PLEISTOCENE MAMMALS FROM AGUASCALIENTES, CENTRAL MEXICO

OSWALDO MOOSER AND WALTER W. DALQUEST

ABSTRACT.—Hundreds of fossils of middle Pleistocene age mammals have been obtained from the tufa, sands, and gravels of the Tacubaya Formation just east of the City of Aguascalientes, in central Mexico. The fossils are probably of Illinoian age. This is the only large, systematically-collected, local fauna known from the Pleistocene of Mexico. Few remains of small mammals were found, but the Cedazo local fauna includes at least 39 species, three here described as new. The Cedazo local fauna is a unit fauna, representing the kinds of mammals that lived together in one small area during one period of time. The Cedazo local fauna lived on plains or grasslands with brush and trees along watercourses but with no tropical forest element in the environment.

During the past eighteen years the senior author has gathered Pleistocene vertebrate remains exposed in sediments a few kilometers southeast of the City of Aguascalientes, State of Aguascalientes, in central Mexico (Fig. 1). Here two small canyons, Arroyo Cedazo and Arroyo San Francisco, have been formed by intermittent streams that have cut through the Pleistocene Tacubaya Formation in courses to the Rio Aguascalientes. The fossils are exposed in volcanic tufa, sandstones, conglomerates, and loose sands and gravels, over a straight line distance of about ten kilometers in each canyon.

A general account of the mammalian fauna was published (Mooser, 1959), with special attention to the horses. In the following decade, collecting yielded hundreds of additional mammal specimens. A porcupine was recorded (Hibbard and Mooser, 1963) and a new species of tortoise described (Mooser, 1972), but the press of other work prevented preparation of a detailed account of the mammals. In 1971, Mooser suggested that Dalquest join him in this project, and in the summer of 1972, we worked together for a week, studying the Cedazo deposits and the collection.

It is our opinion that the Cedazo local fauna is a unit fauna, and that the vertebrate fossils are the remains of animals that lived in one small area during a relatively short period of time. Astonishing is the number of species of large mammals that occurred together, sympatrically, on the Mexican Plateau. We identify no less than seven distinct kinds of horses, four kinds of camels, and four kinds of four-horned prongbucks in the Cedazo local fauna. Associations such as this occur in middle and late Tertiary faunas, but are known today only among the African antelopes.

We suspect that such sympatric associations were the rule in central and southern Mexico during the Pleistocene. The study of Mexican vertebrate paleontology is in its infancy and the Cedazo local fauna is the only large, systematically collected sample of Pleistocene mammals from Mexico. The only comparable collection is from the Tequixquiac area of the State of

FIG. 1.—Dot indicates location of city of Aguascalientes.

Mexico, but the collections from Tequixquiac were derived from two or more different Pleistocene formations and many lack data as to locality and stratigraphic level of collection. The specimens from Tequixquiac have accumulated over a century and were taken by many different individuals.

GEOLOGY

Arellano (1953) placed the Pleistocene deposits in the area about the city of Aguascalientes in the Tacubaya Formation, and we have accepted his treatment uncritically. We conceive the Tacubaya Formation as a continuous layer of sediments, lying, where studied by us, unconformably on dull rusty-brown tuffaceous sandstones of mid-Tertiary age. Locally, the Tacubaya deposits average eight to ten meters thick, with a varied erosional surface. Low areas of the erosional surface have been filled with black, loess-like silts of late Pleistocene age. The present ground surface is nearly flat, except where gullied by streams, and locally may consist of soils developed on either exposed Tacubaya sediments or black Pleistocene silts.

The Tacubaya sediments are varied but the predominant lithologic feature is a massive, orange-red tuff. Examination suggests that this consists mostly of fine volcanic ejecta with some re-worked mid-Tertiary bedrock, and with a heavy ferruginous stain, presumably accumulated on a slowly agrading surface. Almost invariably the tuff forms the lower part of the Tacubaya Formation, and locally may reach a thickness of five meters or more. Lenses of sand and gravel occur through the orange-red tuff, although sometimes there are exposures of almost pure orange-red tuff hundreds of meters in length and several meters in thickness.

Also present are strata of conglomerate, loose gravel, almost pure white pumice, and sandy clay with a grayish color. These beds are usually level-lying but in places are strongly cross-bedded. Sometimes they lie on thick orange-red tuff and are covered in places with a thick layer of orange-red tuff, but elsewhere the sand and gravel tend to overlie the tuff almost everywhere.

The bulk of the fossils assigned to the Cedazo local fauna came from very low in the section, in the tuff, or lower strata of sand and gravel. Few fossils were found in the upper levels of tuff or the upper sand and gravel strata.

Unity and Age of the Fauna

Mooser (1959) included some horse teeth in the Cedazo local fauna that were taken high in the section. The teeth are fossilized but, as Mooser noted, they are much younger than the rest of the Cedazo local fauna. We do not include the black silts, where these teeth occurred, in the Tacubaya Formation.

The Cedazo local fauna was recovered from the lower few meters of the Tacubaya Formation. The nature of fossilization reflects the matrix containing the fossils. In the orange-red tuff the fossils are white, somewhat fibrous, and have a ferruginous stain. They tend to be fragile and easily destroyed by weathering. That such fossils could be reworked from older sediments without destruction is almost inconceivable. When bones or teeth were buried in sand and gravel, however, the fossils are hard, smooth-surfaced, and white or black in color, depending on the amount of manganese stain. It is possible that some bones could have fallen from a higher level of the arroyo without being destroyed. Few bones were seen in higher levels and most specimens were found in place in the matrix. We strongly doubt that any mixing of bones from different levels of the Tacubaya Formation has occurred.

The possibility of reworking and mixing of specimens in the ancient channels that are now the gravel and sand layers can neither be disproved nor established. The very number of kinds of horses in the Cedazo local fauna tempts one to consider reworking. However, we deny the possibility that specimens from the orange-red tuff could be redeposited without destruction and nearly all of the kinds of horses are represented by specimens from this matrix. We are of the firm opinion that the Cedazo local fauna is a unit fauna.

In the original announcement of the Cedazo local fauna, Mooser (1959) assigned the fauna to the early Pleistocene. Additional material has caused us to revise this opinion.

The alternating cold (glacial) and warm (interglacial) faunas of the United States did not occur in central Mexico. In effect, central Mexico had only "interglacial" faunas during the Pleistocene. However, faunal changes initiated by evolution and immigration of species probably occurred in all warm-climate Pleistocene mammalian faunas of North America at approximately the same time, and correlation of such faunas in the United States and central Mexico is possible.

We think the Cedazo local fauna is post-Kansan in age. *Bison* is present, represented by a giant species. Early Rancholabrean age (Savage, 1951) is indicated. We think the Cedazo local fauna could be as old as Yarmouthian or as young as Sangamon, but favor Illinoian Age. Analysis of additional Pleistocene mammalian faunas from the Mexican Plateau will be necessary for more exact placement.

Materials and Methods

Specimens listed in the following accounts were collected by Mooser. Most are in his private collection, catalogued with the prefix FC (Fauna Cedazo). Some 250 specimens were deposited in the collection of the Instituto Geologico de Mexico and these, when mentioned, have catalogue numbers prefixed by IGM.

Included in the Cedazo collection are numerous specimens, especially postcranial elements, of edentates, camels and horses, but including many jaws and isolated teeth, not listed here. Our primary purpose is to describe the rich and curious fauna that lived in Aguascalientes during the middle Pleistocene. Much material of considerable interest but not pertinent to the present objective has been left for future study.

Measurements given in whole millimeters (mm) involve some degree of estimation, but most are probably accurate to within two millimeters. When measurements could be taken

with relative accuracy, the figures are given in fractions of a millimeter. Such measurements are probably accurate to the nearest half millimeter. In measurements of long bones and teeth, anteroposterior diameter is given first, followed by transverse diameter, for example 28.4 by 36.9.

Specimens have been catalogued as coming from exact sites in either Arroyo Cedazo or Arroyo San Francisco. In most cases, the exact collection locality has been inked directly on the fossils. For the sake of brevity this information is not given in the accounts of species. It is available on request to the senior author.

Systematic Accounts

Order Marsupialia

Family Didelphidae

Didelphis marsupialis Linnaeus

The skull and lower jaws of a fossil opossum were described by Alvarez and Ferrusquia (1967), and reported to have been collected by Mooser in Arroyo Cedazo. The original material catalogued in the Institute of Geology Collection (see Mooser, 1959) included the skull and much of the postcranial skeleton of a pocket gopher, *Thomomys* or *Pappogeomys*. Mooser and Dr. Ticul Alvarez, in 1974, verified that the opossum specimen was not a specimen found by Mooser and that the original specimen, a pocket gopher partial skeleton, is missing from the collection. We have no evidence of the opossum in the Cedazo local fauna.

Order Rodentia

Family Geomyidae

? **Thomomys umbrinus** (Richardson)

The distal half of the humerus of a pocket gopher (FC 670) seems too small for even a female *Pappogeomys* and may be from a male of a large race of *Thomomys umbrinus*. There are old records of *Geomys* from the State of Mexico (Silva-Barcenas, 1969) but these are open to doubt. *Geomys*, as a living animal, is known only from a few sites in northern Mexico.

Pappogeomys cf. **castanops** (Baird)

A right lower jaw (FC 671) lacks all cheek teeth except M_2. The incisor is present and the angular process is typical of this genus. Alveolar length of the cheek tooth row is 10.9 and the greatest length of the jaw to the tip of the incisor is 40.4.

No species of *Pappogeomys* lives in Aguascalientes today but *P. castanops* occurs to the northeast and *P. gymnurus* to the south. Hibbard (1955) listed two specimens of *Cratogeomys* [*Pappogeomys*] from Pleistocene deposits in the State of Mexico. Russell (1968), in discussing this record of *Pappogeomys* stated "The Wisconsin age of these beds [Becerra Superior] suggests an earlier Pleistocene derivation of the *gymnurus*-group of species."

Alvarez (1969) believes that the late Pleistocene *Pappogeomys* from the State of Mexico represents a species different from *P. castanops* and *P. gymnurus* and does not identify his specimen to species. The Aguascalientes fossil lacks the premolar and cannot be compared with Alvarez's specimen.

Family Erethizontidae

Erethizon ? dorsatum (Linnaeus)

Hibbard and Mooser (1963) reported the lower jaw of a porcupine, with the complete dentition, from Arroyo Cedazo. This specimen is now in the University of Michigan Museum of Paleontology (No. 47106).

White (1968) described *Coendou stirtoni* from the middle Pleistocene of California, and suggested that the specimen from Aguascalientes might also be referable to the genus *Coendou*. The Mexican fossil can be separated from the lower jaws of the living *Erethizon dorsatum* only by seemingly minor features, not even considered to be of specific value by Hibbard and Mooser (1963). We consider the jaw from Arroyo Cedazo as questionably *Erethizon* until the fossil forms are better known.

Order Lagomorpha

Family Leporidae

Lepus cf. **californicus** Gray

The only specimen of *Lepus* is the articulated distal part of a tibia and a calcaneum (FC 668). The measurements are within the range of variation for *Lepus californicus* and are a bit small for *Lepus alleni* Mearns. No skeletons of *L. mexicanus* Lichtenstein are available for comparison. Both *L. californicus* and *L. mexicanus* occur in the State of Aguascalientes today.

Sylvilagus cf. **auduboni** (Baird)

A cottontail is represented by a left maxillary fragment (FC 667) and a pair of conjoined lower jaws (FC 670). Both *Sylvilagus auduboni* and S. *floridanus* (Allen) live today in the State of Aguascalientes and separation of these two species without good skulls is impossible. The Cedazo specimens are small, the size of S. *auduboni*.

Order Edentata

Family Megalonychidae

Nothrotherium cf. **shastense** Sinclair

The small ground sloth is represented by a cheek tooth, oval in cross section and measuring 20.8 by 14.4, with a shallow groove on one (labial) side (FC 637), a nearly complete scapula about 660 in maximum length (FC 641), two humeri, one of which measures greatest length 398, proximal

end 95.9 by 74.3, midshaft 51.6 by 37.4, and distal end 153.1 by 40.0 (FC 640), the proximal half of a femur (FC 639), and a quantity of other postcranial material, including isolated and some associated vertebra and a flattened ungual phalanx (FC 614). The material is like specimens of *Nothrotherium* cf. *shastense* figured by Stock (1925) from the Rancho La Brea.

Family Mylodontidae

Paramylodon harlani (Owen)

There are numerous isolated and articulated vertebra of a large sloth, and fragments of a sacrum like that of *Paramylodon*. A fifth metatarsal was deposited in the Collection of the Institute of Geology (IGM 56–103) and measurements given by Mooser (1959:413). Although postcranial elements of *Paramylodon* are rather common in the Tacubaya sediments, no skulls, jaws, or teeth were found.

Family Dasypodidae

Holmesina septentrionale (Leidy)

The giant armadillo must have been common. There are two articulated scutes and 25 isolated ones in the collection (FC 636). The most complete scute measures 96.6 by 38.8, maximum thickness above the lateral groove 12.0, and lateral groove 15 high by 3.9 deep. There is also a cheek tooth in a fragment of lower jaw, about 20 by 8 and 6.4 wide at the constriction.

Family Glyptodontidae

Brachyostracon cf. **mexicanus** (Cuataparo and Ramirez)

There are three large pieces made up of conjoined scutes and many isolated scutes (FC 635). The three sections of shell probably come from a single animal but the isolated scutes represent a number of different individuals. The average carapace scute is about 30 in diameter and the largest in the collection is 43 in diameter. The scutes resemble those from Veracruz referred to *B. mexicanus* by Dalquest (1961), and scutes from the Cedazo local fauna were provisionally referred to *B. mexicanus* by Mooser in 1959. In addition to carapace scutes, the collection contains most of two glyptodon sacra and some isolated vertebra.

Order Carnivora
Family Canidae

Canis latrans Say

FC 605 is a slightly crushed skull. The palate is separate. On the left side, the incisors are present, P^4 is broken, but M^1 is present and complete.

Right I^1–I^3 are present, the canine is broken, P^2 is broken, but P^3–M^2 are complete. Left I^1–M^2 measures 94.4. The breadth of the muzzle at P^3 is 55.6.

FC 606 is a lower jaw with the alveolus of P_1 and well-preserved P_2–M_2. Alveolar length, P_1–M_3 is 80.5, and P_2–M_2 is 67.2. M_1 measures 21.6 by 8.7.

Canis cedazoensis, new species

Holotype.—Right maxillary fragment containing P^3–M^1 and the alveoli of M^2, number FC 634, collection of O. Mooser.

Type locality.—Arroyo Cedazo, 3 kilometers SE Aguascalientes, State of Aguascalientes, Mexico.

Age.—Probably middle Pleistocene.

Distribution.—Known only from sediments of the Tacubaya Formation at the type locality.

Etymology.—The species is named for the type locality, Cedazo ravine.

Diagnosis.—A small dog, larger than the largest North American foxes, but smaller than the coyote, *Canis latrans*. As compared with the coyote, the upper M^1 is relatively small.

Description.—The maxillary fragment contains the alveoli of M^2 and well-preserved P^3–M^1. The infraorbital foramen is a vertical slit, like that of the coyote, and located about 6 mm above the ventral edge of the maxilla, above the center of the anterior root of P^3. The teeth are moderately worn with the tips of the cusps worn flat. There is a gap of 2 mm separating the posterior edge of the crown of P^3 from the anterior edge of P^4, and a gap of 1 mm separating the posterior edge of P^4 from the anterior of M^1. (Fig. 2)

Measurements.—Alveolar length P^3–M^2, 40.5; crown length P^3–M^1, 38.6; greatest length of crown of P^3, 10.3; width of P^3 anteriorly, 3.5; width of P^3 posteriorly, 3.7; greatest length of crown of P^4, 16.9; breadth of P^4 anteriorly (without protocone, see discussion) 6.9; breadth of crown posterior to carnassial notch, 6.3; length of M^1, along labial border, 10.1; breadth of crown at right angles to labial border, 12.2.

Discussion.—The protocone on P^4 of the holotype has been broken away. The teeth are far too large to belong to any fox. The type specimen was compared with nearly 100 Recent coyote skulls from Texas and occasional variants were found to match some of the distinctive characters of the holotype. Some coyotes have the upper teeth widely spaced. Numerous specimens lack a cingulum on the lingual side of P^4 except for a faint one posteriorly. The very smallest coyotes had the upper carnassial as short, but never as narrow, as the tooth of *C. cedazoensis*. No coyotes had the M^1 as small as that of *C. cedazoensis*. In the few coyotes with the P^4 as short as the P^4 of *C. cedazoensis*, the contrast in the size of M^1 in the two species was striking. The upper dentitions of coyotes are surprisingly variable and it is not unexpected that extreme variants do match *Canis cedazoensis* in one

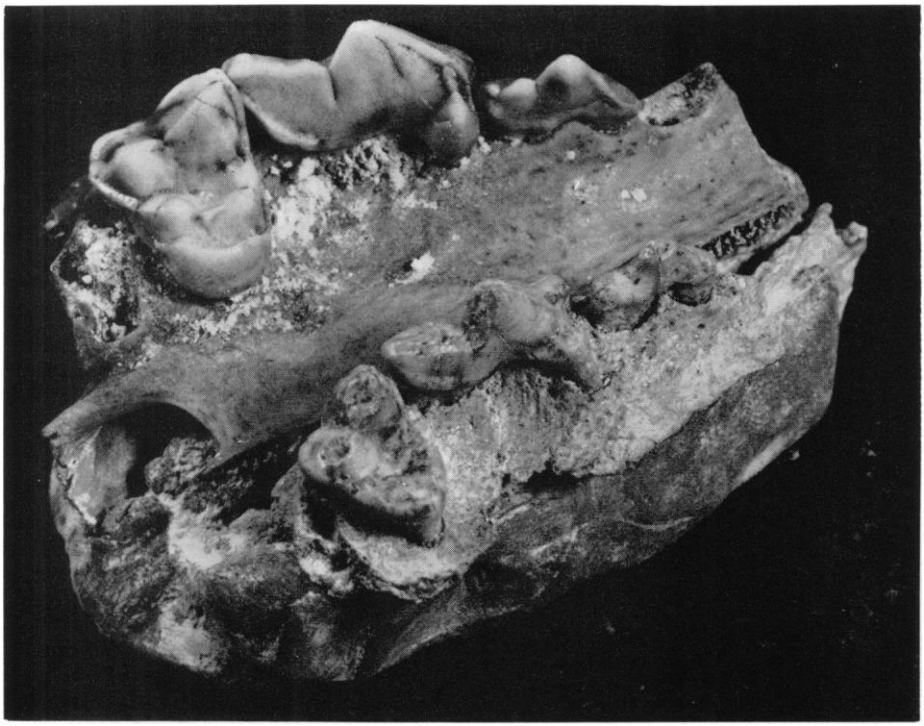

FIG. 2.—*Canis cedazoensis*, holotype, maxillary fragment with P^3–M^1, foreground, and for comparison the equivalent parts of a modern coyote, *Canis latrans*.

or two characters. *Canis cedazoensis* upper teeth differ from 90 percent of coyotes in other dental characters, and from all coyotes examined in the small size of M^1.

This specimen (holotype) is the second collected by Mooser. The first and more complete specimen was sent to the United States for identification and never returned.

Canis cedazoensis is not a coyote. The species may have filled the niche between fox and coyote, occupied in the Old World by various jackals.

Canis dirus Leidy

The dire wolf must have been common when the Tacubaya sediments were forming. Available are four lower jaws (FC 601, 602, 603, and 604), with teeth well-worn or shattered. The teeth are larger and the jaws heavier than those of a gray wolf. A tibia (FC 608) measures as follows: greatest length, 225; proximal end, 55.0 (across crest) by ?; midshaft, 29.2 by 18.1; distal end, 23.4 by 32.5. These measurements are smaller than those given by Merriam (1912) for a "relatively large" dire wolf from the Rancho La Brea (greatest length, 237).

Maldonado-Koerdell (1955) recorded a skull of *Canis dirus* from the State of Mexico, but Avina (1969) did not include the species among the new records of Pleistocene carnivores from Mexico.

Urocyon cinereoargenteus (Schreber)

Mooser (1959) included this fox in the Cedazo local fauna on the basis of a fragment of long bone (IGM 56-222). Now available is a right lower jaw fragment with the P_4.

Family Mustelidae

Taxidea cf. **taxus** (Schreber)

The radius of a badger (FC 1073) is from a large individual and is the only representative of the Mustelidae in the Cedazo local fauna.

Family Ursidae

Arctodus simus Leidy

Mooser (1959) recorded a tooth, identified for him by A. R. V. Arellano as a bear (*Tremarctotherium*). For use of the name *Arctodus* see Kurten (1963) and for recent records of Pleistocene bears from Mexico see Avina (1969).

Family Machairodontidae

Smilodon cf. **californicus** Bovard

A sabertooth is represented by a greatly worn upper carnassial (FC 714) and an astragalus (FC 607). The "neck" of the astragalus is short, as in sabertooths and not long as in the true cats.

Family Felidae

Panthera atrox (Leidy)

A radius of this enormous cat measures as follows: greatest length, 395; proximal end, 42.8 by 61.8; transverse breadth midshaft, 42.5; distal end, 41.5 by 67.4. The bone (FC 600) is exceeded in length by a single specimen from the large series listed from the Rancho La Brea by Merriam and Stock (1932).

Harrington (1969) discusses the relationships of this lion to the Old World cave lion. The earliest previous Pleistocene record is from the Sangamon of Kansas (Hibbard and Taylor, 1960).

Panthera onca (Linnaeus)

Mooser (1959) listed a palatal fragment (IGM 56-102), a tibia (IGM 56-190), and other bones of a large, robust cat. The greatest length of the tibia

is 260. A cervical vertebra (FC 613), probably the third or fourth, has a centrum length of 37.7 and depth of 25.7.

The palatal fragment, IGM 56-102, was examined through the courtesy of Dr. Silva-Barcenas. It consists of the right maxillary and zygomatic arch and separate premaxillary fragment with I^3. The teeth are worn. P^4 measures 20.9 by 11.4. The alveolus of M^1 measures approximately 30.5 by 18.2.

These specimens are not sabertooth, are much too small for *Panthera atrox*, and too large for *Felis concolor*. They probably are of a jaguar. Jaguars occur today in the lowlands west of Aguascalientes.

Felis (Lynx) rufus Schreber

A slender, straight radius (FC 612) belongs to a bobcat. Measurements are as follows: greatest length, 138.4; proximal end, 9.9 by 18.3; midshaft, 5.8 by 10.5; distal end, 18.3 by 12.1.

Order Proboscidea

Family Mammutidae

Mammut americanus (Kerr)

A lower jaw with well-preserved teeth (FC 664) is from the Tacubaya sediments 3.5 kilometers north of Aguascalientes, on the bank of the Rio Aguascalientes. It comes from the same level of the same formation as the other fossils recorded here.

Hibbard (1955) figures a mastodon tooth from an unknown locality, presumably in Mexico, but our specimens seem to be the first definite records from the country. See also Cope (1884).

Family Elephantidae

Mammuthus cf. **meriodionalis** (Nesti)

Remains of elephants are common in the Cedazo ravines, and include teeth, tooth fragments, and numerous postcranial elements. The teeth resemble the teeth of *M. meriodionalis* as figured by Maglio (1973). Hibbard (1955) listed *Mammuthus imperator* from the Becerra Superior Formation.

Order Perissodactyla

Family Equidae

Equus conversidens Owen

This is a common species in medial and late Pleistocene deposits in Mexico and much of the United States. It is important that there be no doubt that the name *Equus conversidens* is properly linked to the correct species of horse. This requires a review of the history of the name, and the holotype material.

The holotype consists of a palate with the cheek teeth of both sides, discovered sometime before 1869 by Antonio Del Castillo. Del Castillo sent photographs of the holotype and other horse teeth to Richard Owen, in England. Owen (1869) gave a brief description of *Equus conversidens*, based on the holotype palate. The holotype was clearly figured. There was controversy about *Equus conversidens* during the next 85 years (for summary see Hibbard, 1955:60–62). In 1949, Claude W. Hibbard and Morris F. Skinner discovered the holotype in the collection of the Instituto de Geologia in Mexico City (Hibbard, 1955). The rediscovery removed much of the doubts concerning *E. conversidens*. The name belongs to a small horse with moderately complicated foldings of the enamel of the upper teeth. The enamel pattern has few other distinctive features and can be matched by the enamel patterns of some other species of Pleistocene horses of larger size.

The type locality of *Equus conversidens* has been variously given as "Valley of Mexico" or "Tequixquiac." Overlooked by other workers is Del Castillo's own descriptions and accounts of his fossil finds, published by the Deutsche Geologische Gesellschaft (1869). The type of *Equus conversidens* is clearly Del Castillo's number "10. *Equus* n. sp. ? Oberkiefer." This is obvious from Del Castillo's description and his references to a letter from Owen to him, which includes details that Owen used in his description of *E. conversidens*. Del Castillo states that the palate was discovered in a naphtha mine, three meters deep, on the slopes of Tepeyac Mountain, behind the church of the city of Guadelupe. This is the correct type locality.

The commonest small horse in the Cedazo local fauna is a species with upper dentition almost identical in size and enamel pattern to that of the type of *E. conversidens*. Numerous lower jaws and jaw fragments have teeth similar in size to the upper dentitions and doubtless belong to the same species. Among the metapodials, the most common small bones are short and relatively stout.

A skull (FC 680) lacks much of the rostrum and most of the cranium posterior to the dentition, but the cheek teeth of both sides are present and only slightly worn (Fig. 3). A palate (FC 684) has the rostrum, complete cheek toothrow on the left side and lacks only M^3 on the right side. The diastema from posterior border of I^3 to the anterior border of the canine alveolus is 17.0. The diastema from the canine to P^2 is 62.5. Still another skull (FC 681) lacks only the rostrum. The deciduous premolars are still in place, M^1 is moderately worn, M^2 is very slightly worn, and M^3 has not yet erupted. A vestigial P^1 is present just anterior to DP^2. Measurements of this specimen are not included in Table 1.

FC 682 is a pair of conjoined lower jaws lacking the distal end. FC 683 is a right lower jaw fragment with the cheek teeth; M_3 is erupted but not worn. Depth of the ramus under the anterior edge of M_3 is 84.7.

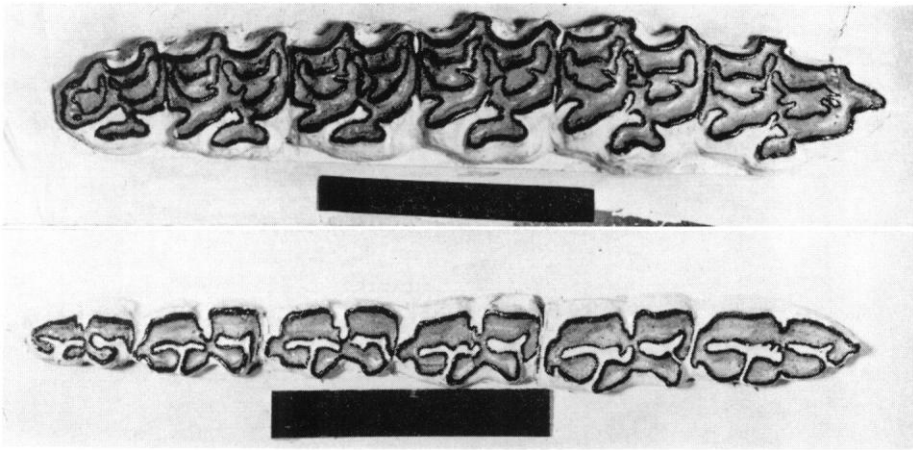

FIG. 3.—*Equus conversidens*, upper left cheek teeth (FC 680), above, and lower right cheek teeth (FC 682), below. Photographs from casts; black bars equal 5 centimeters.

FC 685 is a left lower jaw with the complete cheek tooth row (Table 2). The depth under the anterior edge of M_3 is 101.5. On M_1 and M_3 the valleys between protoconid and hypoconid extend to the very base of the isthmus between metaconid and metastylid, and in M_2 the valley enters for a short distance into the isthmus. This condition is not uncommon in well-worn lower dentitions of *E. conversidens*.

Mooser (1959) listed *Equus conversidens* (as *Asinus conversidens*) from the deposits overlying the Tacubaya Formation in Arroyo Cedazo as well as from the Tacubaya Formation in the same area. Hibbard (1955) reported several specimens of *E. conversidens* from the Becerra Superior Formation which overlies the Tacubaya Formation in the State of Mexico. Apparently *E. conversidens* was resident on the Mexican Plateau for much of the later Pleistocene.

It is unfortunate that more metapodials were not found in the Tacubaya deposits. The number of metapodials complete enough to give accurate measurements of greatest length is small. We have included measurements of these in Tables 3 and 4. The most helpful measurement is the greatest length of the bone. We have also given measurements of proximal and distal ends but have found that, for actual comparative purposes, the midshaft dimensions are of greater value. Relative stoutness or slenderness is usually made clear by the midshaft dimensions. We have found midshaft diameters to vary but little at different points along the approximate center of any single metapodial.

The most common metapodials are relatively short, stout bones of moderate size that we attribute to the common horse of medium size in the fauna, *Equus excelsus*. The bones are quite uniform in size and proportions.

TABLE 1.—*Measurements of upper dentitions of* Equus.

Number	P^2–M^3	P^2–P^4	M^1–M^3	P^2	P^3	P^4	M^1	M^2	M^3
				Equus conversidens holotype (Hibbard, 1955, left side)					
	147.7	82.2	65.8	33.3×20.7	24.3×23.8	25.2×22.3	22.0×21.7	21.9×19.8	20.6×17.2
				Equus conversidens, Cedazo local fauna					
680	149.0	84.8	65.4	33.6×23.9	26.3×25.2	25.3×25.0	23.0×23.8	24.2×22.6	20.0×16.9
680	152.8	84.1	61.3	32.2×24.5	25.7×25.5	26.5×24.7	23.0×23.3	22.7×22.6	21.3×16.6
684	140.6	76.8	64.6	30.2×22.4	24.4×24.3	23.0×24.2	20.1×22.3	20.8×22.5	24.5×20.5
				Holotype and referred material of *Asinus aguascalentensis* (Mooser, 1959)					
7–12	160.1	89.0	71.3	34.0×22.5	27.5×23.5	27.5×22.8	24.2×21.8	24.1×22.1	23.0×16.8
14–18	160.5	87.0	73.5	33.0×24.0	27.0×25.0	27.0×24.0	26.5×25.8	23.0×25.1	24.0×17.0
21–32	159.1	88.1	71.5	35.0×23.0	26.3×25.0	26.8×25.3	24.0×24.0	23.0×23.0	24.5×21.0
				Referred material of *Onager altidens* (Mooser, 1959)					
IGM	–	86.5	–	33.0×24.0	27.0×26.0	26.5×25.0	24.0×24.0	–	–
62–71r	–	86.0	–	33.0×23.0	27.5×25.0	25.5×26.0	23.0×24.0	23.6×22.5	–
62–71l	–	–	71.4	–	27.4×25.0	26.0×24.0	23.4×22.0	24.0×24.1	24.0×17.6
				Holotype of *Onager hibbardi* (Mooser, 1959)					
205r	156.5	87.8	68.7	35.0×25.4	26.2×27.5	26.6×27.1	22.0×26.0	21.2×25.4	25.5×21.8
				Equus excelsus					
709r	160.6	88.6	75.3	35.1×25.8	29.2×26.7	28.8×27.9	24.4×25.7	26.0×24.6	25.8×21.5
709l	159.5	87.8	74.9	33.9×26.6	27.5×26.6	27.5×25.4	26.3×23.5	23.8×20.3	24.0×19.9
				Equus cf. *caballus*					
109	–	–	–	–	25.1×24.0	24.0×24.0	–	–	–
				Equus tau					
673	118.4	63.1	56.2	24.6×18.7	19.5×20.2	19.4×20.7	16.4×19.1	18.0×18.2	21.3×16.9
				Equus calobatus					
686r	182.0	100.6	81.5	40.6×27.9	31.3×31.7	30.4×30.0	27.4×27.3	28.5×26.5	27.4×22.7
686l	182.0	100.2	82.0	39.7×28.7	31.9×29.8	30.9×28.2	26.4×27.7	28.0×26.9	28.5×22.6
				Equus mexicanus old male					
678	–	101.1	–	42.4×27.8	28.8×31.7	29.8×30.0	–	–	–

TABLE 2.—*Measurements of lower dentitions of* Equus.

Number	P_2–M_3	P_2–P_4	M_1–M_3	P_2	P_3	P_4	M_1	M_2	M_3
					Equus conversidens				
682	147.6	81.3	67.0	31.7×14.1	27.0×15.4	24.5×13.7	23.9×13.6	22.6×11.8	19.5× 8.4
683	150.0	83.0	73.4	29.5×14.5	27.1×15.8	26.4×13.3	25.5×13.8	23.5×11.3	23.9× 9.3
685	149.3	76.2	71.0	28.6×14.5	25.0×15.9	24.1×13.6	22.4×12.9	22.6×11.8	27.5×10.2
					Holotype of *Onager zoyatalis* (Mooser, 1959)				
IGM	147.0	77.6	69.7	28.3×13.2	24.7×13.9	24.5×13.4	22.8×12.6	22.8×12.4	25.4×11.0
					Referred material of *Asinus aguascalentensis* (Mooser, 1959)				
IGM	154.6	81.5	73.1	29.5×14.7	26.3×16.9	25.7×18.0	22.5×14.0	23.6×14.0	27.0×12.8
					Holotype of *Onager arellanoi* (Mooser, 1959)				
88	167.0	89.0	78.0	35.0×16.0	28.0×17.0	26.0×16.0	25.0×14.0	25.0×14.0	28.0×11.5
					Equus excelsus				
710	159.1	87.5	77.6	32.5×16.3	29.2×16.5	28.4×17.1	26.4×16.2	25.5×15.5	26.3×14.4
711	155.7	81.0	74.6	29.7×18.4	26.4×16.5	26.0×14.8	23.5×14.8	25.0×18.6	27.9×13.2
					Equus sp.				
675r	155.5	84.4	72.2	31.8×14.6	22.0×17.5	22.1×15.6	23.3×15.0	24.3×16.0	24.3×11.9
675l	161.0	87.2	72.6	32.3×14.5	23.5×16.3	27.3×16.5	25.2×15.7	24.0×13.8	25.7×10.9
676r	144.3	75.2	68.6	27.6×18.0	24.5×13.9	23.2×13.9	21.5×13.8	22.1×12.5	26.5×10.8
676l	144.3	77.1	68.6	27.3×12.3	20.5×14.3	23.5×14.3	21.7×13.3	22.1×12.8	26.0×10.5

TABLE 2.—*continued.*

Number	P_2–M_3	P_2–P_4	M_1–M_3	P_2	P_3	P_4	M_1	M_2	M_3
					Equus cf. *caballus*				
716	–	–	77.3	–	29.9×15.9	28.0×16.4	25.8×14.0	24.8×12.9	26.5×11.2
					Equus tau				
672	118.8	64.8	56.4	24.7×11.4	20.2×12.6	19.8×12.6	19.4×11.2	17.2×11.0	19.3× 9.8
					Equus calobatus				
686r	180.7	94.2	86.7	35.5×16.1	29.9×18.3	29.9×18.3	26.7×15.2	28.2×15.9	32.0×16.8
686l	182.0	95.7	86.3	35.3×16.1	30.0×18.3	29.4×16.8	26.8×15.7	29.0×15.3	31.1×16.2
					Equus mexicanus old male				
679	182.4	89.4	92.0	31.3×17.0	31.0×17.5	30.3×17.5	25.0×16.6	28.8×17.0	39.8×15.1
					Equus parastylidens				
107	–	82.5	–	32.5×16.5	25.0×17.0	25.0×17.0	–	–	–
677	–	–	77.4	–	–	25.4×17.1	23.5×14.4	23.9×14.3	28.6×12.7

TABLE 3.—*Measurements of metacarpals of* Equus.

Number	Length	Proximal end	Midshaft	Distal end
		Equus conversidens		
FC 701	226.5	33.3×49.0	25.0×34.9	34.9×48.8
FC 702	226.7	31.6×55.0	25.1×35.5	32.4×44.4
		Equus excelsus		
FC 698	230.7	33.9×54.2	27.2×30.5	39.4×50.7
FC 699	234.3	36.9×55.1	28.7×37.4	40.0×51.0
FC 700	233.3	33.8×50.5	27.0×33.2	33.6×40.1
		Equus sp.		
FC 697	248.9	32.0× ?	27.3×33.5	37.4×44.6
		Equus calobatus		
FC 705	284.4	36.6×50.6	28.4×31.5	33.9×42.1

The second most common metapodials are similar in proportions to those of *Equus excelsus* but are distinctly smaller with no overlap in measurements. These we assign to the second most common horse in the fauna, *Equus conversidens*. Identity of the upper dentitions of *E. conversidens* from the Cedazo local fauna seems quite certain. The metapodials include only one type that could logically belong to *Equus conversidens*. Identically small, stout metapodials from the Valley of Mexico, near the type locality of *E. conversidens*, are preserved in the collection of the Institute of Geology in Mexico City.

A third kind of metapodial is represented only by one metatarsal, so small, long and slender that it can be only referable to *Equus tau*, a rare species in the Cedazo local fauna. The specimen resembles metatarsals of *Equus francisci* (Lundelius and Stevens, 1970). A fourth kind of metapodial, represented by one metacarpal and three metatarsals, is of the stilt-legged horse, *Equus calobatus*. Still another species is represented by a single metacarpal, larger than the metacarpal of *E. excelsus*, longer and relatively more slender. It closely matches the measurements of the metacarpal of *Equus altidens* (Quinn).

Equus excelsus Leidy

Equus excelsus Leidy, 1858.
Onager (*Hesperohippus*) *hibbardi* Mooser, 1959: 428.
Onager arellanoi Mooser, 1959: 424.
Onager altidens Quinn, in part, Mooser, 1959.
Asinus aguascalentensis Mooser, 1959: 434.

Morris F. Skinner (personal communication) has examined casts of dentitions of this species and believes that they belong to *Equus excelsus*. Mooser recognized remains of this horse under four different specific names, three of them new. Specimens accumulated since 1959 show that the characters

TABLE 4.—*Measurements of metatarsals of* Equus.

Number	Length	Proximal end	Midshaft	Distal end
		Equus conversidens		
FC 695	240.5	37.9×44.0	30.2×31.3	32.5×40.0
FC 696	242.0	38.2×44.5	29.1×32.5	33.6×42.3
FC 707	253.1	41.8×42.9	29.5×29.6	? ×40.2
FC 713	252.0	46.0×38.5	29.0×29.0	38.7×33.0
		Equus excelsus		
FC 687	265.6	42.5×50.7	33.7×38.1	37.4×45.5
FC 688	268.4	40.3×49.5	30.3×32.8	34.8×44.4
FC 689	261.9	43.2×47.2	29.7×32.1	36.1×44.5
FC 690	261.9	42.4×45.9	31.2×32.3	34.1×44.6
FC 691	264.3	42.2×42.9	31.5×32.4	37.1×45.5
FC 692	260.2	42.5×45.7	31.1×32.4	36.0×43.2
FC 693	259.6	41.3×44.5	29.5×32.4	33.8×41.9
FC 694	258.8	43.4×48.6	32.8×34.5	37.2×48.8
		Equus tau		
FC 708	280.2	35.1× ?	26.2×24.0	29.8×34.6
		Equus calobatus		
FC 703	308.9	40.6×44.6	32.4×32.7	32.4×43.5
FC 704	296.0	? × ?	36.5×36.3	37.6×45.3
FC 712	297.0	39.5×35.4	28.0×28.0	38.0×32.0

originally thought to be diagnostic of the several species grade into one another, and that the four specific names pertain to a single taxon. The following constitutes a revision of this group of specific names.

Onager arellanoi Mooser.—The holotype is a lower jaw with the complete cheek tooth series (FC 88). The mandible appears to be of about the size and proportions of *Equus excelsus*, and the dentition is similar except that the length of P_2–M_3 is greater than usual in *E. excelsus*. The length seems to be partly the result of an exceptionally long P_2. The other teeth compare well with those of *E. excelsus*. We refer *O. arellanoi* to the synonymy of *E. excelsus*.

Onager (*Hesperohippus*) *hibbardi* Mooser.—The holotype is a skull (FC 205) with complete cheek teeth of both sides. Referred and figured are as follows: three upper premolars (IGM 56-108); a lower jaw fragment with P_2–M_1 (IGM 56-5 to 56-8); both deciduous premolar series of one individual (IGM 56-109 to 56-110). We are uncertain as to the identity of the inferior milk dentition. Mooser noted (1959:432) that the incisors of this specimen had no infundibuli. The holotype is referable to *Equus excelsus*.

Asinus aguascalentensis Mooser.—This species was based on upper dentitions (FC 21-32) and referred upper and lower dentitions. Material now available shows varying degrees of intermediacy and we feel that *E. excelsus* and *A. aguascalentensis* are conspecific.

Onager altidens Quinn.—Upper teeth, P^2–M^1 (IGM 56-51 to 56-54) and the right and left upper dentitions of one individual (FC 62-71), figured by Mooser, were referred to *Onager altidens*. The specimens fall into the known range of variation of *Equus excelsus*. A lower jaw fragment (IGM 56-16 to 56-18), figured and referred to *O. altidens*, appears to be *Equus conversidens*.

The type of *Equus altidens* is a partial skeleton in the collection of the University of Texas. The teeth are distinctly larger than those of *E. excelsus* and the metapodials are larger, longer and relatively more slender.

Among the horses of the Cedazo local fauna, *Equus excelsus* may be identified by the following characters: size medium, larger than *E. conversidens* (P^2–M^3 154-170), with little if any overlap in greatest length of premolar-molar series; upper enamel pattern rather simple in all but the very earliest stages of wear; styles strong and prominent; protocone relatively short and broad, usually with lingual groove; lower dentition simple; protoconid-hypoconid valley not passing between metaconid-metastylid complex (though rarely approaching this condition in some worn molars); metaconid rounded, usually larger than metastylid; metastylid pinched and angular but rarely elongated; metaconid-metastylid valley broadly "V" or narrowly or broadly "U" shaped but not narrowly "V" shaped. As with many kinds of extinct species of horses, seemingly diagnostic characters of the enamel patterns, especially of the upper teeth, break down when larger series of specimens become available.

Equus excelsus was described from a maxillary fragment with right P^4–M^3, from Nebraska, figured by Gidley (1901). The upper dentitions from Aguascalientes resemble the holotype in size and simplicity of enamel pattern. The upper teeth from Mexico usually, but not always, have the protocones grooved. The P^4 of the holotype has no groove. The outer walls of the protocones of M^1 and M^2 of the holotype have been broken away; they may have been grooved. There is a strong tendency for the long axis of the protocones of the premolars of the Mexican specimens to be tipped lingually, which is not apparent in the P^4 of the holotype. The differences noted are within the observed range of variation of the series of dentitions of *E. excelsus* from Aguascalientes.

Equus excelsus is the common horse in the Cedazo sediments. It is represented by five skulls, three palates, numerous upper and lower complete and partial dentitions, and hundreds of isolated teeth.

FC 709 is a nearly complete skull with lightly worn teeth. Some measurements are as follows: greatest length of skull from anterior edges of incisors to posterior end of occipital crest, 545.0; greatest zygomatic breadth, 207.0; breadth across I^3's, 73.7; breadth across rostrum just in front of premolars, 60.2; interorbital breadth, 76.9; braincase breadth at center of zygomatic process of squamosal, 113.3; breadth at auditory meatus, 127.0; breadth across P^4's, 116.3.

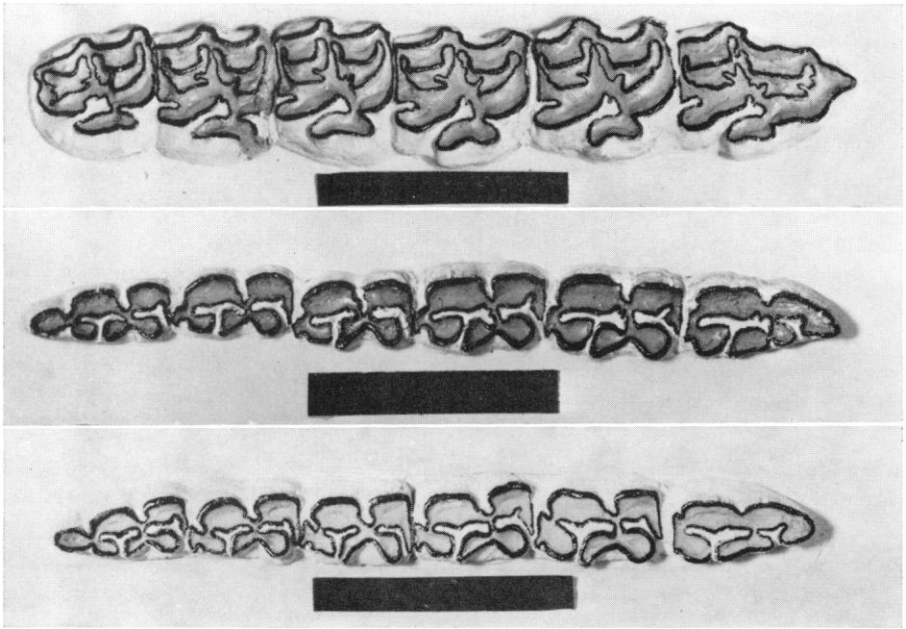

FIG. 4.—*Equus excelsus*, upper left cheek teeth (FC 718), above, lower right cheek teeth (FC 57), middle, and lower right cheek teeth of a younger individual (FC 671), beneath. Note that in the M_1 of the middle figure the protoconid-metaconid valley penetrates to but does not pass between the metaconid-metastylid. Photographs are from casts; black bars equal 5 centimeters.

Skull FC 718 has moderately worn teeth, and the occipital region is missing. Breadth across the I^3's is about 75.5; breadth across P^4's is about 115.0. The P^2–M^3 length is 164.0 (Fig. 4).

FC 719 is a palate with moderately worn teeth. The dentition is good. The P^2–M^3 length is 155.3. Breadth across P^4's is 122.0.

FC 717 is the skull of an aged horse with much worn teeth. The interorbital breadth is 83.9; breadth of rostrum just in front of premolars, 60.2; breadth across I^3's, about 70; breadth across P^4's, about 115; length P^2–M^3, 154.1.

FC 720 is a damaged skull with P^2–M^3 on the left side but only M^2 on the right. The nasals are complete—they are slender, tapering, and separated for about 40 mm anteriorly. The breadth of the conjoined nasals at the narial notch is about 50.

FC 681 is the palate of a colt with DP^2–^{4}, M^1 and M^2 unworn, and M^3 just erupting. There is a vestigial P^1 on both sides.

FC 721 is the anterior part of a skull with complete cheek teeth. Vestigial P^1's are present. The deciduous teeth are lost but the M^3's are just erupting. The P^2–M^3 length is 162.8 and probably would measure a bit less when the

last molars were in place. Breadth across the rostrum just anterior to the premolars is 58.0. Breadth across the P^4's is 110.4.

FC 722 is a palate with rostrum, incisors, and complete cheek teeth. The teeth are slightly more worn than in FC 721, with M^3 fully erupted but only slightly worn. The P^2–M^3 length is 167.7. Breadth across the P^4's is 122.5.

The lower jaws of *Equus excelsus* uniformly show the following features: beneath the posterior edge of the exposed M_3 the bone curves smoothly down and back, so that the angle of the jaw lies beneath the level of the ramus anterior to it; anterior to M_3 the ventral surface of the ramus curves down to a low point beneath P_3, and then upward again; when the jaw is placed on its ventral surface, it touches just anterior to the angle and beneath the posterior edge of P_3; there is a gap 10 high between P_3 and M_3, and the posterior edge of the symphysis lies about 10 above the baseline. Harrington and Clulow (1973) have described a similar condition in the lower jaw of *Equus lambei* from the Yukon Territory, of Canada.

Equus sp.

Among the specimens from Aguascalientes is a pair of jaws of an adult horse (FC 675) that stand out by the extreme complexity of the enamel pattern. Another pair of jaws, FC 676, is very similar but contains greatly worn teeth. These jaws appear to be of about the size of *Equus excelsus*.

Horse teeth with unusually complicated enamel patterns occur sporadically in Pleistocene deposits. Usually there are no characters other than complexity to distinguish these specimens from teeth of other described species. Some have been named as new; *Equus pectinatus* Cope is one. *E. pectinatus* has been recorded from the State of Mexico. The teeth of *E. pectinatus* are far too large to be conspecific with the jaws from Cedazo.

Equus cf. **caballus** Linnaeus

Mooser (1959) recorded *Equus caballus* from Arroyo Cedazo on the basis of a maxillary fragment with P^3–P^4 (FC 109) and a lower jaw fragment with P_3–M_3 (FC 108). The identity of the lower jaw is not certain. The metaconid-metastylid valley is broadly rounded, "U" shaped, as in *Equus caballus*. The protoconid-hypoconid valley does not approach the isthmus between metaconid and metastylid in M_1, and does not enter between the metaconid and metastylid in M_2 and M_3. Typically, in molars of *E. caballus*, the protoconid-hypoconid valley enters between the metaconid and metastylid.

A more recently taken specimen (FC 716) consists of P_3–M_3 (Fig. 5). When discovered, the teeth were in a nearly complete lower jaw but the jaw was destroyed and only the five teeth could be recovered. The metaconid-metastylid valleys are broadly "U" shaped in both molars and premolars. In the molars, the protoconid-hypoconid valley passes deeply between metaconid and metastylid.

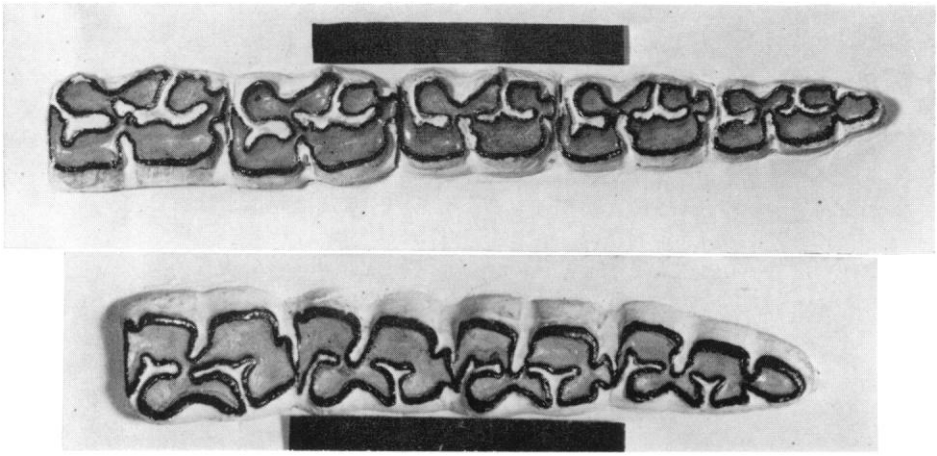

FIG. 5.—*Equus* cf. *caballus*, lower left P_3–M_3 (FC 716), above, and *Equus parastylidens*, lower right P_4–M_3, (FC 677), below. Photographs from casts; black bars equal 5 centimeters.

The specimens referred to *E. caballus* are from a small species of horse. The dentitions are larger than those of *E. conversidens*, and about the size of *E. excelsus*. They are too small to be *E. crenidens* Cope, a zebra-like horse known from the State of Mexico (Hibbard, 1955).

Apparently a horse similar to the Old World *Equus caballus* lived on the Mexican Plateau in the middle Pleistocene. Specimens from widely separated localities in the United States and Canada have been referred to *Equus caballus* but the Pleistocene age or identity of most of these finds have been questioned.

Equus (Hemionus) tau Owen

Owen (1869) named *Equus tau* in the same paper in which he named *Equus conversidens*. The description was brief and poor, and no measurements were given. Five upper teeth of the left side were figured (Owen, 1869: Pl. XLI, Fig. 4). This specimen should be considered the holotype, and not the lower deciduous dentition (Owen's Fig. 5). Owen stated that the teeth were smaller than those of *Equus conversidens* but gave no distinguishing characters of the species. Much confusion has resulted.

Hibbard (1955) pointed out that Owen's figures of both *Equus tau* and *E. conversidens* were prepared from photographs furnished him by Del Castillo. The palate of *E. conversidens*, when compared with Owen's figure, shows that the figure was distorted, and this may be true of the figure of the holotype of *E. tau* as well. Hibbard also noted that the P^3–M^3 length of the figure of *E. tau*, from Owen's figure (111 mm) is almost the same as the P^3–M^3 length from the figure of *E. conversidens* (113 mm), an insignificant

difference. The identity of *E. tau* hinges largely on the actual size of the holotype.

Most workers have overlooked Del Castillo's (1869) own account of his fossil horse specimens from Mexico (see foregoing account of *E. conversidens*). Del Castillo referred six specimens to *Equus tau* Owen, on the basis of correspondence with Owen previous to 1869. Only one of these, two deciduous upper teeth, were figured by Owen (his Fig. 3), and by Owen were referred to *Equus conversidens*. None of Del Castillo's isolated teeth were figured or mentioned by Owen.

The holotype upper jaw of *Equus tau* must be the specimen referred to by Del Castillo as "7. *Equus* n. sp." Del Castillo said "Die zahnreihe ist 0.122 Meter lang und die erste falsche Backenzahn 0.025 Meter breit." The length of the toothrow is thus almost the same as the length of the toothrow of a referred skull from Aguascalientes (118.4).

Only five teeth are shown in Owen's figure (P^3–M^3) of the holotype of *Equus tau*. Del Castillo gave the measurement of the "zahnreihe," implying that all six teeth were present, and specifically mentions the P^2, missing in Owen's figure. The P^2 may have been lost after the measurement was taken and before the photograph was made, or Del Castillo may have taken the measurement from the alveolus of a missing tooth. Only the crowns of the teeth are figured by Owen. It is more likely, however, that the P^2 was so fractured that Owen considered it not worth figuring. The P^3 in the figure clearly shows open fractures, and the fractures of the P^2 may have been more extensive.

There are two species of small horses in the Cedazo local fauna. One of these is *Equus conversidens*. There is good reason to think that the other is referable to *Equus tau*. The matter might be settled if the holotype of *Equus tau* still existed. Dr. Angel Silva-Barcenas has informed us (personal communication) that the holotype was once in the School of Mines in Mexico City but has since vanished. Appeal to the type specimen seems to be impossible.

We refer Aguascalientes specimens to *Equus tau* on the following basis: 1) upper teeth from Aguascalientes resemble those of the holotype and nothing in the figured enamel pattern of the type contradicts such reference; 2) Owen stated that *E. tau* was smaller than *E. conversidens*, even though the figure of the teeth of *E. tau* is only slightly smaller; 3) Del Castillo's measurement of the toothrow of the holotype of *E. tau* is almost the same as the length of the toothrow of the referred skull, and both are smaller than measurements of any other known North American species of *Equus* (had Del Castillo's measurement been of P^3–M^3, *E. tau* would have been distinctly larger than *E. conversidens*, for the P^3–M^3 length of the figure of *E. conversidens* is 115 or less); 4) both species occurred together at Aguascalientes as they apparently occurred sympatrically in the later Pleistocene of the Valley of Mexico.

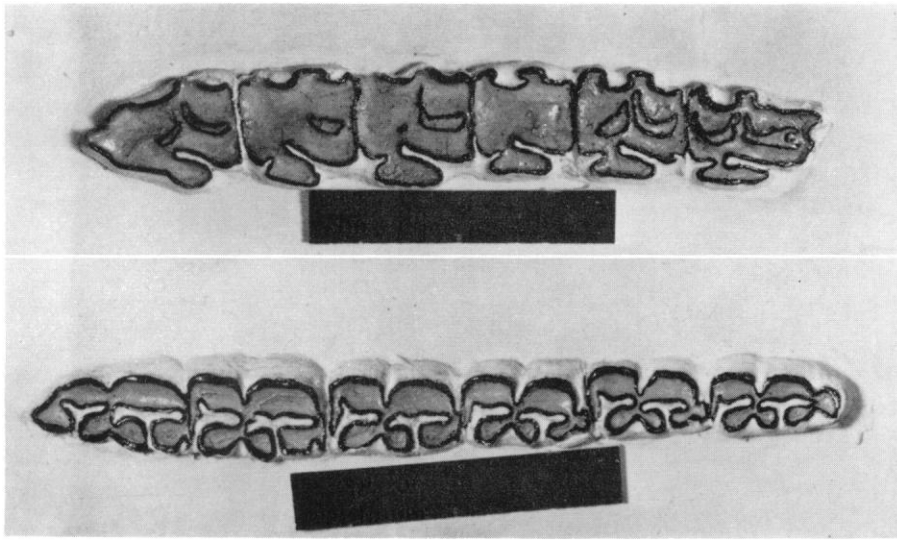

FIG. 6.—*Equus tau*, upper left cheek teeth (FC 673), above, much worn, and lower right cheek teeth (FC 672), beneath. Photographs from casts; black bars equal 5 centimeters.

One horse metatarsal in the collection is small, long and slender. The bone must have been fractured in life, and the healed break passes diagonally across the proximal end of the metatarsal. Distal tarsal elements are partially fused to the end of the bone. The anteroposterior diameter of the proximal end is excessively great and the transverse diameter cannot be measured because of fusion with tarsals.

The metatarsal (Table 4) is only about an inch in midshaft diameter, and distinctly more slender than metatarsals of *Equus conversidens*. Yet the bone is much longer than metatarsals of that species. Similar metatarsals have been described by Lundelius and Stevens (1970) for *Equus francisci*.

The referred skull (FC 673) is of an old animal, with premolars and M^1 greatly worn (Fig. 6). The posterior portion of the skull is missing. A trace of an infundibulum is visible on the left I^3. The lachrimal fossa is very shallow. The orbit is almost round, 52 high by 52 anteroposteriorly. The canine measures at its base 10.1 by 8.1. The breadth across the canines is 45.5; breadth across incisors 51. The protocones of the cheek teeth increase in length from P^2 to M^3 as follows: 8.1; 8.3; 11.3; 11.5; 11.3; 11.9. The cementum on the teeth is very thick.

FC 674 consists of four associated upper teeth; left M^1–M^3 and with them a right M^3. The teeth are well-worn and have a heavy coat of cementum. The lengths of the protocones of the M^1–M^3 series are 10.4, 10.6, and 10.7.

A nearly complete lower jaw (FC 672) is from the right side, broken 15 anterior to P_2 (Fig. 6). The valley between protoconid and hypoconid does

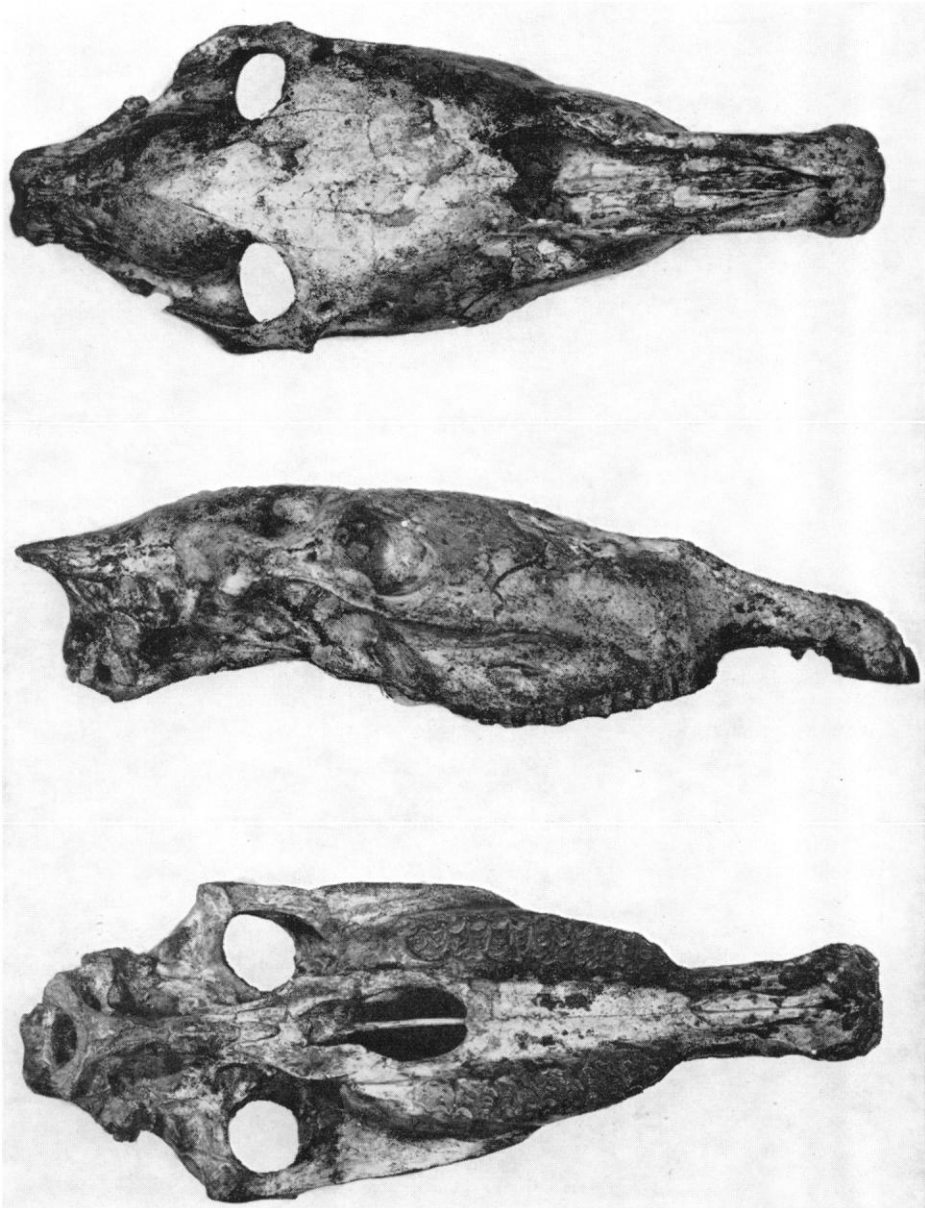

FIG. 7.—*Equus calobatus*, skull (FC 686), in dorsal, lateral, and ventral views. For measurements see text.

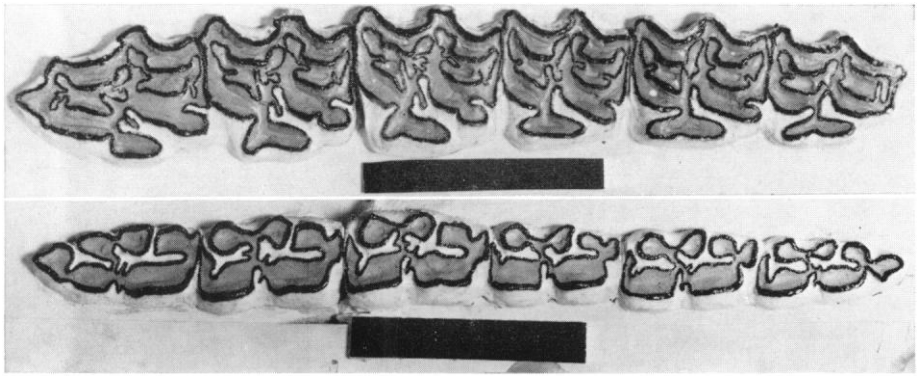

FIG. 8.—*Equus calobatus*, upper left cheek teeth, above, and lower left cheek teeth, beneath, of FC 686 (Fig. 7). Photographs from casts; black bars equal 5 centimeters.

not pass between the metaconid-metastylids of the molars. The metaconid-metastylid valley is sharply "V" shaped. The metaconid is rounded and the metastylid is pinched. The depth of the jaw at the anterior edge of M_3 is 72.8. The characters of the lower dentition of *Equus tau* are much like those of the holotype skeleton of *E. francisci*.

Lundelius and Stevens (1970) placed *Onager zoyatalis* Mooser in the synonymy of *Equus francisci* (Hay). The holotype is a lower jaw with dentition (IGM 56-2), from Arroyo Cedazo. The specimen seems to be too large for *Equus francisci* and the valleys between the metaconids and metastylids are in general more open than in *E. francisci*. We suspect that the specimen actually is *Equus conversidens*.

Equus (Hemionus) calobatus Troxell

The stilt-legged horse is represented best by a skull with associated lower jaws (FC 686) of a young-adult, probably a female (Fig. 7). The diastema (I^3–P^2) is 114.0. The pit of I^1 is small but distinct. The pit of I^2 is large. I^3 is almost unworn. The alveolar breadth across the incisors is 81.4. The greatest breadth across the incisors is 87.7. The nasals are 48.3 broad across the narial notch and taper to a point 110 anteriorly. The lower diastema (I_3–P_2) is 90.9 and the depth of the ramus beneath M_3 is 102.5.

The upper dentition of *E. calobatus* has never, so far as we are aware, been found associated with the lower dentition. FC 181 is, therefore, unusually important. The postprotoconal valley in both molars and premolars is very deep, turning almost at right angles to the longitudinal axis of the tooth and penetrating almost to the anterior fossettes. This we have not noted in any other American Pleistocene horse (Fig. 8).

The protocones of the premolars are relatively short and wide, grooved in P^3 and P^4. In the molars the protocones are more elongated and slender.

Anteroposterior lengths of protocones from P^2 to M^3 are, respectively, as follows: 10.5; 14.3; 14.3; 13.9; 16.5; 15.0. The pli caballin is moderately large in the premolars and absent in the molars. The fossettes of the molars are simple but those of the premolars are more complicated. The mesostyles are broad and flat in the premolars but smaller and more narrow in the molars.

The lower dentition is as figured by Skinner and Hibbard *et al.* (1972). The metaconids are larger than the metastylids and both are rounded. The metaconid-metastylid valley is broadly "U" shaped. There is a small pli caballinid in all teeth. The protoconid-hypoconid valley is rather narrow and does not penetrate between the metaconid-metastylids in either molars or premolars.

Equus calobatus is an uncommon element in the Cedazo horse fauna, greatly outnumbered by representatives of smaller species. It is comparatively large, exceeding all species but *E. mexicanus* in size.

Equus (Hesperohippus) mexicanus Hibbard

Onager (*Hesperohippus*) *oviedoi* Mooser, 1959.

Remains of this large horse are rare in the Cedazo deposits. Fortunately a skull (FC 678) was found. Much of the ventral part is missing but the incisors and premolars of the left side are present. Some measurements are as follows: length from median incisive border to posterior end of occipital crest, 613; breadth I^1–I^3, much worn, 45; a trace of a pit remains on I^3; diastema, canine to P^2, 90; canine, 15.0 by 11.0; postorbital breadth, 86.5; zygomatic breadth, 216; greatest breadth of braincase, 105.0; least breadth of occipital crest, 58.1; least interorbital breadth, 170. This skull is much like the holotype skull of *Equus* (*Hesperohippus*) *mexicanus*. The teeth present are greatly worn.

FC 679 consists of the two maxilla and conjoined lower jaws of one individual. The upper teeth are so greatly worn as to be of little value, but they are large and similar in structure to those of *Equus* (*Hesperohippus*) *mexicanus*. A large canine indicates that the animal was a male. The diastema (C–P_2) measures 91.5. The depth of the ramus at the anterior edge of M_3 is 116.8.

As Hibbard pointed out in the original description, *Equus* (*Hesperohippus*) *mexicanus* is a large horse, comparable in size to *Equus scotti* and similar forms of the United States. Hibbard placed *E. mexicanus* in a separate subgenus, *Hesperohippus*, and noted ways in which it differed from *Equus crenidens*, another large horse found in the Pleistocene deposits of the State of Mexico.

Mooser (1959) described *Onager* (*Hesperohippus*) *oviedoi* from the Cedazo local fauna on the basis of an upper premolar, probably P^4. We now think that *Onager* (*Hesperohippus*) *oviedoi* Mooser is a synonym of *Equus* (*Hesperohippus*) *mexicanus* Hibbard.

Equus (Parastilidequus), new subgenus

Subgenotype.—*Equus parastylidens* Mooser, 1959.

Distribution.—Known only from the Cedazo local fauna, Tacubaya Formation, middle Pleistocene, of the State of Aguascalientes, central Mexico.

Diagnosis.—A horse of medium size with quite hypsodont teeth. Parastylids, unique in American *Equus*, strongly developed on premolars and M_1, present but small on M_2, absent on M_3. The valley between protoconid and hypoconid does not enter between metaconid-metastylid of premolars but enters deeply between them in the molars.

Etymology.—Name based on the parastylids of the lower teeth and *equus*, horse.

Equus parastylidens Mooser

The holotype of this horse consists of a lower jaw fragment with broken incisors and P_2–P_4, taken in Arroyo Cedazo (Mooser, 1959: 445, Fig. 25). A recently discovered specimen (FC 677) is a fragment of lower jaw containing P_4–M_3 (Fig. 5). *Equus parastylidens* is so distinctive that we have erected a new subgenus for it. The parastylids of the lower teeth set this form off from other described species of American *Equus*.

Both the holotype and FC 677 are from the right side and, because both contain P_4, represent different individuals. The teeth of FC 677 are more worn than those of the holotype but are still high. Crown height of P_4 is about 58. Both rami appear rather slender. The holotype has a small canine. The diastema, I_3–P_2, measures 120. The dentitions suggest a horse about the size of the contemporary *Equus excelsus*.

The parastylids are the outstanding feature of the dentition and are apparently unknown in the adult dentition of any other species of American *Equus*. The parastylid of P_2 of the holotype gives the anterior end of the tooth a clover-leaf shape. On P_3 and P_4 the parastylids are strong, semicircular ridges at the anterolabial corner of the teeth. On the P_4 of FC 677, the parastylid is approximately as well developed as on the holotype. On M_1 the parastylid is distinctly smaller than on P_4, and on M_2 it is smaller yet but still distinct. There is no parastylid on M_3.

The metaconid of P_2 of the holotype is of moderate size and rounded but the metastylid is much elongated. The metaconid-metastylid valley forms a broad obtuse angle and the apex of the angle is sharp. In the remaining teeth, the metaconids are rounded but the metastylids are pinched, pointed, and smaller than the metaconids. In the P_3 of the holotype and the molars of FC 677, the metaconid-metastylid valleys are sharply but broadly "V" shaped. In the P_4 of both the holotype and FC 677, the metaconid-metastylid valleys are broadly "U" shaped. This may be coincidental, for it would be most unusual for the P_4's alone of a species of horse to have "U" shaped valleys and the molars and P_3's to have "V" shaped valleys.

The protoconid-hypoconid valleys do not enter deeply or penetrate between the metaconid-metastylids of the premolars, but do penetrate deeply between the metaconid-metastylids of the molars.

The affinities of this species are uncertain. The deep penetration of the protoconid-hypoconid valleys of the molars suggests the zebrine or cabaline horse groups. The "V" shaped metaconid-metastylid valleys of most of the teeth are suggestive of the zebrine horses and *Equus excelsus*. Identification with the latter is, of course, ruled out by the deeply penetrating protoconid-hypoconid valleys of the molars.

The entire appearance of *Equus* (*Parastylidequus*) *parastylidens* is unlike that of other species of *Equus*. The subgenus may have branched from the *Equus* stock in the Pliocene, and have no close relatives among other Pleistocene forms. The abundant horse material from Aguascalientes includes only two fragments referable to *E. parastylidens*. This suggests that the species was a rare visitor to the Cedazo area from another place or habitat.

We note here the resemblance of the lower dentition of *Equus parastylidens* to that of the common lowland zebra, *Equus burchelli* (Gray) of Africa. This resemblance extends to the development of parastylids on the lower premolars. It seems most unlikely that the Burchell zebra lived in Mexico during the Pleistocene and the similarity of dentitions is probably a result of convergence.

Order Artiodactyla

Family Tayassuidae

Platygonus sp.

Peccary remains are rare in the Cedazo deposits. Mooser (1959) recorded a tooth (IGM 56-242). Part of a skeleton had eroded out of the orange-red tuff, but all that could be retrieved were some of the bones of the ends of the hind limbs, catalogued under number FC 638. A complete metatarsal measures as follows: greatest length, 87.1; proximal end, 7.4 by 15.2; mid-shaft, 17.8 by 10.6; distal end, 14.9 by 15.2. The greatest length of a calcaneum is 21.4.

Family Camelidae

Camelops cf. **hesternus** (Leidy)

Large camelids have been known from the Mexican Pleistocene for more than a century, but they are poorly understood. *Camelops mexicanus* (Del Castillo) (=*Palauchenia magna* Owen, see Dalquest, 1974*a*) was described in 1869 and is still certainly known only from the holotype, a lower dentition from the Valley of Mexico. Other specimens have been tentatively referred to *Camelops hesternus* (for example, Hibbard, 1955).

We recognize two kinds of large camels in the Cedazo local fauna, on the basis of skulls and maxillary dentitions. *Camelops* cf. *hesternus* is repre-

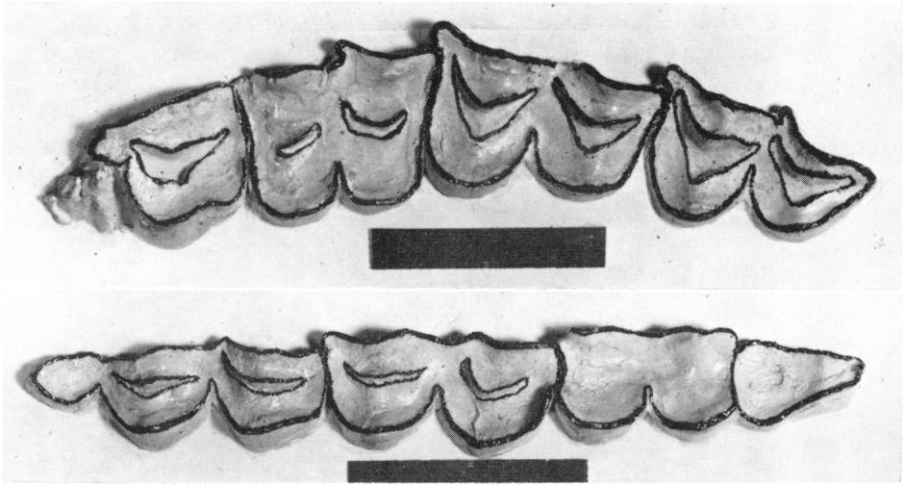

FIG. 9.—*Camelops traviswhitei*, upper left cheek teeth (above) and lower left cheek teeth (below) of holotype. Photographs of casts. The thickness of the enamel bordering the lingual sides of the lakes has been greatly exaggerated to show the shapes of the lakes. Black bars equal 5 centimeters.

sented by a maxillary fragment with cheek teeth (FC 644) and several fragmentary lower jaws. The maxillary is relatively small and there is no canine. Doubtless it was from a female. The I^3 (we follow Webb, 1965, in referring to the upper anterior caniniform tooth as I^3 and the second caniniform tooth as the canine) alveolus, roots of P^3 and P^4 are present with well-preserved molars. The antorbital foramen is large, located above the anterior edge of M^1. The M^3 is worn so that the style between the lakes forms a closed column in the occlusal surface. Some measurements are as follows: alveolus of I^3, 13.3; diastema I^3–P^3, 92.7; anterior edge of I^3–posterior edge of M^3, 248.5; P^3 alveolus, 10.0; P^4 alveolus, 27; M^1, 28.9 by 26.1; M^2, 38.5 by 28.7; M^3, 49.3 by 24.3.

The enamel surrounding the lakes of the molars is thick. The lakes are bent-oval in shape with bluntly rounded ends. The cavities of the lakes are solidly filled with cementum. The dentition is similar to but smaller than dentitions referred to *Camelops hesternus* from the United States. In part the small size of the teeth results from wear, for teeth of *Camelops* decrease in length with wear, and in part may be due to sex.

Four lower jaws are referred to this form. All of the lakes of the molars have a bent-oval form, very thick enamel bordering the lakes, and have relatively short molars.

Camelops traviswhitei Mooser and Dalquest

This large camelid was described (Mooser and Dalquest, 1975) on the basis of a skull and lower jaws from Arroyo Cedazo. Tentatively referred

are a metacarpal and a metatarsal. The species can be separated from other species of Pleistocene *Camelops* on the basis of dentition. In both upper and lower cheek teeth the enamel bordering the lakes is very thin on the lingual sides but moderately thick on the labial sides. The ends of the lakes are sharply pointed, and the lakes lack cementum. In other species of *Camelops*, the enamel bordering the lakes is uniformly thick, the ends of the lakes are blunt-ended, and the lakes are filled with cementum (Fig. 9). The referred metapodials are relatively very short and stout.

Camelops traviswhitei is a camel as large as the largest *C. hesternus* of the United States. For detailed measurements, see Mooser and Dalquest (1975).

Tanupolama small species

Two kinds of small camels are present in the Cedazo local fauna, neither identifiable to species. Criteria for recognition of species of *Tanupolama* are found in the lower jaws and dentitions, and no lower jaws were found in the Tacubaya sediments.

FC 654 is a metatarsal measuring as follows: greatest length, 317.0; proximal end, 30.3 by 36.4; midshaft, 24.2 by 22.6; distal end, 22.8 by 42.1. The bone is complete and belongs to a small camel of about the proportions of the living South American llama.

Tentatively referred to the small species is a right maxillary fragment (FC 653) with a greatly worn P^4 and less worn M^1–M^2. The length of P^4–M^2 is 58.8; M^1–M^2 is 46.3. M^1 measures 22.0 by 20.8; M^2 is 24.5 by 19.9. The external styles are very strongly developed.

Tanupolama large species

A metatarsal (FC 655) enables comparison of this and the previous species. Measurements of the bone are as follows: greatest length, 399; proximal end, 38.5 by 43.6; midshaft, 28.7 by 27.4; distal end, 28.9 by 47.8. Though only slightly larger in diameter than the metatarsal of the small species, the bone is 82 mm, or 25 percent, longer. The large species is a stilt-legged form. We cannot conceive that this great difference could represent individual or sexual variation. The presence of two species of *Tanupolama* in a single deposit is known from other Pleistocene deposits (for example, Hibbard and Dalquest, 1962).

Family Antilocapridae

Stockoceros conklingi Stock

A skull-cap with almost complete horn cores (IGM 56-204) was mentioned by Mooser (1959). Six additional specimens (FC 618-623) are now available but none are as complete as this first specimen. All have the following distinct characters: anterior and posterior tines about equally developed; anterior and posterior tines both distinctly flattened through most of their

lengths; supraorbital shelf and postorbital bar strongly developed and horn cores set far out over orbits; size relatively small. Apparent ages vary from moderately young (FC 622) to old (FC 623). Some measurements are as follows: braincase breadth measured at the smooth constriction medial to the supraorbital shelf, 73.8 (FC 618), 94.4 (FC 623); breadth across occipital condyles, 42.7 (FC 618), 43.6 (FC 623); posterior tine just above fork, 33.1 by 23.6 (FC 622), 36.8 by 19.0 (FC 621), ? by 21.4 (FC 619), 40.7 by 22.3 (FC 623); anterior tine just above fork, 27.7 by 21.3 (FC 622), 31.1 by 19.1 (FC 619), 34.1 by 20.2 (FC 623).

Tetrameryx mooseri Dalquest

This peculiar antilocaprid was described by Dalquest (1974*b*) from the holotype and referred specimen from Arroyo Cedazo. It is readily recognized by the short, flat anterior tine, almost conical in lateral view, and long, slender posterior tine with the external sulcus confined to the center of the outer face of the bone. The supraorbital shelf and postorbital bar are not as well developed as in other known antilocaprids.

Tetrameryx tacubayensis, new species

A third species of large antilocaprid is represented in the Cedazo local fauna by three specimens. The species is distinct and easily characterized.

Holotype.—Top of cranium with most of right posterior tine, base of left posterior tine, and bases of anterior tines; number FC 615, collection of O. Mooser.

Type locality.—Arroyo San Francisco, 4 kilometers SE City of Aguascalientes, State of Aguascalientes, Mexico.

Distribution.—Known only from the type locality, middle Pleistocene age, Tacubaya Formation, Cedazo local fauna.

Diagnosis.—A large antilocaprid of the four-horned type; anterior tines of horn cores shorter than posterior tines; anterior tines strongly inclined anteriorly and angle of divergence wide, as in *Tetrameryx irvingtonensis*; horn core base narrowed and relatively elevated at fork (point of divergence of tines); posterior tine slender, straight and round without external sulcus; external sulcus visible on bases of anterior tines; supraorbital shelf well developed; braincase grooved laterally medial to supraorbital shelf.

Referred material.—Posterior part of a braincase with base of anterior left tine and much of the left posterior tine (FC 617); base of a horn core with bit of anterior tine and part of posterior tine (FC 625).

Etymology.—The species is named for the Tacubaya Formation.

Description.—Size large. Referred specimen FC 625 consists, at this time, mostly of fragments but much of the base of the posterior tine is present. This horn core is larger than any antilocaprid horn core with which we are familiar. The holotype and the other referred specimen are as large as most specimens of *Tetrameryx* (Figs. 10–11).

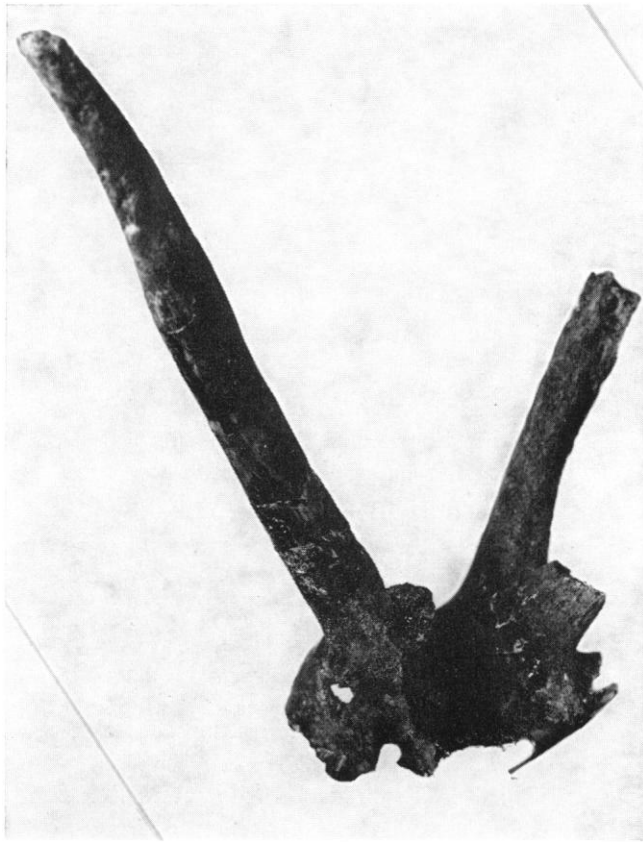

FIG. 10.—*Tetrameryx tacubayensis*, holotype skull cap. For measurements see text.

The horn core case is shown in the holotype and less perfectly in FC 616. It is distinctly narrowed anteroposteriorly, and the fork is well elevated above the supraorbital shelf. The anterior tine is strongly inclined anteriorly but the posterior tine is of normal position for the genus. The angle of divergence is wide, about 70°. A trace of external sulcus is visible on the remaining stub of the anterior tine.

The posterior tine of the holotype is long, slender, straight, and rounded in cross section. Its length, measured from the fork, is 235 as preserved, and was probably about 270 in life. All three specimens are unique in lacking an external sulcus on the posterior tine.

The horn cores are well out over the orbits, as in other antilocaprids except *Tetrameryx mooseri*.

Five species of *Tetrameryx* are now known as follows: *T. schuleri* Lull, the type of the genus, known from the holotype and several other specimens from Texas; *T. irvingtonensis* Stirton, known from abundant material (Savage,

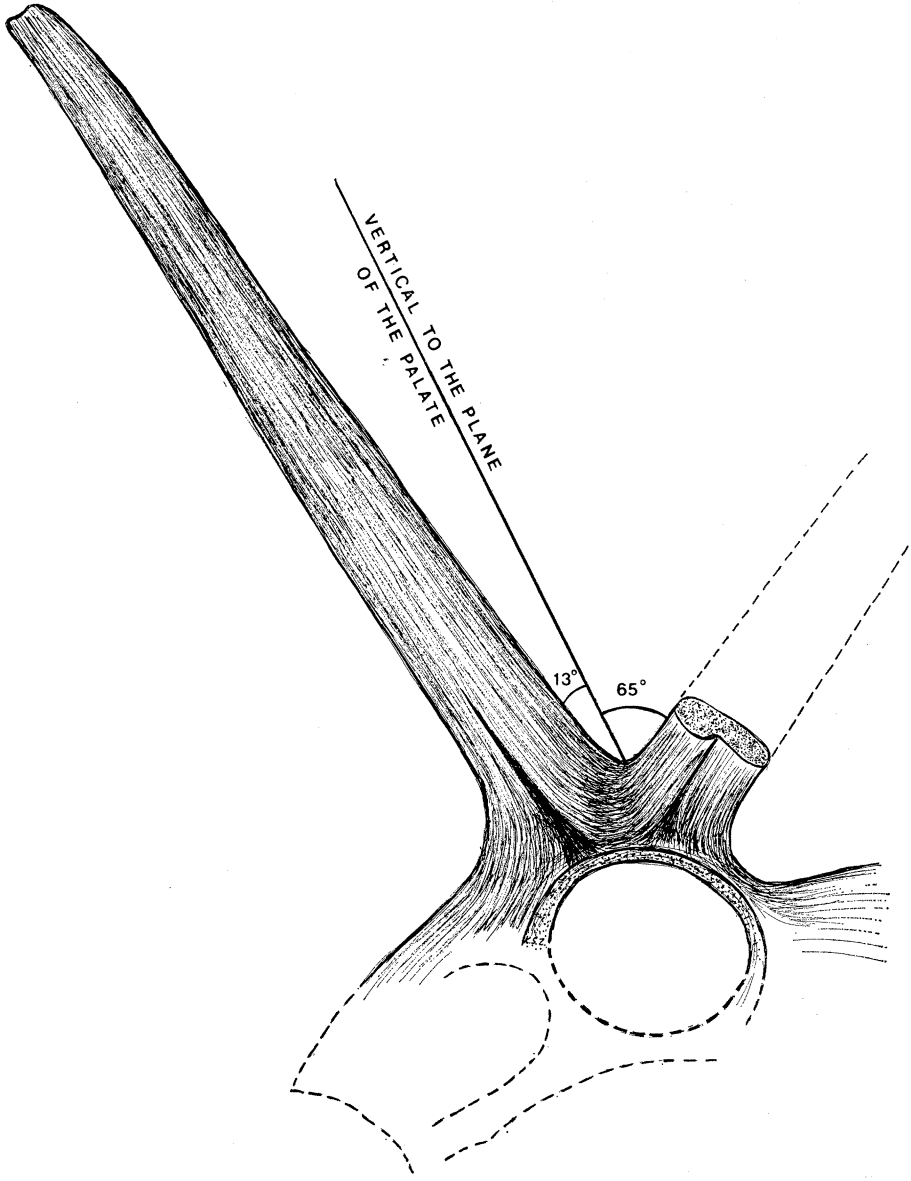

FIG. 11.—*Tetrameryx tacubayensis*, horn cores in standard orientation.

1951) from California; *T. knoxensis* Hibbard and Dalquest, known from two specimens from Texas; *T. mooseri* Dalquest, known from two specimens from Aguascalientes, and *T. tacubayensis*, known from three specimens from Aguascalientes. All are readily characterized.

T. schuleri has the following characteristics: anterior and posterior tines slender, straight, and rounded in cross section; anterior tine shorter than

posterior tine but relatively long; external sulcus along outside of anterior tine but on posterior tine the sulcus spirals anteriorly, in all specimens, from a basal position on the outer surface of the bone.

T. irvingtonensis is similar to *T. schuleri* but the posterior tine is relatively longer, strongly curved anteriorly, and external sulcus of posterior tine is confined to outer surface though tending to spiral anteriorly. It is best separated from the preceding species by the curved posterior tine.

T. knoxensis possesses the following characteristics: both anterior and posterior tines strongly flattened; external sulcus confined to middle of outer side of posterior tine; anterior tine apparently lacking sulcus; posterior tine curved anteriorly. This species differs strongly from the preceding two forms in the flattened, probably rather short, posterior tine. It seems to have had stout horn cores.

T. mooseri is distinguished as follows: posterior tine slender, straight and rounded in cross section with strong, straight external sulcus; anterior tine very short, straight and flat; unique in relatively poor development of supraorbital shelf.

T. tacubayensis is characterized as follows: posterior tine slender, straight, rounded in cross section, and without external sulcus; anterior tine (imperfectly known) strongly inclined anteriorly, slender, with external sulcus; horn core base narrowed anteroposteriorly and elevated at fork.

Measurements.—Measurements of holotype are as follows: breadth of braincase in groove lateral to supraorbital shelf, 69.4; distance across anterior tines at bases, 77.8; breadth across outer edges of supraorbital foramina, 80.1; greatest breadth of braincase behind horn cores, 73.0; base of anterior tine just above fork, 26.8 by 18.7; posterior horn core just above fork, 28.5 by 21.8. Referred specimen FC 617 measured as follows: breadth across occipital condyles, 49.5; posterior horn core just above fork, 33.3 by 23.6.

Capromeryx mexicana Furlong

This tiny antilocaprid is represented by two horn cores and a left lower jaw fragment. The most complete horn core (FC 626) is on a fragment of orbit and represents an adult. The tip of the anterior tine is missing, and a part of the tip of the distal tine is lost. The anterior tine is thickened anteroposteriorly near its base and bears an external sulcus. The posterior tine is round. The horn core base, at the constriction beneath the fork and above the orbital shelf, measures 21.0 (anteroposterior). The anterior tine diameter, just above the fork, is 7.6 by 6.1; the posterior tine 12.3 by 10.8. The posterior tine, as preserved, measures 44.4 and may have been about 25 higher.

The second specimen (FC 627) is broken just beneath the fork and much of the posterior tine is missing. The bone is smooth and not as dense as that of FC 626. The posterior tine is round in cross section but has a deep

external sulcus passing straight up the outer surface of the tine, and a second sulcus extending from the bottom of the fork to the top of the preserved bone, along the extreme anterior face. The anterior tine is slender and apparently was not swollen at the base. It has a sulcus on the external surface and is almost triangular in cross section.

Reference of the Cedazo materials to *Capromeryx mexicana* is based on probability. The species was described from the late Pleistocene of Tequixquiac, state of Mexico.

Family Cervidae

Odocoileus halli Alvarez

A deer antler (FC 630) is from a yearling, and is only 89.7 long, including burr. Two associated and fragmentary teeth (FC 631) include an M^2 that was at least 19 by 18, or about the size of very large male mule deer from Texas. A lower jaw fragment (FC 663) has a broken M_2 but complete M_3 that measures 28.4 by 12.9, larger than any available M_3 of mule deer from Texas. The length agrees with the M_3 of *Odocoileus halli* (maximum length 30.0), recently described from near Tlapacoya, in the state of Mexico (Alvarez, 1969).

Family Bovidae

Bison aguascalentensis, new species

Holotype.—Cranium with complete left horn core, number FC 658, collection of O. Mooser (Fig. 12).

Type locality.—Arroyo San Francisco, 4 kilometers SE City of Aguascalientes, State of Aguascalientes, Mexico.

Distribution.—Known only from the type locality, middle Pleistocene age, Tacubaya Formation, Cedazo local fauna.

Diagnosis.—Size of male, and probably female also, very large; horn cores directed at right-angles to long axis of skull; horn cores distinctly flattened at base and through much of their length.

Referred material.—Femur (IGM 56-241, Mooser, 1959), scapula (FC 659), back end of lower jaw with M_3 (FC 660), left lower jaw with alveolus of P_2–P_4 and broken M_1–M_3 (FC 661), lower jaw fragment with M_1–M_2, and additional postcranial material.

Etymology.—The species is named for the city of Aguascalientes, near the type locality.

Description.—The skull and horn core are enormous. The skull anterior to the backs of the orbits is missing. The horn core of the left side is complete. It leaves the cranium at right angles to the longitudinal axis of the skull and dips down only slightly, rather than greatly, before curving outward smoothly to the recurved, untwisted tip. The horn core is strongly flattened at the base (index of compression 70) and through most of its

FIG. 12.—*Bison aguascalientensis*, holotype skull and horn core. For measurements see text.

length. The superior longitudinal groove is deep and well-developed, as in *Bison alleni* and other flat-horned species.

This species needs comparison only with the giant bison forms, and differs from all of them. The strongly flattened and recurved horn core separates it from *Bison latifrons* and the angle of emergence from the skull (90°) separates it from *Bison chaneyi* Cook and related forms. The horn core resembles that of *Bison alleni* (Marsh) but is much larger. The great size of the animal is borne out by the size of the scapula and jaw fragments from

the same sediments. The femur found in association with the holotype skull, was not available for study.

Bison aguascalentensis may have been ancestral to *Bison alleni*, and we consider it the earliest American record of the *Bison alleni* group.

The following measurements permit comparison with Skinner and Kaisen (1947): 1) spread of horn cores tip to tip (2 by 770), 1540; 2) greatest spread on outside curve (2 by 772.5), 1545; 3) core length on upper curve tip to burr, 755; 4) core length on lower curve tip to burr, 900; 5) length, tip of core to upper base of burr, 640; 6) vertical diameter of core base at right angles to longitudinal axis, 118; 7) circumference of core at right angles to longitudinal axis, 640; 8) greatest width at auditory openings, 340; 9) width of occipital condyles, 147; 10) depth, occipital crest to top of foramen magnum, 124; 11) depth, occipital crest to lower border of foramen magnum, 157; 12) transverse diameter of core at right angles to longitudinal axis, 167; 13) width between bases of cores (2 by 150), 300; 14) width of cranium between horn cores and orbits, 353; 15) greatest postorbital width, 374; 16) index of curvature (4/5 by 100), 140; 17) index of compression (6/12 by 100), 70; 18) horn core proportion (3/7 by 100), 164; 19) index of length (3/14 by 100), 211.

Some measurements of the scapula are as follows: greatest length, 640; greatest breadth at tip of blade, 350; anteroposterior distance across glenoid fossa, 106.1; transverse breadth, 84.4; breadth above acromion, 99.2; length from notch at bottom of scapular spine to top of blade, 506; surface of blade to highest point on spine, 88.3.

FC 661 is a left lower jaw fragment with the alveoli of P_2–P_4, and broken M_1–M_3. The alveolar length M_1–M_3 is 114.5. The alveolar length of M_1 is 29.2, of M_2, 35.7, of M_3, 49.6. The depth of the jaw under M_3 is 74.4 and the thickness 39.2.

FC 662 is a lower jaw fragment with M_1–M_2. Maximum crown measurements of the teeth are M_1, 28.5 by 20.7 and M_2, 32.1 by 18.5. The median style of the lingual side is closed and isolated.

Paleoecology

In colonial times the State of Aguascalientes was clothed with rich forest and grasslands. Some woodland persisted until recent decades, but, over large areas, the burgeoning human population has almost eliminated trees for fuel and lumber. At present even the small, woody shrubs are being extirpated, utilized for fuel. Overgrazing by cattle and goats has destroyed much of the soil and the land is largely a stony desert dominated by cacti and yuccas. Only in inaccessible or protected sites are remnants of the original lush environment found.

One hundred and fifty kilometers west of Aguascalientes the land drops off in the mountains of the Sierra Madre Occidental, and its tropical rain-

forest and cloudforest with, farther westward, tropical jungles of the State of Nayarit. The present mammalian fauna of Aguascalientes is typical of the upland deserts of the Mexican Plateau. Small rodents adapted to the cactus and yucca habitats of the desert are locally abundant but other forms are absent or scarce. Only along the western margin of the state is there any influx of the varied tropical and subtropical faunas from the west, and then only where local areas of suitable vegetation permit.

The Cedazo local fauna suggests ecological conditions during Cedazo time that differed from the colonial woodland habitat, the modern desert habitat, and the western tropical environment. Of the 39 species known from the fauna, the two gophers, two rabbits, elephant, four camels, four antilocaprids, bison, and seven horses were probably plains adapted forms. Of the extinct species listed, all have hypsodont teeth, and were grazers, and some have living relatives that inhabit prairies. Browsers include the porcupine, perhaps the four edentates, the mastodon and deer, and possibly the peccary. Except for edentates, these are all rare or uncommon elements of the Cedazo local fauna. The carnivores are probably too generalized in habits to suggest ecological conditions but none would not be expected to occur on open plains or in woodlands fringing watercourses on open plains. No species of tropical habitat is included in the Cedazo local fauna. One would expect that the western coastal lowlands were tropical forests when the Cedazo sediments were deposited but no tropical species wandered to the Cedazo area and left its remains to be discovered.

No species of aquatic habits is represented in the fauna. The Cedazo deposits are quite extensive, are clearly water-deposited, and their deposition must have continued over a considerable period of time. One would expect that beavers, capybaras, pacas, murine opossums, or other such species, lived by the watercourses. It is unfortunate that no local concentration of vertebrate microfossils was discovered. Knowledge of the kinds of mice, shrews, and squirrels that lived in the area would be helpful in determining the ecological conditions during Cedazo time.

The fossils available suggest the following habitat; rich and extensive grasslands or prairie, capable of supporting herds of large grazing mammals, with patches of brush and trees fringing watercourses. Neither savannah nor forest is indicated.

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Francisco I. Madero 309, Aguascalientes, Aguascalientes, Mexico and Department of Biology, Midwestern University, Wichita Falls, Texas 76308. *Submitted 17 July 1974. Accepted 24 April 1975.*