H. No. 3820, fragment of left maxilla. 4. External view. 5. Internal view. 6, 7. *Saniwa* sp., A.M.N.H. No. 3814, incomplete dentary. 6. External view. 7. Internal view. All $\times 8$



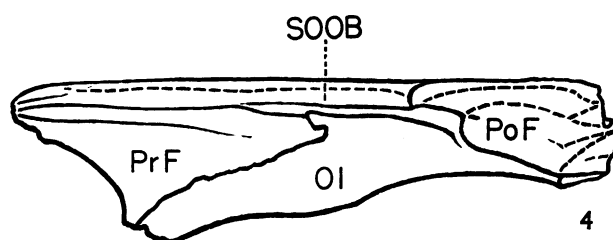
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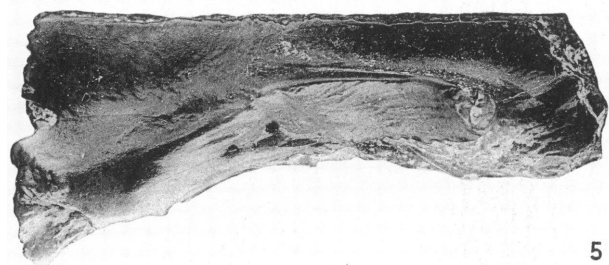
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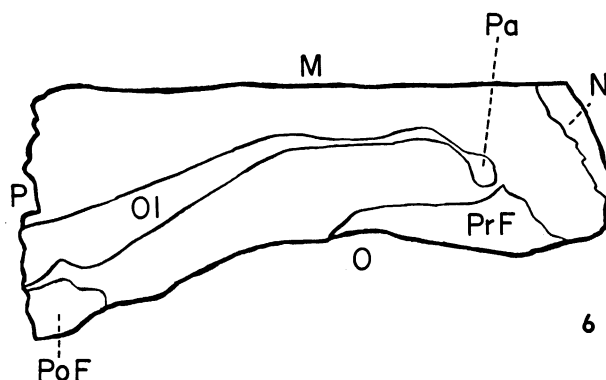
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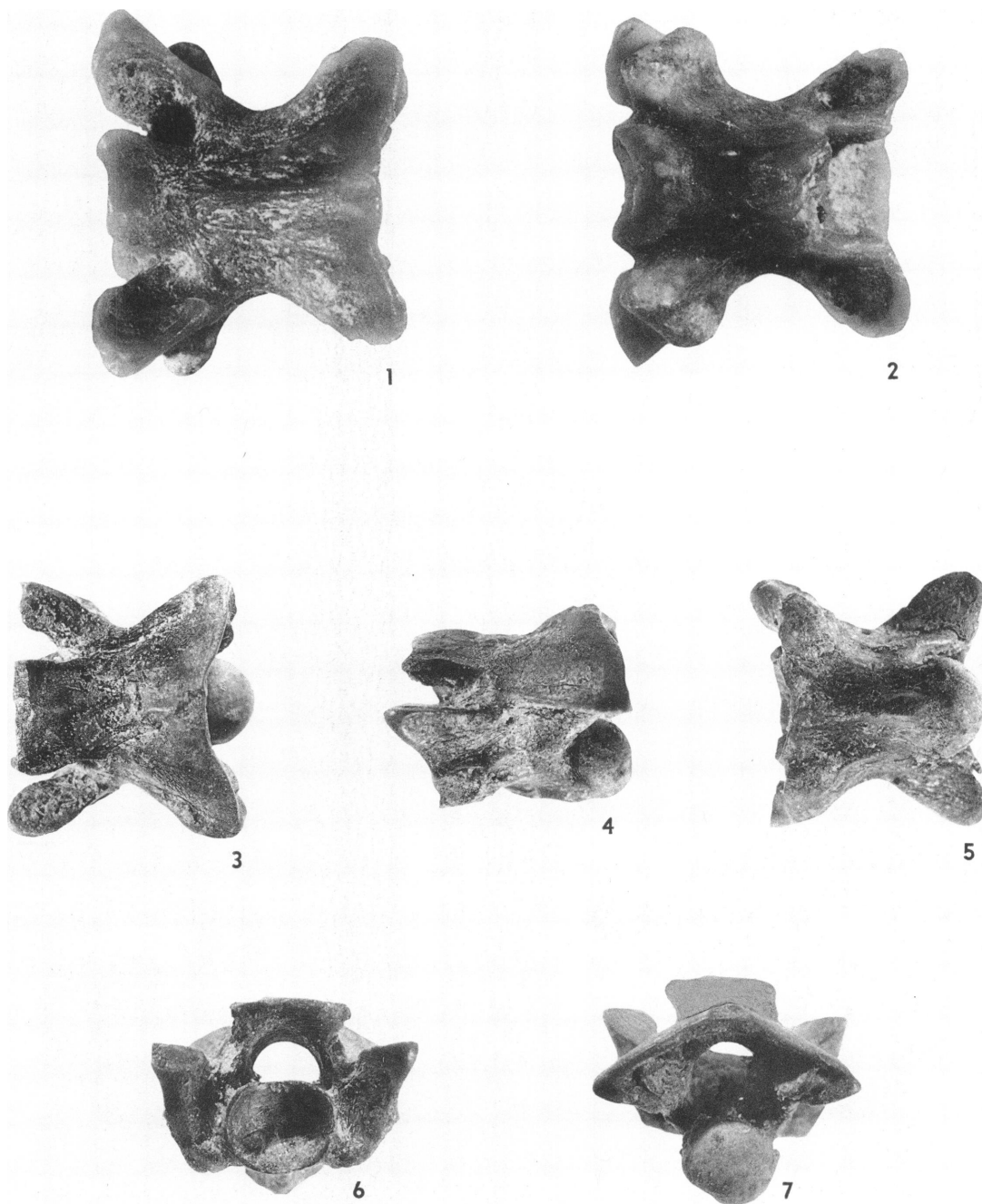


6

Type of *Dimetopisaurus wyomingensis*, A.M.N.H. No. 3819, frontal bone. 1. Dorsal view. 2. Diagram of dorsal view. 3. Lateral view. 4. Diagram of lateral view. 5. Ventral view. 6. Diagram of ventral view. Abbreviations: F, frontal scute area; FP, frontoparietal epidermal scute area; IP, interparietal epidermal scute area; M, metopic suture; N, nasal incision; O, orbital border; Ol, olfactory process; P, frontoparietal suture; Pa, articulation for palatine bone; PoF, postfrontal incision; PrF, prefrontal incision; SOOB, groove for supraorbital osteodermal bones. $\times 4$



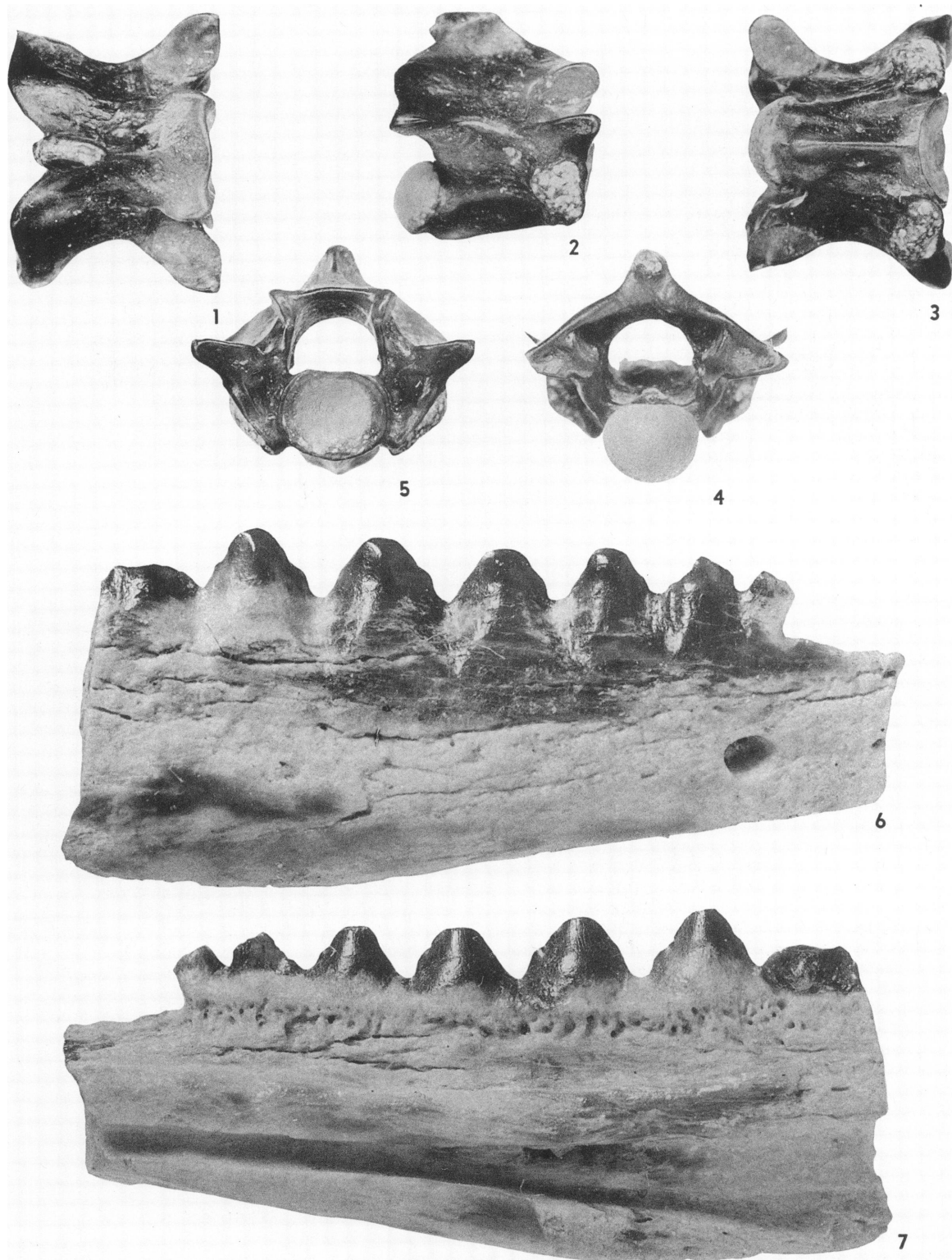
Type of *Coniophis carinatus*, new species, A.M.N.H. No. 3826, thoracic vertebra. 1. Dorsal view. 2. Ventral view. 3. Lateral view. 4. Anterior view. 5. Posterior view. All $\times 8$



1, 2. Type of *Coniophis platycarinatus*, new species, A.M.N.H. No. 3827, thoracic vertebra. 1. Dorsal view. 2. Ventral view, with condyle broken off

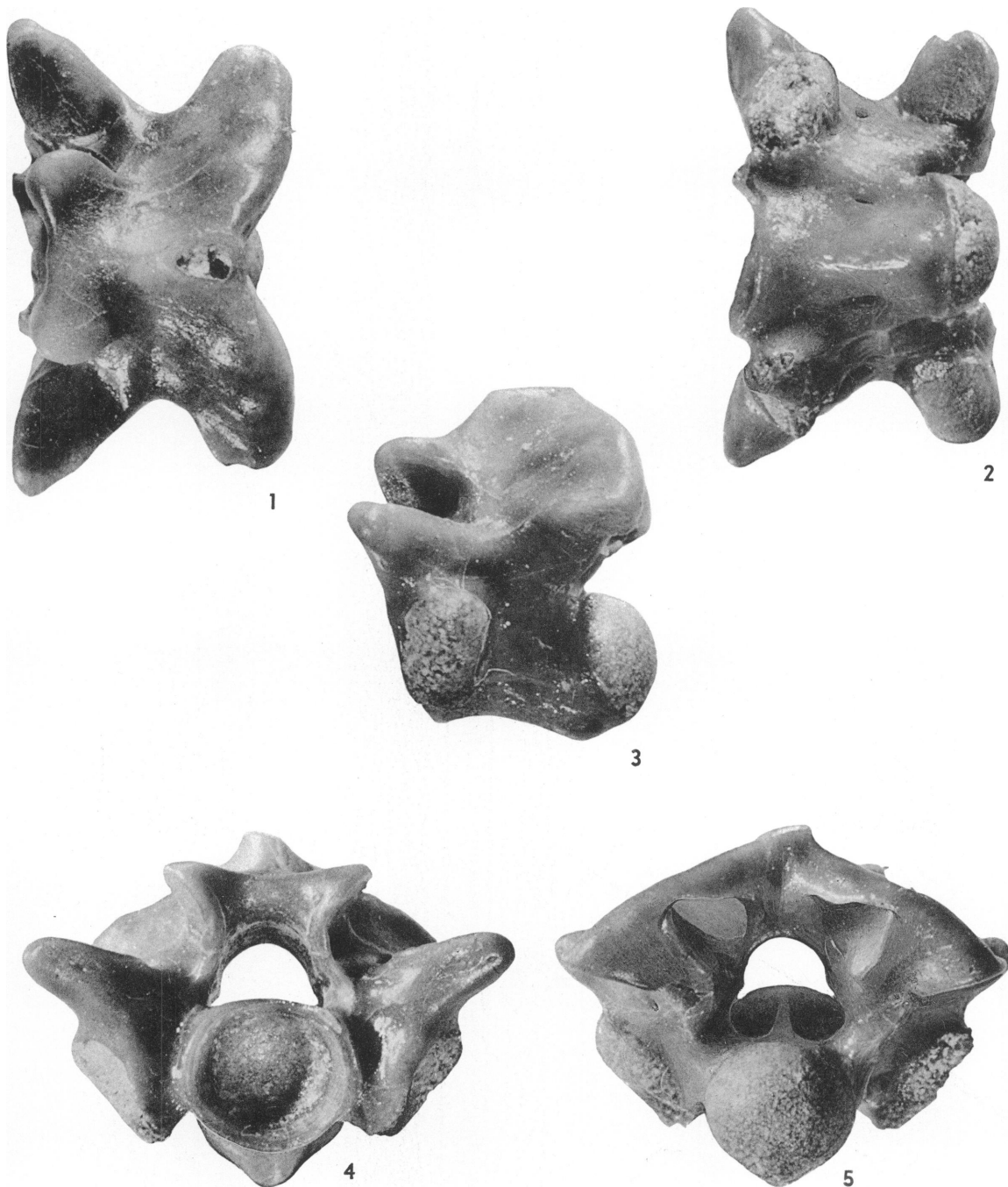
3-7. Type of *Coniophis precedens* Marsh, U.S.N.M. No. 2134, thoracic vertebra. 3. Dorsal view. 4. Lateral view. 5. Ventral view. 6. Anterior view. 7. Posterior view

All $\times 8$

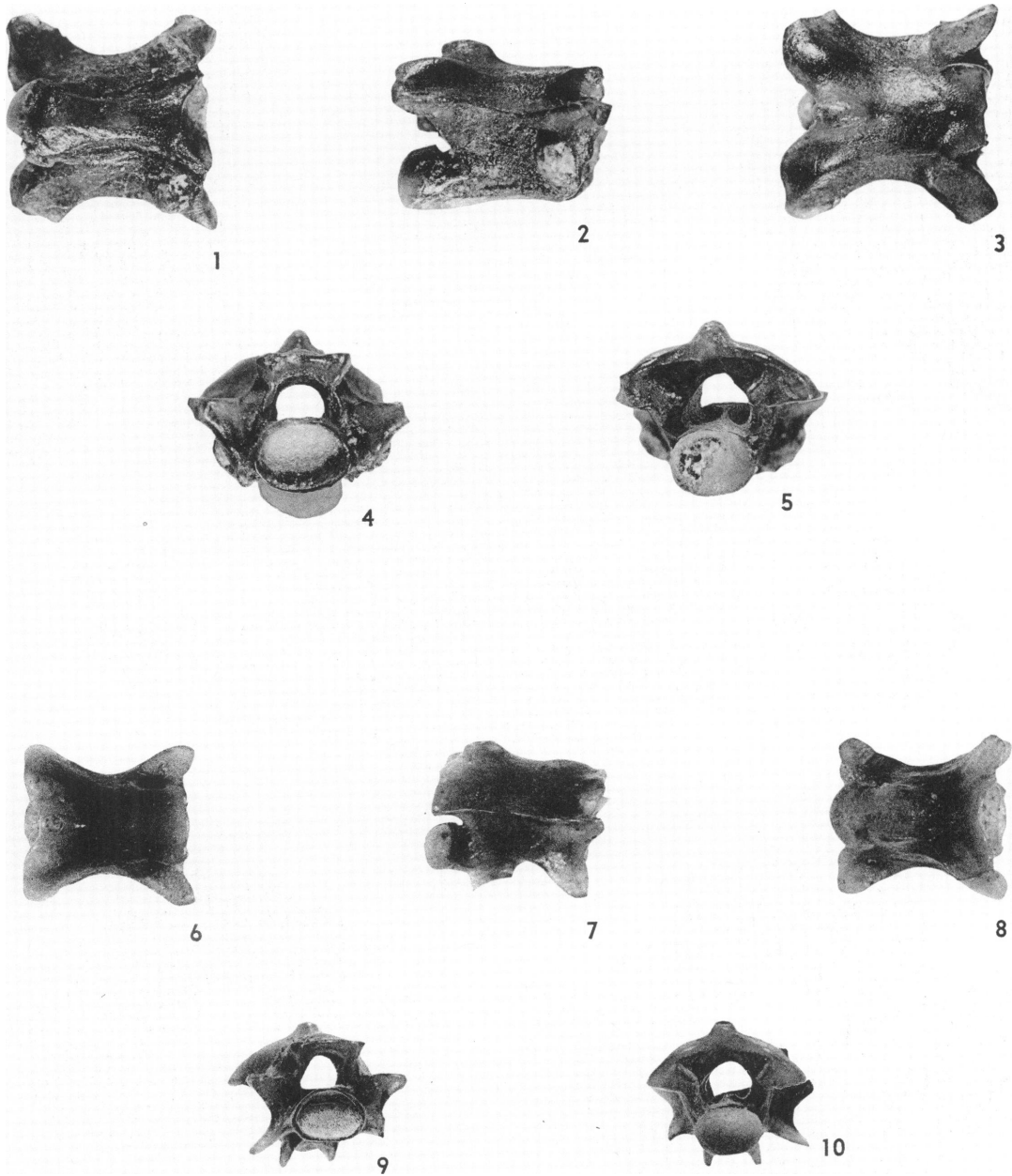


1-5. Type of *Calamagrus primus*, new species, A.M.N.H. No. 3828, thoracic vertebra. 1. Dorsal view. 2. Lateral view. 3. Ventral view. 4. Posterior view. 5. Anterior view. 6, 7. *Thinosaurus stenodon* Marsh, A.M.N.H. No. 3823, incomplete dentary. 6. External view. 7. Lingual view.

All $\times 10$

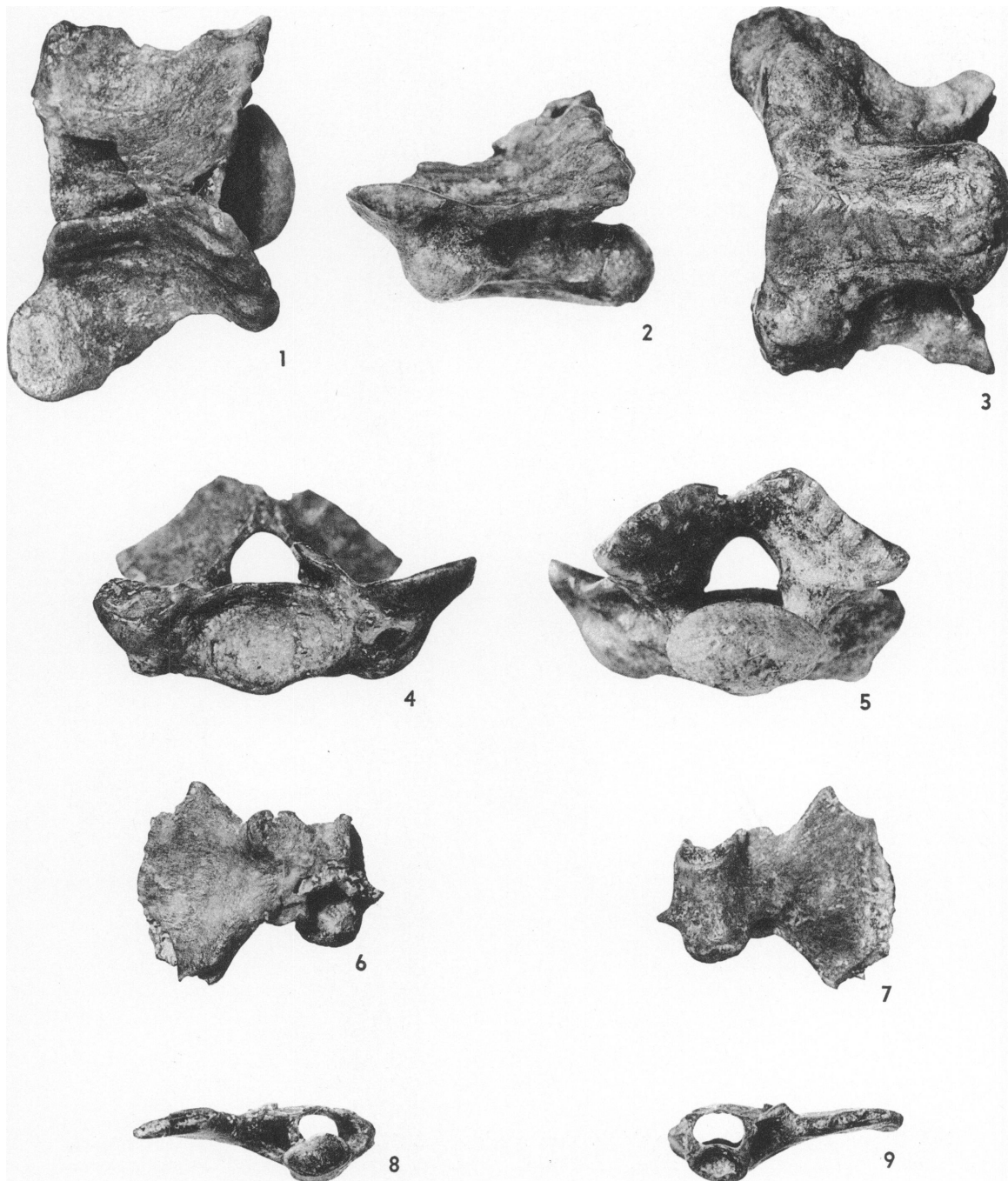


Type of *Paraepicrates brevispondylus*, new species, A.M.N.H. No. 3829, thoracic vertebra. 1. Dorsal view. 2. Ventral view. 3. Lateral view. 4. Anterior view. 5. Posterior view. All $\times 8$



1-5. Type of *Dunnophis microechinis*, new species, A.M.N.H. No. 3830, thoracic vertebra. 1. Ventral view. 2. Lateral view. 3. Dorsal view. 4. Anterior view. 5. Posterior view. All $\times 8$

6-10. *Dunnophis microechinis*, A.M.N.H. No. 3831, caudal vertebra. 6. Dorsal view. 7. Lateral view. 8. Ventral view. 9. Anterior view. 10. Posterior view. All $\times 10$



1-5. *Lestophis anceps* Marsh, A.M.N.H. No. 3824, thoracic vertebra. 1. Dorsal view. 2. Lateral view.
 3. Ventral view. 4. Anterior view. 5. Posterior view
 6-9. Pelobatid sacrum, A.M.N.H. No. 3832. 6. Dorsal view. 7. Ventral view. 8. Posterior view.
 9. Anterior view
 All $\times 6$

