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Charles D. and Mary Vaux Walcott
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(With 1 Plate)

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EARLY CENOZOIC VERTEBRATES IN THE RED CONGLOMERATE AT GUANAJUATO, MEXICO[1]

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INTRODUCTION

Most of Mexico's mineral deposits are scattered over the high central plateau country that extends from the Sierre Madre Oriental westward to the Sierra Madre Occidental and from the United States border southward to the Sierra Madre del Sur. The principal ore bodies in this region are in either Mesozoic rocks, nonmarine Cenozoic rocks, or both, and are apparently of Cenozoic age. One of the great problems in studying these ore deposits is the lack of any Cenozoic time marker earlier than middle Pliocene for the nonmarine deposits between the United States border and the northern part of South America, with the consequent difficulty in correlating Cenozoic rocks

[1] The authors deeply appreciate the cooperative assistance received during the course of the project here reported from the administrations of the Instituto Nacional para la Investigación de Recursos Minerales and the Instituto de Geología of Mexico. They are grateful also to Drs. Doris M. Cochran and C. Lewis Gazin, U. S. National Museum; Dr. Joseph T. Gregory, Peabody Museum, Yale University; Dr. George Gaylord Simpson, American Museum of Natural History; and Dr. Edward H. Taylor, University of Kansas, for generous permission to study specimens under their care. Dr. Robert W. Wilson, University of Kansas Museum, has given numerous especially pertinent suggestions in the study of the rodent and has kindly read that part of the manuscript pertaining to it. Thanks are also extended to Drs. E. H. Colbert, John A. Dorr, Jr., C. L. Gazin, George Haas, G. E. Lewis, E. H. Taylor, and T. E. White for various helpful criticisms.

The illustrations of the rodent were made possible by the financial support accorded to Hibbard by the Board of Governors of the Horace H. Rackham School of Graduate Study of the University of Michigan.

from place to place, and learning the age of different periods of faulting, intrusion, and metallization.

The western part of the Mexican plateau has been a land mass since early Mesozoic time or before; the southern and eastern parts were covered by the sea as recently as late Cretaceous time. The lower Mesozoic rocks consist largely of sandstone and shale, now strongly metamorphosed. The middle Mesozoic rocks (late Jurassic and early Cretaceous) are mainly limestone, and upper Cretaceous rocks are largely shale. All these rocks were strongly folded, faulted, intruded by igneous bodies, and eroded before the earliest nonmarine Cenozoic rocks were deposited.

The rocks of earliest Cenozoic age in the plateau region are generally reddish clastics composed largely of eroded Mesozoic rocks and, in smaller part, of pene-contemporaneous volcanic materials, except locally where the volcanic rocks predominate. A few of the outcrop areas of these clastics are shown in figure 1. The youngest rocks on which these clastics rest are strongly folded, intruded, and eroded marine sediments of latest Cretaceous age. The clastics are in turn intruded, faulted, and strongly tilted, but they are not folded except perhaps as very broad, broken arches. They are overlain by volcanic rocks and interbedded clastic rocks, which reach great thicknesses locally. These latter rocks are in turn overlain by middle and upper Pliocene conglomerates and volcanics. All these younger overlying rocks are affected by normal faulting, but they are only slightly tilted locally, in marked contrast to the structure of the older clastic rocks.

BACKGROUND OF THE RED CONGLOMERATE STUDY

As part of the cooperative scientific and technical assistance program of the United States Government, geologists of the U. S. Geological Survey in collaboration with geologists of the Instituto Nacional para la Investigación de Recursos Minerales and the Instituto de Geología of Mexico have for some years been mapping red clastic deposits of early Cenozoic age incidental to mineral-district studies. In 1949 John D. Edwards began field work on a study of the deposits of red clastic rocks with the encouragement and counsel of personnel of the Survey and the Instituto de Geología. Brief investigations were made at Zimapan, Guanajuato, Zacatecas, and Taxco, all mining districts that have been exploited actively for more than three centuries. During that field season the need was recognized for a more intensive study and fossil search in at least one of these areas, preference being given to the Guanajuato area because of its relatively large extent.

The Instituto de Recursos Minerales provided the services of Gustavo Ortiz as a geologic assistant to Edwards in the summer of

FIG. 1.—A few early Cenozoic red conglomerate localities in Mexico.

1950. Major effort was directed to the red conglomerate outcrop area in the Guanajuato district, with the principal objectives of learning the depositional environment of the conglomerate and searching for fossil remains. This search was rewarded by the discovery of some bone fragments in silty beds in the lower part of the conglomerate, but the material was unfortunately not diagnostic enough to permit a close age assignment. The results of the two summers of field work have been summarized in a manuscript submitted to the Geological Survey and the Instituto de Recursos Minerales, covering the Guanajuato, Taxco, and Zacatecas areas, which is being prepared for publication as a chapter in Professional Paper 264 of the U. S. Geological Survey.

SKETCH OF THE GEOLOGY AT GUANAJUATO

The following résumé of the pre-Cenozoic rocks and the somewhat detailed description of the red conglomerate and overlying rocks are partly abstracted from the unpublished report by Edwards on the Guanajuato area and are partly the result of observation and interpretation by Fries over a decade during which he visited the area a number of times. The Guanajuato area, as shown in figure 1, is near the geographic center of Mexico and near the midline of the high plateau. Mining has been carried on there along the Veta Madre gold-silver lode for about four centuries. The ores are in a fault zone trending northwest, whose southwest side has apparently been downthrown more than 1,500 meters (see fig. 2). The northeast side of the fault is composed of metamorphosed sediments (*mes* in fig. 2), mainly phyllites, and some igneous intrusive rocks. These sedimentary rocks are believed to be in part of Triassic age, because of their lithologic similarity to rocks in the Zacatecas mining district where some poorly preserved Triassic fossils were found by Burckhardt and Scalia in the early part of the present century. Edwards and Ortiz found fragments of limestone in the overlying conglomerate of Cenozoic age that contained lower Cretaceous fossils, and hence the area of pre-Cenozoic rocks (*mes*) must have contained outcrops of early Cretaceous limestone and probably some Jurassic sediments as well. The southwest side of the fault is composed of red conglomerate of Cenozoic age, which is the host rock to most of the ore in the district and also to the vertebrate fossils described in this paper.

All the exposed contacts of the red conglomerate with the older, underlying rocks are faults, and hence the complete thickness of the formation and the lithology of the basal part are not known. Edwards has estimated the thickness to be at least 1,500 meters and probably nearer 2,000 meters. The conglomerate is preserved because it has been faulted down to depths where it has been protected from erosion. The formation may be divided into three principal parts; the first two parts are grouped into one in the map in figure 2. The lowest part visible consists largely of layers of andesitic and basaltic tuff, breccia, and lava, interbedded with tuffaceous sandstone of different colors (*Teoc* in fig. 2). These beds grade upward into beds of sandstone, siltstone, and fine-grained conglomerate (also *Teoc*)

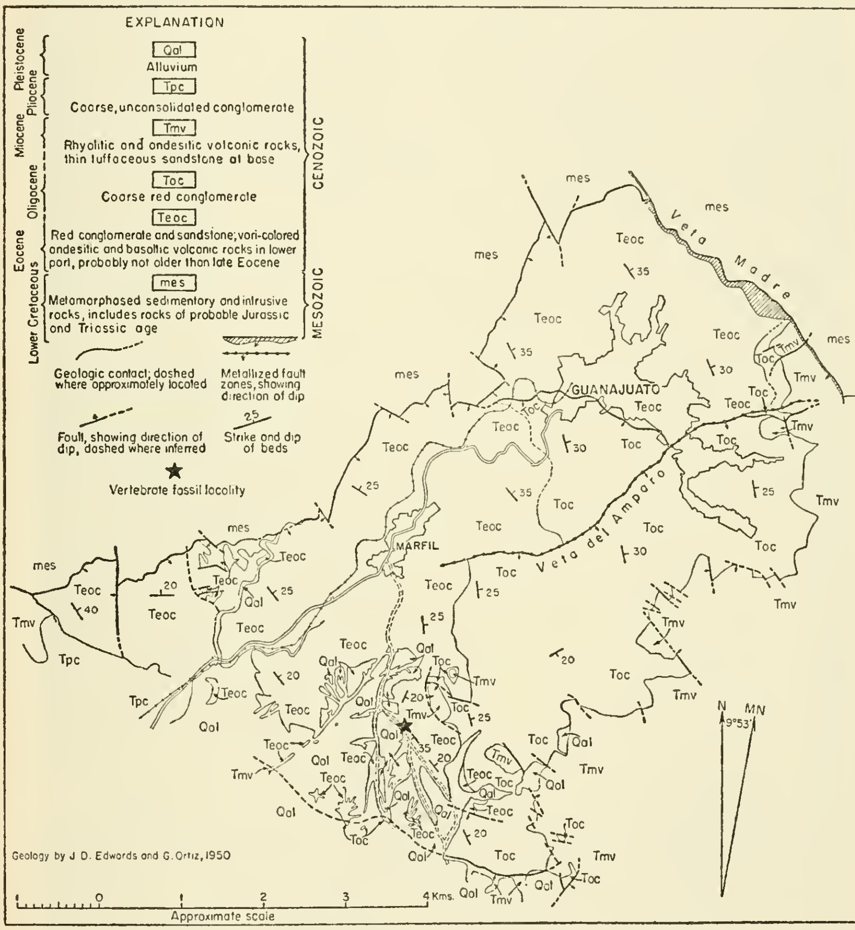

FIG. 2.—Geologic map of red-conglomerate outcrop area at Guanajuato, showing vertebrate fossil locality.

of a predominantly reddish hue. A disconformity separates these beds from overlying coarser grained conglomerates (*Toc*), which are also dominantly reddish.

Nearly two-thirds of the pebble-size or larger constituents of the conglomerate consist of fragments of volcanic rocks, mainly rhyolite and latite, in contrast to the andesitic volcanics in the lower part of the formation. The remainder of the coarse clastics consists largely of limestone, chert, and granitic and dioritic rocks in varying proportion. The matrix is in part tuffaceous but contains also a reddish residual soil formed in the source area and carried with the coarser debris down into the basin of deposition. This reddish color is characteristic of these early Cenozoic clastic deposits. It apparently is the product of weathering in the upland areas of that time, where probably moist temperate climates prevailed, and was preserved by rapid accumulation and burial in drier lowlands formed by active downfaulting. The formation is in strong angular discordance with the Mesozoic rocks and has itself been broken by faults into many wedge-shaped and irregular blocks, which dip generally between 20° and 35° to the northeast, except adjacent to faults. Inasmuch as the conglomerate was derived from a high area to the northeast, the present strong dips are the reverse of the originally low dips to the southwest.

The conglomerate passes abruptly into thin-bedded tuffaceous sandstone (*Tmv* in fig. 2), which was apparently deposited nearly horizontally over a broad area. The sandstone shows crossbedding and ripple marks and seems to have been deposited on a flood plain. The beds aggregate from 20 to 40 meters in thickness, decreasing from northeast to southwest, and pass abruptly upward into massive beds of what may be devitrified, rhyolitic welded tuffs. These are followed by a thick sequence of normal tuffs, breccias, and some lava flows, intercalated with a few thin beds of conglomerate. An angular and erosional unconformity separates these volcanic rocks from overlying poorly consolidated pale-yellowish to grayish conglomerate (*Tpc*), which, by lithologic, structural, and stratigraphic similarity to conglomerate in the Lajas River Valley to the northeast and to other conglomerates in Guanajuato, Hidalgo, and Mexico State, is believed to be of middle and late Pliocene age. Thin fine-grained clastics (*Qal*) rest unconformably upon the conglomerate of Pliocene age.

HISTORY OF THE FOSSIL DISCOVERIES

Vertebrate remains were found by J. D. Edwards and G. Ortiz in August 1950 in the red conglomerate about 2,000 meters south of the town of Marfil (see fig. 2) in thin beds of poorly consolidated reddish-brown sandstone and bentonitic siltstone dipping about 35° to the southwest. The direction of dip in these beds is the reverse of the general dip of the conglomerate and is probably due to drag along

View at fossil vertebrate locality, looking west, showing thin-bedded, reddish-brown, silty and sandy clays in the lower part of the red conglomerate at Guanajuato. Beds trend northwest and dip 35° southwest.

a nearby small fault. Edwards and Ortiz pointed out the locality to Fries late that same month, and by several hours of further examination Fries found some rostral parts of a tiny rodent and a fragment of jaw bone with two minute cheek teeth. In transporting the materials and cleaning them for transmittal for study, the fragment with the cheek teeth was unfortunately destroyed. The rest of the material was examined in the winter of 1950-51 but was not found to be diagnostic enough for an age assignment.

The urgent need for assigning an age to the conglomerate stimulated a continued search of the beds for additional fossil materials. Fries revisited Guanajuato in the spring of 1951 without success. Edwards returned to the locality in October 1951 to finish up some mapping details and to look for more fossils but found nothing of diagnostic value. Another trip to the area was made by Fries in March 1952. Accompanied by Kenneth Segerstrom, of the Geological Survey, he was this time fortunate in finding other parts of skulls and jaws of a rodent with cheek teeth. This new material was picked up at a point some 15 meters from the first find in beds perhaps 3 meters higher in the section. Finally, Mr. Segerstrom and several associates guided the junior author Dunkle to the locality in October 1952, on which occasion the lizard specimens herein described and some few additional rodent bones were obtained at widely scattered and undetermined levels in the exposures.

The rodent material recovered by Fries in 1952 was submitted to Hibbard for study, and at about the same time the Instituto de Geología sent the original Edwards specimen to R. A. Stirton, of the University of California, for an independent opinion as to its identity. Stirton indicated that the remains probably belonged to an artiodactyl of the family Merycoidodontidae, suggesting an early Cenozoic age. The establishment of the early Cenozoic age of the beds, within relatively narrow limits, has been based primarily on Hibbard's study of the rodent remains. The lizard specimens have been studied by Dunkle but, because of the meager fossil record of the Lacertilia, have proved to be of slight use as time indicators. A brief note on the discovery of the fossils and their significances was published by Arellano (1952) in Mexico.

DESCRIPTION OF THE FOSSIL-BEARING BEDS

The beds in which the fossil remains have been found are shown in the photograph in plate 1. They are composed of reddish-brown mudstone consisting mainly of silt with some sand; they are generally less than 3 centimeters thick. Some of these beds have an upper layer of clay a few millimeters thick, and some of these clay layers were broken into curved fragments or flakes by drying before the next layer of silt was deposited. This indicates that the area consisted of a mud flat that was subject to intermittent flooding and drying at the time the vertebrate remains were buried. The material seems to be bentonitic, for it is firm and hard when dry but swells and then completely disintegrates when placed in water. Each rainstorm therefore washes away a thin surface layer and exposes fresh material for fossil search. Some thin calcite veinlets cut through the beds in different directions, and small calcareous nodules are present though rare. From the fragmentary nature of the fossil remains, it appears that the bones must have been washed into their position of burial. The remains may not have been transported very far, but probably far enough to cause dismemberment of the skeletons and scattering and partial destruction of the bones. No plant remains were noted in any of the nearby beds.

SIGNIFICANCE OF THE FOSSIL DISCOVERY

The composition and structure of the lower Cenozoic marine sediments along the coastal plain some 250-300 kilometers east of Guanajuato city indicate, according to Muir (1936, p. 140), that the compressive phase of the Laramide orogeny took place there principally in middle Eocene time. He indicates that movements had either decreased in intensity or nearly ceased by late Eocene time, although they continued on a reduced scale until latest Oligocene time when relative stability was reached. Fries had felt that the earliest Cenozoic reddish nonmarine clastics on the plateau were deposited soon after the culmination of the compressive stage of the Laramide orogeny, but no fossil record for dating these clastics was on hand until the material described in this report was discovered. The late Eocene or early Oligocene age assigned to these fossils from the red conglomerate near Guanajuato permits for the first time a correlation between the orogenic history as far west as Guanajuato and that along the Gulf coast east of there, indicating that the major compressive orogeny inland had been effected also by late Eocene time. We do not yet know how early the folding took place farther inland, but at least in the eastern part of the State of Querétaro, halfway between Guanajuato and the coastal plain, shales of late Maestrichtian age were affected by the strong folding. We also now know that gentle folding and strong faulting and tilting of fault blocks continued on the plateau through Oligocene time, just as strong movements contined through Oligocene time in the coastal country.

The fossil discovery also indicates that the great bulk of the volcanic rocks in the central part of the Mexican plateau are probably of late Oligocene and Miocene age, for these rocks are conformable with the upper part of the red conglomerate and are separated by strong faulting and a period of erosion from the next younger rocks, which are conglomerates and fine clastics known to be of middle and late Pliocene age. The great masses of tin-bearing rhyolite distributed over the plateau region of Mexico, as for example to the northeast of Guanajuato city, are almost surely of Miocene age rather than of Pliocene age as generally presumed up to now. The discovery will help to determine the age of faulting, intrusion, and metallization in many of the mining camps in the plateau country of Mexico.

Class REPTILIA

Order Squamata

Family IGUANIDAE

PARADIPSOSAURUS Fries, Hibbard, and Dunkle, new genus

Genotype.—Paradipsosaurus mexicanus.

Diagnosis.—Skull elevated and of broad, robust construction. Snout deep without prominent nasolachrymal cristae; and external nares opening forward. Parietal plate broad with only shallow lateral embayments by the wide supratemporal fossae. Pineal foramen in advance of the parietofrontal suture. Postfrontal small but distinct; postorbital with long, ventrolateral expansion; and maxillary longer than deep and excluded from contact with the frontal by articulation between the nasal and prefrontal. Coronoid projecting high above the dorsal margin of the mandible and, in lateral aspect, with both the anteroventral and posteroventral angles somewhat produced. Splenial extended forward to the symphyseal region and completely covering the Meckelian groove. Dentition pleurodont; individual teeth relatively large and few in numbers; each with a laterally situated, longitudinal cutting edge, which is vertically wrinkled but noncuspidate, and with the crown slightly widened transversely.

PARADIPSOSAURUS MEXICANUS Fries, Hibbard, and Dunkle, new species

Diagnosis.—The same as for the genus (the only species).

Type.—U.S.N.M. No. 20667, skull and lower jaws, both lacking the anterior and posterior extremities, collected in October 1952 by

D. H. Dunkle. *Referred specimen:* No. I.G.M. 52-139, Instituto de Geología de la Universidad Nacional Autónoma de México; tooth-bearing right maxillary and associated parts of a macerated skull, collected in October 1952 by D. H. Dunkle.

Horizon and locality.—Sandy, nodular masses in red conglomerate, respectively, 2,200 and 2,000 meters south of the town of Marfil, Guanajuato, Mexico.

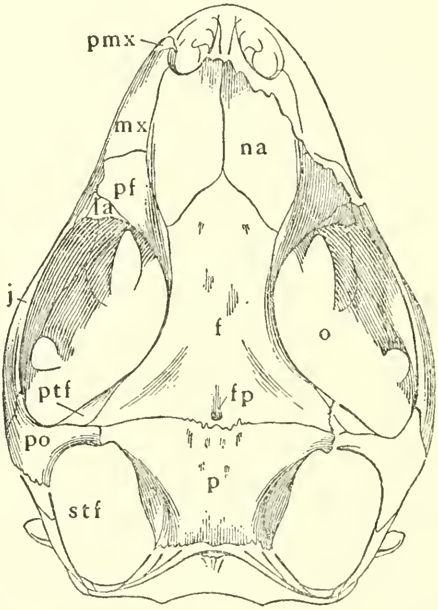

FIG. 3.—*Paradipsosaurus mexicanus,* new genus and species (U.S.N.M. No. 20667). A somewhat restored diagram of the skull in dorsal aspect. Approximately × 3.

Abbreviations: *f,* frontal; *fp,* pineal foramen; *j,* jugal; *la,* lachrymal; *mx,* maxillary; *na,* nasal; *o,* orbit; *p.* parietal; *pf,* prefrontal; *pmx,* premaxillary; *po,* postorbital; *ptf,* postfrontal; *stf,* supratemporal fossa.

Description.—The type skull, which serves as the principal basis for the following description, is only slightly deformed and except for the missing parts noted in its designation above, is exceptionally well preserved. The appearance of the whole cranial complex and the relationships of its component parts are typically lacertilian (illustrated in figs. 3-5).

In dorsal aspect the skull is roughly triangular in outline with bluntly rounded snout and with the greatest observable width occurring in a transverse plane through the posterior halves of the orbits.

Exhibiting only moderate dorsoventral depression, the skull has a quadrangular profile when viewed from the side.

The braincase, because of the hardness of the matrix and consequent danger of damage, has not been completely exposed. Observable, therefore, are only the thoroughly co-ossified bones of the occiput and the ventral cranial basis. The occipital region is badly eroded but articulates loosely with the skull roof above and appears to have had a depth two-thirds its width. The paroccipital processes are indicated to have been short and to have projected outward and slightly forward. When viewed from below, the fused basioccipital and basisphenoid elements comprise a plate of quadrangular outline.

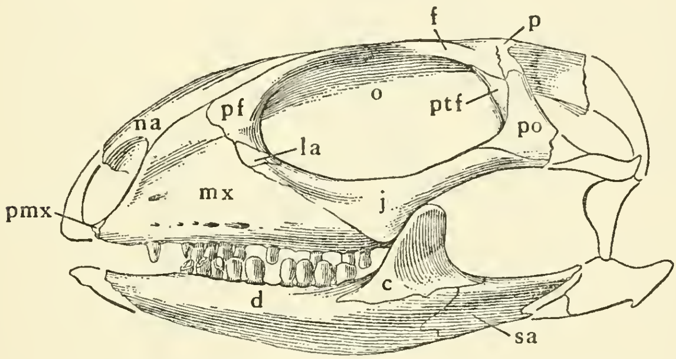

FIG. 4.—*Paradipsosaurus mexicanus,* new genus and species (U.S.N.M. No. 20667). A somewhat restored diagram of the skull in lateral view. Approximately × 3.

Abbreviations: *c,* coronoid; *d,* dentary; *sa,* surangular. (Other abbreviations as in fig. 4.)

A deep emargination on each side separates the anterior basipterygoid processes from the posterior basioccipital processes. The margins of the posterior portion of the plate are strongly produced and the surface of the part is, thus, markedly concave in both sagittal and transverse sections.

The single fused parietal would appear to be approximately one-third wider than it is long. Its dorsal surface is practically flat and shows a faintly rugose texture. This latter surface is sharply delimited by cristae from both the ventrolateral and ventro-occipital laminae. Emargination of the dorsal plate by the supratemporal fossae laterally and by the dorsal body musculature posteriorly is shallow. Posterolaterally the parietoquadrate arch appears to have been well elevated, and the anterior parietofrontal suture is straight.

The frontals are similarly co-ossified, and their maximum width across the posterolateral processes is almost equal to the greatest length of the bone. The pineal foramen pierces the plate just in advance of the parietal border. Low massive olfactory ridges denote a longitudinal groove on the ventral surface. The anteriorly succeeding nasals are large paired elements. Each, in keeping with the forward

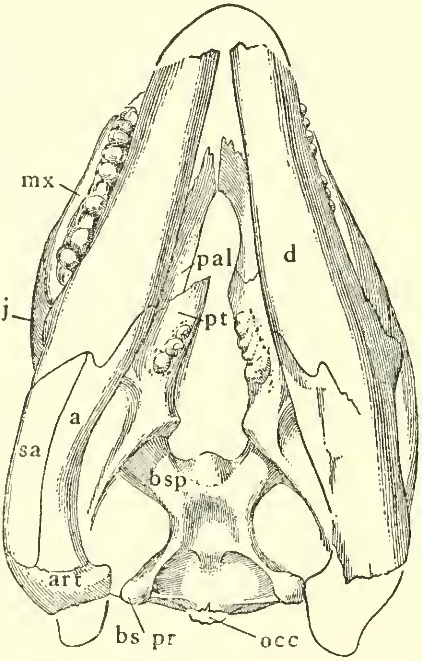

FIG. 5.—*Paradipsosaurus mexicanus*, new genus and species (U.S.N.M. No. 20667). A diagram, somewhat restored, of the skull in ventral view. Approximately × 3.

Abbreviations: *a*, angular; *art*, articular; *bsp*, basipterygoid process; *bspr*, basioccipital process; *occ*, occipital condyle; *pal*, palatine; *pt*, pterygoid. (Other abbreviations as in fig. 4.)

opening nostrils, must have possessed a length fully two and a half times their individual widths. The prefrontals are elongate bones with wide contacts with both the nasals and frontals. However, they do not extend far back over the orbits. Anterolaterally, each element displays a low swelling that continues obliquely across the dorsal lamina of the maxillary to the border of the external nares as an indistinct nasolachrymal ridge. The lachrymals are small. Laterally, they are exposed as low, short slivers of bone between the prefrontals and jugals. Within the orbit they have no greater development and are excluded from articulation with the palatine bones by an interposed contact between the prefrontal and jugal. The vertically elongated lachrymal foramen notches the inner edge of the lachrymal bone and is bounded mesially by the prefrontal.

A distinct postfrontal is present on each side and is a small elongate bone situated at the posterodorsal border of the orbit, articulating with the frontal and postorbital. The latter element is large and triangular with a high, short apex in contact with the frontal and parietal dorsally and with its long expanded base extensively articulating with both the jugal and squamosal ventrally.

The jugals are low curved bones forming the lower border of the orbits. Anteriorly each joins the lachrymal. Posteriorly the bones meet the postorbitals in oblique sutures, which are highest at the orbital margin. It may be assumed also that they are in contact with the anterior extremities of the squamosal posteriorly. A blunt process projects from the ventral margin of the jugal, which is not produced backward as a spur but merely descends to a union with the ectopterygoid behind the posterolateral extremity of the maxillary.

As a result of the incompleteness of the parietoquadrate arch no evidences of the tabular elements are preserved. The osseous tissue of the squamosals has likewise been destroyed by weathering. However, the outline of a portion of the left squamosal is impressed in the matrix and indicates the completeness of the supratemporal arcade. The quadrate possesses a narrow internal flange and a wide external one. Both portions are deeply concave posteriorly and the lateral one is much wider at the top than at the bottom.

Tips of the median dorsal spine and the left posterolateral process are the only remnants of the premaxillary bone preserved. The maxillary is of the customary triangular shape with posteriorly produced alveolar base and high anterodorsal lamina abutting on the nasal and prefrontal.

The right and left halves of the palate are nearly complete. The pterygoids articulate with the dilated and dorsoventrally compressed basipterygoid processes by an elongate facet. Behind this point, the bone thins, becomes vertically inclined, and extends outward and backward to the quadrate region. Anteriorly it is directed parallel to the medial line and arches upwardly to a sutural connection with the palatine. A few relatively large teeth are set in a single row near the inner edge of this forward segment of each pterygoid. Slightly in advance of the neurocranial processes, the elements give off anterolateral maxillary processes to which the incompletely exposed ectopterygoid is joined. Long narrow palatine bones present flattened surfaces in ventral view. The posterior ends of the elements are widely separated and continue the anterodorsal arching initiated by the anterior arms of the pterygoids. Anteriorly the bones become closely apposed in the median line and are decurved to a horizontal position. The maxillary processes of the palatines are short and project almost straight forward from the lateral borders of the bones. The vomers are indicated to be short without posterior extensions and to be narrowly separated by a median longitudinal fossa.

The mandibles are robust structures. From the symphysis, each diverges gradually in a sigmoidal curvature to a maximum separation immediately in front of the quadrate articulation. Most details of the lingual side of the lower jaws remain obscure although it has been ascertained that the splenial bone on either side is a long, low element, extending from the coronoid level to the region of the symphysis, completely covering the Meckelian groove. In external view the coronoid supports a short, high dorsal process, and its ventral margin is produced a moderate distance both anteriorly and posteriorly. The dentary does not extend to the posterior limit of the coronoid bone. Surangular and articular bones are distinct. The posterior angle of the latter is prominent, dorsoventrally flattened, and has a small mesially directed retroarticular process.

In the absence of premaxillaries and the symphyseal portions of the mandibles, no complete dental formulae can be offered. The more complete left maxillary and dentary contain about 16 teeth and alveoli each. The teeth are pleurodont. All are closely set. As preserved, the front and hind teeth appear to be somewhat smaller than the more centrally situated ones of the series. Also, the lower teeth are in some slight degree more robust than the upper. In labial view the crowns appear low. From within, the shafts are of moderate length and hollow at the base. Through anteroposterior compression, the transverse diameter of the teeth is greater than the longitudinal dimension. Apically the crowns are a little dilated also in anteroposterior direction and pinched to a cutting edge that is alined along the longitudinal axis of the jaw above the labial side of the crown. These cutting edges show fine vertical wrinkles in the enamel but are noncuspidate.

MEASUREMENTS OF HOLOTYPE OF PARADIPSOSAURUS MEXICANUS, NEW GENUS AND SPECIES (U.S.N.M. NO. 20667)

	Mm.
Projected horizontal length of skull roof from anteromesial limit of nasal to posteromesial border of parietal	22.0
Projected vertical depth of skull at level of posterior orbital border	14.3
Maximum width of skull across jugals	18.2
Maximum length of frontal	11.0
Maximum width of frontal across posterolateral processes	11.0
Minimum interorbital width of frontal	4.0
Average height of labially exposed tooth crowns	1.1
Average anteroposterior diameter of tooth crowns	1.0
Average transverse diameter of tooth crowns	1.1

Discussion.—In general structure, the presently described skull is essentially iguanid in character (Camp, 1923; Cope, 1892; Gilmore, 1927). Although incomplete and not revealing the method of tooth replacement, the dentition also would appear to be basically of the iguanid type. For the present, therefore, *Paradipsosaurus* is considered an extinct representative of the family Iguanidae.

From comparative study *Paradipsosaurus* would appear to approach more closely to the northern crested lizard *Dipsosaurus* than to any of the other iguanids that presently live in Mexico and the southwestern United States (Smith, 1946; Smith and Taylor, 1950). The most noticeable points of resemblance are: the broad, flat parietal table elevated well above the level of the supratemporal arch; the unrestricted supratemporal fossa; the deep, broad snout without pronounced nasolachrymal ridges; and the forward-opening external nares. These writers have been, as yet, unable to determine whether these and other more detailed osteological similarities denote genetic relationship between *Dipsosaurus* and *Paradipsosaurus* or merely adaptive convergences. Certainly, however, such demonstrable contrasts between the two genera as the dentition and splenial elements, among other differences, are sufficient reasons by current taxonomic criteria for separating the fossil from the living genus.

The oldest recognized lizard remains derive from rocks of late Jurassic age (Romer, 1945). However, they do not become a common component of continental faunas until the late Cretaceous, by which time it may be presumed that most of the major lacertilian categories had appeared. Fossils referred to the Iguanidae are known in every geologic epoch from the late Cretaceous to the Recent. Unfortunately, this family representation is meager in terms of taxonomic entities and collectively displays no progressive morphologic trend into which the unique Mexican form can be fitted. *Paradipsosaurus,* therefore, offers no clue as to the specific age of the sediments from which it was recovered.

Class MAMMALIA

Order Rodentia

Family ISCHYROMYIDAE

Subfamily Sciuravinae

FLORESOMYS Fries, Hibbard, and Dunkle, new genus

Genotype.—*Floresomys guanajuatoensis.*

Diagnosis.—Dentition 1/1, 0/0, 2/1, 3/3; crowns of cheek teeth slightly higher than those of *Sciuravus* and *Taxymys.* P^3 is reduced and pointed. There is no evidence of a cingulum. P^4 is molariform and smaller than M^3. The paracone and protocone, also the metacone and hypocone of P^4–M^2 are distinct and well developed. The paracone and protocone of these teeth are distinctly separated from the metacone and hypocone by a deep transverse median valley. The mesostyle is lacking on P^4–M^3. The teeth have an indistinct basin between the anterocrest and the posterocrest. A true metaconule is absent. A small conule (more properly called a hypoconule) is present at the anteromedian base of the hypocone of P^4–M^3. The lower cheek teeth are lacking a mesoconid and mesostylid. The protoconid, metaconid, hypoconid, and entoconid are distinct and well developed, the basin between the cusps is reduced and the transverse valley is deep, separating the tooth into distinct anterior and posterior parts. The masseteric fossa extends forward as far as the middle of M_1.

FLORESOMYS GUANAJUATOENSIS Fries, Hibbard, and Dunkle, new species

Type.—I.G.M. No. 52-137, Instituto de Geología de la Universidad Nacional Autónoma de México, associated rami, each bearing part of the incisor and P_4–M_3; and the left maxillary bearing P^3–M^3, collected in March 1952, by Carl Fries. *Paratype:* U.S.N.M. No. 20139, fragmentary left ramus bearing P_4–M_3 of a young adult rodent, collected in October 1952 by David H. Dunkle.

Horizon and locality.—Thin sandy silt lens in red conglomerate about 2,000 meters south of the town of Marfil, Guanajuato, Mexico.

Description (fig. 6).—The lower jaws and associated left maxillary are those of a young rodent. P^3 is so greatly reduced that it is not functional at this stage of wear. The surface of its crown is below the base of the anterior cingulum of P^4. P^4, though reduced in size, is molariform. The anterior cingulum is short, connecting with the

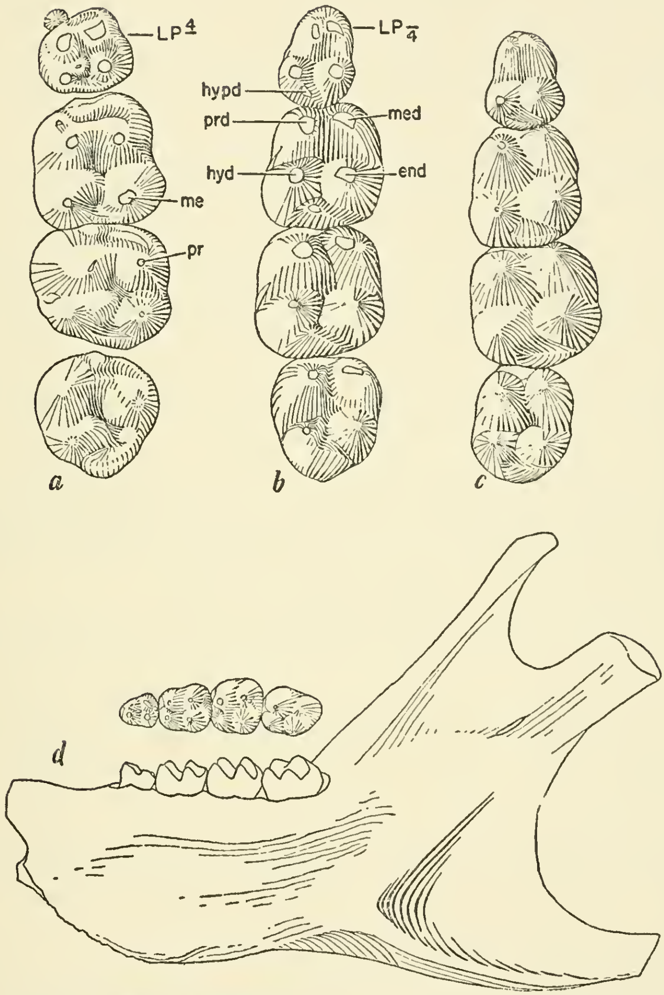

FIG. 6.—*Floresomys guanajuatoensis,* new genus and species. *a,* LP^3-M^3, *b,* LP_4-M_3, occlusal views of type specimen (I.G.M. No. 52-137). × 12. *c,* LP_4-M_3, occlusal view of paratype (U.S.N.M. No. 20139). × 12. *d,* Right ramus, P_4-M_3 (I.G.M. No. 52-137); lingual and occlusal view of type specimen. × 5.

Abbreviations: *end,* entoconid; *hyd,* hypoconid; *hypd,* hypoconulid; *me,* metacone; *med,* metaconid; *pr,* paracone; *prd,* protoconid.

anterior edge of the paracone and passing slightly upward to near the inner base of the protocone. The protocone is larger than the paracone. The occlusal surfaces of the cusps are separated by a very shallow anteroposterior valley. With slight wear a broad, pronounced anterocrest (paracone-protocone crest) would be developed. A distinct transverse valley separates the paracone and protocone from the metacone and hypocone. The valley is slightly deeper on the labial side and broadens between the median edges of the cusps. The metacone is slightly larger than the hypocone and is the size of the protocone. A distinct conule on the anteromedian base of the hypocone helps to close the valley between the hypocone and the metacone. The posterior cingulum is much better developed than the anterior cingulum. It forms a part of the posterior occlusal surface of the hypocone and swings upward, joining the metacone near the lingual edge about midway up the cusp. Between the posterior edge of the accessory conule and the posterior cingulum is a shallow pit. With wear, a broad posterocrest (metacone-hypocone crest) would develop. It appears that with further wear the two crests would join first on the lingual side, giving a broad U-shaped pattern. Then with further wear the crests would soon join on the labial side leaving a shallow enamel pit between the median edges of the cusps.

M^1 is nearly square in outline. It consists of four large distinct cusps, the paracone, protocone, metacone, and hypocone. The anterior cingulum is well developed, and therefore more pronounced than the posterior cingulum. The cingulum joins the paracone at the anterolabial edge and does not reach the occlusal surface of the cusp. The cingulum passes nearly horizontally across the anterior surface of the tooth to join the protocone slightly beyond the midline. Between the cingulum and the anterocrest is a very shallow and narrow valley. The paracone and protocone are but slightly separated in the midline and would soon wear to a broad distinct anterocrest (transverse crest). The transverse valley between the anterior cusps and the posterior cusps is deep. The median valley separating the metacone and hypocone is deeper than that separating the paracone and protocone. With wear, a distinct posterocrest would be developed. The tooth then would develop, with further wear, the same pattern as P^4. If the accessory conule at the anteromedian base of the hypocone is not considered, the protocone is the largest of the cusps of M^1, M^2, and M^3. The posterior cingulum is not pronounced and a shallow pit is between it and the posteromedian bases of the metacone and hypocone. M^2 is the size of M^1 and is like that tooth, except that the hypocone has shifted slightly toward the center of the tooth and gives a slightly rounded appearance to posterolingual corner of the tooth. The accessory conule at the anteromedian edge of the hypocone is larger than that of M^1 and extends well into the transverse valley filling the posterior part of this valley between the median bases of the metacone and hypocone. In wear the anterocrest and posterocrest would join on the lingual side first and a broad U-shaped pattern would exist on M^2 much longer during occlusal wear than on P^4 or M^1 owing to the development of the accessory conule on the hypocone.

M^3 is reduced, posteriorly rounded, and smaller than M^1 and M^2. It is slightly larger than P^4. The protocone is twice as large as either the paracone or hypocone. The metacone is greatly reduced. The paracone joins the protocone by a narrow protoloph. This condition did not exist in P^4–M^2, owing to the large development of the paracone and protocone. In these teeth the median sides of the paracone and protocone join each other. The anterior cingulum of M^3 is well developed. It extends from the anterolabial edge of the paracone to the anteromedian edge of the protocone. A deep valley, deeper than on the other teeth, is present between the cinglum and the anterocrest. The metacone is a low small cusp that closes the labial reentrant valley. The valley narrows rapidly at the midline of the tooth to end abruptly at the base of the large protocone. The lingual part of the transverse valley is closed by the large accessory conule that is developed on the hypocone. Posterior to the small metacone and forming the posteromedian border of the tooth is a cusp larger than the metacone. This cusp is continuous with the metacone. Its base joins the base of the hypocone. It is not so high as the hypocone. The posterior cingulum, which is very short, connects the occlusal surface of the accessory cusp (apparently developed from the cingulum) with the occlusal surface of the hypocone.

The following description is taken from the right lower jaw of the holotype. The diastema between the incisor and P_4 is short, being 2.6 mm. The ramus is noticeably deeper below P_4 than below M_3. There is no pit, depression, or broad shelf between M_3 and the ascending ramus. The dental foramen is situated posteriorly, 4.6 mm. from M_3. It is a narrow, elongated slit. The ventral surface of the angular process forms a distinct shelf. The mental foramen is small and is anterior and ventral to P_4. The masseteric ridge is not pronounced. The masseteric fossa extends anteriorly as far as the middle of M_1. Owing to the fragile condition of the jaw, the matrix has not been removed posterior to M_1 on the labial side. The incisor is rounded ventrally, with the transverse width approximately one-half of the dorsoventral height.

P_4 is rectangular in shape and approximately one-half as wide as M_1. The metaconid is much larger than the protoconid. The protoconid is slightly posterior to the metaconid. The median sides of the two cusps join and will wear to a distinct anterocrest. They are higher than the entoconid and hypoconid, and are separated from them by a broad, deep valley. There is no mesoconid or mesostylid present, nor are these present on M_1–M_3. The entoconid is distinct and well separated from the hypoconid by a narrow valley. The entoconid is as large as the metaconid. The hypoconulid is distinct, and as large as the protoconid. M_1 is smaller than M_2, which is the largest tooth. M_1 is nearly square in outline, being slightly longer than wide. M_2 is square in outline. The cusps are distinctly developed in these two molars, the protoconid and metaconid being separated by a narrow, shallow valley. The hypoconid and entoconid are more distinctly separated. The anterior cingulum is confined to the anterior face of the protoconid. The lingual cusps of P_4–M_3 are higher than the labial cusps, except the entoconid of M_3, which is the same height as the hypoconid. The metaconid and protoconid of M_1 and M_2 would have worn to form a pronounced anterocrest. A distinct hypoconulid is present on M_1 and M_2. M_3 is rounded posteriorly and is the size of M_1. The anterior cingulum is not so pronounced as that of M_1 and M_2. The valley separating the protoconid and metaconid of M_3 is deeper than on M_1 and M_2. This valley is approximately the same depth as the lingual side of the transverse valley on M_3. The hypoconid is large while the hypoconulid is reduced and becomes a part of the posterior cingulum. M_3 would never develop, with wear, the pronounced anterocrest that would be developed on P_4, M_1, and M_2.

The teeth of the left ramus are like those of the right. The posterior part of the left ramus is missing. Both lower jaws were tightly compressed in a small nodule of matrix with the fragmentary maxillary. Parts of the upper incisors are present. They are narrow transversely, and the curvature is circular in outline.

The paratype, U.S.N.M. No. 20139, is a fragmentary left ramus of a young individual. The anteroposterior length of P_4–M_3 is 5.1 mm. The cusps of P_4 and the protoconid of M_1 show evidence of some occlusal wear. Owing to the lack of wear the valley separating the protoconid and metaconid of M_1 and M_2 is much deeper than in the holotype and emphasizes the distinctness of these cusps. The anterior cingulum of M_1 is better developed than that of M_2. The size and shape of the teeth and their cusp development are like those of the holotype.

MEASUREMENTS OF HOLOTYPE (I.G.M. NO. 52-137) OF FLORESOMYS GUANAJUATOENSIS, NEW GENUS AND SPECIES

	Mm.
P^3–M^3, anteroposterior length	5.3
P^4–M^3, anteroposterior length	5.1
M^1–M^3, anteroposterior length	4.3
P^4, greatest anteroposterior length	1.0
P^4, greatest tranverse width	1.0
M^1, greatest anteroposterior length	1.5
M^1, greatest tranverse width	1.5
M^2, greatest anteroposterior length	1.5
M^2, greatest transverse width	1.6
M^3, greatest anteroposterior length	1.5
M^3, greatest transverse width	1.4
Depth of ramus at M_1	4.3
Depth of ramus at M_3	4.1
Distance from incisor alveolus to tip of condyle	7.5
Length of diastema, between incisor and P_4	2.6
P_4–M_3, anteroposterior length	5.33
M_1–M_3, anteroposterior length	4.3
P_4, greatest anteroposterior length	1.1
P_4, greatest transverse width	0.8
M_1, greatest anteroposterior length	1.4
M_1, greatest transverse width	1.2
M_2, greatest anteroposterior length	1.5
M_2, greatest transverse width	1.5
M_3, greatest anteroposterior length	1.4
M_3, greatest transverse width	1.3

The cheek teeth of *Floresomys* appear to be higher crowned than other specimens of sciuravines with which it was compared; this may be due to the small size of *F. guanajuatoensis* and the age of the specimens. The genus is named in honor of Ing. Teodoro Flores, director of the Institute of Geology of the National University of Mexico.

Other specimens.—In August 1950, Fries recovered parts of two fragmentary rami and the anterior part of a skull, Instituto de Geología of Mexico No. 52-136, at the same locality where the holotype was subsequently found. The two fragmentary rami are parts of right lower jaws. The larger consists of the diastemal region, part of the incisor and the alveoli, and roots of P_4. This fragment compares closely in shape and size with the paratype. The incisor is smaller than that of the holotype. The other fragment is like the holotype in the shape and position of the masseteric fossa, the location of the tooth roots, and in the outline of the ramus, except that it is much smaller, with a noticeably smaller incisor. P_4 was 2-rooted, the roots round and long. M_1–M_2 was 2-rooted, with the roots broad transversely. This specimen, owing to its smaller size, may indicate another form present in the deposit.

The skull fragment consists of the rostral region, the premaxillaries, nasals, incisors, and the anterior part of the maxillaries. The upper incisors are the shape of those of the holotype but larger. The rostrum slopes forward from the small infraorbital foramina. The width of the rostrum between the infraorbital foramina is 8.5 mm. The width across the incisors is 6.5 mm. The anterior palatine foramina are anterior and small. They end posteriorly at the suture between the premaxillaries and the maxillaries. The nasals extend 4.2 mm. posterior to the infraorbital foramina. They are long, rectangular in shape, and do not noticeably flare transversely at their anterior tip. The upper incisors are as much larger than the upper incisors of the holotype, as the lower incisor in the fragmentary ramus is smaller than the holotype. From all characters present it appears that the rostral region of the skull belongs to a specimen of *Floresomys* or a closely related form. This rodent very likely grew throughout much of its life like many of the gophers and beavers, and the size difference shown by the fragmentary material is that of individual age.

Discussion.—*Floresomys guanajuatoensis* is placed in the subfamily Sciuravinae on the basis of the distinct cusp development and the reduction of conules (Wilson, 1949, p. 96). *Floresomys* is distinct from the other known genera of Sciuravinae by the presence of the broad deep valleys separating the paracone and protocone from the metacone and hypocone and the metaconid and protoconid from the entoconid and hypoconid, as well as by the absence of a true metaconule, mesostyle, mesoconid, and mesostylid. It is probably more closely related to *Taxymys* than to any of the other genera, but it still represents a distinct line of rodents. Robert W. Wilson, in a letter which clearly expresses the position of the specimen, made the following comment in regard to the holotype: "In many ways this rodent is similar to but somewhat more advanced than *Sciuravus powayensis* of the early late Eocene [on the vertebrate paleontologist's time scale] of southern California. In one presumable fundamental character, however, it is more like *Taxymys* (middle Eocene) than any other described sciuravine. This is the structure of the paracone-protocone crest, which is continuous rather than composed of a short, oblique inner crest, and a largely independent paracone."

Order Perissodactyla

Superfamily Tapiroidea

In August 1950, John D. Edwards found, associated with the rodent fragments, part of the right carpal and metacarpal of a right forelimb, I.G.M. No. 52-4. These were sent by Fries to the U. S. Geological Survey and the following report was made by G. Edward Lewis: "The tapirid specimens consist of fragments, probably associated and even articulated originally. The right unciform, magnum, trapezoid, and fragments of metacarpals 2, 3, 4, and 5 are present. They represent an animal perhaps less than a third the size of the living tapir, with a relatively less splayed out, more slender, and probably longer forefoot. With respect to proportions, this same relation is also applicable between this animal and *Miotapirus* [Miocene of North America] and *Protapirus* [Eocene and Oligocene of Europe, Oligocene of North America]. It is about 60 percent as large as these two genera. In proportions and size it resembles and is about 85 percent as large as *Colodon* [Oligocene of North America] but does not show the latter's tendency toward monodactyly in the third metacarpal."

Ing. A. R. V. Arellano (1952, p. 63) sent these specimens to R. A. Stirton, of the University of California, who considered the foot bones very similar to those of the oreodonts of the family Merycoidodontidae. The bones were later studied by Dr. C. Lewis Gazin, of the U. S. National Museum, who spent considerable time studying the specimen and stated: "I confirm Lewis's determination of it as a tapiroid foot."

Age of fossils.—The exact geological age of the specimens is unknown. The lack of any knowledge concerning the early and middle Cenozoic vertebrate life of Mexico leaves the age assignment of the vertebrate fossils open to question. It is not known whether the vertebrate faunas of Mexico during the early and middle Cenozoic were noticeably different from the faunas to the north, and especially whether or not some generalized forms hold on longer in Mexico than in the north. This can be determined only by future study of the deposit and its contained fossils. Wilson (1949, p. 97) makes the following statement in regard to the geologic range of this subfamily: "In time, the Sciuravinae are known to have ranged from early Bridgerian to early Uintan, inclusive. If '*Sciuravus*' *depressus* is a sciuravine, the downward limit is middle Wasatchian. Records of the group later than early Uintan are vague, but Burke (1934, p. 391) speaks of teeth of the *Sciuravus* type persisting into the basal Duchesne River beds." Gazin (1952, p. 48) records *Sciuravus* from the La Barge fauna from Wyoming (late Wasatchian).

If *Floresomys* did branch off from the *Taxymys* stock, its specialized development could have occurred during the late Eocene. If *Floresomys* is more closely related to the *Sciuravus powayensis* Wilson (1940) line, there is still no morphological evidence that it is younger than late Eocene.

The dentition of *Floresomys* is reminiscent of the Heteromyidae, although the diastema and the M^3 rule out such a relationship unless it was very early in the development of the Geomyoidea.

Wilson (1940) described *Griphomys alecer* from the Eocene (Tapo Ranch fauna of California), which may be a Geomyoidea. There is some similarity between *Griphomys* and *Floresomys* in the development of the deep transverse valley that divides the tooth into anterior and posterior parts. It may be that *Floresomys* is a descendant of a generalized paramyline stock and that the dental pattern is a simplification of the paramyline tooth pattern. If such is the case *Floresomys* would not be expected to be younger than *Griphomys*. The development of the lower jaw, and of the lower and upper dentition, indicate a form no younger than earliest Oligocene.

In the comparative study of these specimens the aberrant *Kansasimys* (Wood, 1936) from the middle Pliocene of Kansas should be noted because of its probable relationship to the Ischyromyidae. *Kansasimys* presents certain specialized characters that distinguish it from the early Ischyromyidae and *Floresomys*. The more generalized characters of the lower jaws and rostral region of the skull(?) of *Floresomys* indicate a much greater antiquity than that of *Kansasimys*.

The tapiroids of North America (north of Mexico) are known from the lower Eocene to the Pleistocene. The generalized characters and small size of the tapiroid foot can be taken to indicate an age no younger than earliest Oligocene for the deposit.

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