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BIOSTRATIGRAPHY OF THE MEXICAN CONTINENTAL MIOCENE:

PART II, THE SOUTHEASTERN (OAXACAN) FAUNAS.

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ABSTRACT

The areas and faunas treated in this part of the study are: (1) Suchilquitongo, northwestern Oaxaca Valley; (2) Matatlán, southeastern Oaxaca Valley; and (3) Nejapa, eastern Isthmus of Tehuantepec region.

In Suchilquintongo, the Tertiary sequence unconformably overlies a basement formed by the Proterozoic Oaxaca Complex (schistous and gneissic bodies) intruded by Paleozoic granites, overlain by the ?late Jurassic ?Yogana Formation (red arkisic sandstone), in turn unconformably overlain by Cretaceous marine sedimentary units (sandstones, shales and limestones). The sequence includes an ?Oligocene informal unit (basaltic flows, and conglomerates), unconformably covered by the Suchilquitongo Formation (tuffs, tuffaceous sandstones and silts largely of lacustrine desposition), which bears the latest Hemingfordian-earliest Barstovian (medial Miocene) homonymous local fauna; this unit is unconformably overlain by a late Tertiary conglomeratic one, in turn covered by Quaternary deposits. The Suchilquitongo local fauna includes: Rhinocerotidae Gen et sp. indet.; the tridactyl high crowned horse *Merychippus* sp.; the protoceratid cf. *Paratoceras* sp.; and the oreodon *Merychyus* aff. *M. minimus.*

In Matatlán, the Tertiary sequence unconformably overlies Cretaceous units (limestones and marls); it consists of rhyolitic vitric tuffs, tuffaceous-arkosic fluviatile sandstones, and associated aphanitic to porphyritic andesitic bodies; the sequence is unconformably covered by Quaternary deposits. The sandstone strata bear the homonymous local fauna, whose age falls in the late Hemingfordian-Clarendonian (medial to late Miocene) intervale, and it consists of: Rhinocerotidae Gen et sp indet.; *Merychippus* cf. *M. primus;* Camelidae Gen. et sp. indet.; and a tylopodan.

In Nejapa, the Tertiary sequence unconformably overlies a basement of silicic metatuffs and ?andesitic volcanics and metavolcanics, both of very restricted outcrop area and unknown Precenozoic age; the sequence includes rhyolitic vitric tuffs and fluvio-lacustrine tuffaceous-arkosic sandstones that bear the El Gramal and El Camarón local faunas of late Hemingfordian-early Clarendonian (late medial Miocene) age; it is unconformably covered by Quaternary deposits. The El Gramal local fauna consists of: The primitive mastodon *Gomphotherium* sp., the common Miocene horse *Merychippus (s. l.)* sp., seemingly represented by a population with simple patterned cheek teeth and another one with complex patterned ones; Camelidae Gen. et sp. indet., and ?Protoceratidae Gen. et sp. indent. The El Camarón local fauna consists of *?Gomphotherium* sp., the mustelid carnivore *Plionictis oaxacaensis* sp. nov., *Merychippus (s. l.)* sp., represented by a population of horses with a simple occlusal pattern in the cheek teeth, and Antilocapridae Gen. et sp. indet.

To sum up, the Tertiary sequence remains undifferentiated in two of the three studied areas; it occupies grabens limited by horsts made up of the Precenozoic basement; it is affected by extensive faulting and fracturing; it attests extensive —largely silicic— Mid-Tertiary volcanic activity; in one area, Suchilquitongo, radiosiotopic data allow a measure of age-calibration; the mammalian record includes exclusively taxa of strict North American affinites, and its faunas closely correlate to well known Hemingfordian and Barstovian faunas in North America, and to the only seemingly Hemingfordian Central American fauna of Panama; in fact, the Oaxacan faunas appear to represent partial samples of a large and continuos medial Miocene North-and-Middle American therofauna.

RESUMEN

Las áreas y faunas tratadas en esta parte del estudio son: (1) Suchilquitongo, en la porción noroccidental del Valle de Oaxaca; (2) Matatlán, en la porción suroriental de este valle; y (3) Nejapa, en la región occidental del Istmo de Tehuantepec.

En Suchilquitongo, la secuencia terciaria discordantemente sobreyace un basamento formado por el Complejo Oaxaca del Proterozoico (cuerpos esquistosos y gnéisicos), intrusionado por granitos paleozoicos; discordantemente cubiertos por la Formación ?Yogana (areniscas arkósicas rojas) del ?Jurásico, a su vez cubierta en discordancia por unidades cretácicas marinas sedimentarias (areniscas, pizarras y calizas). La secuencia incluye una unidad informal (derrames basálicos y conglomerados) del ?Oligoceno, discordantemente cubierta por la Formación Suchilquitongo (tobas, y areniscas y limolitas tobáceas, en gran parte de sedimentación lacustre), la cual porta la fauna homónima del Hemingfordiano más tardío-barstoviano más temprano (Mioceno medio); esta unidad está discordantemente sobreyacida por una conglomerática del Terciario tardío, a su vez cubierta por depósitos cuaternarios. La fauna local Suchilquitongo incluye: Rhinocerotidae Gen. et sp. indet.; el caballo tridáctilo hipsodonte *Merychippus* sp., el protoceráido cf. *Paratoceras* sp., y el oreodon *Merychyus* aff. *M. minimus.*

En Matatlán, la secuencia terciaria sobreyace discordantemente a unidades cretácicas (calizas y margas); consta de tobas riolíticas vítricas, areniscas tobáceo-arkósicas fluviolacustres, y de cuerpos andesíticos afaníticos a porfiríticos asociados; la secuencia está discordantemente cubierta por depósitos cuaternarios. Los estratos arenosos portan la fauna homónima local, cuya edad cae en el intervalo Hemingfordiano temprano-Clarendoniano (Mioceno medio a tardio), y consta de Rhinocerotidae Gen. et sp. indet., *Merychippus* cf. *M. primus,* Camelidae Gen. et sp. indet. y un tilópodo.

En Nejapa, la secuencia terciaria discordantemente sobreyace a un basamento formado por metatobas y por volcánicos y metavolcánicos ?andesíticos, ambos de muy restringida area de afloramiento y de edad precenozoica desconocida; la secuencia incluye tobas vítricas riolíticas y areniscas tobáceo-arkósicas fluviolacustres que portan a las faunas locales El Gramal y El Camarón del Hemingfordiano tardío-Clarendoniano temprano (Mioceno medio-tardío); ella está discordantemente cubierta por depósitos cuaternarios. La fauna local El Gramal consta de: El mastodonte primitivo *Gomphotherium* sp., el caballo común del Mioceno *Merychippus (s. l.)* sp., aparentemente representado por una población con molariformes de patrón oclusal simple y otra de patrón oclusal complejo; Camelidae Gen et sp. indet., y ?Protoceratidae Gen. et sp. indet. La fauna local El Camarón consta de: *?Gomphotherium* sp., el carnívoro mustélido *Plionictis oaxacaensis* sp. nov., Merychippus *(s. l.)* sp., representado por una población de caballos con un patrón oclusal simple en sus molariformes; y *Antilocapridae* Gen. et sp. indet.

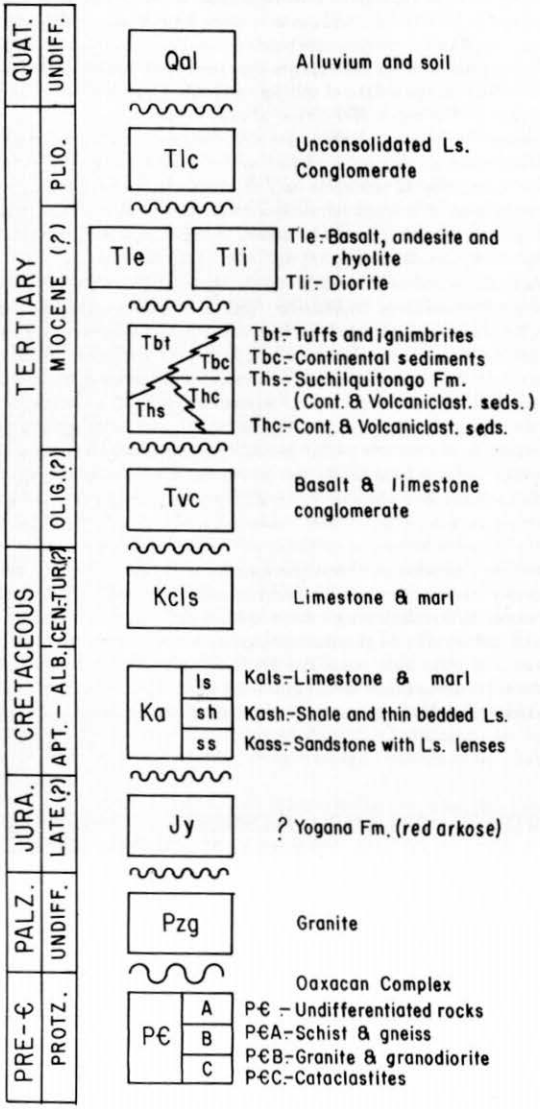
Para sumarizar, se tiene que la secuencia terciaria permanece indiferenciada en dos de las tres áreas estudiadas; ocupa grabens limitados por horsts formados por el basamento precenozoico; está afectada por extenso fallamiento y fracturamiento; evidencia extenso volcanismo —principalmente silícico— del Terciario medio; en una area, Suchilquitongo, datos radioisotópicos permiten cierta calibración de edad; el registro mamiferiano incluye taxa de afinidades biogeográficas norteamericanas, y sus faunas se correlacionan estrechamente con otras bien conocidas del Hemingfordiano y Barstoviano de Norteamerica, así como a la aparentemente única fauna Hemingfordiana de Centroamerica en Panamá; de hecho, parecen representar muestras parciales de una gran y contínua terofauna norte y-Mesoamericana del Mioceno medio.

THE SUCHILQUITONGO LOCAL FAUNA, SUCHILQUITONGO FORMATION, LATE-EARLY MIOCENE (LATEST HEMINGFORDIAN-EARLIEST BARSTOVIAN), OAXACA

GEOLOGIC SETTING

The area occupies the northeastern part of the Oaxaca valley and surroundings (Figure 1). The geology of the vallet was described by Wilson and Clabaugh (1970). The lowest unit is the Oaxacan Complex, which according to Ortega-Gutiérrez (1977, p. 28) is a paragneissic sequence concordantly overlain by a grabbroid-anorthositic complex, both metamorphosed in the late Proterozoic, and intruded by granites and granodiorites seemingly in the Paleozoic. The basement is unconformably overlain by younger units, the oldest of these is a red, medium to coarse grained, well indurated, thickly bedded arkose some 50 m thick, questionably assigned to the Jurassic; its designation is debatable since it has been referred to as Yogana

LEGEND


QUAT.
UNDIFF.
TERTIARY
PLIO.
MIOCENE (?)
OLIG.(?)
CRETACEOUS
CEN-TUR(?)
APT. – ALB.
JURA.
LATE(?)
PALZ.
UNDIFF.
PRE-Є
PROTZ.
Qal
Alluvium and soil
Tlc
Unconsolidated Ls.
Conglomerate
Tle
Tli
Tle-Basalt, andesite and rhyolite
Tli-Diorite
Tbt
Tbc
Ths
Thc
Tbt-Tuffs and ignimbrites
Tbc-Continental sediments
Ths-Suchilquitongo Fm.
(Cont. & Volcaniclast. seds.)
Thc-Cont. & Volcaniclast. seds.
Tvc
Basalt & limestone
conglomerate
Kcls
Limestone & marl
Ka
ls
sh
ss
Kals-Limestone & marl
Kash-Shale and thin bedded Ls.
Kass-Sandstone with Ls. lenses
Jy
? Yogana Fm. (red arkose)
Pzg
Granite
Oaxacan Complex
PЄ
A
B
C
PЄ-Undifferentiated rocks
PЄA-Schist & gneiss
PЄB-Granite & granodiorite
PЄC-Cataclastites

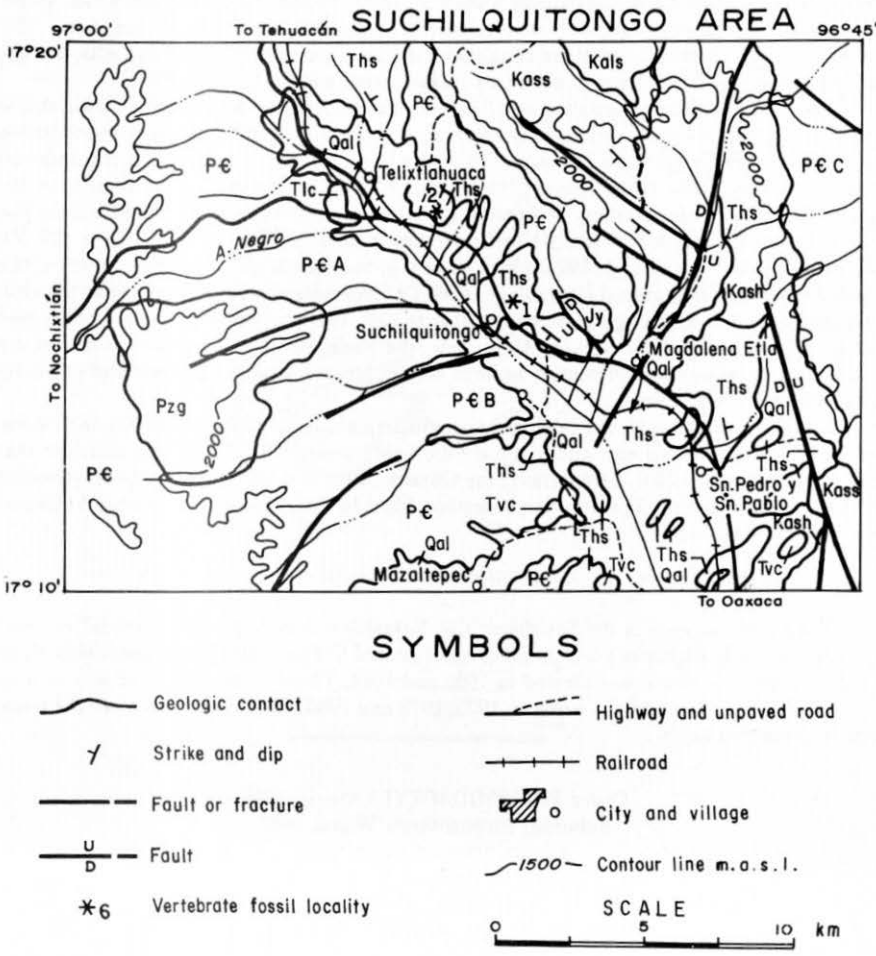


Figura 1.— Geologic map of the Suchilquitongo Area, Oax. (Modified from Wilson and (Clabaugh, 1970; supplemented from López Ramos, 1974b and INEGI, 1982e).

Formation (Wilson and Clabaugh, 1970, fig. 1), Yogana Series or Red Series (Barrera, 1946, p. 82), Todos los Santos Formation (López-Ramos), 1976) and El Rosario Formation (Cárdenasd Vargas, 1966), but no compelling reasons were given to validate any of these designations.

The red arkose body is unconformably overlain by brown, medium to coarse grained, well indurated quartzitic sandstone with limestone lenses bearing fossils of Aptian-Albian age. This unit is unconformably overlain by a body on thinly bedded limestone and shale, seemingly of late Cretaceous age, and unconformably overlain by the Cenozoic sequence. The pre-Miocene unit includes limestone conglomerates, plagioclase rich-basalts and silts; the basal subunit varies from place to place; no formal name was proposed for it.

The Suchilquitongo Formation overlies (unconformably?) the plagioclase-rich basalts, it consists of cream to light pink to gray color, thin to medium bedded tuffaceous sandstone and siltstone, partly silicified lacustrine limestone and dominantly light green ingnimbrite; its measured thickness at the type-section is 276.2 m. This unit forms several islated low rolling hills on the Oaxaca valley; its precise age poses a problem, because samples from the Etla Member (of this formation) yielded radiometric ages of 16.5 ± 0.3 to 17.4 ± 0.3 Ma (Ferrusquía-Villafranca *et. al.*, 1974) which place it in the early middle Miocene; however, the small but significant mammal assemblage collected from tuffaceous sandstones near Shuchilquitongo indicates a (younger) late early Miocene age. This problem is discussed below (see the section on age and correlation). At any rate, the Suchilquitongo Formation is one of the two formal coontinental sedimentary units in Mexico whence both radiometric and paleontologic dates are available.

A friable, cobbly to blocky calclithitic conglomerate questionably assigned to the Pliocene, overlies the previous unit and it is unconformably overlain by Quaternary alluvium that makes up the valley floor. Structurally, the Oaxaca valley is a northwest-southeast trending graben developed in the Precambrian basement, filled by the sedimentary cover and affected by Cenozoic faulting.

THE SUCHILQUITONGO LOCAL FAUNA

The fossil contents of the Suchilquitongo Formation include abundant reeds? or root? fillings 2-4 mm in diameter y 2-5 cm long, concentrated in zones, and scarce but highly significant mammalian remains, collected in 1969 and 1984. Those of the first field season were preliminarily discussed by the writer in 1975, 1978 and 1984. The description of all the material is presented below.

Order PERISSODACTYLA Owen, 1848
Suborder HIPPOMORPHA Wood, 1937
Family EQUIDAE Gray, 1821
Genus *Merychippus* Leidy, 1857
Merychippus sp.
(Figure 1, Plate 1, figures 9, 10, Table 1)

Referred material

IGM-4307, fragment of an upper molar collected from the Suchilquitongo Formation in outcrops near Km 168 of the Panamerican Highway, Huajuapan-Oaxaca section, in the vicinity of Suchilquitongo, a small village in the Oaxaca valley, by Dr. J. A. Wilson and the present author, in 1969.

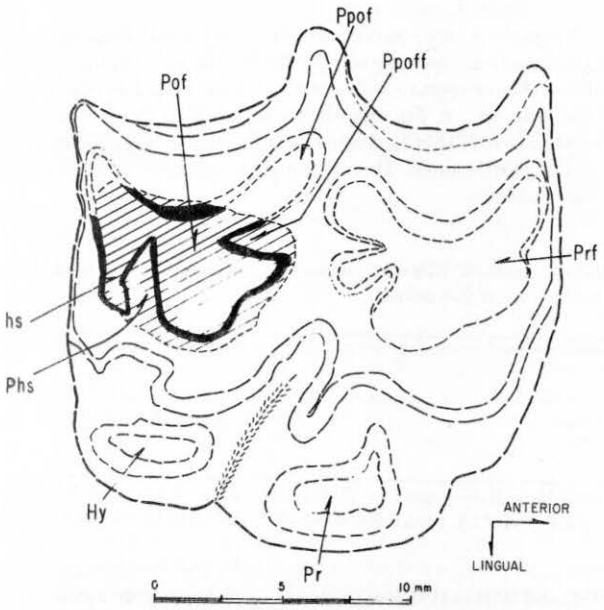


Figure 2.— Restored. IGM-4307, right upper molariform referred to *Merychippus* sp., occlusal view. Hatchurred pattern denotes actual specimen. *Abbreviations:* hs. hypostyle; Hy, hypocone; Phs, plihypostyle; Pof, prostfessette; Ppof, plipostfossette; Ppoff, pliopostffossette-flexure; Pr, Protocone; Prf, pre-fossette. (Restoration following Osborn, 1918, figs. 74 and 96).

Description

The fossil is an almost complete postfossette of a right upper molariform tooth (Figure 2, Plate 1, figures 9, 10). The tooth is moderately curved and rather hypsodont; occlusally it is unequally beveled, the anterior part forms the main section of the fossette and shows only a wide, V-shaped flexure for the plipostfossette, whose main labialward arm is largely missing (Figure 2). The highest point of the fossette lies in the midpoint of its labial wall. The posterior part is the hypostyle, that lingually is as wide as the fossette itself; the plihypostyle is deep and narrow.

Discussion

The fossette fragment is very reminiscent of that of the late Hemingfordian-early Barstovian *Merychippus seversus* as represented by AMNH-8180 (*cf.* Osborn, 1918, fig. 74), and the seemingly correlative *Merychippus californicus*, as represented by the specimen UCal. Pal. Num. 21217 (*cf.* Osborns, *op. cit.*, Fig. 96), both from the West Coast region of North America.

All share the same size (Table 1), degree of hypsodonty, large hypostyle, and simple plication pattern of the postfossettes. This specimen is assigned very tentatively to the same time-span that these species.

Table 1.— Measurements of IGM-4307, molar fragment referred to *Merychippus* sp., and of selected species of this genus.

Postfossette measurements	A	B	C
Anteroposterior length	8.4e	8.0e	8.0e
Midtransverse width	6.0e	5.0e	7.0e
Height	26.0	26.0e	27.0e

Data source: A, IGM-4307, *Merychippus* sp. B, Am. Mus. 8180, Holotype of *M. seversus* Osborn (1918, fig. 74). C. Univ. Calif. Pal. Coll. 21247, Holotype of *M. californicus* Osborn (1918, fig. 96).

Stirton (1954) and Wilson (1967) reported *Merychippus* sp. from the Nejapa valley in the same State of Oaxaca, and the author collected additional material in the same area (see El Gramal and El Camarón local faunas in this report), but the material seems to correspond to a more advanced species than that represented by the Suchilquitongo specimen, as it is discussed below. No other records of *Merychippus* than those from Oaxaca are known in Middle America.

Suborder CERATOMORPHA Wood, 1937
Family RHINOCEROTIDAE Owen, 1845
Genus et species indet.
(Plate 1, figures 1, 2, Table 2)

Referred material

IGM-3256, left III metacarpal proximal end, collected by Ing. D. Hernández-Láscares about 300 m NNW of the Km 168 sign, Panamerican Highway, Huajuapan-Oaxaca section,

on August, 1984. IGM-4308, thick enamel and dentine fragments collected near the same locality in March, 1969, by Ferrusquía-Villafranca.

Description

IGM-3956 has the trochlea triangular (Plate 1, figure 2), with one of the vertices —the largest— plantar, and a wide lateral projection to contact the IV carpal; the lateral (external) surface shows two small, oval articular facets for the IV metacarpal (Plate 1, figure 1); such facets are separated by a narrow channel nearly as wide as the dorsal facet; the ridge coming from the lateral projection is rounded in section.

The enamel and dentine fragments are as thick as those of the cheek teeth of *Diceratherium* (Table 2), but otherwise show no discernible features.

Table 2.— Measurements of IGM-3956, left metacarpal, Rhinocerotidae Gen. et sp. indet., and of selected rhinocerotids.

Measurements	A	B	C
Anteroposterior distance	26.0	24.0 - 25.2	27.3
Transverse width	32.0	32.5 - 31.4	35.5
Thickness	12.7	16.2 - 16.5	18.7

A, IGM-3956, Rhinocerotidae Gen. et sp. indet. B, *Menoceras arikarense*, American Museum, Frick Collection specimens from the Agata Springs Quarry, Upper Harrison Formation, Sioux Co., Nebraska. C, *Diceratherium niobrarensis*, American Museum, Frick Collection specimens from the 77 Hill Quarry, Harrison Formation, Niobrara Co., Wyoming.

Discussion

IGM-3956 was compared with a series of III metacarpal bones of Miocene rhinoceroses, chiefly species of *Diceratherium* and *Menoceras* of the Frick Collection, American Museum of Natural History; it is concluded that in size, IGM-3956 is intermediate between a small *Diceratherium*, such as *D. anectens*, and a large *Menoceras*, such as *M. barbouri*. The Suchilquitongo specimen differs from the III metacarpal of *Menoceras* in having relatively smaller articular facets, a wider interarticular channel and a lateral projection ridge not sharp or angular but rounded. In all these characters, the Oaxacan specimen is very close to *Diceratherium*, but differs from it in being significantly smaller (Table 2). Under these circumstances, it is impossible to make a closer identification, and, for this reason, IGM-3956 remains as Rhinocerotidae Genus and species indeterminata.

Order ARTIODACTYLA Owen, 1884
Suborder TYLOPODA Illiger, 1811
Family PROTOCERATIDAE Marsh, 1891
Paratoceras Frick, 1937
cf. *Paratoceras* sp.
(Plate 1, figures 3, 4, Table 3)

Referred material

IGM-3957, two isolted mandibular fragments bearing part of a left third lower molar and a cheek tooth fragment, collected by I. Ferrusquía—Villafranca in outcrops of the Suchilquitongo Formation located approsimately 150 m north of Km 167.6 of the Panamerican Highway, section Huajuapan de León-Oaxaca, on August 19, 1984.

Description

The material is severely weathered and well permineralized; both fragments consist of little more than the alveoli. The third molar is brachydont, typically selenodont and lacks the third lobe; the tooth is rather narrow transversely (Plate 1, figure 4), with both selenes of nearly equal size, part of the enamel of the buccal side is missing too, but no cingulum is discernible (Plate 1, figure 3); occlusally, the pattern is simple, camel-like.

The other fragment is only the lower part of a selene, set in a transversely narrower ramal fragment, thus indicating that it belonged to a more anterior cheek tooth.

Discussion

The left M_3 odontography is typically protoceratid, but its allocation within the family is difficult, because the systematics of this group rests heavily on horn and skull morphology (*cf.* Frick, 1937; Patton and Taylor, 1971; 1973). IGM-3957 is very close in size, proportions and morphology to *Paratoceras wardi* cotype (Table 3) from the early Barstovian Flemming Formation, San Jacinto County, Texas; and clearly smaller than the corresponding tooth in *Prosynthetoceras texanus* from the Hemingfordian Oakville and Flemming Formations, San Jacinto County, Texas (Table 3). It is also smaller than the same tooth in most species of this genus (Frick, 1937).

As mentioned previously, the comparison with *Paratoceras* showed similarities in size, proportions and morphologic features, mainly having the proto- and hypoconids without lingual ribs, and set not as posteriorly as in *Protoceras;* and also having the posterior arm of the protoconid reaching further lingually than the anterior arm of the hypoconid (Patton and Taylor, *op. cit.*, fig. 9), suggest the possibility that the protoceratid from Suchilquitongo is referable to this genus, and tentatively it is so regarded here. *Paratoceras* is known from the Barstovian and Clarendonian of North America (Frick, 1937; Patton and Taylor, *op. cit.*), and it is the only protoceratid previously reported from Middle America, being present in the Gaillard Cut local fauna, Cucaracha Formation, Panama Canal Zone, seemingly of Hemingfordian age (Whitmore and Stewart, 1965). The only other published record of protoceratids in this region is that from El Gramal local fauna (Wilson, 1967), corresponding to a single tooth fragment tentatively identified as ?Protoceratidae Gen. and sp. indet. If both proved correct, the Suchilquitongo specimen is the third record of the Protoceratidae in Middle America.

Table 3.— Measurements of IGM-3957, mandibular fragment bearing LM_3 referred to cf. *Paratoceras* sp., and of selected protoceratids.

Measurements	A	B	C	D	E	F	G
Anteroposterior length	—	21.6	31.3	31.0	17.2	18.3	20.0e
Anterior-lobe length/width	7.3/8.9	8.0/10.0	10.5/13.8	13.0/14.0	7.5/10.0	6.4/10.0	7.0/10.0e
Posterior-lobe length/width	6.9/8.0	8.7/10.5	10.5/13.0	12.7/13.0	6.0/6.9	6.0/9.0	6.0/9.0e
Accessory lobe length/width	—	5.0/7.0	8.0/8.0	7.3/8.0	5.5/5.9	5.4/6.1	6.0/6.0e

A, IGM-3957, cf. *Paratoceras* sp. B, AMNH 34181, *Prosynthetoceras texanus.* C. AMNH, *P. francisci.* D, AMNH 33061, *P. francisci.* E, AMNH 40749, *Paratoceras wardi.* F, AMNH 40256, *P. wardi.* G, F:AM 53521, *Protoceras celer;* data from Patton and Taylor (1973, fig. 3). e, estimated.

Suborder RUMINANTIA Scopoli, 1777
Family MERYCOIDODONTIDAE Thorpe, 1923
Genus *Merychyus* Leidy, 1858
Merychyus minimus Peterson, (1907)
Merychyus aff. *M. minimus*
(Plate 1, figures 5-8, Table 4)

Synonymy. Merycodus sp., Wilson and Clabaugh, 1970, p. 126; Merycoidodontidae Gen. et sp. indet., Ferrusquía-Villafranca and coworkers 1974, p. 262; Ferrusquía-Villafranca, 1975; cf. *Merychyus* sp., Ferrusquía-Villafranca, 1978, p. 218-219; Merycoidodontidae Gen. et sp. indet., Ferrusquía-Villafranca, 1984, p. 191.

Table 4. Measurements of IGM-3958, right mandibular fragment referred to *Merychyus* off. *M. minimus* and of selected merychines.

Measurements	A	B	C	D
P_1-M_3 length	70.0	68.0	84.8	65.5
M_1-M_3 length	40.0	39.0	50.8	38.5
P_1-P_4 length	30.5	29.0	34.5	27.0
P_4 length/width	10.0/7.0	10.0/7.6	—	10.0/7.0

A, IGM-3958, *Merychyus* aff. *M. minimus*. B, AMNH 33393, *M. minimus*. C, AMNH 44821, *M. elegans*. D, AMNH 45384k, *M. crabilli*.

Referred material

IGM-3958, right mandibular fragment bearing I_3-P_4, collected by I. Ferrusquía-Villafranca in the northern road cut at Km 168 of the Panamerican Highway, Section Huajuapan de León-Oaxaca, from the Suchilquitongo Formation, on March 25, 1969.

IGM-3959, right and left molar fragments and IGM-3960, single molar fragmented, all collected at the same site and date that IGM-3958.

Description

IGM-3958 is poorly preserved, shows extensive transverse cracking and enamel pitting, suggestive of preburial weathering and some transportation. The fragment lacks the suture region and the ascending ramus.

Mandibular ramus. It shows a rectangular outline (average width: length ratio = 1:3.5, Plate 1, figures 5, 7). The ventral border is straight; the anterior part of the ramus is twisted internally some 20° in relation to the ramus-sagittal plane. The external face is flat, the internal one is divided up in two triangular regions by an oblique anteroinferior-posterosuperior virtual line. The upper one is smaller, set at an angle of 25° to the lower region, which is parallel to the saggital plane, as a result of the twisting mentioned above. It seems that the twisting enabled the oreodont to have a wider tipped snout without laterally arching the rami. The suture region is missing; there is no trace of the caniniform root. Correlatively, the ventral border does not show traces of the downward anterior prominence either, which is a very common feature common in oreodonts (Schultz and Falkenbach, 1940, 1941, 1947, 1949, 1950, 1954 and 1956). The occlusal border is partly broken so that the posterior alveoli of M_1 and M_2 are almost destroyed; it seems to have been straight. This border is widest across M_3.

Teeth. Incisors. They are crowded, thinly enameled and very brachydont; their crown represents 2/5 or less of the tooth-length (Plate 1), I_3 is pear-shaped in cross section; larger diameter perpendicular to tooth row.

P_1 is single rooted, caniniform, ovoid in cross-section; larger diameter parallel to tooth row; tip shows a small facet; the labial wall of the alveolus is broken away exposing the root almost completely. The tooth is set at a larger angle (60°) than I_3.

P_2 seems single rooted, shorter than P_1, ovoid in cross-section; larger diameter set a 45° to the tooth row; anterior facet is smaller (1/3) than the posterior one.

P_3 is double rooted, most of the crown is gone; it shows a bilobated cross-section, larger diameter is parallel to tooth row; anterior lobe smaller.

P_4 is double rooted, largest premolar of the series; occlusal pattern typically oreodont, *i. e.*, with an anterior, oblique lingually directed enamel fold (protoconid), and a much wider ovoid, oblique facet posterolingually directed (hypo- ento- and metaconids) depressed at the midlabial region by a shallow vertical sulcus whose enamel is broken. The wear is suggestive of a mature-adult individual.

M_1, M_2, and M_3 broken at alveoli and further down. The posterior lobe of M_3 probably was small and narrow. The exposed alveoli are very shallow, indicating strong brachydonty.

IGM-3959 is probably a right lower third molar represented by the protoconid and half of the hypoconid (Plate 1, figure 8), it shows thin enamel, modest hypsodonty and size and morphology similar to that of a *Merychyus's* M_3.

Discussion

The poor preservation and incompleteness of the specimens render positive indentification impossible. The size of the ramus and teeth are closest to *Merychyus crabilli* (Shultz and Falkenbach, 1947, table 1). This is the smallest species of merychyines. The Oaxaca specimen (Table 11), is slightly smaller than F:AM 44458 from the Harrison Formation, Niobrara County, Nebraska, referred to this species and the only one with comparable measurements available (Schultz and Falkenbach, *op. cit.*).

Unlike *Merychyus crabilli,* the ramus is nearly horizontal not trapezoidal with the posterior region much deeper than the anterior one. In this character the Oaxaca specimen is closer to specimens referred to promerychochoerines and desmatochoerines than to any other ones (Schultz and Falkenbach, 1949, 1954). The outline and proportions are very similar to AM 7901, questionably from the Middle John Day, John Day Valley, Oregon, referred to *Promerychochoerus superbus,* illustrated by Schultz and Falkenbach (1949, fig. 11, B).

The tooth row appears to be nearly straight as in most promerychochoerines (*cf.* Schultz and Falkenbach, *op. cit.*). The apparent lack of the anteroventral prominence of the ramus is unusual, although in this regard again the promerychochoerines and to a lesser degree the merychyines, come closer, having this feature poorly developed (Schultz and Falkenbach, 1947 and 1949).

The teeth are typically oreodont. The relatively small size of the caniniform P_1, a seemingly common trend among the merychyines (Schultz and Falkenbach, 1947), is noteworthy. Alternatively, but less likely this character might be sexually related, the specimen being a female of an unassessed oreodont.

Comparisons between the Oaxacan specimen with AMNH 33393, referred to *Merychyus minimus* from the Upper Harrison = Marsland Formation, Hemingfordian. Goshen County, Wyoming, and AMNH 44498 from the same formation but in the Niobrara County, Wyyoming show it to be very close both in size (Table 4), proportions and morphology, particu-

PLATE 1

THE SUCHILQUITONGO LOCAL FAUNA, SUCHILQUITONGO FORMATION, LATE-EARLY MIOCENE (LATEST HEMINGFORDIAN-EARLIEST BARSTOVIAN) OAXACA

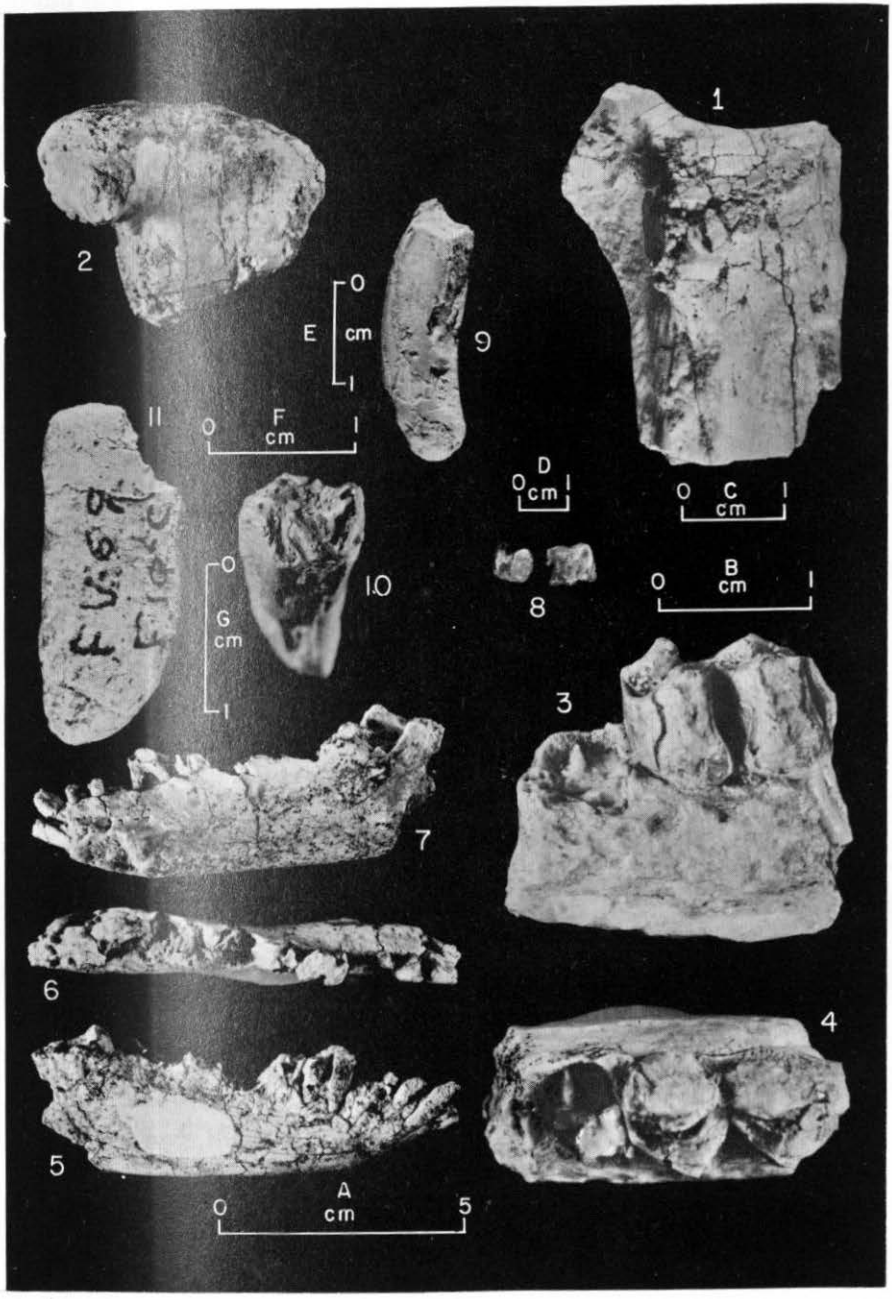
Figures 1-2.— Referred material to Rhinocerotidae Gen, et sp. indet.: 1, IGM-3956, left III metacarpal proximal fragmente, anteiro view; 2, *idem*, proximal view.

Figures 3-4.— Referred material to cf. *Paratoceras* sp.: 3, IGM-3957, left mandibular fragment baring the M_3, lateral view; 4, *idem.*, occlusal view.

Figures 5-8.— Referred material to *Merychyus* aff. *M. minumus:* 5, IGM-3958, right mandibular fragment bearing I_3-P_4, lateral view; 6, *idem.*, occlusal view; 7, *idem.*, internal view; 8, IGM-3959, right molar fragments, occlusal view.

Figures 9-10.— Referred material to *Merychippus* sp.: 9, IMG-4303, right upper molariform (consisting of the postfossette), anterior view; 10, *idem.*, occlusal view.

Figure 11.— Referred material to Mammalia Ord, indet.: 11, IGM-3967, coprolite (nearly complete), lateral view.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larly the odontography of P_4 which is the only one in the Oaxacan specimen whose pattern is discernible, plus the fact of having the premolars crowded in the same fashion.

Comparisons with other *Merychyus* species are as follows: *Merychyus elegans* as represented by AMNH 34314, from the Hemingfordian Runningwater Formation, Dawes County, Nebraska, is clearly larger than the Oaxacan specimen. *Merychyus arenarium* as represented by AMNH 72395, from the Hemingfordian Arikaree Group, Carter County, Montana, is also singificantly larger and shows a prominent "concave chin" not present in the Oaxacan specimen. *Merychyus crabilli* as represented by AMNH 45384K and H, the holotype, from the Morava Ranch, Arikareean, Box Butte County, Nebraska, shows similar size, but differs from the Oaxacan specimen in having a very well developed "concave chin", and an anteriorly tapering horizontal ramus, whose posterior part is very wide. Notice however that *Merychyus crabilli* Shultz and Falkenbach, 1947 has been regarded by Stevens (in Woodburne *et al.*, 1974) as a High Plains population of the Californian Arikareean *Merychypus calaminthus* Jahns (1940), later found also in the Big Bend area, Texas, because of its great morphological similarity. Should Stevens's contention prove to be correct, the foregoing considerations would apply also to *M. calaminthus*.

The Oaxacan specimen then is assigned to *Merychyus* and within this taxon, it is closest to *M. minimus;* however, making due allowance to the limited amount of diagnostic characters objectively discernible in the Oaxacan specimen, it is conservatively identified as *Merychyus* aff. *M. minimus*.

This taxonomic allocation indicates that the geologic age of the specimen is Hemingfordian; however, radiometric dating of the Etla Member of the Suchilquitongo Formation yielded an age of 16.5 ± 0.3 and 17.4 ± 0.3 Ma (Ferrusquía-Villafranca *et al.*, 1974), which is clearly younger. This problem is discussed elsewhere in this paper.

Oreodonts are among the most common fossil mammals in North America throughout the Tertiary, yet there are only other two records of Miocene oreodonts south of the United States— Mexico border, namely *Merychyus* cf. *elegans* from the Zoyatal local fauna, of Aguascalientes, central Mexico (Dalquest and Mooser, 1974). The other record is that of *Desmatochoerus* sp. and an unidentified genus from the Hemingfordian Gaillard Cut local fauna, Panama Canal Zone. These last oreodonts are considerably larger than the Oaxacan specimen, which occupies an intermediate geographic position between the southern United States oreodont records and the Panamian ones, thus strengthening the plausability of faunal continuity southward down to the Panamian Canal Zone during the Miocene, as suggested by Whitmore and Stewart (1965).

The paleoecological information derived from the specimen is scant. The thin enamel cover and overall delicacy of the teeth and jaw, strongly suggest a soft foliage dietary basis for this oreodont. This in turn calls for a woodland habitat as the most probable one for *M.* aff. *minimus,* rather than an open prairie or savanna habitat which is the common ecological setting for the oreodonts in North America. This problem is also addressed elsewhere. Finally, the tooth wear indicates adulthood for the specimen.

Class MAMMALIA
Order INDETERMINED
(Plate 1, figure 11)

Referred material

IGM-3967, a coprolite collected by Ismael Ferrusquía at the same locality that IGM-3958.

Description

The coprolite is small, 23 mm long, 10 mm wide and 7 m thick; it is peglike, slightly depressed; one end is pointedd whereas the other is blunt. No discernible structure is seen inside; a slight constriction is present in the body near the blunt end.

Discussion

Coprolites have been known for a long time, but detailed information on the ichnology of coprolites of the various vertebrate groups is still largely lacking, in spite of their paleoecological importance. Small artiodactyls produced discrete bulbose or beadlike feces, whereas carnivores tend to produce contorted tube-like feces. On this regard alone, the specimen might belong to a small artiodactyl such as *Merychyus*, but too little is known about it to be precise.

This is the first record of mammalian coprolites in the Tertiary of Mexico.

AGE

The identified taxa at generic or lower level are *Merychippus* sp. cf. *Protoceras* sp. and *Merychyus* aff. *M. minimus*. The chronostratigraphic range *Merychippus* extends from the late Hemingfordian to the Clarendonian, but the specimen is reminiscent of the early Barstovian species of North America. Likewise, *Paratoceras* is known in North America from the Barstovian to the earliest Hemphillian; but in Panama's Gaillard Cut l. f., it coexists with seemingly older taxa such as *Diceratherium*. The fauna is in need of revision, and probably this identification is erroneous (R.H. Tedford, written communication, January 1988); if so, there is no *Paratoceras* record older than early Barstovian. The Oaxacan specimen of cf. *Paratoceras* sp. is closest to the early Barstovian *P. wardi*, as discussed above. *Merychyus* aff. *M. minimus* is closest to *M. minimus* from the Hemingfordian Upper Harrison Formation, and to the late Hemingfordian *M. relictus*. Given the scarcity and poor preservation of the material, one must be cautious; the Suchilquitongo l. f. would fit best a latest Hemingfordian-earliest Barstovian time span. This age is slightly at variance with the K-Ar date yielded by the Etla Ignimbrite Member of the Suchilquitongo Formation, which is of 16.5 ± 0.3 and 17.4 ± 0.3 Ma (Ferrusquía-Villafranca *et al.* 1974), thus placing the Etla Ignimbrite Member in the same time intervale that Suchilquitongo l. f., notwithstanding the fact that seemingly this member is stratigraphically about 82 m above the fossil-bearing beds (Wilson and Clabaugh, 1970, p. 126). However, there is no physical continuity between the outcrops where radiometric samples and the fossils were collected.

THE MATATLAN LOCAL FAUNA, UNNAMED FORMATION, (PROBABLY) MEDIAL MIOCENE, OAXACA

GEOLOGIC SETTING

The area lies in the Tlacolula-Mitla-Matatlán valley and surroundings (Figure 3); no detailed published geologic information is available and, for this reason, the summary presented below was prepared from the compilations by López-Ramos (1974b) and INEGI (1982e), supplemented by the observations of the author. The oldest unit consists of light to dark gray,

medium to thickly bedded biomicrite and marl tentatively assigned to the Aptian-Albian; it is overlain by cream color, thin to thickly bedded biomicrite and marl, also tentatively assigned to the late Cretaceous; both are complexly folded and faulted.

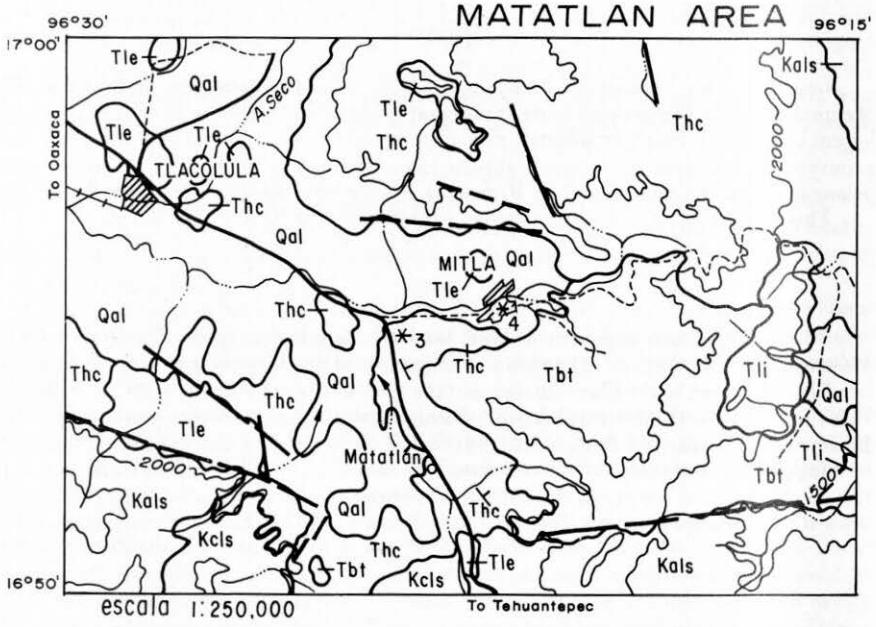

Figure 3.— Geologic map of the Matatlán Area, Oax. (Modified from López-Ramos, 1974b and INEGI, 1982e). For legend see Figure 1.

The Cenozoic sequence unconformably rests on the Cretaceous bodies, its lower portion includes fluviatile tuffaceous sandstones and silstones seemingly covered by silicic tuffs and ignimbrites that make up the top of mesas and low rolling hills. This portion closely resembles the Suchilquitongo Formation, but the lack of physical continuity and of detailed geologic work, renders futile any attempt to formally recognize this unit in the Matatlán area. The apparent lack of lacustrine sediments in Matatlán is an important difference though. From tuffaceous sediments near Matatlán, a small mammal assemblage comparable to that of Suchilquitongo allows dating this part of the sequence as Miocenee. A small dioritic body intrudes the sequence in the eastern part of the area. The upper portion consists of basalt and andesite flows and rhyolite domes. Quaternary alluvium forms the valley floor.

THE MATATLAN LOCAL FAUNA

The fauna was collected on road cuts and outcrops close to the Panamerican Highway, around the Matatlán valley. The lithologyy is similar to that of the Suchilquitongo Formation,

but no physical continuity exists for the red beds in both areas, which are at least some 70 km apart. The mammal remains are scarce and include rhinocerotids, equids and tylopodans.

Order PERISSODACTYLA Owen, 1848
Suborder CERATOMORPHA Wood, 1937
Family RHINOCEROTIDAE Owen, 1845
Genus et species indetermined

Referred Material

IGM3961, enameled molar fragments; IGM-3962 and IGM-3963, *idem*.; all fragments were collected by John A¿ Wilson and the author on the nothern road cut outcrops at Km 63.7 of the Panamerican Highway, section city of Oaxaca-Tehuantepec, on March 24, 1969.

Description

IGM-3961 includes a large molar fragment covered with enamel 2.9 mm thick, curved; the other fragments are dentine ones, large, just as thick and were found close together, suggesting that they are the weathered remains of a large tooth.

Discussion

No other mammals were found at Matatlán that would have such large molars with 2.9 mm thick enamel. The thickness of the enamel cover in the Miocene rhinoceroses *Menoceras* and *Diceratherium* is 2.8 to 3.1 mm, as disclosed by measurements of several specimens housed at the American Museum. By contrast, the proboscidean molars, such as those of *Mastodon*, have enamel covers 6.0 to 8.0 mm thick. Consequently, the author interprets these specimens as belonging to a Rhinocerotidae. The Suchilquitongo record of rhinocerotids lends additional support to this assessment.

Suborder HIPPOMORPHA, Wood, 1945
Family EQUIDAE Gray, 1821
Genus *Merychippus* Leidy, 1857
Merychippus sp.
(Plate 2, figures 1ı15, Table 5)

Referred material

IGM-3964, left humeral mesial condyle; left radial fragments: proximal end, proximal and distal shaft, and distal end; left III metacarpal fragments; proximal shaft and distal end. The material was collected by Mr. Julio Mateos, at a depth of 6 to 8 m while digging a water well at his property located in Morelos 24, Matatlán village. Matatlán lies on tuffaceous strata similar to those cropping out along Panamerican Highway Oaxaca-Tehuantepec section, Km

50-70, where the other material was found. Mr. Mateos gave the material to Dr. J. A. Wilson in April, 1969, who turned it over to the present author for study later that year.

Table 5.— Measurements of IGM-3964, appendicular fragments referred to *Merychippus* sp., and of a selected species of this genus.

	A	B
HUMERAL MESIAL CONDYLE		
Ant-post. diameter	26.0	—
Transverse diameter	18.0	—
Apparent height	19.0	—
RADIAL FRAGMENTS		
PROXIMAL END		
Glenoidal face, maximum length	33.8	33.0
maximum width	19.0 (across the facet for the mesial condyle)	17.4
DISTAL END		
Articular face, maximum length	31.3	30.5
maximum width	18.0 (across the carporadial facet)	18.5
SHAFT SEGMENT		
Transverse diameter	21.2	22.0
Anteroposterior diameter	14.5 (perhaps a bit more, because the posterior face is slightly broken)	16.2
METACARPAL III SEGMENTS		
DISTAL END		
Condylar face, maximum length	19.6	19.5
maximum width	15.2	15.9
SHAFT SEGMENT		
Transverse length	16.5	15.5
Ant-post. diameter	13.0	11.4

A, IGM-3964, *Merychippus* sp. B. AMNH 11146-206, referred to *M. primus*.

Description

Humeral fragment: It is the complete left mesial condyle broken right at the median sulcus that separates it from the lateral condyle, and broken also in a virtual oblique plane that included the distal ends of the coronoid and olecranon fossae (Plate 2, figures, 9, 10). The articular surface of the condyle narrows toward the coronoid fossa (Plate 2, figure 9), whose lateral outlet is very narrow; laterally, the most conspicuous feature is a rather deep fossa for the mesial ligament, whereas the corresponding epicondyle is not prominent (Plate 2, figure 11).

Radial fragments

Three fragments of the left radius are present (Plate 2, figures 1-8). The proximal end (*idem.* 1, 4, 8) is ovoid in cross section, its glenoid cavity shows the facet for the mesial cond-

yle much greater than that for the lateral one (*idem.* 8), in the same fashion that in a modern horse; however, the tuberosities for the ligaments and brachial muscles are less well developed; it is noteworthy that the sulcus for the brachialis extremity is very small and shallow (*idem.* 4).

The distal end (Plate 2, figures 3, 6, 7) is broken in the ventral or posterior face (*idem.* 6); the articular facets for the carporadial and the intermedius are complete and typically equine (*idem.* 7), and for the carpocubital are partly broken; on the anterior face, the sulci for the tendons of the carporadialis and the communis digitalis extensors are proportionally shallower than in modern horses (*idem.* 3); the tuberosities are also less prominent.

The shaft fragment (Plate 2, figures 2, 5) is spatially very close to the distal end, and its posterior face is broken too.

Metacarpal III: Two fragments of the left third metacarpal are present (Plate 2, figures 12-15). The distal end is ovoid in cross section, its condyles are nearly the same size (*idem.* 13, 15), from their outer margin two prominent crests —directed downward— occur; the mesial condylar crest does not reach the anterior third of the condylar surface, thus suggesting that the front limb gait ought to have been slightly oblique —forwardly— rather than straight as in a modern horse (*idem.* 13); in fact, the condylar surface anteriorly ends in a shallow depression that probably functioned as a brake for the phalangial rotation.

The shaft fragment is spatially closer to the distal end, and planoconvex in cross section, with the flat portion in the posterior face (*idem.* 14); posterolaterally, it shows the facets for the II and IV metacarpals; both are separated by a rather wide and shallow sulcus for the suspensorium ligament.

Discussion

The material was compared to the extensive series of merychippine limb elements of the American Museum collection; a very close fit in size, morphology and proportions was found between the Matatlán specimens and those referred to *Merychippus primus,* particularly AMNH 1146-206 Ts (1938), left radio-ulna complex; and AMNH 624 S23, left III metacarpal; both from the Hemingfordian Sheep Creek Formation, Thompson Quarry, Sioux County, Nebraska. The fit is so close (*cf.* Table 5), as to represent virtual identity; the lack of diagnostic material, however, calls for caution, and the specimenss are best referred to cf. *Merychippus* sp.

This genus spanned the Hemingfordian to the Clarendonian in North America, hence its record in Matatlán, falls within this intervale.

Order ARTIODACTYLA Owen, 1848
Infraorder TYLOPODA Illiger, 1811
Family CAMELIDAE Gray, 1821
Genus et species indeterminatae
(Plate 2, figures 16-18, Table 6)

Referred material

IGM-3965, right astragalus collected by Mr. Julio Mateos at the same locality that IGM-3964.

PLATE 2

THE MATATLAN LOCAL FAUNA, UNNAMED FORMATION, (PROBABLY) MEDIAL MIOCENE, OAXACA

Figures 1-15.— Referred material to *Merychippus* sp.: 1-15, IGM-3964, limb bone fragments; 1, left proximal radial fragment, anterior view; 2, left medial (shaft) radial fragment, anterior view; 3, left distal radial fragment, anterior view; 4, same as 1, posterior view; 5, same as 2, posterior view; 6, same as 3, posterior view; 7, same as 3, distal view; 8, same as 1, proximal view; 9, left humeral mesial condyle, distal view; 10, *idem.*, broken surface; 11, *idem.*, articular surface; 12, left mesial (shaft) III metacarpal fragment, anterior view; 13, left distal III metacarpal fragment, anterior view; 14, same as 12, posterior view; 15, same as 13, posterior view.

Figures 16-18.— Referred material to Camelidae Gen. et sp. indet.: 16, IGM-3965, right astragalus (nearly complete), superior (or dorsal) view; 17, *idem*, lateral view; 18, *idem.*, inferior (or ventral) view.

Figures 19-20.— Referred material to ?Tylopoda Fam., Gen. et sp. indet.: 19, IGM-3966, edentulous right mandibular fragment with the alveoli of P_2, and the anterior root of P_3, internal view; 20, *idem.*, occlusal view.

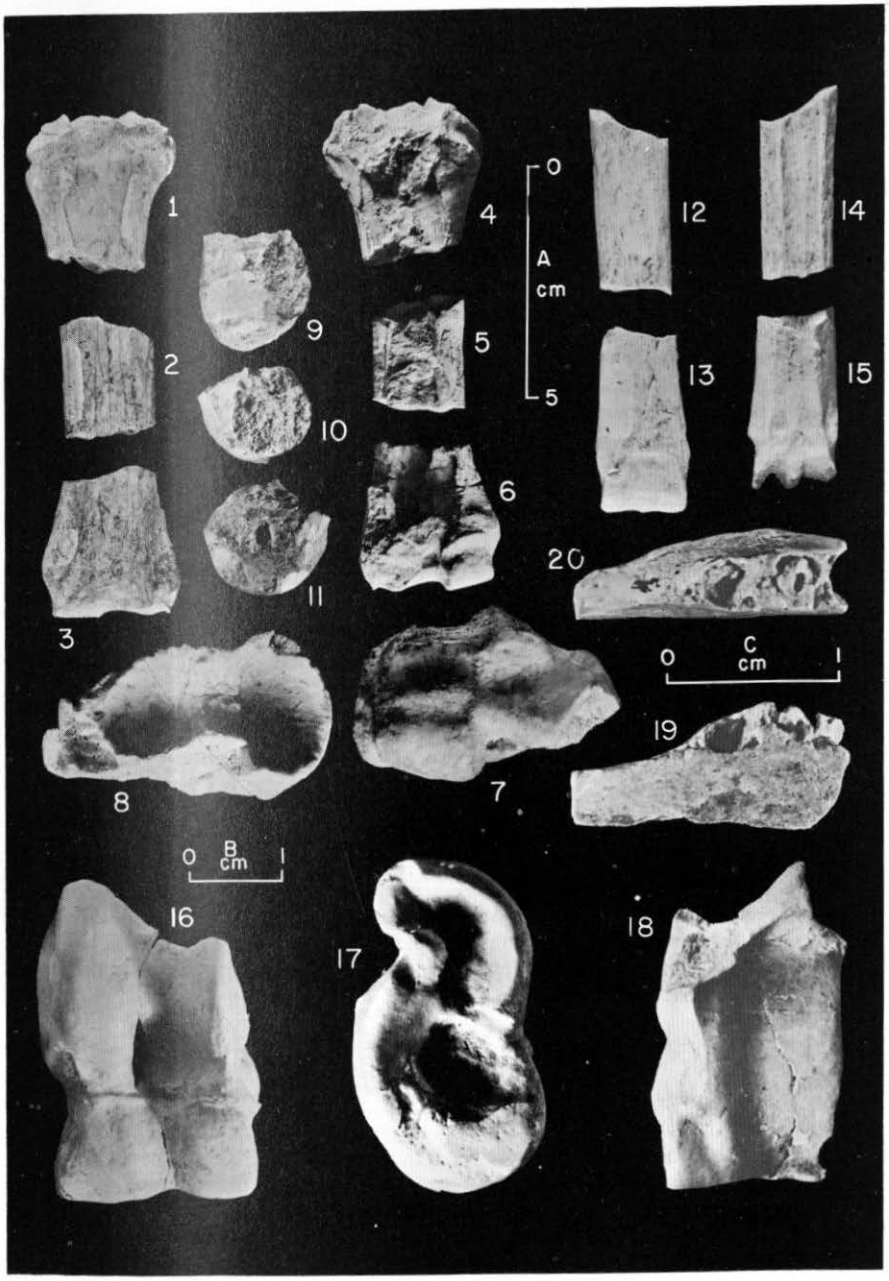
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Table 6.— Measurements of right astragali of selected camelids and of *Paratoceras wardi.*

Measurements	A	B	C	D
Greatest length	37.0	39.0 - 50.0	29.5	29.5
Mesial lateral width	22.5	23.0 - 30.0	16.8	17.5
Greatest dorsoventral distance	19.7	18.0 - 25.0	16.3	17.0

Data source: IGM-3965, Camelidae Gen. et sp. indet. B, UCMP-37236, astragali lot referred to *Oxydactylus* sp., observed range. C, AMNH-40865, referred to *Paratoceras wardi.* D, AMNH-40866, *idem.*

Description

The astragalus is nearly complete, so that only the medial crest of the tibial trochlea is lacking (Plate 2, figure 18); its size is slightly larger than that of a goat, sheep or a white tail deer, but smaller than than of a guanaco (*cf.* Peterson, 1904, p. 467). Proximally the tibial trochlea is the dominant feature, its lateral crest (=condyle) is much larger than than the medial one (Plate 2, figure 18) in a typical cameline fashion; the median sulcus is broad and deep, ending inferiorly in the fossa for the tibial mesial malleolus; the narrow medial condyle ends downward in a prominent facet that stops the gliding of the tibial medial malleolus. The naviculo-cuboid trochlea has its lateral (=cuboid) condyle slightly wider than the mesial (=navicular) one, and it is separated from this by a very shallow median sulcus. The naviculo-cuboid trochlea ends distally on the sustentacular (=calcasneal) facet, by means of a faint ridge that is transverse to the navicular condyle and oblique to the coboid one, ending some 9 mm more proximally, *i.e.*, above the starting point.

The sustentacular facet is the chief feature of the plantar (Plate 2, figure 18) face, it is convex, has a very shallow medial sulcus, and shows no subsustentacular fossa as *Camelops* does (Webb, 1965, fig. 15c). Laterally three distinct articular facets are discernible (Plate 2, figure 17): The side of the lateral tibial trochlear condyle shows a narrow fibular facet devoidad of a fibular salient (Webb, 1965, fig. 15, a); opposite to it there is a wide parasustentacular facet, terminated proximally by a small prominence that stops fibular gliding; distally appears the distal astragalar facet, located on the side of the navicular condyle, for the corresponding calcaneal facet. A deep and wide sulcus separates the fibular and parasustentacular facets, and a deeper, circular fossa separates the latter from the distal astragalar facet; it serves as an anchorage for the branches of the lateral ligaments. Medially there are two smooth facets, one occupies the side portion of the medial tibial trochlear condyle, and shows distally a prominent medial tibial malleolus; opposite to it, there is a smooth quadrangular surface for the tibial ligament (Webb, 1965, fig. 15, b), and it bears three small, lengthwise aligned nutritious foramina.

Descussion

It is always difficult to identify a mammal on postcraneal material alone. The specimen is an astragalus of a medium sized artiodactyl. In the area oreodonts, protoceratids and camels have been recognized; hence, comparisons with astragali of these groups are in order.

Oreodont astragali have different overall shape and proportions than the Oaxacan specimen. Camparisons with the astragalus of *Oxydactylus, Camelops,* and other camelid genera as described by Peterson (1904) and Webb (1965), further strengthens the opinion that the

Oaxaca specimen belongs to a small sized camel. The cameline astragalus seems to be more elongated, and to have the lateral crest of the tibial trochlea signficantly broader than in other artiodactyls. The Oaxacan specimen shows both characters, thus suggestion cameline membership.

Comparisons with the Protoceratidea indicates that *Prosynthetoceras* has a significantly smaller astragalus than the Oaxacan one. *Paratoceras wardi,* as represented by AMNH 40865 and AMNH 40866, from the early Barstovian Upper Flemming Formation, Texas Gulf Coastal Plain, has some 25% smaller astragali than the Oaxacan specimen (Table 13).

Comparisons with *Oxydactylus* as represented by UCMP-37236 an astragali lot from the Havorka locality, Marsland Formation, Hemingfordian, Box Butte County, Nebraska, indicate that the Oaxacan specimen is just in the lower limit of the size-range observed for this lot (Table 16); IGM-3965 differs from the astragali of this collection in being narrower transversely, and in having a much narrower trochlear fossa. Similarly, the Oaxacan specimen is of the same size and morphology as the astragali of other small camels such as *Michenia* or *Protolabis;* consequently, its identification beyond family is unwarranted.

Infraorder TYLOPODA Illiger, 1811
Infraorder TYLOPODA?
Family, genus et species indeterminatae
(Plate 2, figures 19, 20, Table 7)

Referred Material

IGM-3966, edentulous, right mandibular fragment, collected by Ismael Ferrusquía by Km. 50 of the Panamerican Highway, section city of Oaxaca-Tehuantepec, 50 m south of the Matatlán town sign from light colored, silty tuffaceous sediments belonging to an unnamed formation.

Table 7.— Measurements of IGM-3966, right mandibular fragment referred to ?Tylopoda Fam., Gen. et sp. indet., of selected tylopodans and of *Blastomeryx elegans.*

Measurements	A	B	C	D
Mandibular border trickness at P_2 alveoli	5.7	5.6	5.0e	4.0
Combined alveolar length for P_2	5.7	8.0	12.0e	4.0

A, IGM-3966, ?Tylopoda Fam., Gen. et sp. indet. B, AMNH 40249, referred to *Paratoceras wardi.* C, CM 918, Holotype of *Oxydactylus longipes;* data from Peterson (1904, plate IV, fig. 4, p. 446). D, AMNH 52955, referred to *Blastomeryx elegans.* e, estimated.

Description

The fragment is the anterior part of the mandibular ramus bearing the diastema and two and a half alveoli (Plate 2, figures 19, 20); the ventral border is missing. The labial face

is convex lengthwise and the lingual one is flat. The occlusal border is nearly straight and the diastema makes a very small angle with the occlusal line. The first alveolus is partly broken, directed anteroventrally and bears a small, dental base ("root"), whose cross section is semicircular anteriorly and flat posteriorly (*idem.* 20). The second alveolus is smaller, ovoid, with the larger diameter transverse to the antero-posterior ramus axis; it also bears a "root" that shows up on the lower side; this "root" is also ovoid and open. The third alveolus, only represented by its anterior half, is much larger than the second one; these last two are directed ventrally.

Discussion

Artidocatyls —suiformes and oreodonts excepted— have a well developed diastema. The Traguloidea such as *Blastomeryx elegans* (AMNH 52955) have a diastema sharply directed downward, not at all in a straight line with alveolar border of the horizontal ramus, as it is the case with the Matatlán specimen; so it is not a traguloid.

Comparison with the Tylopoda indicates that the fragment resembles best the Protoceratidae rather than the Camelidae. *Paratoceras wardi* as represented by AMNH 40249, from the Hemingfordian Flemming Formation, Texas Gulf Coastal Plain, has its corresponding part of the mandible (viz. the diastemal-P_2 alveolar region) of similar shape (diastema straight) and size (Table 7, thickness 5.6 mm vs. 5.7 in the Matatlán specimen). It differs from IGM-3966 in that the alveoli are much larger, ovoid and very close to each other. Other *Paratoceras* specimens, juvenile ones such as AMNH 40759 and CRQ 89.2567 from the same area, resemble the Matatlán specimen in size and morphology, but differ in details of the alveoli —either size or shape—, which are certainly larger. The above facts indicate that IGM-3966 most probably is a Tylopoda, but its familial allocation must remain open.

AGE

The paleontological evidence alone indicates that the fauna falls within the chronologic range of *Merychippus,* its only taxon identified (tentatively) to the generic level, *i.e.,* within the late Hemingfordian-Clarendonian time span.

THE EL GRAMAL LOCAL FAUNA, UNNAMED FORMATION, MEDIAL MIOCENE (BARSTOVIAN), OAXACA

GEOLOGIC SETTING

The area lies in the Nejapa valley, Isthmus of Tehuantepec region (Figure 4). Only general information is available (López-Ramos, 1974b; INEGI, 1982e, 1982g), which was supplemented by the author's observations to prepare the summary below. The oldest unit consists of silicic metatuffs with a dominant foliation direction of N50°E, its precise age is unknown, but should it prove to be a part of the Oaxacan Complex, it would be of late Proterozoic age.

The Cenozoic sequence occupies most of the area, and includes, according to INEGI, continental clastics and tuffs in the eastern part, rhyolites in the western part and Quaternary sediments in the northeastern one (Figure 4). Work now in progress shows that the first unit is largely restricted to the lower parts of the area; it includes light brown to pink, crystalvitric, medium grained, friable silicic tuff; interbebbed by light brown to cream color, coarse grain-

ed, cross-bedded, mediumly stratified arkosic sandstone, light greenish-brown, poorly consolidatedf silstone and chloritic clay; the sequence becomes sandier upward; the lower contact is not exposed; the estimate thickness is 60 to 90 m. Two small mammal assemblages were collected from this unit at localities near the villages of El Gramal and El Camarón, and were dated as late medial Miocene.

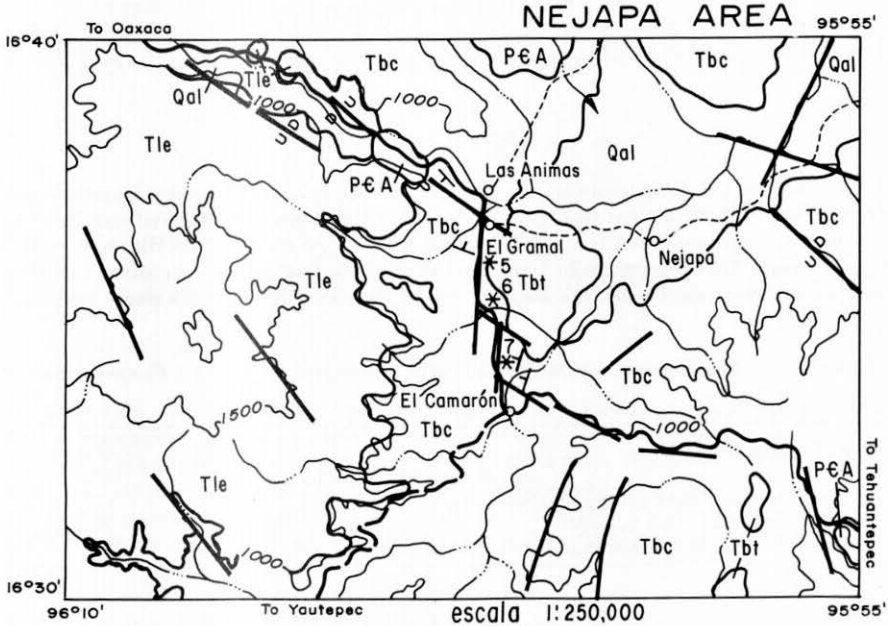


Figure 4.— Geologic map fo the Nejapa Area, Oax. (Modified from López Ramos, 1974b; and INEGI. 1982e and 1982f). For legend see Figure 1.

The rhyolite makes up most of the mountains; it consists of dark pink, vitriclithic, coarse to lapilli-size grained, well indurated, thickly bedded rhyolithic tuffs and ignimbrites, superficially resembling flows; several cooling units were observed; the estimated thickness is of 150 to 200 m;, its precise age is unknown. The contact with the clastic unit is by faults.

Block faulting affects the Cenozoic sequence, so that 20 to 35° dips and even vertical beds are frequently observed. Quaternary alluvium occurs chiefly in the Nejapa Valley.

THE EL GRAMAL LOCAL FAUNA

Stirton (1954) described the first pre-Hemphillian terrestrial mammals from Mexico: *Merychippus* sp. and *?Oxydatylus* sp. Wilson (1967) added *Gomphotherium* sp. and a ?Protoceratidae Gen. and sp. indet., and named the assemblage the El Gramal local fauna. Additional

material was collected by Wilson and Frrusquía-Villagranca in 1969, which was preliminarily discussed by the author in 1984; in the same year more material was found by Messrs. D. Hernández-Láscares, H. Barrios-Rivera and this author, which together with the former is described below.

Order PROBOSCIDEA Illiger, 1811
Family Gomphoteriidae Cabrera, 1929
Genus *Gomphotherium* Burmeister, 1837
Gomphotherium sp.
(Plate 3, figures 1-3, Table 8)

Referred material

IGM-3968, a tusk tip (probably the upper left); IGM-3969, tusk fragment found associated to -3968; IGM-3970, other smaller associated tusk fragments. The material was found by the present author on the eastern outcrop at Km 126.5 of the Panamerican Highway, section city of Oaxaca-Tehuantepec, about 1 km south of the El Gramal bridge, on coarse to medium grained tuffaceous sandstones. It is assumed that all fragments belonged to a single individual.

Table 8.— Measurements of IGM-3968 and -3969, tusk fragments referred to *Gomphotherium* sp.

Tusk-tip fragment-lenght	98.0
" " " -maximum width of enamel band	23.0
Angle of the enamel band and the abrasion surface	120°
Trickness of the other tusk fragment	26.0
Estimated diameter of the tusk fragment	94.0

Description

IGM-3968, the tusk tip fragment is 98 mm long, its greatest diameter is of 32 mm, (Table 8), is bluntly conical and shows a flat abraded surface set nearly at a right angle to the flat surface covered by a thin enamel band (Plate 3, figures 1, 2). Only the tip of the cone is complete and shows no enamel cover. IGM-3969 is a cylindric segment 50 mm long and estimatedly 94 mm in diameter, its true thicknees is only 26 mm, and shows a central lumen at least 45 mm in diameter (Plate 3, figure 3); this fragment has no enamel cover nor abrasion marks. The other fragments are too small to merit individual description.

Discussion

The anatomical identification of tusk fragments is problematical; however, comparison of these with several Miocene and Pliocene gomphothere specimens housed in the American Museum of Natural History and the Museum of Paleontology of the University of California at Berkeley, suggests that the tusk tip fragment probably corresponds to the upper left tusk, which seems to be frankly conical, whereas the lower ones are more cylindrical, and less conical at the tip; further, IGM-3968 matches the upper left fragment of UCMP-38645, referred

to *Pliomastodon nevadensis* from the Hemphillian Smith Valley Beds, Lyon County, Nebraska. The enamel band is a diagnostic character of *Gomphotherium* (*cf.* Hay, 1925; Osborn, 1936); its presence on IGM-3968 idnicates that it belonged to a member of a species referable to this genus. IGM-3969, another tusk fragment, suggests that this tusk is not as large as those of the Clarendonian and Hemphillian species of *Gomphotherium*, which have tusk diameters of 120-150 mm or even more. The interpretation of this difference is uncertain, because the exact position of the fragment in the tusk is unknown.

To conclude, it seems safe to assign this material to *Gomphotherium* sp. The chronostratigraphic range of *Gomphotherium* in North America spans the late Barstovian to the latest Hemphillian (Hay, 1925; Osborn, 1936; Savage and Russell, 1983; Tedford *et al* 1987).

Order PERISSODATYLA Owen, 1848
Suborder Hippomorpha Wood, 1937
Family EQUIDAE Gray, 1821
Genus *Merychippus* Leidy, 1857
Merychippus (sensu lato) sp.
(Figure 3, Plate 3, figures 4-5, Table 9)

Referred material

IGM-3971, upper right molariform tooth collected by I. Ferrusquía-Villafranca at the same locality that IGM-3968.

IGM-3972 A and B, molariform fragments collected by D. Hernández-Láscares and H. Barrios-Rivera in an outcrop at Km 125.2 of the Panamerican Highway, section city of Oaxaca-Tehuantepec, some 250 m north of the Arroyo El Gramal bridge. This locality as well as that of IGM-3971 are different from those described by Stirton, 1954, but all lie in the El Gramal vicinity.

Description

IGM-3971 is incomplete, missing the protocone and the proto- and metalophs (Plate 5, figures); the occlusal pattern suggests that the tooth is probably an M^1 or M^2. The preservation is moderate, most of the enamel cover is gone; the internal border is smooth, suggesting abrasion (transportation?) before burial. The tooth is hypsodont, in size (Table 9), comparable to that of a small species of *Merychippus*, such as *M. primus (cf.* Osborn, 1918, fig. 78; Stirton, 1940, fig. 18) or *M. seversus (cf.* Osborn, 1918, fig. 74), but its occlusal pattern is complex however, suggestive of a highly advanced species of this genus (Figure 5, Plate 3, figure 5).

The ouststanding features of the occlusal patterns are the complex plications of the fossettes, which are more numerous and better developed than in any other species of *Merychippus (cf.* Osborn, 1918; Stirton, 1940; Quinn, 1955; Storer, 1975, *et cet.*), and are reminiscent of the condition observed in the advanced hipparionine horses (Skinner and Taylor, 1967; Skinner and MacFadden, 1977; Mac-Fadden, 1984). The prefossette shows a tiny pliprotoloh (Figure 5), and numerous plications on its posterior margin, marked Pf-I t Pf-VI on Figure 5. Pf-I and -II are simple invaginations that almost touch the paracone; Pf-III is forked, its labiasl arm (Pf-IIIA) is shorter and continuous, whereas the labial arm (Pf-IIIB) has the tip isolated, forming a pillar; Pf-IV is the shortest; Pf-V is as large as Pf-I; Pf-VI is the largest

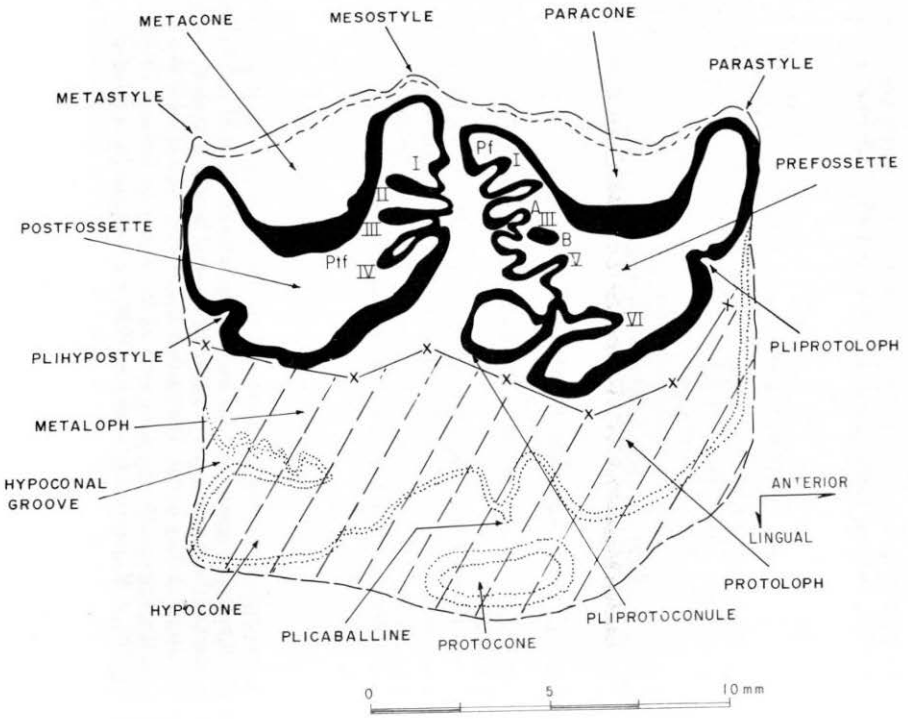


Figure 5.— Restored IGM-3971, right upper molariform referred to *Merychippus (s. l.)* sp., occlusal view. Hatchured pattern indicates missing part of the tooth. *Abbreviations:* Pf, prefossette plications I-VI; Ptf, post-fossette plications I-IV.

and it is separated from Pf-V by the large pliprotoconule, a globous evagination of the fossette margin still attached to it by a narrow enamel wall. The postfossette is somewhat smaller, has a small plihypostyle, and its anterior margin has four plications, marked Ptf-I to Ptf-IV on Figure 15. All are simple invaginations, Ptf-I is the smallest; Ptf-II to -IV are nearly of equal size; the first two are directed posteriorly and the last is posterolingually oriented. The fossettes are separated by a narrow median valley. The plication complexity probably increased the grinding efficiency of the tooth.

The fragment IGM-3972A is part of the ectoloph, shows a well developed mesostyle and a very weak protostyle that curves downward and posteriorly to meet the mesostyle in a typical merychippine fashion; the shape of the fragment fits closely that on the upper right M^1 or M^2.

The other specimen, IGM-3972B is a small part of a lower right molariform; it shows a portion of the metalophid, the ectoflexid and just the posterior end of the hypoflexid. The enamel is 1.3 mm thick and suggests a high degree of hypsodonty.

Discussion

This is the third record of *Merychippus* from the El Gramal local fauna; hence, a detailed comparison with the previous records is necessary. Stirton (1954) described and figured UCMP-42293, a palate fragment with right I^{1-3}, C, P^2-M^3 and left I^{1-3}, C. P^{2-3}. The specimen as of 1984 remains largely unprepared; the matrix is olive green rather than pink which is the dominant color of the beds at the IGM-3971 locality, so clearly both specimens come from different strata within the El Gramal vicinity. Lack of stratigraphic control prevents knowing whether such strata are above or below those of the IGM-3971 locality. A detailed description of UCMP-42293 is out of place here, and only a general description of P^3-M^2 will be given. The occlusal pattern can only approximately be discerned because of wear. The chief features are a broad ectoloph; narrow, crescentic fossettes with simple unplicated margins; only M^1 shows a remnant of the plicaballin-crochet complex, viz. a cuspule near the posterior arm of the prefossette; the styles are moderately developed, but the metastyle is weakly developed (M^2 and M^3) to nearly lacking (P^3-M^1).

The results of the comparison are: The size of IGM-3971 is only slightly smaller than the one of the UCMP-42293 molariforms, as shown in Table 9; the -3971 has a highly plicated fossette margin not seen in -42293; other features are also different. Under these conditions, two alternative interpretations are possible: (1) The differences are interpreted as intrasecific variation, and explained by age, sex, individual or a combination of the above factors. (2) The differences are interpreted as specific. Since it would be little probable that two species of horses would share the same ecological resources, the first alternative seems more probable.

Wilson (1967) described an M^3(IGM-6845) collected from the same area; it shows moderate wear, is as large, but of simpler occlusal pattern than IGM-3971, and very similar to the corresponding tooth in the specikmen described by Stirton (1954). Hence, it is very probable that UCMP-42293 and IGM-6845 are conspecific.

IGM-3972A and -3972B are very small for positive identification, however, enough remains to discern their merychippine pattern, and it seems appropriate to lump them together with the other material from El Gramal, as representing a single species. So assuming, the following assertions apply:

a) The specific identification rests chiefly on IGM-3971, because it best preserves the occlusal pattern.

Table 9.— Measurements of IGM-3971, upper right molar referred to *Merychippus (s. l.)* sp., and of selected species of this genus.

Measurements	A	B	C	D	E	F	G	H	I
M^1									
Anteroposterior length	(16.4)*	17.5	—	17.0e	20.0e	—	16.5e	19.5e	19.0e
Transverse width	—	22.5	—	18.0e	19.0e	—	18.5e	22.0e	22.0e
Crown height	(28.0)	—	—	14.5e	39.0e	—	20.0e	—	—
M^2									
Anteroposterior length	(16.4)	17.0	—	16.5e	—	17.0e	—	21.0e	20.0e
Transverse width	—	22.3	—	16.0e	—	17.0e	—	21.0e	21.0e
Crown height	(28.0)	—	—	16.5e	—	27.0e	—	—	—
M^3									
Anteroposterior length	—	21.0	14.0e	14.5e	—	—	19.5e	19.0e	14.5e
Transverse width	—	22.0	14.5e	13.5e	—	—	17.0e	—	18.0e
Crown height	—	—	26.0e	24.0e	—	—	—	—	—

A, IGM-3975, rigth upper molariform referred to *Merychippus (s. l.)* sp.

* This specimen might be M^1 or M^2, to ase comparisons hence its measurements, bracketted by parenthesis, were placed in both positions. B, U.C. Mus. Pal. no. 42293, referred to *Merychippus* sp. C, IGM-6845, referred to *Merychippus* sp.; this is the Wilson specimen; data from Wilson (1967, fig. 1). D, Amer. Mus. 14187, Holotype of *Merychippus primus;* data from Osborn (1918, fig. 78). E, *Merychippus insignis;* data from Stirton (1940, fig. 22). F, Am. Mus. 8180, probable M^2, Holotype of *Merychippus seversus;* data from Osborn (1918, fig. 74). G, Am. Mus. Cope Coll. 8673, Holotype of *Merychippus relictus;* data from Osborn (1918, fig. 73). H, U.S. Natl Mus,. 2572, Holotype of *Merychippus calamarius;* data from Osborn (1918, fig. 98). I, Amer. Mus. 8347, Holotype of *Merychippus republicanus,* data from Osborn (1918, fig. 99).

b) The degree of hypsodonty and basic occlusal pattern, with numerous plications, large round pliprotoconule and small pliprotoloph and plihypostyle indicates that very probably, this represents a fairly advanced species of *Merychippus.*

c) The degree of hypsodonty and complex plication of the fossettes approaches the condition seen in the hipparionine horses, but it does not so happen with the pliprotoconule, pliprotoloph and plihypostyle, To sum up the Oaxan species is closer *to Cormohipparion goorisi* than to any other hipparionine species, but it is clearly not conspecific to it.

It appear then that the Oaxacan species very probably is an undescribed species of *Merychippus,* approaching in some regards the odontographic condition observed in the hippartionine horses, and provides a tantalizing, albeit small testimony of the changes involved; but it is too incomplete a sample of this dynamic population to merit formal specific or generic. recongnition. Because of this and to avoid nomenclatorial confusion, IGM-3971, -3972A and -3972B (and by implicación UCMP-42293, the Stirton specimen, and IGM-6845, the Wilson specimen), are formally referred to *Merychippus sensu lato* sp.

The geologic age of the specimen, judging by its degree of hypsodonty, and particularly by the complexity of the fossette configuration, strongly suggests that it can not be older than Barstovian; in fact, in this last regard it reaches the stage of developmet seen in the Clarendonian hipparionines. Both Stirton (1954) and Wilson (1967) tentatively assigned their records of *Merychippus* to the Barstovian.

At any rate, the Oaxacan record of *Merychippus* is the southernmost one for this genus in North America; its closets correlatives are in the Texas Gulf Coastal Plain, some 2,000 km to the north.

Order ARTIODACTYLA Owen, 1848
Suborder *Typolopoda* Illiger, 1811
Family CAMELIDAE Gray, 1821
Genus et species indeterminata
(Plate 3, figures 6-13, Tables 10, 11)

Referred material

IGM-3973, left, edentulous mandibular fragment bearing the roots and alveoli of C. P_1-P_4 . It was collected by John A. Wilson in the same outcrop that yielded IGM-3968 and -3969; IGM-3974 A and B, two tooth fragments collected at the same locality that IGM-3968 by the present author in August,1984; and IGM-3975, right calcaneum collected by H. Barrios-Rivera at the same locality that IGM-3968.

Description

The horizontal ramus fragment is abraded so that the broken edges are smooth, suggesting moderate transport (Plate 3, figure 6, 7). The most conspicuous character is the diastema where the ramus is slenderest. The oclussal border bears seven and a half alveoli, some filled with roots (Plate 3, figure 7). The first is the largest and it is interpreted as the canine; the ramus is broken off anterior to it. The remainder six are interpreted as those of P_2, to P_4, *i. e.,* two alveoli each. The half alveolus is larger than the six mentioned, and it is interpreted as belonging to M_1. The diastema length is estimated in 23 mm (Table 10. The lower part of the ramus is missing, hence the depth of the horizontal ramus and the shape of its lower border can not be established.

Table 10.— Measurements of IGM-3973, left mandibular fragment referred to Camelidae Gen. et sp. indet., and of selected camelids.

Measurements	A	B	C	D	E
C*					
Anteroposterior length	7.3+	7.5	12.0e	8.3	6.8 - 12.1
Transverse width	4.5+	4.3	6.0e	4.4	—
C - P_2 diastema	23.0	22.4	45.0	19.0	66.0 - 72.0e
P_2					
Anteroposterior length	10.5+	6.0	10.0	12.8	5.0 - 7.7
Transverse width	5.5+	—	5.0	5.2	3.2 - 4.2
P_3					
Anteroposterior length	9.1+	—	12.0	12.5	8.5 - 11.4
Transverse width	5.1+	—	5.0	5.2	4.5 - 5.6
P_4					
Anteroposterior length	11.0+	—	12.0	15.0	10.3 - 13.1
Transverse width	6.7+	—	7.0	7.0	5.7 - 8.0
mandibular thickness at canine	11.0	—	—	8.0	—
Mandibular thickness at diastema	8.0	—	—	7.0	—
Mandibular thickness at P_3	9.6	—	—	7.5	—
Mandibular thickness at P_4	11.0	13.0	15.0e	8.5	—

A, IGM-3973, cf. Camelidae Gen. et sp. indet. B, AMNH 42018, *Protolabis* sp. C, CMNH 918, Holotype of *Oxydactylus longipes;* data from Peterson (1904, p. 446, plate IV, fig. 4). D, UCMP-37193, *Oxydactylus* sp. E, *Protolabis coartatus,* observed range; data from Honey and Taylor (1978, table 4, figs. and d). *, this tooth has also been interpreted as P_1. +, measured at alveous. e, estimated from the illustration.

IGM-3974A is a small fragment of a bladed tooth, 9.0 mm long, 5.0 mm wide and 4.3 mm thick; one of the surfaces, interpreted as the labial one, is gently convex (Plate 3, figure 8, 10), while the other, interpreted as the lingual surface, is strongly concave toward the margin and convex again away from it (Plate 3, figure 9), thus defining a vertical columnar structural reinforcement. The edge is sharp, its margin is intact and laterally defines a trapezoid, being straight for the two basal thirds of its length, and then gently curving to the apex.

The other specimen, IGM-3974B, is irregularly prismatic, consisting mainly of a 9.0 by 5.0 mm block of dentine, covered by a 1.0 mm thick sheet of enamel.

IGM-3975 is nearly complete, missing only part of the body and the articular facet for the cuboid (Plate 3, figures 11-13). The corpus calcanei has an elliptic outline, wider toward the plantar side. The sustentaculum is moderate, two thirds as long as the antero-posterior "width" of the bone at this level (Plate 3, figure 12), this is a diagnostic camelid feature. The astragalar apposition (*i.e.,* the part of the calcaneum distal and lateral to the sustentaculum) has a triangular outline, with one of the vertices as the distalmost part of the calcaneum; here there is a prominence for the external ligament. The astragalar appositon has a deep articular facet for the tibiofibular malleolus. The cuboid articular facet is large, in a typical camelid fashion (*cf.* Webb, 19655, p. 30).

Discussion

IGM-3973 shows enough morphological features to safely ascertain its camelid allocation. The broad, gently curved diastema, the canine size, premolar alveoli size and shape as

well as the general horizontal ramus proportions are those of a medium sized camel (Table 17). For instance *Oxydactylus longipes,* as represented by AMNH 101201, collected from the type middle Hemingfordian, Whistle Creed, Sioux County, Nebraska, shows a diastema 27 mm long, it is more curved, and the ramus is thicker; whereas *Protolabis* sp., as represented by AMNH-42018, collected from the middle Hemingfordian, Dunlop Camel Quarry, Dowes County, Nebraska, shows a gently curved diastema 22.4 mm long, and it is just as thick as the Oaxacan specimen. Comparisons with other small camels would lead to no closer taxonomic assigment, so the specimen remains unassignable to a camelid genus.

The bladed tooth fragment is assigned to the Camelidae, because of the taxa identified at El Gramal, only camels have bladed premolars.

The calcaneum described is typically tylopodan, and considering that camelids and protoceratids have been identified in the Miocene of Oaxaca, it is necessary to compare it with selected genera of these families (Table 11). *Prosynthetoceras trinitiensis,* as represented by AMNH-34156, Flemming Formation, Trinity River, San Jacinto County, Texas, has a calcaneum about 16% shorter anteroposteriorly, and with its astragalar apposition 15% smaller than that of the Oaxacan specimen (Table 11). *Protolabis* and *Oxydactylus* have calcanei much smaller than IGM-3975 (Honey and Taylor, 1978; and Peterson, 1904, respectively). *Aepycamelus* sp., as represented by AMNH-36905, from the Barstovian Pawnee Creek Formation, Colorado, is morpholigically very similar to, and only slightly larger than the Oaxacan calcaneum (51 vs. 47.6 mm anteroposteriorly long, and 42 vs. 41 mm long astragalar apposition). The calcaneum IGM-3975 could be assigned to *Aepycamelus* or to its subfamily, but the lack of diagnostic material does not warrant its taxonomic allocation beyond the family level.

By the same token, Stirton's identification of *Oxydactylus* sp. based upon a limb bone fragment (Stirton, 1954, p. 636-638), is rejected and the material assigned to Camelidae Gen. et sp. indet.

Table 11.— Measurements of IGM-3975, right calcaneum referred to Camelidae Gen. et sp. indet., and of selected tylopodans.

Measurements	A	B	C	D
Greatest length	—	67.3	127.0	115.0
Greatest width	47.0	40.0	52.0	37.0
Distance of the sustentaculum to the lower tipo of the cuboid articular facet	42.0	25.0	41.0	—

A, IGM-3975, referred to Camelidae Gen. et sp. indet. B, AMNH 34156, *Prosynthetoceras trinitiensis.* C, AMNH 36905, *Aepycamelus (Pseudalticamelus)* sp. D, CMNH 918, Holotype of *Oxydactylus longipes;* data from Peterson (1904 p. 467).

Class MAMMALIA Linnaeus, 1758
Order Indetermined
(Plate 3, figura 14)

Referred material

IGM-3976, a tubular coprolite collected at the same locality that IGM-3968 by H. Barrios-Rivera in August, 1984.

PLATE 3

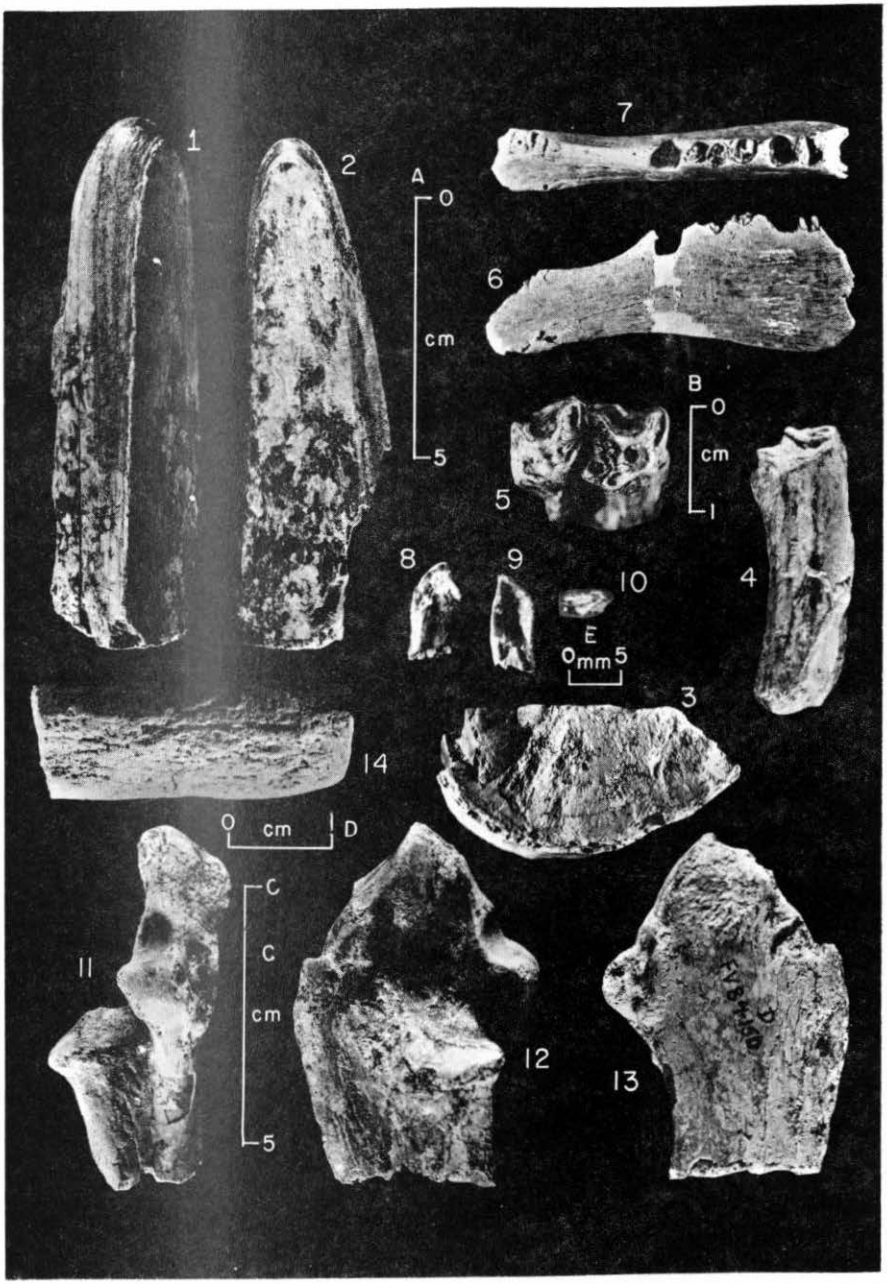
THE EL GRAMAL LOCAL FAUNA, UNNAMED FORMATION, MEDIAL MIOCENE (LATE BARSTOVIAN), OAXACA

Figures 1-3.— Referred material to *Gomphoterium* sp.: 1, IGM-3968, tusk distal fragment, notice the enamel band to the right; 2, *idem*., the enamel band appears weathered; 3, IGM-3969, tusk fragment cross section view.

Figures 4-5.— Referred material to *Merychippsu (s.l)* sp.: 4, IGM-3971, upper right molariform (probably an M^1 or M^2), anterior view; 5, *idem*., occlusal view.

Figures 6-13.— Referred material to Camelidae Gen. te sp. indet.: 6, IGM-3973, left mandibular fragment bearing the alveoli for P_{2-4}, lateral view; 7, *idem*., occlusal view; 8, IGM-3974A, premolariform bladed tooth, ?labial view; 9, *idem*., ?lingual view; 10, *idem*., occlusal view; ss, IGM-3975, right calcaneum fragment anterior view; 12, *idem*, internal view; 13, *idem*, external view.

Figure 14.— Referred material to Mammalia Ord. indet, IGM-3976, fragment, side view.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13

Description

The coprolite is small, 33 mm long; the transverse section is ovoid, its greatest diameter is 13 mm and the least one is 9.0 mm. One end is blunt and the other is broken off. The surface is alightly rugous and pitted. The coprolite is nearly straight.

Discussion

As mentioned in the discussion of the Suchilquitongo coprolite, the ichnology of this kind of remains is largely lacking. The coprolite currently discussed is tubular; the straight attitude and the rugous surface are suggestive of it being shed fairly rigid (or solid), as it is common in modern carnivores such as tthe canids. Its size would indicate a small mammal such as a fox. There is not sufficient information to be more precise in the identification.

AGE

The El Gramal l.f. includes only two taxa identified at generic level, *Gomphotherium* sp. and *Merychippus (s. l.)* sp. In North America, *Gomphotherium* is known from the Barstovian to the late Hemphillian, and *Merychippus* spans the Hemingfordain to the Clarendonian (Tedford *et al.*, 1987). Therefore, fauna could fall within the late Barstovian-Clarendonain intervale, although traditionally, it has been regarded as Barstovian (Stirton, 1954; Wilson, 1967). However, the gomphothere is smaller than the Clarendonian and Hemplillian species, and the *Merychippus* approaches the morphology of the Barstovian and Clarendonian hipparionines; therefore, it appears than conservatively the El Gramal I, f. is most probably of late Barstovian age.

THE EL CAMARON LOCAL FAUNA, UNNAMED FORMATION, MEDIAL MIOCENE (BARSTOVIAN), OAXACA

GEOLOGIC SETTING

Same as for the El Gramal local fauna.

The El Camarón local fauna

This fauna was collected from a steep outcrop located just east of Km 132 of the Panamerican Highway, city of Oaxaca-Tehuantepec section. The outcrop is set in a patch of badlands associated with a gully tributary of the Arroyo Virgen de Guadalupe, in turn a tributary of the Río Tehuantepec. The Arroyo Virgen de Guadalupe is roughly parallel to Arroyo El Gramal, 2 to 3 kilometers eastward; El Camarón locality area is some 7 kilometers southwest of El Gramal locality-area. The Tertiary sequence is similar. In neither area, the lower contact crops out. The fossiliferous possibilities of this area were long known (Stirton, 1954, p. 634). however, the area was not investigated until 1984, and the results of that research are here reported.

Order CARNIVORA Bowdich, 1821
Family MUSTELIDAE Swainson, 1835
Genus *Plionictis* Matthew, 1924
Plionictis oaxacaensis sp. nov.
(Plate 4, figures 1-14, Table 12)

Holotype

IGM-3977, associated right and left mandibular rami bearing RI_{1-3}, C, P_{3-4}, and M_{1-2}; LP_3, and M_{1-2}; plus these isolated teeth: LC; R and LC, RP^2, RP^3, R and LP^4 and $^1IM^1$. The material was collected using screening techniques by H. Barrios-Rivera, D. Hernández-Láscares and I. Ferrusquía-Villafranca in August, 1984.

Locality and stratigraphic unit

The material was collected from an outcrop just east off Km 132 of the Panamerican Highway, city of Oaxaca-Tehuantepec section; it comes from a dark greenish silty clay belonging to an unnamed formation that seems to represent flood plain sedimentation in a sinking basin affected by penecontemporaneous volcanism.

Diagnostic features

Plionictis oaxacaensis differs from other species of *Plionictis* in being about the same size that *P. parviloba*, but with sharper, transversely narrower cheek teeth, especially the carnassials, and in having a relatively large M_2, 25% larger that of P. *parviloba*.

Etymology

The specific name is formed by the word Oaxaca, the name of the Mexican State where the locality occurs and the Latin suffix *-ensis*, roughly "from", *i. e.*, the geographic provenance of someone or something.

Description

The mandible (Plate 4, figures 10, 11) is slender, delicately built; its masseteric fossa is rather deep and shows a prominent lower ridge; the angular process is very short. The lower border is curved upward whereas the upper border is nearly straight; the horizontal ramus is shallow, so that the mandibular depth at M_1 is just slightly larger than the M_1 length. A single mental foramen is present, below P_3.

Lower dentition. The dental formula is I_{1-3}, C, P_{2-4}, M_{1-2} (Plate 4, figures 12, 13). The incisors are gently curved, convex outward, styliform, closely appressed, bluntly pointed, oval cross sectioned (elongated anteroposteriorly), and with wear facets postero-upwardly directed.

The canine is conical, convex anteriorly; its cross section is ovoid, anteriorly elongated.

The second premolar is missing, it was single rooted. The third premolar is trenchant, double-rooted, with a very faint paraconid, a high protoconid united to the former cusp by an anteriorly curved, blade-like sharp ridge; the "metaconid" is split, and from its medial

part receives the gently concave cutting edge coming from the protoconid. The fourth premolar is morphologically similar to the third, but the protoconid region is thicker and the tooth is larger. The first molar is the carnassial tooth, the trigonid is very well developed and shows sharp cutting edges; the paraconid lingual ridge is a bit larger than the labial one, both are downwardly directed and do not meet the other trigonid cusps; the protoconid is the largest cusp, its anterior ridge is the largest cutting edge, it is directed downward and meets the labial paraconid ridge at its (lowest point) right angle defining an open V; the protoconid posterior ridge is nearly straight, whereas the anterior one is gently convex; the metaconid is set posterolingual to the protoconid, and is as high as the paraconid; the talonid is broad, squarish, basined; the hypoconid is higher than the entoconid and set more anteriorly; the posterior margin is gently curved. The second molar is well developed, nearly as large and high as the M_1 talonid, occlusally its outline is ovoid, antero-posteriorly elongated; it shows no real trigonid, because the paraconid is not developed; there is a large, anterolingually directed basin limited posteriorly by the proto- and metaconids —the latter being larger—; the talonid is also a (small) basined area directed posteriorly, with very faint hypo and entoconids.

Upper dentition. It is incompletely preserved (Plate 6, figures 1-9), the incisors are lacking. The canine (Plate 4, figure 1) is tubulo-conical, almost straight and much larger than the lower one.

The second premolar (Plate 4, figure 2) is represented by the posterior half of the right one and it is a low, conical, transversely narrow tooth. The third premolar (Plate 4, figures 33, 4) is nearly complete (missing only the paracone), trenchant and very similar to the corresponding lower tooth, but somewhat narrower and with both anterior and posterior protocone borders straight rather than curved. The fourth premolar (Plate 4, figures 5 - 8) is the carnassial tooth, its occlusal outline is ovoid and very elongated anteroposteriorly (being 7.2 mm long by 2.6 mm wide); the paracone is just a minor spur posterolabial to the protocone. This last and the metacone are the chief cusps; both are aligned and united by a gentle, lingually curved cutting edge, very sharp and long; the protocone is higher than the metacone, hence the edge is also concave, and its anterior part nearly straight. There is a faint cingulum on the labial side and and only a minor spur at the base of the protocone. The first (and only) molar is represented by a small fragment, formed only by part of the metacone (Plate 4, figure 9), still set in a portion of the corresponding maxilla, which includes the base of the zygomatic arch.

Discussion

The mustelid species represented by IGM-3977 can confidently be assigned to *Plionictis*, because it possesses the following combination of diagnostic features (Matthew, 1924, p. 130, 135): (a) a single upper molar, (b) lingual half of M_2 more or less expanded, (c) tubercular teeth reduced, (d) sectorial teeth sharp and compressed, (e) premolars reduced, (f) M_1 metaconid of moderate —not small— size, and (g) M_1 talonid crested. To this it should be added the dental formula as well as the size and morphology of the mandible (*cf.* Table 12).

A comparison of IGM-3977 to AMNH-9042, the holotype of *P. ogygia* Matthew collected from the early late Barstovian Pawnee Creek Formation discloses that: (a) both specimens are about the same size; (b) the Oaxacan specimen still has the P_1; evidenced by the alveolus; (c) both P_4 and M_1 are wider transversely in IGM-3977; (d) the M_1 metaconid is set more anteriorly in IGM-3977; (e) the M_1 talonid is considerably larger in IGM-3977; (f) M_2 relatively large, well developed and fairly elongated in the Oaxacan specimen, and not so in AMNH-9042. The differences are interpreted as significant at the species level.

P. glareae Sinclair also from the Pawnee Creek Formation seems to be, according to Mat-

thew (1924, p. 134), conspecific to *P. ogygia*, just being slightly larger and retaining a minute P_1. Even if *P. glareae* Sinclair turns out to be a valid species, the differences with the species represented by IGM-3977 are enough to merit taxonomic distinction at this level.

Table 12.— Measurements of IGM-3977, right and left mandibular rami plus isolated upper teeth that conform the Holotype of *Plionictis oaxacaensis* sp. nov., and selected mustelids.

Measurements	A	B	C
C			
Anteroposterior length	3.1	—	—
Transverse width	2.8	—	—
P_2			
Anteroposterior length	—	3.9e	—
P_3			
Anteroposterior length	4.0	4.0e	—
Transverse width	2.1	1.8e	—
P_4			
Anteroposterior length	4.0*	5.1e	—
Transverse width	2.5	2.0e	—
M_1			
Anteroposterior length	7.1	9.3e	7.3
Transverse width	3.8	3.7e	3.2
M_2			
Anteroposterior length	3.0	—	—
Transverse width	2.8	—	—
C-M_2 length	28.5	—	—
Depth below M_1	7.2*	11.6e	6.1e

A, IGM-3977, Holotype of *Plionictis oaxacaensis* sp. nov. B, A.M. 17208, referred to *Plionictis parviloba;* data from Matthew (1924, fig. 35). NMC 8967, referred to *Plionictis* cf. *P. ogygia;* data from Storer (1975, p. 23, fig. 15). *, estimated because the structure is broken. e, estimated from a published illustration.

P. parviloba Matthew was originally described from the Clarendonian Snake Creek Formation, and later found in the Barstovian of New Mexico. IGM-3977 was compared to F:AM-AMNH 62858, referred o *P. parviloba* from New Mexico. Both are about he same size, the carnassials of -62858 are blunter, M_1 metaconid is more reduced and lies closer to the protoconid than in -3977, M_1 protoconid anterior cutting edge is set more lingually than in -3977, M^1 is wider, shows a large protostyle and a reduced metacone, M_2 smaller and transversely very narrow, whereas in -3977 it is 25% larger and wider.

These differences sharply set apart the species represented by IGM-3977 from *P. parviloba.*

The foregoing comparisons lead to conclude that IGM-3977 represents a hitherto undescribed species of mustelid, foir which the name *Plionictis oaxacaensis* species nova is formally proposed.

It is charecterized by a unique combination of features, difficult to evaluate evolutionarily, because some are primitive, such as the presence of P_1, and of a large, well developed M_2; whereas others, such as the sharp carnassials, similar to those of *Mustela frenata,* are interpreted as advanced, and may represent a stricter and more efficient flesh eating adaptation than in the other species of *Plionictis.*

The chronostratigraphic range of *Plionictis* extends from the Hemingfordian to the Clarendonian (Savage and Russell, 1983; Tedford *et. al.*, 1987); *P. oaxacaensis* in some regards is more primitive than the Barstovian and Clarendonian *P. ogygia* and *P. parviloba*, and in others is more advanced than the Barstovian *P. parviloba* population from New Mexico, therefore the geologic age of *P. oaxacaensis* falls somewhere in the Barstovian-Clarendonian time-span.

Plionictis oaxacaensis sp. nov. is very significant on the following grounds: It is the first pre-Hemphillian record of the Order Carnivora in Mexico's mainland; it is also the oldest and southernmost record of this order in North and Middle America; it extends the geographic range of the pre-Hemphillian Mustelidae at least 2,000 km southward from its former record in the southern United States (New Mexico and Florida). There is only one additional record of Tertiary mustelids in Mexico, it is in the Hemphillian fauna of Guanajuato, central Mexico (O. Carranza-Castañeda, oral comunication, February, 1981); according to him, carnivorans belonging to at least three families are represented in this assemblage.

Order PROBOSCIDEA Illiger, 1811
Family GOMPHOTHERIIDAE Cabrera, 1929
?Gomphotheriidae
Genus et species indeterminata

Referred material

IGM-3978 and -3979, mandibular fragments; -3980, tusk fragment; -3981, skull fragment; -3982, rib fragment; -3983, pelvis? fragment; -3984 and -3985, leg bone fragments; -3986 to -3992, miscellaneous bone fragments; all were collected by I. Ferrusquía-Villafranca and D. Hernández-Láscares at the same locality that IGM-3977, on August, 1984, at various stratigraphic levels; the main concentration was sett about 2.0 m below he IGM-3977 bearing stratum.

Description

The material is very fragmentary, and probably all the specimens weathered out of a single carcass, because they show the same color, weathering pattern and were found spatially very close; the search for the carcass was unsuccessful, though. IGM-3978, one of the mandibular fragments, shows part of the lower border, and IGM-3979, the other, shows part of the alveolus; both are edentulous. IGM-3980, the tusk fragment consists of dentine only and is 21.5 mm thick. IGM-3981, the skull fragment is irregular, partly compact and partly porous. IGM-3982. the rib fragment is nearly square in cross section, some 33 mm thick, and gently curved lengthwise. IGM-3983, the supposed pelvian fragment is flat and compact. IGM-3985 the leg bone fragments are 18 to 26 mm thick and too fragmentary for an anatomical identification, other than they seem to be parts of long bones. IGM-3986 o -3992 are fragments of large bones.

Discussion

The size of the fragments indicates that they belonged to a large mammal, and the presence of a tusk fragment as well as the morphology of the mandibular fragments unmista-

kingly identify them as referable to a proboscidean. Further, gomphothere proboscideans have already been identified in the nearby and close correlattive El Gramal locality. Therefore, the author questionably refers the El Camarón remains to the Gomphotheriidae.

It is noteworthy that some of the fragmens show numerous shallow, 1.0 to 2.3 mm wide, parallelly arranged furrows, that are interpreted as gnawing rodent marks; this interpretation is further strengthened by the presence of a pelvian and other bone fragments belonging to a small mammal, associated to the proboscidean remains, thus indicating that the later were not immediately buried.

Order PERISSODACTYLA Owen, 1848
Family EQUIDAE Gray, 1937
Genus *Merychippus* Leidy, 1857
Merychippus (sensu lato) sp.
(Plate 4, figures 15-22, Table 13)

Referred material

IGM-3993, right ?P^2 fossette; IGM-3994, left P^4 ectoloph; IGM-3995, left P^4 or M^1; IGM-3996, ?lower right $I_{?2-3}$; IGM-3997, left P_3; and IGM-3998, left M_3; all collected at the same locality that IGM-3977 at various levels in the sixth stratigraphic intervale, by H. Barrios-Rivera, D. Hernández-Láscares and the present author.

Table 13.— Measurements of IGM-3994 to -3998, isolated teeth referred to *Merychippus (s. l.)* sp., and of selected species of this genus.

Measurements	A	B	C	D	E	
I						
Anteroposterior length	7.3	—	—	—	8.0e	9.0e
Transverse width	11.0	—	—	—	4.0e	9.0e
P^4						
Anteroposterior length	16.5	19.7	—	16.0e	18.5	19.8 —
Transverse width	16.5e	—	—	18.5e	19.0	23.4e —
Crown height	2.5	32.5e	24.5e	—	—	— —
P_3						
Anteroposterior length	20.0e	—	15.9	15.0e	20.0	— —
Transverse width	9.0	—	9.4	10.0e	10.0	— —
Crown height	28.8	—	—	—	—	— —
M_3						
Anteroposterior length	21.5	—	18.0	19.0e	20.5	— —
Transverse width	8.0	—	6.9	7.0e	7.5	— —
Crown height	35.0*	—	—	—	—	— —

A, El Camarón specimens referred to *Merychippus (s. l.)* sp.: IGM-3996, ?RI^2; IGM-3995, LP^4 or M^1; IGM-3994, LP^3; IGM-3997, LP_3; IGM-3998, LM_3. *, measured at the protoconid. B, AMNH 112364, *Merychippus primus*, LP_3 and LM_3. C, Amer. Mus. 14187, *M. primus*, LP^4, LP_3 and LM_3; data from Osborn (1918, fig. 78, plate 18, fig. 3b). D, F:AMNH 87011, *M. insignis*, LP^4; AMNH 111688, LP_3 and LM_3. E, U.C. Mus. Pal. Coll. 42293, *Merychippus* sp. from El Gramal, Oax., LI^1, RI^2 and LP^4.

Description

IGM-3993 is an upper molariform fragment seemingly bearing the post-fossette (Plate 4, figure 16), its outline is simple, devoided of plications, it is two and a half times longer than wide. IGM-3994 is the ectoloph of the fourth upper premolar (Plate 4, figure 18), it is nearly complete, thickens away from the occlusal surface, its mesostyle is bigger than the parastyle; there is no metastyle; the ectoloph is nearly 33 mm high, which indicates strong hypsodonty, it is gently convex labially, its occlusal border depicts a wide and low M and the para- and mesostyles emerge from the anterior and medial lows. IGM-3995 is a left upper fourth premolar or first molar (Plate 4, figure 17), it is worn down almost to the "base" and lacks the ectoloph; the occlusal pattern is faint, the prefossette is comma-shaped with its tail directed anteriorly and with no plications; the postfossette is ovoid, three times longer than wide, its anterior end is slightly directed labially.

IGM-3996, the ?lower incisors (only one is figured, Plate 4, figure 15), are broadly conical, hollow, pointed downward; the supposed I_2 has the occlusal surface broken, the I_3 is complete, its occlusal surface is elliptical, the internal border is flat and the lateral border is sharp, hence the occlusal surface is broad mesially and pointed laterally.

IGM-3997 left lower third premolar (Plate 4, figures 19, 20), is nearly complete, only the anterior part of the metalophid is missing; the tooth is nearly straight, 34 mm high, and 8.0 mm wide, the enamel is 1.3 mm thick on the medial part of the lophids; both meta- and hypolophids have a very simple, not plicant pattern; the metaconid is wide and large, more prominent than the entoconid which has a semicircular outline; the hypostylid is very small.

IGM-3998 left lower third molar (Plate 4, figures 21, 22), is nearly complete and only lacks the anterior part of the metalophid; it is 37 mm high, 8.4 wide, the enamel at the metalophid is 1.4 mm thick; the occlusal surface is set at 60° with respect to the vertical axis of the tooth; the dental base is 20% longer than the occlusal surface, and the anterior border is more curved than the posterior one; as in IGM-3997, the metaconid is larger and better developed than the entoconid; in fact, the metaconid is connected to the metalophid by a narrow bridge, thus appearing as a distinct structure, whereas the entoconid is just the posterior end of the hypolophid; both proto- and hypolophids are relatively long, narrow, thus defining wide open semilunar features, their margins are simple, unplicated. The accessory lobe is set off from the hypolophid, it is circular in section and conical-truncated heightwise; at the occlusal surface is half as long as the hypolophid.

Discussion

The taxonomic assessment of these teeth is complicated by the status of flux on the conception and delimitation of the Miocene horses, chiefly in the reevaluation of the Genus *Merychippus*. But this is no place to pursue that matter. Assuming that all the material represents one species, it is clear that it has a simple occlusal pattern and a degree of hypsodonty similar to that of Barstovian merychippines (Table 13). So, in all probability, the El Camarón material could be referred to *Merychippus (s. l.)* sp. As it was stated, the biogeochronologic range of *Merychippus* spans the Hemingfordian to the Clarendonian, but the El Camarón material is close to the Barstovian species, and as such is regarded here.

The taxonomic relationships of the highly probable contemporaneos merychippines from the close El Gramal and El Camarón localities are problematical. On one hand, El Gramal discloses the presence of a merychippine population evolving toward the hipparionine clade;

whereas on the other hand, the El Camarón evidences the presence of a merychippine population evolving toward the pliohippine clade. Additional material is needed to solve this riddle.

Order ARTIODACTYLA Owen, 1848
Suborder RUMINANTIA Scopoli, 1777
Infraorder PECORA Linnaeus, 1758
Family ANTILOCAPRIDAE Gray, 1886
Genus et species indeterminata
(Plate 4, figure 23, Table 14)

Referred material

IGM-3999, isolated right third upper molar, collected at the same locality that IGM-3977 by D. Hernández-Láscares, in August, 1984.

Table 14.- Measurements of IGM-3999, RM^3 referred to Antilocapridae Gen. et sp. indet., and selected antilocaprids.

Measurements	A	B	C	D	E
Anteroposterior length	13.7	14.8	12.9	13.3	11.9
Anterior lobe length	5.7	—	5.9	—	5.3
Anterior lobe width	7.8	9.7	9.0	8.9	8.0
Posterior lobe length	8.0	8.7	7.0	7.1	6.6
Posterior lobe width	7.7	7.7	7.8	7.0	6.6

A, IGM-3999, antilocapridae Gen. et sp. indet. B, F:AM Ains 524-379, *Cosorux fucatus*; Clarendonian. C, AMNH, *Merycoceras joraki;* Barstovian. D, AMNH 32984, *Osbornoceras osboerni;* Hemingfordian. E, AMNH 31570, *Plioceras flobairi;* late Barstovian or early Clarendonian.

Description

The tooth is heavily worn, pitted and slightly broken at the base (Plate 4, figure 23). It is selenodont, relatively narrow; the paracone area is wider than the protocone one, and the metacone is slightly wider than the metaconule; the prefossette is very narrow and has its lingual and labial margins closely appressed; on the other hand, the postfossette is longer, crescent-shaped, its anterior part projects labially, whereas the posterior part remains posteriorly directed, the labial and lingual margins leave a narrow space; the protostyle is very faint; the metastyle is very prominent, 1.6 mm transversely and 1.2 mm antero-posteriorly, it is formed by an enamel fold tightly appressed, with almost no dentine; the metastyle is also 1.6 mm long (anteroposteriorly), but 2.0 mm wide (transversely), *i. e.*, it is thicker than the mesostyle because the presence of dentine; finally, the tooth tapers occlusally, but much more markedly on the anterior than in the posterior side.

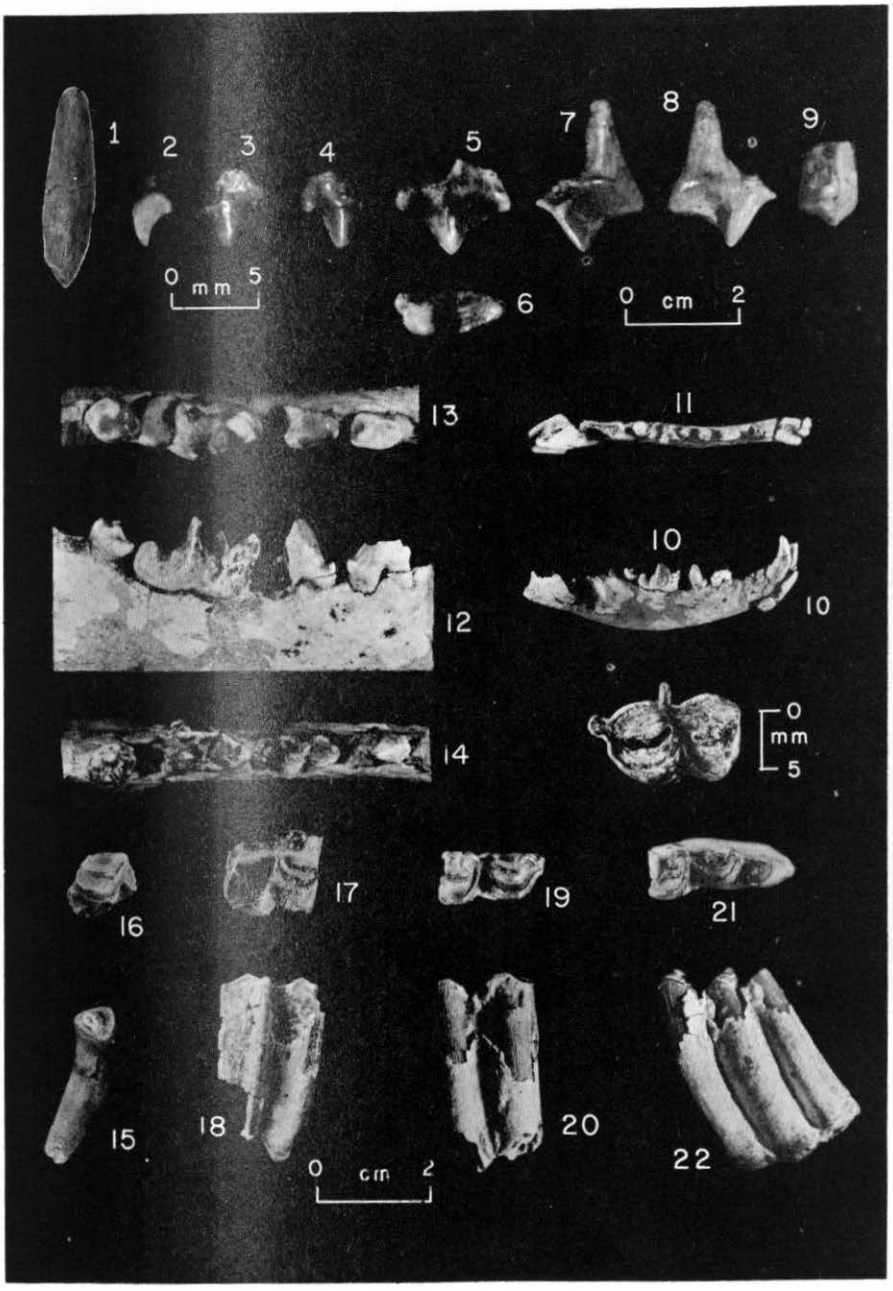
PLATE 4

THE EL CAMARON LOCAL FAUNA, UNNAMED FORMATION, MEDIAL MIOCENE (LATE BARSTOVIAN) OAXACA

Figures 1-14.— Holotype of *Plionictis oaxacaensis* sp. nov., IGM-3977, isolated upper teeth and left mandibular fragment: 1, right *C.* labial view; 2, ritht P^2, labial view; 3, right P^3, labial view; 4, *idem.*, lingual view; 5, right P^4, labial view; 6, *idem.*, occlusal view; 7, left P^4, labial view; 8, *idem.*, lingual view; 9, left M^1 fragment, occlusal view; 10, right mandibular horizontal ramus bearing I_1-M_2 lateral view; 11, *idem.*, occlusal view; 12, *idem.*, grater detail, lateral view showing P_3-M_2 13, *idem.*, occlusal view; 14,ft mandibular horizontal ramus, occlusal view showing P_3-M_2 in detail.

Figures 15-22.— Referred material to *Merychippus (s. l.)* sp., isolated upper und lower teeth: 15, IGM-3996, ?right I^2 posterolateral view; 16, IGM-3993, upper molariform fragment bearing the postfossettre, occlusal view; 17, IGM-3995, P^4-ectoloph, labial view; 19, IGM-3997, left P_3, occlusal view; 20, *idem.*, labial view; 21, IGM-3998, left M_3, occlusal view; 22, *idem.*, labial view.

Figure 23.— Referred material to Antilocapridae Gen, et sp. indet: IGM-3999, right M_3, occlusal view.


1
2
3
4
5
7
8
9
0 mm 5
6
0 cm 2
13
11
12
10
10
0 mm 5
14
16
17
19
21
15
18
20
22
0 cm 2

Discussion

The hypsodonty and narrowness of IGM-3999 (Table 14), set it as an Antilocapridae. The systematics of this family is largely based upon the horn morphology (Frick, 1937), hence positive generic identification of the Oaxacan specimen is not possible. The presence of styles, especially the mesostyle, agrees better with the Antilocaprinae than with the Merycodontinae, but the material is too scanty to go beyond the family level.

Order RODENTIA Bowdich, 1821

?RODENTIA

Family, genus et species indeterminata.

Referred material

IGM-4000, right pelvian fragment bearing part of the acetabulum. It was collected at the same locality that IGM-3977 by the author.

Description

The fragment is only 8.4 mm long, delicate; it bears part of the ischion, which is laterally compressed, its anterior end shows the posterior part of the acetabular articular surface ending in the acetabular trough for the femoral ligaments.

Discussion

The size and shape of the pelvian fragment are very reminiscent of those of a rodent about the size of a domestic mouse to a small rat; it could be another small mammal, but considering that gnawing-marks were already observed in some proboscidean bone fragments in this very locality, the possibility of being actually a rodent fragment is strenghtened. Nothing, of course, could be said about the geologic age of the specimen. The reason for calling attention to this find is that it constitutes the first material evidence of micromammals in the pre-Hemphillian Miocene faunas of Mexico. It is noteworthy to mention that this remain was recovered by screening, thus indicating that using this technique, the record of micromammals is bound to increase.

AGE

Only *Plionictis oaxacaensis* sp. nov. and *Merychippus (s. l.)* sp. were identified beyond family level; the first is a species slightly more advanced than the Barstovian *P. parviloba* from New Mexico, and less so than the Clarendonian *P. ogygia; Merychippus (s. l.)* sp. has a degree of hypsodonty similar to that of the Barstovian species, therefore the age of El Camarón l.f. is most probably Barstovian —perhaps late Barstovian—, and so is interpreted here.

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NOTE ADDED IN PROOF

While this paper was in press, the results of the interdisciplinary study on the Tertiary, aluded to in the Introduction of Part I of this series (Ferrusquía-Villafranca, in press), became available (Ferrusquía-Villafranca, 1990A-D), and because they supplement and/or modify some of the conclusions reached here, they are summarily presented below.

Suchilquitongo Area.- (1) The stratigraphic differentiation of both the Precenozoic Basement and the Tertiary Sequence was carried further than Wilson and Clabaugh (1970) did, and new units were recognized; (2) The Suchilquitongo Formation is rigourously redifined, and additional K-Ar radioisotopic dating was carried out by F. W. McDowell, from the Univ. Texas-Austin (written comm., april, 1989) yielding ages of 19.3 Ma (from feldspars) and 20.6 Ma (from biotite), biogeochronoligically corresponding to the medial Hemingfordian, thus favoring a Hemingfordian rather than a Barstovian age for the Suchilquitongo local fauna. (3) Supplementary collecting in the area furnished better preserved material — toothed jaws— of *Paratoceras* sp., thus confirming the presence of this protoceratid here. Also paleontologically very significant was the find in an area located some 65 kms northwest of Suchilquitongo, in a graben called La Cañada Oaxaqueña, the Tecomavaca-Cuicaltán Area (Ferrusquía-Villafranca, 1990, A), of a small but very important mammalian assemblage consisting of a small Camelidae Gen. te sp. indet., a merychippine Equidae Gen. et sp. indet., and the Antilocapridae cf. *Merycodus* sp., designated the Cui-

catlan local fauna, tentatively assigned to the medial Miocene, and then broadly correlative to the Suchilquitongo local fauna.

Matatlán Area.- (1) Detailed cartography of thea area (Ferrusquía-Villafranca, 1990C), allowed the discrimination of the various lithostratigraphic units that form the Precenozoic Basement and the Tertiary Sequence. (2) The unit bearing the Matatlan local fauna was formally proposed. (3) It unconformably overlies a tuff sequence dated by means of K-Ar radioisotopes as 14.4 ± 0.4 to 16.0 ± 0.4 Ma (F. W. McDowell, written comm., April, 1989), that falls in the Barstovian, thus dissipating some of the uncertainty of the age assignment (late Hemingfordian-earliest Hemphillian) given here to the Matatlán local fauna. (4) Additional collecting in the area included material referable to Rhinocerotidae Gen. et sp. indet., and *Merychippus* cf. *M. primus*, represented by a poorly preserved cheek tooth and postcranial elements.

Nejapa Area.- (1) Datailed geologic mapping of the area (Ferrusquía-Villafranca, 1990D), permited the stratigraphic differentiation of both the Precenozoic Basement and the Tertiary sequence. (2) The unit bearing the El Gramal and El Camarón local faunas was formally proposed. (3) It unconformably overlies a tuff sequence dated by means of K-Ar radioisotopes (F. W. McDowell, wrtten comm., April, 1989) as of 14.96 ± 0.85 Ma of age, i. e., corresponding to the early Barstovian, thus confirming the age assignment (late Barstovian-early Clarendonian) given here to the El Gramal and El Camaron local faunas. (4) Additional prospecting in the area disclosed a new, relatively rich fossil locality placed some 7 kms NNE of El Gramal, in the Village of La Mancornada; the fossil assemblage called La Mancornada local fauna includes: *Gomphotherium* sp., a small to medium size Camelidae Gen. et sp. indet., two kinds of equids, one referred to Genus ?aff. *Cormohipparion* sp. n. desc., resembling that from El Gramal (of a fairly complex occlusal pattern), and another referred to *Merychippus (s. l.)* s.p., of a simple occlusal pattern, similar to that of El Camarón, but represented by many cheek teeth; and a carnivore questionably referred to ?Ursidae Gen. et sp. indet.

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