PLEISTOCENE EQUIDAE OF TEXAS

James Harrison Quinn

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ABSTRACT

Pleistocene age fossil horses of Texas belong to three faunal assemblages. The oldest contains *Hippotigris* (= *Plesippus*) which disappeared before Yarmouthian time. The second contains *Equus scotti* and *Onager semiplicatus* (= *Equus Asinus calobatus*) which disappeared before Sangamon time. Both these groups are found on the High Plains but not on the Coastal Plain or along the central Texas rivers, where a later Sangamon age fauna is found which contains remains of *Equus*, *Asinus*, and *Onager* but no *Hippotigris*. The Texas *Onager* material is referable to the Asiatic group and contains beside *O. semiplicatus*, *O. lambei*, *O. littoralis*, *O. fraternus*, *O. complicatus* and others.

It is necessary to reject *Hemionus* F. Cuvier (1824) in favor of *Onager* Brisson (1762) because of priority.

Post-Pleistocene horses of the Texas High Plains region contain *Equus caballus*, both the draft and pony-horse types. These are treated as sub-species, *Equus c. caballus* for the larger and *Equus c. laurentius* for the smaller form. *E. laurentius* was described by Hay (1913) and has subsequently been considered a "feral" horse that somehow became fossilized. It seems doubtful that fossilization could have taken place in less than 400 years, the maximum time available for a "feral" horse. Also, *E. laurentius* is inseparable from *E. niobrarense alaskae* and the Texas materials.

Two new species are described, five species transferred to *Onager*, additional species reconsidered.

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INTRODUCTION

Teeth and bones of horses of Pleistocene age (Fig. 1) have been found in fluvial and basin deposits of the Texas Gulf Coastal Plain and the southern High Plains. Some of these are associated with human artifacts, some with the remains of fossil bison, and others with forms long extinct. Three and possibly four separate faunal assemblages ranging from earliest to latest Pleistocene are distinguishable and appear relatable to Quaternary glacial chronology.

The oldest of these assemblages is typified by presence of Hippotigris (= Plesippus) and is related to Nebraskan glacial, Aftonian interglacial, or early Kansan glacial time. In Nebraska, Hippotigris remains are found in coarse gravel deposits probably related to interglacial phenomena (McGrew, 1944).

Deposits of Yarmouth or early Illinoian age in Texas, called the Tule formation or Rock Creek beds, contain bones of Equus scotti Gidley and Onager semiplicatus (Cope) (p. 12). In Nebraska this period of time is represented by the Hay Springs beds containing Equus niobrarensis (Hay) and O. semiplicatus (Frick, 1930). Bison remains have not been found in these deposits (Hibbard, 1955 B, P. 221).

A large collection of Texas fossils belonging to the Bureau of Economic Geology, The University of Texas, and the Texas Memorial Museum contains an assemblage of horses distinct from those of the Blancan and Tule formations. These are associated with a species of large bison and possibly with human artifacts. The fossils are found throughout a series of sediments extending from near the present strand of the Gulf of Mexico, inland to the southern High Plains. Near the edge of the Coastal Plain the deposits are fine silt and clay, called the Beaumont clay formation. Farther inland the Beaumont clay formation is replaced by sand called the Lissie sand formation. Both occupy broad belts roughly parallel to the coast line, and overlap truncated Tertiary formations. Inland of the Lissie sand belt, gravel and sand deposits extend up the major river channels and have been called the Leona formation (Plummer, 1933). Gravels resting on the high divides between the river valleys are called the Uvalde formation, considered by some authors to be of late Pliocene age (Plummer, 1933, p. 777). Along the Brazos, Colorado, and other rivers the gravels appear to be terraced and these have been correlated (Weeks, 1945) (Quinn, 1957) with various Pleistocene glacial events. Study of the fossil horse remains from the Beaumont clay formation (Ingleside Quarry, San Patricio County, Texas; Sellards, 1940) the Leona formation (terraces on Colorado River in the vicinity of Austin, on the Brazos River in Stonewall County, and on the Trinity River in Henderson County), and in several minor localities indicates all are of the same age, and that they do not include species of horses belonging either to the Aftonian or to the Yarmouth age assemblages.

Since these horses are found in association with species of large Bison, but not with the small forms which are throught to have appeared in late Wisconsin time, it follows that the horses are of Sangamon interglacial or possibly early Wisconsin age, but not younger. Geological evidence has been introduced (Quinn, 1957) which offers stronger evidence that the sediments containing the horse remains described here belong to an interglacial and not to a glacial stage, and that they therefore must belong to the Sangamon interglacial stage.

LOCALITY MAP OF TEXAS WITH

PRINCIPAL FOSSIL LOCALITIES

Figure 1. -

1. Blanco beds
2. Rock Creek beds
3. Stonewall County terrace deposits
4. Trinity River terraces, Henderson Co.
5. San Saba River terraces
6. Kincaid Shelter (4 mi. N. Sabinal, Uvalde Co.)
7. Colorado River terraces, Austin
8. Ingleside Pit, San Patracio Co.
9. Berclair Terrace
10. Scharbauer Site, Midland Co.

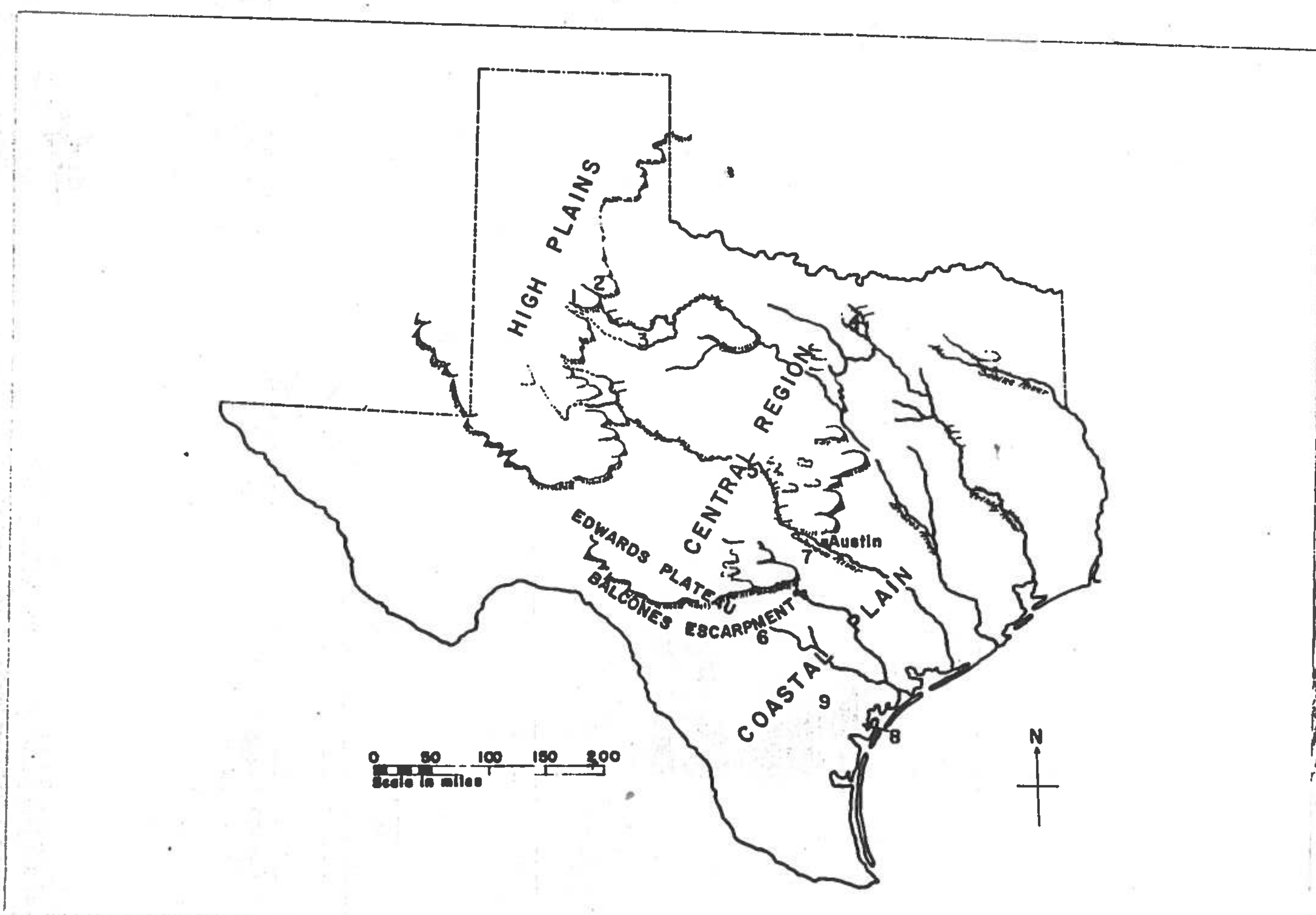
HIGH PLAINS
CENTRAL REGION
EDWARDS PLATEAU
BALCONES ESCARPMENT
COASTAL PLAIN
Austin
2
3
5
6
7
8
9
0 50 100 150 200
Scale in miles
N

Fig 1

In recent years there has been muc dissatisfaction expressed by workers concerning the taxonomy of Pleistocene horses. There seems to be a general feeling that too many species have been described on too little evidence (Savage, 1951, pp. 241-252), and that most characters based on tooth differences are invalid because these exhibit a high degree of variability.

Two factors seemingly have contributed much of the difficulty experienced by investigators. One of these is the question of variability and the morphologic limits of a paleontological species. The other has to do with the distribution of Pleistocene species of horses in time and space.

Paleontological species can be identified only on the basis of morphologic similarity. The problem is not so much one of placing identical materials in a taxonomic category but one of deciding how much dissimilarity specimens may exhibit and still belong in a common category. The principle that closely related genetic units will not occupy a common ecological niche at the same time has been applied to quarry assemblages and even to materials from a common locality and has been used to demonstrate degrees of variability in species of horses. That such procedures are not always advisable has already been discussed (Quinn, 1955) and is borne out by examination of the Texas Pleistocene age fossils. One of the species found in the quarry assemblages is Onager littoralis (Hay), smallest of the Equini. Another is Equus pacificus (of Gidley), one of the largest of the Pleistocene horses. Besides these, there are materials of horses of intermediate size, so that teeth grade from smallest to largest with no appreciable breaks. Few investigators would place E. littoralis and E. pacificus in the same species; yet the practice outlined above, if strictly adhered to, would lead to just this.

The second factor contributing to the difficulty of equine taxonomy, namely distribution in time and space, results from peculiarities introduced by successive occupation and elimination of populations in Pleistocene time, in connection with climatic fluctuations and the probability that the horses inhabited several separate ecologic areas. Onager complicatus and Onager fraternus are found in deposits of the Trinity River terraces and west along the Gulf of Mexico to San Patricio County, Texas. They are absent in the Brazos River terraces and those farther west. The type localities of these horses are in Mississippi and South Carolina respectively. They are typical of southeastern North America and seemingly have not been found elsewhere. Likewise Asinus coversidens (Owen) has been found only in the southwestern United States and Mexico. It is not possible to establish precise ranges and provinces for the horses of Pleistocene age here, since that would require re-examination of all preserved material.

Destruction and replacement of species of horses in response to climatic fluctuations during Pleistocene time seems to be a well supported concept. It may be supposed, however, that populations were not affected, or were less affected, in southeastern North America, extreme southwestern North America, and possibly along the West Coast. Replacement species for the central region may have originated from these areas as well as from the Old World. Little has previously been done to compare Old and New World species, perhaps because the current idea of a late Pliocene or Pleistocene age for origin of the genus Equus has made great diversification of the group seem unlikely. That the Equini actually developed much earlier has been recently indicated (Quinn, 1955). Species belonging to Asinus of Africa and Onager of Asia have been found in the fauna of Sangamon age in Texas, and elsewhere, and are reported here. These indicate greater correspondence between the New and Old World species than has been supposed.

The phylogeny and taxonomy of the Pleistocene horses thus may be highly complex rather than simple. It is not surprising that materials of a given area and of undetermined age may not easily be correlated with named species. Once it is recognized that several local (ecological) faunas of at least three different ages are concerned, it is obvious that an attempt to restrict the number of species for the sake of "simplicity" is lumping of the worst sort. Only when the various components of these faunas are identified and described will it be possible to develop fully the usefulness of the horses in estimating Pleistocene chronology and correlations.

Recognition of _Onager_ (= _Hemionus_) as well as _Asinus_ and _Equus_ in the New World raises a question of the validity of referring New World forms to the Old World groups. The resemblances are undeniable perhaps but these might be ascribed to parallelism. There are four Old World groups of late Pleistocene and Recent horses; there are four New World groups, all distinguished on the same characters as the Old World groups. _Equus_ undeniably occurs in both areas. That _Hippotigris_ occupied North America in early Pleistocene time was proposed by McGrew (1944). This proposition, although not fully accepted by other workers, has not been rejected. Old World _Asinus_ originated and remained in the New World until late Pleistocene (Quinn, 1955 a-b). The evidence seems to be conclusive that materials here referred to _Onager_ can belong to no other group. Hibbard (1955a) in a recent publication suggests that the New World horses must eventually be recognized as belonging to the Old World genera.

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ABBREVIATIONS

Abbreviations used in the text and tables of measurements are:

B.E.G. - Bureau of Economic Geology, The University of Texas, Austin, Texas.

Inst. de Geol. - Institute de Geologica, Universidad Nacional Autonoma de Mexico. Mexico City, Mexico.

C.M.N.H. - Colorado, Museum of Natural History, Denver, Colorado.

C.N.H.M. - Chicago Natural History Museum, Chicago, Illinois.

T.M. - Texas Memorial Museum, Austin, Texas.

W.F.I.S. - Wagner Free Institute of Science, Philadelphia, Pennsylvania.

P. 2-3-4 - Premolar two, three, four.

M. 1-2-3 - Molar one, two, three.

SYSTEMATIC DESCRIPTION

Order PERISSODACTYLA

Family EQUIDAE

Tribe EQUINI

Genus Onager Brisson, 1762

Onager Brisson (1762) Regnum Animale, Leiden.

Hemionus F. Cuvier (1823) No reference available.

Tomolabis Cope (1892) American Phil. Soc. Proc. XXX, p. 125.

Equus (Hemionus) Stehlin and Graziosi (1935) Soc. Pal. Suisse Mem., vol. LVI.

Asinus (in part) Hopwood (1942) Ann. Mag. Nat. Hist., vol. II, no. 9.

Hemionus Bourdelle and Frechkop (1950) Mammalia, vol 13.

Type species. - Onager onager Brisson, 1762; Kaslin, N. W. Persia.

Range. - Pleistocene (New World and Old World) to Recent (Old World).

Distribution. - North America and Eurasia.

Diagnosis. - Size range equal to Equus; pattern of upper cheek teeth more complex, protocones elongated, hypoconal groove of premolars tend to be partly closed, third molar less modified than in Equus or Asinus; lower molars with median valley shorter than in most species of Equus; upper and lower teeth equalling or surpassing Equus in hypsodonty and appreciably more hypsodont than Asinus; metapodials long and more slender than in Equus, longer and more slender than in Asinus.

Discussion. - The oldest valid generic name applicable to the Asiatic wild asses is Onager Brisson 1762, according to Dr. G. G. Simpson (personal communication) who supplied the following information,

> "The reference to Brisson 1756 [Simpson, 1945] is of course invalid because it antedates the tenth edition of Linnaeus. However, Brisson repeated the generic use of the name Onager in 1762 in Regnum Animale, p. 72. We have confirmed this reference in the

original publication and it seems certainly to be valid. That date is of course four years after Linnaeus' tenth edition and therefore the name is available in scientific nomenclature."

Smith (1842) referred the kiang and onager to the species Asinus hemionus and considered the asses, horses, and zebras to belong in separate genera.

Flower (1892, p. 86) treated the Asiatic forms as species of Equus, stating, "The true E. hemionus Pall., the kiang or dzeggetai is the largest and darkest in color...E. onager Pall. is smaller and paler in color..."

Stehlin and Graziosi (1935) placed the Asiatic asses in the genus Equus but considered them as a separate subgenus, Hemionus. They also considered the African asses as members of the genus Equus, subgenus Asinus.

Hopwood (1942) considered onager and kiang as species of Asinus, stating, "I have included the Kiang and Onager in the genus Asinus rather than Equus, because their limbs and teeth show a series of characters which, in the sum, are much nearer to those of the Ass than they are either to the Horse or to the Zebras."

Bourdelle and Frechkop (1950) considered the Asiatic asses, African asses, horses, and zebras to belong in separate genera. They proposed that the expanded classification would be more nearly equivalent to that accepted for other groups of ungulates, and would be more in keeping with the present state of knowledge concerning the horses. They also suggested the characters used to distinguish fossil horses are of less magnitude than those of the species of living horses. This view is opposed to that expressed by Stirton (1940, p. 194): "It is generally understood by most investigators that fossil genera and species of vertebrates cannot be divided so closely as living animals...Hence it seems that many paleontologists have been justified in retaining a rather wide definition of the genus Equus, thus expressing a rank more or less equivalent to the other genera of Equidae which are not so well known."; also, Savage (1951, p. 219) stated, "It seems tenable that if various proposed genera for later equids--Asinus, Plesippus, Hemionus--are recognized, a much greater 'splitting' of the Tertiary genera would be necessitated as a corollary. Stirton (1948, oral communication) has pointed out that such a classification is in keeping with the presently accepted categorical distinction between subgenera and genera of equids."

Bourdelle and Frechkop included the Asiatic asses in the genus Hemionus, pointing out that the reference Onager Brisson 1756 is invalid, but did not mention the 1762 reference.

Although the above list is far from complete, it illustrates the diversity of opinion among authors concerning the affinities of the Asiatic wild asses. How many Old World species exist and the taxonomy properly applicable to these is a problem beyond the present work.

Morphological differences, such as greater hypsodonty, more elongated protocones, more complex enamel pattersn, tendency for the hypoconal groove of the premolars to close,and longer metapodials distinguish the Asiatic from the African asses. Likewise, differences in enamel pattersn, flatness and elongation of the protocones, closure of the premolar - hypoconal grooves and greater slenderness of the metapodials distinguish the Asiatic asses from Equus. The elongated, flattened protocones, shortened median valleys of the lower molars, and slender metapodials also distinguish the Asiatic asses from the zebras. It appears that the four groups are about equally distinct or, for that matter, about equally related.

Obviously, if after 200 years, taxonomists are still undecided as to whether the Asiatic asses belong with Equus or Asinus, it may be assumed they belong with neither since they can not very well belong with both. If Asinus, Equus, and Hippotigris are to be accorded generic rank, and this appears acceptable due to their long history as distinct groups (Quinn, 1955), the Asiatic asses should be accorded generic rank also.

The American Pleistocene species of horses previously referred to Equus which have the characters of the Asiatic asses and, therefore, appear referable to that group, make it more than ever necessary to give them separate recognition. For this reason the prior generic designation Onager Brisson, 1762 is re-established and the American and Old World species with the proper morphological characteristics are referred to that genus. Hemionus, therefore, becomes a synonym.

Reference of E. fraternus Leidy, 1860, to Onager (p. 32) introduces consideration of Tomolabis Cope, 1892. Cope named the genus on the basis of a lower dentition referred by himself, and separately by Leidy, to E. fraternus, which lacks the infundibuli (cusps) of the lower incisors, thus making E. fraternus the type of the genus Tomolabis. Cope later abandoned the genus because he noticed a tendency toward loss of the infundibuli in other horses. Inclusion of E. fraternus in Onager places Tomolabis in synonymy. (*)

Hoffstetter (1950) proposed the genus Amerhippus principally to receive E. andium and related South American horses which lack the infundibuli of the lower incisors. Hoffstetter added E. occidentalis Leidy, the North American Tar Beds horse, to the group and considered E. occidentalis as the possible ancestor of the South American horses. (The reverse might be equally true.)

(*) Es sinónimo de Amerhippus, si como dice Hoff. su carácter diagnóstico es falta de esmalte interno (infundíbulo). Luego hoy [illegible] E. frat. Leidy [illegible]

Cooke (1950) called attention to the fact that *Hippotigris burchelli* customarily lacks the infundibuli. Hoffstetter (1950a) proposed *Pseudoquagga* for zebras lacking the infundibulum.

It appears that loss of the infundibuli, like the appearance of monodactyly, shortening of the median valley of the lower molars, loss of the parastylid and other similar characters has appeared separately in several genera of horses and is due to long range genetic trends (Quinn, 1955) or evolutionary response to environmental factors and may not in itself be useful as a generic criterion. The South American horses may represent a separate genus, but *E. occidentalis*, except for loss of the infundibuli, seems closely related to *Equus*. The species does not belong to *Onager*, or with the American species referable to *Onager*.

Onager semiplicatus (Cope)

Pl. 2, fig. 5

Equus semiplicatus Cope, 1893, Geol, Surv. Texas, 4th Ann. Rept.

Equus (Asinus) calobatus Troxell, 1915, American Jour. Sci. 4th Ser., Vol. 39, No. 234.

Type. - Second upper molar, from Tule formation, Tule Canyon (Rock Creek), Briscoe County, Texas, early Illinoian, Pleistocene; coll. The University of Texas.

Range. - Early Illinoian, Pleistocene.

Distribution. - Texas (Southern High Plains), Oklahoma (Holloman gravel pit, Fredrick, Okla.), Kansas (Arkalon gravel pit, Sewart County), Nebraska (Hay Springs).

Referred material. - Maxillary, ramus, isolated teeth, second phalanx, T.M. no. 276, Rock Creek, Tule formation, Briscoe County, Texas; metatarsal, Holloman gravel pit, Fredrick, Okla.

Diagnosis. - (Cope, 1893, p. 80) "Teeth indicate a species of about the dimensions of the E. tau, but characterized by a greater complexity of the enamel foldings.....the anteroposterior diameter of the protocone is more than half that of the grinding face of the crown."

Description. - A maxillary, T.M. no. 276, Tule formation, Briscoe County, Texas (pl. 2, fig. 5) retains the cheek tooth series. The second molar is closely similar to the type described by Cope. The dimensions of the teeth, although slightly more worn, almost exactly equal those of Onager lambei (Hay) (p. 18), B.E.G. no. 31058-2. The styles of the premolars are not as prominent as those of O. lambei and the fossette borders are less folded. The protocones are considerably shorter, anteroposteriorly, but are otherwise similar in shape. The hypoconal grooves are open on all but the third molar.

The metatarsal from Holloman gravel pit is of approximately the same length and proportion as the type material described by Troxell (1915) as E. (Asinus) calobatus. Metatarsals from Texas and Kansas differ somewhat in length and diameter but all are larger and longer than those of Onager from the Sangamon age deposits.

Discussion. - Although the type of E. semiplicatus is a molar tooth and the type of E. (Asinus) calobatus is a metatarsal, comparison of these materials with the maxillary T.M. no 276 and materials of Onager from the Sangamon age deposits indicates they belong to closely related forms. Since E. semiplicatus Cope, 1893, is the prior name, E. (Asinus) calobatus becomes a synonym. In recognition of the affinities of the species it is referred to Onager.

In Texas, Oklahoma, and Kansas O. semiplicatus is found in association with bones of Equus scotti Gidley. Reported but undescribed materials from Nebraska are found with E. niobrarensis Hay. Bones of Bison have not been found in association with these species. Authors agree in general that the faunas are of Yarmouth interglacial age. The metatarsals of O. semiplicatus are sufficiently striking in their length and slenderness to be useful for index purposes.

Measurements *Onager semiplicatus* (Cope)

Pl. 2, fig. 5

Upper dentition, T.M. no. 276-2, Rock Creek, Briscoe County.

	AP	Tr	CL	PL	PW
P.2	37.5	25.8	33.0	8.5	5.3
P.3	29	----	----	14.0	6.0
P.4	26.3	27.3	55	14.6	5.3
M.1	23.5	26.0	----	12.5	5.1
M.2	24.6	25.5	----	14.0	5.0
M.3	25	----	----	14.0	3.5

Lower deciduous dentition, T.M. no. 276-1, Rock Creek, Briscoe County

(not figured)

	AP	Tr	CL	MM	
D.P.2	36.5	12.0	----	17.0	
D.P.3	33.7	12.0	----	17.0	
D.P.4	35.4	11.3	----	16.6	
M. 1	31.0	12.1	----	16.7	section 16 mm below top of crown

Depth ramus anterior of M. 1, 80 mm.

Metatarsal III, T.M. no. 934-6, Holloman gravel pit, Frederick, Okla.

Length metatarsal 330 mm, proximal width 49.5 mm, distal width 44 mm.

Onager littoralis (Hay)

Pl. 3, fig. 13

Equus littoralis Hay, 1913, U.S. Nat. Mus. Proc., vol. 44, pp. 575-576.

Equus achates Hay and Cook, 1930, Colorado Mus. Nat. Hist. Proc., vol. 9, no. 2, p. 15.

Type. - Upper left molar, W.F.I.S. no. 4086, Pleistocene, Peace Creek, Florida.

Range. - Sangamon interglacial, Pleistocene.

Distribution. - Texas (Coastal Plain, Southern High Plains) Oklahoma (Holloman gravel pit), Florida (Peace Creek).

Referred material. - Upper right premolar, B.D.G. no. 31186-13, (pl. 3, fig. 13), Powers Ranch, left bank of Medio Creek, Berclair Terrace, Bee County, Texas; first or second lower molar, B.E.G. no. 30965-11, right bluff of Blanco Creek, 1700 feet upstream from bridge on Beeville-Goliad road, Bee County, Texas; third or fourth lower premolar, B.E.G. no. 31034-75, right bluff of Blanco Creek, 3 miles downstream from bridge on Beeville-Goliad road, J. J. O'Brian Ranch, Bee County, Texas.

Diagnosis. - Smallest of the Equini,teeth slightly larger than those of Nannippus phlegon: (From Hay, 1913a, p. 575) "Characterized by teeth of small size...enamel surrounding the lakes rather strongly folded. The crown somewhat more curved than in E. leidyi."

Description. - An upper premolar B.E.G. no. 31186-13, (pl. 3, fig. 13), has a crown height of 74.5 mm, measured on the mesostyle. The parastyle and mesostyle are low and broad. The interstylar valleys are shallow and without ribs. The prefossette has, in addition to the pli protoloph, three small antero-external plications. Internally, the border is flattened and diagonally oriented. Posteriorly there is a broad V-shaped pli protoconule and double pli prefossette. The postfossette has a bifurcated pli postfossette, is broadly rounded on its internal border and has a doubly inflected pli hypoloph. The protocone is long and oriented in a slight diagonal direction. It has a flattened, sharply pointed anterior heel, flattened and slightly grooved internal border, and is connected to the protoselene by a narrow transversely directed commissure. The postprotoconal valley has a small pli caballin and extends transversely into the V of the pli protoconule, indicating an early stage of wear for the tooth. The hypocone is small, restricted anteriorly by a weak groove and poteriorly by a shallow hypoconal groove which extends to the base of the crown.

A lower first or second molar B.E.G. no. 30965-11 (not figured) has a crown height of about 50 mm. The paralophid is thin, directed posterointernally and has a small posteriorly directed inflection. There is a very short metaflexid. The mataconid is large, rounded and deflected; the metastylid is small leaf-shaped, strongly deflected and the intervening valley is broadly V-shaped. The entoconid is broken but the tip approaches closely to the metastylid. There is no parastylid. The protoconid is flattened but transversely broader anteriorly than posteriorly. The median valley is short and does not penetrate between the flexids but approaches them more closely than in the premolars.

A third or fourth lower premolar, B.E.G. no. 31034-75 (not figured) does not differ markedly from the molar. It is larger, the median valley is shorter and has a trace of the pli caballinid.

These teeth are closely akin to those of Asinus somaliensis Noak and the burro, but differ in their smaller size, longer protocones and greater hypsodonty.

Discussion. - Hay and Cook (1930, p. 13-14) referred a lower jaw fragment, C.M.N.H. no. 616, and an upper left second molar, C.M.N.H. no. 623A, from a bison quarry on Lone Wolf Creek, near Colorado, Texas, to *Equus littoralis*. They compared the material with that of *Equus francisi* Hay, and concluded it represented a distinct species, on the basis of smaller size and some differences in the enamel pattern of the teeth. The upper molar was referred to *E. littoralis* as was the lower jaw because it was found at the same locality.

In the same paper (p. 15) Hay and Cook described an upper left second molar, C.M.N.H. no. 1085, from Hollomans Gravel Pit, Fredrick, Oklahoma as *Equus achates* new species. They gave as diagnostic characters its extreme hypsodonty and curvature.

Savage (1951, p. 244) regarded both *Equus achates* and *Equus littoralis* as nomina vana.

These materials are distinguishable as belonging to the smallest of the Pleistocene Equini. The extreme hypsodonty and elongation and flattening of the protocones indicate they belong to *Onager* rather than *Asinus*. The Texas materials occur in beds of Sangamon interglacial age. No materials of *O. littoralis* have been found in the Tule formation. The Hollcman Gravel Pit specimen is probably of the same age as the Texas materials. Its occurrence in the same locality with *Equus scotti* and *O. semiplicatus* indicates mixing, or strata of different ages in the gravel pit.

Measurements *Onager littoralis*

B.E.G. no.		AP	TR	CL	MM	PR
31186-13	P.3?	22.6	20.6	74.0	----	13.7
30965-11	M.1	----	11.5	30*	11.0	----
31034-75	P.3?	20.0	12.0	39	13	----

Onager lambei (Hay)

Pl. 2, fig. 4

Equus lambei Hay, 1917, U. S. Nat. Mus. Proc., vol. 53.

Equus cf. caballus Savage, 1951, Univ. Cal. Bull. Dept. Geol. Sci. Bull., vol. 28, no. 10.

Type. - Skull and lower jaw, U.S.N.M. no. 8226, from Gold Run Creek, Klondike Region, Yukon Territory, Alaska, late Pleistocene.

Range. - Sangamon interglacial.

Distribution. - Alaska, Southern High Plains, Gulf Coastal Plain.

Diagnosis. - (From Hay) Small, broad skulled horse; teeth unusually broad; their enamel little plicated; the protocones unusually long.

Referred material. - Skull B.E.G. no. 31058-2 (Pl. 2, fig. 4) previously referred to E. fraternus (Sellards, 1940, p. 1633-1635, pl. 2, fig. 2) from left bank of Blanco Creek, 3 miles downstream from bridge on Beeville-Goliad Road, Bee County, Texas; deciduous and permanent teeth from Kincaid Shelter (Sellards, 1952, p. 94, 143), 4 miles north of Sabinal, Uvalde County; teeth from Brazos River Terraces, Stonewall County, Texas; teeth from Colorado River (Asylum Terrace), Travis County, Texas;

Description. - Onager lambei (Hay) is distinguished from other species of Pleistocene horses by its moderately small size, intermediate between Asinus somaliensis and Hippotigris burchelli, short skull and jaw, moderately complex cheek teeth and excessively elongated, flattened protocones. Hay (1917, p. 440) considered the plications of the fossettes to be very simple, a condition not altogether due to excessively worn teeth. The Texas materials indicate the teeth are a little less complex than those of Onager fraternus.

Upper dentition. - The upper dentition of the skull B.E.G. no. 31058-2, (Pl. 2, fig. 4) indicates an age of 5 to 6 years for the animal.

The first incisor has a shallow anterior groove and a deep, oval infundibulum, without an anterior inflection. The canines are broken at the alveoli and appear to have been small. There are no first premolars.

The second premolar is short anteroposteriorly like those of <u>Onager altidens</u> (p. 22) but is more compressed transversely. The fossettes are more elongated and the protocone less divergent. The hypoconal groove is closed and the fossette lost. The closed hypoconal groove of the premolars is not found in <u>Equus</u> but appears in <u>Onager</u> and the zebras.

The third premolar is smaller and shorter than that of <u>O. altidens</u>. The mesostyle is much heavier; the borders of the fossettes are much more complex and the protocone far longer. The pli protoloph is deep and narrow. The pli protoconule consists of a series of four loops. The pli prefossette is small but nearly touches the posterior loop of the pli protoconule. Externally there is a series of small inflections. The postfossette is rectangular and has a very long cornua. The protocone has a long broad heel and toe, is slightly inflected internally, and oriented parallel with the long axis of the tooth row. The postprotoconal valley is shallow. The pli caballin arises from the posterior border of the valley. The hypoconal groove is closed.

The fourth premolar is smaller than the third; the plications of the fossettes are deeper and the protocone is considerably longer, equalling 67 per cent of the anteroposterior length of the tooth.

The plications are less pronounced on the first molar; the protocone is shorter than on the fourth premolar and the hypoconal groove is closed. There is no pli caballin, which probably is the result of greater wear.

The second molar retains the plications of the premolars and is much like them except it is smaller and has less pronounced styles of the ecto-loph. The hypoconal groove is open.

The third molar, as Owen (1869, p. 542) suggested concerning the kiang, is less modified than in Equus and Asinus. The posterior border has two minor inflections but is nearly straight. The hypoconal groove is closed, remaining as a large nearly round fossette.

The cheek teeth are oriented in a nearly straight line with less divergence from the axial plane of the skull than in Hippotigris or Asinus, and less curvature than in Equus. In this as well as the great length of the protocones the Texas horse agrees nearly exactly with the type from Alaska.

Deciduous upper dentition. - A maxillary, B.E.G. no. 31186-23 (not figured) with the first and second molars in place and from the same locality as the type of O. altidens, appears to belong to O. lambei. The protocones of the molars are of the same length as those of the skull described above whereas those of O. altidens are much shorter. Likewise the protocones of the deciduous upper cheek teeth are oriented more nearly parallel with the axis of the skull and are longer than those of O. altidens. Materials from Kincaid Shelter include a number of permanent upper, deciduous upper, and lower cheek teeth, and deciduous incisors. The permanent and deciduous uppers belong to O. lambei as presumably do the deciduous lowers.

Lower dentition. - Lower teeth of the permanent series belonging to O. lambei were not recognized in the collections. A lower jaw associated with the type skull is figured, Hay, 1917, pl., 53, fig. 2.

A number of deciduous incisors from Kincaid Shelter lack the infundibulum and are considered to be lowers of O. lambei. According to Hay (1917, p. 438) the lower incisors of the type are so worn that the cups (infundibuli) have disappeared but they are still all present in the upper incisors. It seems more probable that like O. altidens the lower incisors of O. lambei did not possess infundibuli. (Wear would obliterate those of the upper teeth as well as those of the lower teeth.)

Lower deciduous premolars from Kincaid Shelter are slightly smaller than those of O. altidens. The metaconid and metastylid are less deflected and the valley between them is broadly V-shaped rather than sharply so.

Skeletal material. - A metacarpal, B.E.G. no. 31058-3, from the same site as the skull described above agrees in length and slenderness with that of O. kiang (Stehlin and Graziosi, 1935, pl. 2, fig. 3) and differs from that of O. altidens in being 32 mm. shorter.

Measurements Onager lambei (Hay) Berclair Terrace

Upper dentition B.E.B. no. 31058-2

Pl. 2, fig. 4

	AP	TR	CL	PL	PW
I. 1	6.0	19.0	----	----	----
P. 2	36.0	25.8	50.0	12.4	5.0
P. 3	27.5	27.5	51.0	15.9	5.2
P. 4	27.1	28.6	60.5	18.5	6.0
M. 1	24.0	26.0	----	15.1	5.0
M. 2	24.0	25.0	----	16.0	5.2
M. 3	27.0	22.5	----	16.0	4.5
Deciduous upper dentition, T.M. no. 908-2297, 2372, 2369, Kincaid Shelter					
D.P. 2	38.0	24.0	25.0	10.5	5.0
D.P. 3	29.1	23.0	27.6	10.5	4.8
D.P. 4	30.0	22.0	31.2	13.9	4.8

Deciduous lower dentition, T.M. no. 908-2362, Kincaid Shelter

	AP	TR	CL	MM
D. P. $\overline{2}$	31.5	13.5	----	16.0
D. P. $\overline{3}$	29.5	14.0	----	15.0
D. P. $\overline{4}$	33.7	12.4	----	15.2

Metacarpal, B.E.G. no. 31058-3, Berclair Terrace

length 215 mm

proximal width 44 mm

middle of shaft 28.5 mm

Onager altidens Quinn, new species

Pl. 1, figs. 1-5; Pl. 5, fig. 3

Latin, altus = high, and dens = tooth.

Type. - Right maxillary, with worn D.P.2-4, unerupted P. 2-4, M.1-2, B.E.G. no. 31186-35; right and left lower jaws with I.1, D.I.2, D.P.2-4, M.1-2, P.2-4 unerupted; B.E.G. no. 31186-36; cranium lacking occiput 31146-37; right Mc. 3 B.E.G. no. 31186-3; right and left femora 31186-2, 34; right and left tibiae, B.E.G. no. 31186-1, 10; right and left Mt. 3, B.E.G. nos. 31186-4, 7: phalanx, first, B.E.G. no. 31186-24, all believed to belong to one individual, approximately three years old. In addition to the type material a pair of maxilla, B.E.G. no. 31186-23, and a right lower jaw, B.E.G. no. 31186-22, of an animal about one year old, and 24 deciduous and permanent upper and lower teeth, all apparently belonging to the same species, were recovered from the site. It is situated on the bank of Blanco Creek, Powers Ranch, one mile south, one mile east, 4.3 miles southeast, 0.7 mile southwest of Berclair, Bee County, Texas, on the Berclair Terrace, of late Pleistocene age.

Range. - Sangamon, Pleistocene

Distribution. - Gulf Coastal Plain, terrace deposits.

Diagnosis. - Size slightly larger than Onager kiang, teeth extremely hypsodont exceeding E. caballus somewhat and Asinus considerably; upper teeth curved both transversely and anteroposteriorly; protocones elongated, especially anteriorly; metaconid-metastylid valley V-shaped on premolars; upper and lower third molars greatly reduced anteroposteriorly; limbs longer and more slender than those of Onager kiang or Onager onager.

Referred material. - Third upper premolar, B.E.G. no. 31278-2, Fort Sam Houston, San Antonio, Texas, from 40 feet deep in a well; third or fourth lower premolar, B.E.G. no. 18608, Onion Creek, near Austin, 1½ miles east of junction of Burleston Road and Lockhard Highway, found 40 feet below surface in a well, and 3 feet above contact of gravels with Taylor marl.

Owen (1869, p. 542) described the dentition of a male kiang as Equus hemionus Pallas, stating it probably came from Tibet and that it is specifically identical with a second specimen from Tibet and probably the same species as the Equus hemionus Pallas from the Mongolian plains. He characterized the species as having relatively longer premolars, anteroposteriorly, than Equus, second premolar more obtusely terminated, third molar shorter anteroposteriorly, mesostyle narrower, protocone of P.2 more elongated, M.3 more like M.2, lower teeth relatively narrow transversely; the upper molars curved about as in Equus and straighter than in the ass.

Description. - The upper incisors are not preserved in any of the materials at hand. The cheek teeth are moderately curved, transversely, about as in E. caballus but the molars are more curved anteroposteriorly, and equalling or slightly exceeding those of E. caballus in hypsodonty.

Upper permanent dentition. - The second premolar is unerupted but was removed from the maxillary and sectioned 20 mm below the top of the mesostyle. The tooth is short anteroposteriorly with wide angular styles and moderately complex fossettes. The protocones are not longer but more concave internally than in *E. caballus*. The pli caballin is prominent; there is a closed hypoconal groove forming a small fossette that terminates 5 mm lower on the crown.

The unerupted third premolar was also sectioned. This tooth has the greatest crown diameter of any in the series and appears so much larger than the succeeding teeth it might be supposed to belong to a different animal had it not been found in place. The styles are heavy and the interstylar valleys deep and moderately concave. The fossettes are large and their borders little folded except for a deep pli protoloph and pli protoconule of the prefossette. The protocone has a long anterior heel, is deeply concave internally, and turned inward at the tip. The pli caballin is large as in *Equus*. The hypoconal groove is closed and represented by a small fossette as on P.2. This is seen in some premolars of *Asinus* and *Hippotigris* but not in *Equus* insofar as can be determined.

The fourth premolar is 2.3 mm shorter, anteroposteriorly than is the third, and 2 mm narrower, transversely, which is about the limit of variation found by Gidley (1901, p. 102) for teeth of *E. caballus*.* The styles are weaker than on P.3 and the fossettes smaller but with similar plications. The protocone is slightly longer, less concave and less inwardly deflected. The postprotoconal valley is continued outward nearly reaching the pli protoconule, has a series of small inflections the outermost of which represents the pli caballin. There is no prehypoconal groove.

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* The idea that large individuals of a species have larger teeth than small individuals, is erroneous according to Gidley.

The hypoconal groove is compressed so that the borders are parallel, but remains open to the base of the crown.

The first molar is slightly worn and was not sectioned. The occlusal surface is smaller than that of P.4. The crown is curved anteroposteriorly, and tapered so that there is about 6 mm difference in the anteroposterior diameter between the top of the crown and a point 20 mm above the base. The styles are considerably narrower than on the premolars. The enamel pattern is otherwise similar to that of P.4. The hypoconal groove remains open to the base of the crown.

The second molar is smaller and appreciably (1.5 mm) narrower transversely than is the first.

The third molar is missing in the type. As isolated half worn tooth from the type locality indicates that the third molar is reduced in size, has an elongated protocone and no sign of the hypoconal groove. Posteriorly there is a ridge opposite the postfossette so that the tooth is bilobed as on O. complicatus (Leidy, 1869, p. 563, pl. LXI, fig. 1).

Lower permanent dentition. - The first incisors are present on the lower jaw of the type. They are but slightly worn and are unique in that they are initially slightly concave, anteriorly, and so compressed posteriorly that they are very thin, chisel-like, and lack the infundibuli (Pl. 1, fig. 5).

The second incisors are unerupted, but are in place behind the second deciduous incisors. These too are chisel-like, and there is no cusp or infundibulum, but the enamel of the anterior face of the teeth meets that of the posterior face forming a blade-edge as in the Artiodactyla.

The third incisors and canines if present are not sufficiently developed to be exposed.

The premolars are in place but unerupted. Consequently the left ramus was sectioned to expose these teeth, (Pl. 1, fig. 3).

The second premolar is short anteroposteriorly, as is the second upper premolar. The anterior process of the paralophid is very reduced. The groove between the metaconid and metastylid is shallow V-shaped. The entoconid is large and rounded. There is a small pli hypoconid (Quinn 1955). There is a parastylid anteriorly, on the protoconid. The median valley is shallow and has no pli caballinid. The hypoconid is very much flattened.

The third premolar is broad, transversely, at its anterior end as in O. kiang. The metaconid and metastylid are elongated, strongly divergent, and have a V-shaped valley much as in Hippotigris. There is a prominent pli hypoconid. The anterionternal border of the protoconid has a weak parastylid, and is directed strongly inward, as in O. kiang. The internal face of the protoconid is concave. The median valley is shallow and has a small pli caballinid. The hypoconid is flattened but not concave.

The fourth premolar differs from the third in that the metastylid is directed posteriorly and is not divergent. There is a large pli hypostylid and a similar opposed process projecting into the metaflexid. This process is rudimentary on the third premolar. As on the third premolar there is a weak parastylid and pli caballinid.

The second premolar is sectioned approximately 25 mm below the tip of the metastylid, which is exposed. The third premolar is sectioned 20 mm below the tip of the metastylid, and the fourth premolar about 15 mm below the tip of the entoconid.

The first molar is in place and somewhat worn, probably about 10 mm, (Pl. 1, fig. 4) and is not sectioned. The metaconid and metastylid are divergent and have a broadly V-shaped valley. The metastylid is sharply truncated posteriorly which imparts to it a triangular configuration. The entoconid is flattened internally, and is elongated. There is no parastylid, but a well-developed pli caballinid is present. The external faces of the protoconid and hypoconid are concave. The median valley is very short and does not reach the re-entrants of the flexids.

The second molar has a shorter metaconid-metastylid column than the first, is narrower transversely at its posterior end, and has the shortened median valley.

The third molar is unerupted and possibly has not yet developed. Material from the type locality indicates the third molar is reduced anteroposteriorly, with the hypoconulid nearly eliminated.

Deciduous upper dentition. - The deciduous upper incisors of the type are missing.

The deciduous cheek teeth (Pl. 1, fig. 2) of the type are deeply worn and have lost most of the plications of the fossettes. The styles are heavy as in the permanent premolars. The protocones are smaller than those of the permanent teeth but like them are concave internally and tend to diverge inward at the tip. Although the permanent premolars of the type do not exhibit a complex enamel pattern, two little-worn sets of deciduous premolars from the type locality are complex. Both the anterior and posterior borders of the fossettes are considerably plicated. The postprotoconal valleys tend to be deep. Pli caballinids are present on the second and third but absent on the fourth premolars. The hypoconal grooves of the second and third premolars tend to be closed high on the crowns, as on the second and third permanent premolars.

Deciduous lower dentition. - The second deciduous incisors of the type are preserved. Like the permanent lower incisors they lack the infundibuli.

The deciduous lower cheek teeth (Pl. 1, fig. 4) of the type are badly broken except for D.P. 4 on either side. Additional material from the type locality includes a lower jaw with little worn milk teeth and isolated material. The metaconids and metastylids of all three deciduous milk teeth are divergent and have a V-shaped valley. The entoconids have an anterior spur. The D.P. 2's have prominent parastylids. Most of the D.P. 3's and D.P. 4's have parastylids on the lower half of the crowns. All have prominent pli caballinids. Some have weak hypostylids on the lower part of the crowns.

Skeletal material. - The fragment of cranium B.E.G. no. 31186-37, is distorted but is of a skull a little larger than that of *Asinus comaliensis*. The zygomatic process of the temporal bone is present and is considerably broader than that of *A. somaliensis*, about equalling that of *Hippotigris grevyi*.

The lower jaw is intermediate in size between those of *A. somaliensis* and *H. grevyi* in the length and height of the ascending ramus. The symphysis is short as in *A. somaliensis*. The horizontal ramus is deep, dorsoventrally, equalling that of *H. grevyi* although the zebra is a considerably larger animal.

Of the fore limbs only the third metacarpal (Pl. 7, fig. 1) of the right side is preserved. This bone differs from those of Recent *Equus* chiefly in its greater slenderness. It is much longer than the metacarpals of the burro, and exceeds slightly the length of metacarpals of *O. onager* but equals them in slenderness.

The femora of both sides are preserved. That of the left side is uncrushed and lacks only the great trochanter. It is proportionately more slender than that of E. caballus; otherwise there is very little difference between the two bones, except for size.

The tibiae (Pl. 7, fig. 2) of both sides are present. Part of the proximal ends are missing. These bones are proportionately more slender than those of E. caballus, approximately equalling the femur in length where the tibia of Equus is considerably shorter than the femur. Hay (1915, p. 546-7) indicated the length of the femur equals the length of the tibia in the Arabian horse. The material used for comparison here is that of a "Texas pony".

Both third metatarsals (Pl. 5, fig. 3) are preserved. Of these the left is complete and seems to be undamaged. The proximal articulations differ considerably from those of E. caballus. The anterior articulation for the ectocuneiform is narrow, providing a relatively large nonarticular depression. The articulation for the cuboid is very small and not prominent. The facet for the meso-and ectocuneiform bones is proportionately about the same as in E. caballus. The facets for Mt. 2 and 4 are very much reduced. The transverse diameter of the proximal end of Mt. 3 is relatively less than in E. caballus, while the anteroposterior diameter is relatively greater. The shaft of the bone is slender and more nearly rounded. The distal end is transversely narrow compared with that of Equus.

The first phalanx like the third metatarsal is long and slender. In size and proportions the phalanx agrees precisely with that of O. onager (Stehlin and Graziosi, 1935, Pl. 3, fig. 4). The metatarsal, however, is 18 mm longer than that of O. onager (ibid, Pl. 2, fig. 4).

Measurements *Onager altidens* Quinn

Pl. 1, figs. 1-2

Permanent D. B.E.G. no. 31186-36, right maxillary, type.

	AP	Tr	CL	PL	PW	
P.2	35.	25.4	----	10.	5.4	section 20 mm below top
P.3	31.2	27.0	----	13.5	5.0	section 20 mm below top
P.4	29.0	26.0	----	13.2	5.0	section 20 mm below top
M.1	28.0	25.0	93.0	13.5	5.5	
M.2	28.0	----	78	14	---	occlusal surface partly developed.
M.3	----	----	----	----	---	

B.E.G. no. 31186-35, lower jaw, type.

Pl. 1, figs 3-4

P.2	32.0	13.8	----	14.5	section 25 mm below Ms. tip
P.3	30.0	16.5	----	16.5	section 20 mm below Ms. tip
P.4	30.5	14.0	----	17.0	section 15 mm below Ms. tip approx.
M.1	28.5	14.0	91.5	15.0	
M.2	28.0	11.0	82	13.3	roots not formed
M.3	----	----	----	----	

Deciduous D. B.E.G. no. 31186-36, right maxillary, type.

D.P.2	----	22.0	9.0	9.0	5.0
D.P.3	27.0	23.5	11.0	9.7	5.9
D.P.4	27.8	23.5	15.5	11.6	5.0

Deciduous D. B.E.G. no. 31186-35, lower jaw, type.

D.P.2	32	----	----	----	---
D.P.3	28	----	8	----	---
D.P.4	28.7	15.0	9.0	16.0	---

Length upper premolars 95 mm, at point of section.

Length lower premolars 100 mm. at point of section.

Depth ramus at anterior border of M.1 83 mm.

Length jaw, incisor 1 to angle 416 mm.

Length of symphysis, incl. I.1 81 mm.

Length Mc. 3, B.E.G. no. 31186-3, type?, 247 mm.

Width proximal end 47 mm, width distal end 43 mm.

Length femur, B.E.G. no. 31186-2, type?, head to distal extremity 327 mm., width proximal end 103 mm (damaged), width distal end 86.5 (slightly abraded).

Length tibia, B.E.G. no. 31186-10, type?, 330 mm, (Proximal end damaged), width proximal end 90 mm (damaged), width distal end 63 mm.

Length metatarsal 3, B.E.G. no. 31186-7, type?, 283 mm, width proximal end 45.5 mm, width distal end 42 mm, approximately (damaged).

Length first phalanx, B.E.G. no. 31186-24, type?, 82 mm, width proximal end 41 mm, width distal end 36 mm.

Deciduous upper dentition B.E.G. no. 31186-23

	AP	Tr	CL	PL	PW
D.P.2	41.0	23.0	-----	8.0	5.0
D.P.3	30.5	24.8	-----	10.0	5.0
D.P.4	31.0	24.5	-----	12.0	5.0

Deciduous lower dentition B.E.G. no. 31186-22 (same individual as B.E.G. no. 31186-23.).

				MM
D.P.2	35.0	12.5	-----	15.5
D.P.3	30.0	12.2	-----	14.7
D.P.4	33.0	11.5	-----	15.3

Onager fraternus (Leidy), 1858

Pl. 3, fig. 10; Pl. 5, fig. 4

Type. - Upper P.3* (according to Cope, 1896, p. 467; and Hay, 1913, p. 569-570) from Charleston, South Carolina.

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* Gidley, (1901, p. 111) rejected Cope's choice of the P.3, on the grounds that Leidy did not figure the specimen. Hay (1913) pointed out Gidley's error in not recognizing Leidy's figure. Gidley selected a new type, a P.2 (1901, p. 112, fig. 8A). This tooth belongs to a small horse, about equalling A. conversidens in size. Leidy *1858) stated "its remains are undistinguishable from the corresponding parts of the recent horse...". Gidley's choice of type, therefore, does not correspond with Leidy's characterization.

Referred material. - Upper and lower teeth and metatarsal B.E.G. no. 30907, Trinity River Terrace and B.E.G. no. 30967, Ingleside Pit.

Discussion. - Teeth of O. fraternus are distinguished from those of O. complicatus by their smaller size. Otherwise there seems to be little difference but, since materials of the two sizes are consistently found, both species seem to be valid.

The metatarsal B.E.G. no. 30907-6 (Pl. 5, fig. 4) agrees closely in slenderness with that of Onager (Stehlin and Graziosi, 1935, pl. 9, fig. 4) but is about 7 mm longer. It is much smaller and more slender than the corresponding material, attributed to O. complicatus and even though the enamel patterns are closely similar the two forms may belong in separate subgenera as indicated below (p. 33). The metatarsal figured and measured is from the Trinity River terraces and is identical in all respects with those from Ingleside pit.

Measurements Onager fraternus

Left lower jaw, B.E.G. no. 31041-26

(Not figured)

	AP	Tr	CL	MM
P.2	29.8	14.2	----	16.0
P.3	27.1	15.0	----	15.7
P.4	27.7	14.0	97	14.4
M.1	24.5	12.2	89	14.5
M.2	25.2	12.0	95	13.1
M.3	24	10.0	62.5	11.7

(Pl. 3, fig. 10)

Right upper M.2, B.E.G. no. 30907-46B

				PL	PW
M.2	26.9	24.5	77.5	15.0	3.6

(Pl. 5, fig. 4)

Left metatarsal, B.E.G. no. 30907-6, length 267 mm, width pr. 43.4

Onager (Hesperhippus) complicatus (Leidy,)1858

Pl. 3, figs. 11-12

Type. - Upper M.2, from near Natchez, Mississippi.

Range. - Sangamon, Pleistocene

Distribution. - Southeastern North America.

Referred material. - Upper and lower teeth, B.E.G. no. 30907, Boatwright gravel pit, 2.5 miles northwest of Trinidad, Henderson County, Texas, compares closely with Leidy's type. The crown height, curvature and dimensions of the occlusal surface are the same at about the same point on the crowns. The referred upper tooth (Pl. 3, fig. 11) has a more complex enamel pattern than does the type and the antero-posterior diameter of the postfossette is considerably greater.

Lower cheek teeth from the same quarry are of a size to equal that of the uppers. They are distinguished, principally, by reduction in length of the molar series and relatively short antero-posterior dimension of the premolars as well. In detail the enamel pattern is more plicated than in E. caballus and remains so in well worn teeth. The metaconid of the lower tooth (Pl. 3, fig. 12) is expanded both externally and internally at its end as in E. midlandensis. The metastylid is more regularly oval, and the valley between metaconid and metastylid is narrow and V-shaped. The entoconid of the premolars is larger than in E. midlandensis, and has a more pronounced spur; the hypoconulid is short and narrow and has a noticeable hypostylid. There is a faint but persistent parastylid on the premolars. The protoconid and hypoconid are flattened and concave. The median valley is broad and short with the pli caballinid occupying a central position, producing an M-shaped termination.

Teeth of both O. complicatus and O. fraternus were found in the Henderson County quarries, with metapodials and foot bones which probably belonged tothem, since no teeth of other species of horses were found there. The smaller metatarsals are of a size to belong with O. fraternus and of the type possessed by Onager. The larger ones, possibly belonging to O. complicatus, do not resemble those of Equus, although they are larger and stouter than those of Onager. There is a strong resemblance in the tooth pattern of O. complicatus to that of Onager. It may be that O. complicatus belongs with the subgenus E. (Hesperhippus) mexicanus Hibbard (1955) which undoubtedly is more closely related to Onager than Equus and it is here tentatively placed in that group.

Measurements O. complicatus

Pl. 3, figs, 11-12

Left upper M. 2, B.E.G. no. 30907-24D

	AP	Tr	CL	PL	PW
M.2	31.3	25.2	90	14.8	4.8 (slightly worn)

Right lower P.4? B.E.G. no. 30907-8G

				MM
P.4?	29.9	27.0	51	18.0

Genus Equus Linnaeus, 1758

Pl. 2, fig. 3; Pl. 3, figs. 1-2; Pl. 4, figs. 1-6; Pl. 5, figs. 1-2; Pl. 6, figs. 1-4; Pl. 7, fig. 3

Type species. - Equus caballus Linnaeus.

Range. - Late Miocene, Recent.

Distribution. - Eurasia, North and South America.

Diagnosis. - Large horses with complex permanent upper cheek teeth; styles of ectolph high, thick, bifurcated; valleys deep and concave; fossettes small; protocones less elongated and compressed than in Onager, internally concave but not as markedly so as in Asinus: hypoconal groove open on all but M.3, lower permanent teeth with long, crescentic metaconids and metastylids, intervening valleys U-shaped; lower molars with shortened median valleys; lower incisors with infundibuli except intermittently on I.$\overline{3}$; lower milk dentition without parastylids and hypostylids; skull elongated; metapodials stout.

Referred species. - Equus excelsus Leidy, 1858.
Equus occidentalis Leidy 1865; Equus scotti Gidley, 1900,
Equus pacificus Leidy (of Gidley) 1901; Equus niobrarensis Hay, 1913;
Equus bautistensis Frick, 1921 (List includes only the better known species.)

Equus caballus caballus Linnaeus, 1758

Pl. 4, figs. 1-6; Pl. 5, fig. 1

Type. - Draft horse.

Range. - Wisconsin, Recent.

Distribution. - Southern High Plains (for American fossil form).

Diagnosis. - Large horse, metaconid strongly produced internally, valley between metaconid and metastylid wide and deep, limbs heavy with shaft of metatarsal thick and rounded.

Referred material. - Left upper P.3-M.2, T.M. no. 937-170-4 (Pl. 4, figs. 1-4) lower cheek tooth (Pl. 4, fig. 5), astragalus, ulna, T.M. no. 937, from Blackwater Draw, 7 miles north or Portales, Roosevelt Co. New Mexico. Metatarsal, T.M. no. 892-11 (Pl. 5, fig. 1) Lubbock, Lubbock Co. Texas.

Description. - Associated upper cheek teeth T.M. no. 937-170-4, are of a young animal; the premolars are unworn and the molars are only alightly so. The teeth are moderately curved both anteroposteriorly and transversely, but not more than in some individuals of the living domestic horse. The teeth and limb bones equal those of the draft horse in size and proportions.

Incisors. - Two incisors, T.M. nos. 937-210 and 937-197 are little worn and represent the first and second of the right lower dentition. The anterior surfaces of the incisors are indented by a V-shaped groove situated about 7.5 mm externally of the median borders of the teeth. The posterior borders of the infundibuli are broadly inflected lingually, indicating that the teeth belong in the lower dentition. Those of the upper dentition in E. caballus have an anterior inflection of the anterior border of the infundibulum.

Upper cheek teeth. - The second premolar is missing from the group of associated teeth and there are no isolated specimens in the collection.

The third premolar (Pl. 4, fig. 1) is unworn and was sectioned 20 mm below the top of the mesostyle. Nearly all the cement has been dissolved away and the external details of the tooth clearly exposed. The parastyle is rounded, protrudes anteriorly, and meets the anterior valley of the ectoloph in a faint ridge. The anterior valley is broadly, asymmetrically concave. The mesostyle is prominent, broad, anteriorly deflected and slightly ridged on either side of its rounded outer border. The posterior valley is less broadly concave and meets the metastyle without interruption. The inner portion of the prefossette is sharply restricted by the strongly developed pli protoloph and pli protoconule. The pli prefossette is double. The postfossette has a deep pli postfossette and a small pli hypoloph. The protocone is rounded anteriorly and pointed posteriorly and is deeply grooved internally. The postprotocnal valley extends nearly to the center of the tooth and has a very prominent pli caballin. The hypocone is restricted by a shallow groove anteriorly and a deep posterior hypoconal groove which remains open to the base of the crown.

The fourth premolar (Pl. 4, fig. 2) is smaller than the third, and has a slightly longer protocone. The hypoconal groove remains open to the base of the crown.

The first molar (Pl. 4, fig. 3) has less prominent styles than the premolars but the valleys of the ectoloph are similar. None of the cheek teeth has ribs. The pli protoloph and pli protoconule are prominent and are the only inflections of the prefossette. The pli postfossette is broad and shallow; the pli hypoloph is deeper than on the premolars. The protocone is narrower than on the third premolar, but otherwise similar in shape. The postprotoconal valley has the pli caballin on the posterior border instead of on the anterior border as in the premolars. The hypocone is not restricted anteriorly and the hypoconal groove is open to the base of the crown.

The second molar (Pl. 4, fig. 4) is smaller and narrower posteriorly than the first and lacks the pli caballin. The hypocone is directed more posteriorly. The hypoconal groove remains open.

An isolated third molar, T.M. no. 937-247, worn to within 20 mm of the base. The anterior part of the protocone is missing. It appears to have been much longer, posteriorly, than in the first and second molars. The hypoconal groove is closed and represented by a roughly oval fossette. The posterior border of the tooth is broadly bilobed.

Lower cheek teeth. - The second premolar is represented by a worn tooth, T.M. no. 937-192 (Pl. 4, fig. 6) which agrees in detail with that of the living draft horse. The metaconid is triangular and directed forward, approaching closely to the paralophid. The commissure appears as belonging entirely to the metaconid with the metastylid attached posteriorly. The valley between is shallow and V-shaped. The metastylid is elongated, flattened, moderately rounded internally, and nearly touches the entoconid. The entoflexid is long and transversely compressed. The entoconid is large, roughly rounded, but slightly angular on its anterointernal border. There is a weak parastylid. The median valley is shallow and there is no pli caballinid. The hypoconid is flattened and concave. The hypoconulid becomes broad toward the base of the crown.

A third or fourth premolar, T.M. no. 937-169 (Pl. 4, fig. 5), is slightly worn and nearly perfectly preserved. The paralophid is short and thin and has two minute inflections on its posterior face. The metaconid is rounded anteriorly, greatly produced internally, and separated from the metastylid by a broad, flat valley. The metastylid is elongated but is more obliquely deflected than is the metaconid. The metaflexid approaches closely to the entoflexid, providing a very narrow commissure between them. The entoconid is flattened internally and has a rudimentary spur on its anteroexternal border. The hypoconulid is narrow transversely, and remains so to the base of the crown. The anteroexternal border of the protoconid projects outward so that its concave external face is oblique to the long axis of the tooth. The median valley is shallow but broad and has a well developed pli caballinid. The hypocone is slightly concave.

Skeletal material. - A radius-ulna, T.M. no. 937-240, compares closely with that of the draft horse in length. The shaft is slightly more slender and the ends are damaged so that no accurate width measurements of the articulations can be made. It is larger and longer than a radius B.E.G. no. 30722 (Pl. 6, fig. 2) found with teeth of E. midlandensis, but not greatly so.

A metatarsal, T.M. no. 892-11 (Pl. 5, fig. 1), found at Lubbock, Texas, agrees closely in size and proportions with that of the draft horse and is referred to E. caballus caballus.

Discussion. - The upper cheek teeth, lower P. 3 or 4, and the limb bone material from Portales and Lubbock agree so closely with those of the draft horse as to leave little doubt of relationship.

It has been stated repeatedly that the domestic horse is a product of interbreeding of many races and forms, and that it is unlikely that the ancestry of E. caballus can be traced to any fossil form. This does not seem to be the case. Recognition of E. caballus caballus and E. caballus laurentius (p. 41) indicates simply that the large and small forms have been kept separate by man and that however many varieties or forms of small horses have been combined in the pony horse, these cannot have differed sufficiently, insofar as tooth morphology is concerned, to have appreciably altered the phenotypic expression of tooth characters.

An exhaustive survey of the literature to determine if valid subspecific categories are available for *Equus caballus* is beyond the resources of the present investigation. Nonetheless, it is inconvenient to distinguish the two groups, as Gidley did (1901). Furthermore, one of the primary functions of a classification is to provide a terminology for the designation of such groups. Since Linnaeus (1758) did not designate a type for *E. caballus* but characterized the species as "strongest in running, in carrying, in pulling, best for riding..." it may be assumed he had both the draft horse and the riding horse or pony in mind. The heavy-limbed members may be recognized as belonging to the subspecies *Equus caballus caballus* Linnaeus. The subspecies *Equus caballus laurentius* (Hay) may include the recent as well as the fossil-pony type members of the species.

Measurements of *Equus caballus caballus*

Left upper P.3-M.2, T.M. no. 937-170-173.

No.		AP	Tr	CL	PL	PW
170*	P.3	31.9	28.5	94.0	13.9	4.1
171*	P.4	30.5	28.5	----	15.0	5.0
172	M.1	32.0	26.7	99.5	14.0	5.1
173	M.2	30.0	25.0	97.5	14.8	5.0

* Section 20 mm below tip of mesostyle.

Left upper M.3, T.M. no. 937-247.

M.3	32.2	----	21.4	----	---

Right lower P.2, T.M. no. 937-192, P.3 or 4, T.M. no. 937-169

No.		AP	Tr	CL	MM
192	P.$\overline{2}$	37.5	18.0	44.5	18.5
169	P.3/4	33.0	19.3	94.0	20.4

Radius, T.M. no. 937-240, greatest length, 359 mm.

Metatarsal, T.M. no. 892-11, length, 281 mm.

proximal width, 62.2 mm.

mid-shaft , 42.0 mm.

distal width , 57.0 mm.

Equus caballus laurentius (Hay)

Pl. 3, figs. 1-2

Equus laurentius Hay, April 30, 1913a, U.S. Nat. Mus. Proc., vol. 44.

Equus niobrarensis alaskae Hay, June 4, 1913b, Smith. Misc. Coll., vol. 61, No. 2.

Equus cf. *caballus* Savage, 1951, Univ. Cal. Bull. Dept. Geol. Sci., Publ. vol. 26, no. 10.

Type. - Skull and lower jaws U. K. no. 347, from upper Pleistocene deposits near Lawrence, Kansas.

Range. - Sangamon, late Wisconsin.

Distribution. - Alaska, Kansas, southern High Plains.

Diagnosis. - Smaller than *E. caballus caballus*, metaconid less produced internally, valley between metaconid and metastylid shallower and narrower.

Referred material. - Upper and lower cheek teeth T.M. no. 937, (Pl. 3, figs. 1-2) from Blackwater Draw, Portales, Roosevelt Co., New Mexico.

Discussion. - *Equus laurentius* Hay was described at an earlier date than *Equus niobrarensis alaskae* Hay and therefore is recognized as the prior name. Workers have consistently recognized *E. laurentius* as *E. caballus* but have insisted it belongs to a recent pony that somehow became fossilized (Savage, 1951, p. 252). Comparison of the dentitions of *E. laurentius* with those of *E. niobrarensis alaskae* indicates the following differences: The protocones of the former are slightly shorter and directed a little more inward, and the skull is somewhat smaller than that of the latter. Both specimens compare closely with materials of the "Texas pony," as Gidley (1901) referred to small forms of the domestic horse.

Recognition of *E. n. alaskae* as *E. caballus* requires reconsideration of the status of *E. laurentius*. It is more reasonable to consider the validity of *E. laurentius* as a fossil than to assume the skull, which according to Hay is "fossilized," belongs to a recent or modern horse (less than 400 years old, requiring investigation of the speed of bone fossilization). Bison bones found by the author on the San Saba river in McCulloch County, Texas, were buried about four feet below the surface in silt. There is a well-developed soil profile with live oaks more than a foot in diameter growing on the surface. The exact age of the bones cannot be estimated but must be several hundred years. On ignition these gave a burned bone odor. It does not seem likely that the skull of *E. laurentius*, which may have been preserved in similar circumstances, could have been mineralized in an equivalent length of time. Probably, rapid permineralization could take place in highly mineralized solutions. These are not likely to be met with in the rivers of the Great Plains region. Therefore *E. laurentius* is recognized as a fossil representative of *E. caballus*. *E. n. alaskae* is considered indistinguishable from *E. laurentius* and the name is reduced to synonymy. The Kansas horse appears to belong with the domestic pony (Texas pony) of Gidley.

Materials from Portales, New Mexico, T.M. no. 937-191, (Pl. 3, fig. 2-2a) agree perfectly with Hay's Alaskan material. The lower teeth of size comparable to that of the uppers (Pl. 3, fig. 1-1a), agree with those of a lower jaw from Alaska referred by Hay (1917, pl. 56, fig. 2) to *E. lambei*. It seems probable all these belong to *E. caballus laurentius*.

Equus midlandensis Quinn, new species

Pl. 2, fig. 2; Pl. 5, fig. 2; Pl. 6 figs. 1-4; Pl. 7, fig. 3

Type. - Right and left lower jaws, lacking M.2-3 on the right, M.3 on the left and the ascending rami; upper left P.2, right P.3-M.1; right metatarsal III and navicular; phalanges of fore and hind foot; all believed to belong to one individual, T.M. no. 998, from gray sand strata, Scharbauer Site (Wendorf *et al*., 1955) Scharbauer Ranch, 8 miles southwest of Midland County, Texas, late Pleistocene, Tahoka Clay formation?

Range. - Wisconsin glacial?

Distribution. - Southern High Plains.

Diagnosis. - Size and proportions of skeletal elements preserved, indistinguishable from *E. caballus laurentius*; teeth slightly larger, valley of metaconid-metastylid shallower and broader than *E. caballus*; median valley of lower molars shorter; upper cheek teeth with wider styles, less complex enamel pattern and more elongated protocones.

Referred material. - Teeth and bones, B.E.G. no. 30722, (Pl. 6, figs. 2-4; Pl. 7, fig. 3) J. O. Baggett Ranch, Odessa, Texas; lower cheek teeth, T.M. no. 937, Clovis site 7 miles north of Portales, New Mexico.

Description. - Upper teeth of *E. midlandensis* are slightly larger than those of *E. caballus* and differ in minor ways.

The second premolar (Pl. 2, fig. 3) is short anteroposteriorly and broad transversely. The mesostyle is slightly bifurcated. Plications of the pre- and postfossettes are simple and much as in E. caballus. The protocone has a faint anterior heel, is concave internally and separated from the hypocone by a short, broad postprotoconal valley. The pli caballin is large. The hypocone is restricted by a shallow prehypoconal groove and a hypoconal groove that does not extend to the base of the crown as in most second premolars of Equus.

The third premolar (Pl. 2, fig. 3) is slightly curved anteroposteriorly and transversely. The parastyle is angular but not grooved. There is a broad nonbifurcated mesostyle. The valleys of the ectoloph are shallow and concave. The prefossette has a pronounced pli protoloph, short, blunt cornua, broadly angular pli protoconule, and a double pli prefossette. The postfossette is large and angular with a deep pli postofssette and pli hypoloph. The protocone is elongated, grooved internally, and oriented with the anteroposterior axis of the tooth. There is a large, transversely directed pli caballin. The hypoconal groove is shallow but remains open to the base of the crown.

The fourth premolar (Pl. 2, fig. 3) does not differ materially from the third.

The first molar (Pl. 2, fig. 3) lacks the ectoloph. The tooth is slightly smaller than the fourth premolar and has less pronounced plications, probably due to greater wear. The pli caballin is very small.

There are no second or third molars belonging to the type.

Lower dentition. - Incisors (Pl. 6, fig. 1) are present on the right half of the symphsis. The third is partly erupted indicating the animal was about five years old at the time of death. The incisors are larger than those of E. caballus and the third lacks the infundibulum.

A large, partly erupted canine indicates the animal was a male.

The second premolar (Pl. 6, fig. 1) is short and blunt. The metaconid and metastylid are nearly equal in size and are connected with the protoconid by means of a narrow, deflected commissure that originates from the metaconid. The entoconid is large, sub-oval and approaches closely the metastylid. There is a small pli caballinid and opposing pli hypoconid but no parastylid.

The third premolar nearly equals the second in length. There is a short, blunt paralophid. The metaconid is directed anteriorly, is initially narrow, and enlarged internally near the end, the external border remaining nearly straight. The metastylid is enlarged both internally and externally near its end and extends farther inward than does the metaconid. The intervening valley is shallow and broad anteroposteriorly. The entoconid is nearly square with a suggestion of a spur anteroexternally. The external borders of the protoconid and hypoconid are concave. There is a short median valley with a small pli caballinid and an opposed pli hypoconid.

The fourth premolar is smaller than the third and has a small inflection on the anterior border of the commissure; the ectoloph is narrower transversely. Otherwise the two teeth are similar.

The molars in *E. midlandensis* have the metaconid and metastylid attached by means of a long narrow commissure and a shortened median valley just as in the premolars. In most species of the Equini it is possible to distinguish premolars from molars by means of the longer commissure and shorter median valley of the premolars. Here the molars and premolars are strikingly alike, differing principally in size alone. In this respect *E. midlandensis* has progressed farthest or is most advanced, in what might be termed promolarization of the molars, of all the species of *Equus*.

Skeletal material. - A metatarsal T.M. no. 998-3 (Pl. 5, fig. 2) found with the type jaws and upper teeth may belong to the same animal. It is a little longer and considerably more slender than that of E. caballus caballus, T.M. no. 892-11.

SSkeletal material from the J. O. Baggett Ranch, Odessa, Texas, appears to belong to E. midlandensis. There were several upper and lower teeth with probably associated skeletal elements in the assemblage. The bones may have belonged to a single individual for several of them are paired and there are no duplicates. There also are three deeply worn cheek teeth, probably of E. caballus laurentius, in the collection. Thus, it is possible the limb bones could belong to that species. They compare closely in size and proportion with those of the pony horse but since both upper and lower teeth of E. midlandensis are represented, along with the paired limb bones, it seems more probable that the material belonged to a single individual of that species, and the teeth of E. c. laurentius are accidentally included.

The radius, B.E.G. no. 30722 (Pl. 6, fig. 2), from the Baggett Ranch site agrees closely with that of E. c. laurentius in size and proportion.

It is considerably smaller and shorter than that of E. c. caballus and has a nearly straight shaft, whereas those of both E. c. caballus and the Texas pony are inwardly curved in the lateral plane. The median part of the frontal surface of the distal end of the radius is occupied by a broad, shallow valley in E. midlandensis, where in the other the innermost of two rugosities occupies this position.

The metacarpal, B.E.G. no. 30722 (Pl. 6, fig. 3), agrees closely with that of the Texas pony. Only the distal two-thirds of the metatarsal is preserved (Pl. 7, fig. 3). It does not differ from that of T.M. no. 998-3.

The astragalus (Pl. 6, fig. 4) is considerably smaller than that of E. c. caballus. The phalanges of the hind foot likewise are smaller, shorter, and more slender.

Measurements of Equus midlandensis Quinn, new species

Upper dentition T.M. no. 998-

		AP	Tr	CL	PL	PW
998-	P.2	38-	29	60	10.3	5.7
998-25	P.3	32.3	29.0	87-	15.8	5.0
998-24	P.4	31	30.0	87.0	16.0	5.5
998-26	M.1	29	----	82-	15.5	5.0

Lower dentition T.M. no. 998-1

				MM
I.1	6.0	19.8	----	----
I.2	10.0	19.8	----	----
I.3	11.2	20-	----	----
P.2	35.4	15.6	69*	17.0
P.3	31.4	18.4	91*	19.0
P.4	31.0	17.4	102	17.0
M.1	30.4	15.5	92	16.5
M.2*	30.3	15.9	83	14.6

* Measurements from opposite jaw.

Depth ramus, middle of P.4, 101.5 mm.

Metatarsal, T.M. no. 998-3, length 287 mm, proximal width 55.5 mm, midshaft 37 mm, distal width 52 mm.

Radius, B.E.G. no. 30722, length 340 mm, midshaft width 43 mm, distal width 66 mm.

Metacarpal, B.E.G. no. 30722, length 234 mm, proximal width 52 mm, midshaft 36 mm, distal width 49 mm.

Ungual phalanx, B.E.G. no. 30722, width 77 mm.

Metatarsal, B.E.G. no. 30722, midshaft width 39 mm, distal width 51.5 mm.

Phalanx one, B.E.G. no. 30722, length 92 mm, proximal width 55 mm, midshaft 34 mm, (distal end damaged).

Phalanx two, B.E.G. no. 30722, length 49 mm, proximal width 54 mm, distal width 48 mm.

Ungual phalanx, B.E.G. no. 30722, length on anterior surface from articulation to tip 55 mm, width 74 mm.

Equus pacificus Leidy (of Gidley)

Equus pacificus Leidy, Gidley, 1901, pp. 116-118, fig. 11.

The type of *E. pacificus* was never figured, and Gidley's referred teeth may or may not belong to the species. Material from the terraces of the Brazos River, B.E.G. no. 31041-139, an upper third or fourth premolar, and B.E.G. no. 35133-6, a lower first or second molar, represent the same form as the Oregon material. This horse, insofar as the upper teeth are concerned, is not greatly different from *E. caballus* except possibly in size.

Measurements *E. pacificus*

	AP	TR	CL	PL	PW
P.3 or 4 (upper)	35.0	30.3	82	16.5	5.2
				MM	
M.1 or 2 (lower)	30.5	19.0	67.0	18.0	

Genus *Asinus* Frisch, 1775

Pl. 2, figs. 1-2; Pl. 3, figs. 3-9

Type. - *Asinus domesticus* (Linnaeus)

Range. - Late Miocene? Recent.

Distribution. - North America, Old World, Recent in Africa.

Diagnosis. - Upper permanent teeth with square outline, small fossettes, protocones shorter than in Onager and teeth less hypsodont; lower permanent dentition, metaconid tends to be deflected inward, then forward, metastylid deflected and short tending to be nearly rounded; intervening valley V-shaped as in Hippotigris but less deeply so, no parastylid, pli-caballinid present, hypoconulid prominent and with a hypostylid, median valley of molars not protruding between re-entrants of the flexids (except in very early stage of wear); lower milk dentition with parastylids and hypostylids weak or absent; metatarsals short and stout but less so than in Equus.

Asinus conversidens (Owen)

Pl. 3, figs. 3-9

Equus conversidens Owen (1869) Philos. Trans. Royal. Soc. London, Vol. 159, p. 563, Pl. 61, fig. 1.

Asinus conversidens (Owen), Quinn (1955) in the Midland Discovery, University of Texas Press, Austin, Texas.

Type. - Maxillaries and part of palate, Inst. de Geol. no. 403, from the Valley of Mexico, late Pleistocene, exact stratigraphic position unknown.

Range. - Sangamon interglacial? to late Wisconsin.

Distribution. - Texas to Arizona and Mexico.

Description. - An upper left M.2, T.M., no. 998-8 (Pl. 3, fig. 7) agrees closely in size and configuration with that of the type of A. conversidens figured by Hibbard (1955, p. 58, fig. 3).

Two lower teeth, P. 4, T.M., no. 998-9 and M.2, T.M. no. 998-10, Scharbauer site, Midland, Texas, figs. 9 and 8, are considerably smaller than materials* referred to A. conversidens by Hibbard (1955, p. 53, fig. 2B).

* Referred teeth do not agree in size with the uppers figured and seem too large to belong to A. conversidens (p. 24).

The teeth T.M. no 998 have rounded metaconids as in A. africanus (Stehlin and Graziosi, 1935, p. 8, fig. 6A) but the metastylids are more like those of Onager than those of A. africanus or A. somaliensis.

An anterior first phalanx T.M. 937-227, a posterior first phalanx T.M. 937-228, and a second phalanx, T.M. 937-229, (Pl. 3, figs. 3-5) agree closely with those of Recent Asinus, as does astragalus T.M. no. 937-185 (Pl. 3, fig. 6), Blackwater Draw, Portales, New Mexico. There are no metacarpals or metatarsals, referable to Asinus, in the Texas collections. Skinner (1942, p. 170, not figured) referred material to A. conversidens. This material includes a metacarpal length 212.7 mm. A third metacarpal figured by Stehlin and Graziosi (1935, table 2, fig. 2) of A. somaliensis measures approximately 205 mm. The metacarpal of O. altidens (Pl. 7, fig. 1) has a length of 247 mm. A metacarpal referred to O. lambei (p. 18) has a length of 215 mm. A metacarpal of Onager (=E. (H) hemionus), (Stehlin and Graziosi, 1935, Table 2, fig. 3) has a length of approximately 222 mm. Figures for height of crown of M. 1 of A. conversidens (Hibbard, 1955, p. 56, T. 1) are approximately 62.3 mm and indicate pronounced hypsodonty. By the time M.3 has begun to receive wear, M.1 is shortened by about 20 mm. M.3 of the type is not greatly worn as indicated by the open posterior border of the postfossettes. M.1 was therefore initially approximately 80 mm long. A first molar of A. a. somalicus, Laperung, Br. Somaliland, C. N. H. M. no. 1429, unerupted, has crown height 65.0, enamel deposition not ended. A domestic ass, C.N. H. M. no. 42715, has both M.1 and M.2 in use but roots not fully formed with heights 73.6 and 75.0 , respectively. A. conversidens seems to exceed Recent Asinus both in length of metapodials and hypsodonty, but on the whole appears more closely related to Asinus than to Onager.

Discussion. - The available evidence concerning the relationship of A. conversidens is not conclusive. A. conversidens was referred to Asinus (Quinn 1955B) under the assumption that the Asiatic asses belonged with Asinus. Subsequently it became necessary to consider the Asiatic asses as generically distinct from Asinus (pp. 6-10).

Materials of A. conversidens from Portales, N. M. and Midland, Texas, appear identical with those of A. conversidens from Arizona (Skinner 1942) and are of later than Sangamon age. Materials from Valley of Mexico, according to Hibbard (1955) belong in the Upper Becerra formation and represent "the closing phase of the Sangamon and [beginning of?] Wisconsin subages." Materials from the terraces and Coastal Plain of Texas are from deposits of Sangamon age. These contain specimens which appear referable to A. conversidens but they also contain teeth of seemingly larger and smaller species of Asinus. The smaller species may belong to A. francisi (Hay) but none of the specimens was sufficiently complete or unworn to be certainly assigned to A. francisi.

It will be necessary to make a much more exhaustive study of the available materials of Asinus before it can be certainly demonstrated that the terrace and Coastal Plain deposits contain remains of A. conversidens.

BIOSTRATIGRAPHY

Considerable evidence has been accumulated in recent years indicating extinction and replacement of the large mammal components of Pleistocene faunas in relation to glacial stages. This condition is not as clearly reflected in small mammal components of the faunas (Skinner, 1942, p. 153). Rodents especially and other burrowing animals are less subject to rigorous climatic conditions than animals such as horses which must remain in the open. The point of meximum extinction in a glacial-interglacial cycle is not known but it seems logical to relate the point of maximum extinction with glacial maxima. It is now generally accepted that glacial stages were periods of intense pluviation and undoubtedly of low temperatures--induced by refrigeration from the ice mass if nothing else--and it is understandable that horses especially are most susceptible to wet-cold conditions.

Interglacial stages appear clearly to have been as arid as the glacial stages were pluvial (Quinn, 1957). The major problem during the inter-glacial stages would have been supplies of food and water, but shortages of these would not necessarily have produced extinction of species of large mammals.

The sedimentary cycle indicates extreme aridity, passing gradually into humid conditions but probably changing abruptly from humidity to aridity at the end of the glacial stages. Thus during arid times plant cover is inadequate; runoff, soil wash, and flooding are at a maximum; there is abundant material available for transport; streams tend to waste away through evaporation and infiltration, a process ably described by Johnson (1900), and deposit their loads before reaching the seas, producing "blanket type" continental deposits.

During humid-glacial times plant cover and ice sheets protect the surface of the ground, soil wash is reduced to a minimum, flooding is reduced, streams are more uniform and tend to transport their loads all the way to the seas, and materials for transportation are neither abundant nor of coarse sizes. Deposits during pluvial times tend to be thin and of fine-grained materials. If the change from pluvial to arid conditions were abrupt, widespread areas might be laid bare, providing a source for loess. An ideal section would be composed of 1) loess, 2) coarse clastic material, perhaps calcareous, 3) fine clastic material, perhaps carbonaceous, 4) soil. This would not represent a typical section in an area subjected directly to glaciation where the sequence would necessarily be 1) till, 2) soil (gumbotil), unconformity (dissection), till.

Glaciated		Non glaciated	
regimen	climate	regimen	climate
glaciers	pluvial	soil	pluvial
dissection	humid	fine clastics	waning
soil (gumbotil) (Loess eroded)	humid	coarse clastics (Loess deposited)	arid
till	arid	soil	pluvial
glaciers	pluvial		

If it is accepted that continental glaciation is primarily the product of pluviation, ice sheets would begin to form as soon as winter snowfall exceeds summer melting. When ice accumulates to sufficient depth (250 feet, Flint, 1946, p. 17), flow is induced in any direction away from the center of accumulation. It does not seem improbable that ice sheets would begin to form more or less simultaneously over the entire glacial area. Actually we have no way of knowing how much of the North American continent received a blanket of ice. The preserved evidence is the product of ice that accumulated to sufficient depth to become mobile.

The concept that glacial ice originated in the far north and extended itself southward as expressed by McGrew, (1948, p. 551), Lugn (1948, p. 625) therefore is not necessarily true or even likely to be true. It may not be supposed that animals of continental North America fled southward before an oncoming wall of ice, but rather than over much of the continent conditions gradually worsened, becoming more and more humid with longer winters, deeper snow, and shorter, colder summers, with the result that larger animals unable to shelter themselves and unable to find sufficient food in winter were decimated. Later, with the moderation of conditions, the areas formerly occupied by these animals again became available for habitation. New species moved in, some from the Old World, some from Mexico and Central America, and others perhaps from southeastern and southwestern United States, where climatic conditions may not have been sufficiently sever to bring about extinction. That some such sequence of events took place is borne out by the distribution of the horses through Pleistocene time.

Blanco beds. - According to Evans (1948, p. 619)

> "The Blanco beds evidently represent a period of relative humidity preceeded and succeeded by periods of relative aridity. This condition suggests a glacial stage, and the faunal evidence precludes any but the first glacial as the time of the Blanco deposition."

Evans pointed out that the Blanco beds were deposited following formation of a caliche cap rock indicating arid conditions, and assumed the cap rock was developed in pre-Nebraskan time. There is no evidence to support (or con-

	Recent		
		Scharbauer-Portales	*Equus caballus* *Equus midlandensis* *Asinus conversidens*
Wet	Dry		
Wisconsin		Takoha fm.	*Equus sp.*
	Sangamon	Beaumont-Lissie-Leona-Uvalde-Holloman (B)	*Equus caballus?* *Equus pacificus* *Asinus conversidens* *Onager fraternus* *Onager lambei* *Onager altidens* *Onager littoralis*
			Bison
Illinoian		Tule fm. Holloman (A) Hay Springs	*Equus scotti* *Onager semiplicatus* *Equus niobrarensis*
	Yarmouth		
Kansan.		Blanco beds	Extinction of *Hippotigris* (= *Plesippus*)
			Nannippus phlegon
			Hippotigris (= *Plesippus*)
	Aftonian	Hagerman-Sand Draw (coarse clastic lithotope)	
		Sand Draw (fine clastic lithotope)	
Nebraskan			

trovert) this view. Immediate pre-Nebraskan conditions are undetermined. The cap rock may very well have formed during the Aftonian interglacial period and the Blanco beds may represent pre-climax Kansas deposition which is indicated by presence of Hippotigris (= Pleisippus). No fossils of Blancan age have been found in the terrace or Coastal Plain deposits of Texas.

Rock Creek beds. - The Rock Creek beds, or Tule formation, according to Evans and Meade (1945, p. 493-495) are basin deposits similar to the Blanco beds. The fauna is distinct from that of the Blanco beds, and does not contain Bison characteristically present in this region in deposits known to be of late Pleistocene age. It seems probable the Tule formation is the product of a cycle of events similar to that responsible for the Blancan beds and belongs to pre-Illinoian-climax deposition. No fossils of Yarmouthage have been found in the terrace or Coastal Plain deposits of Texas.

Terrace and Coastal Plain deposits. - It has been shown (Quinn, 1957) that the terrace and Coastal Plain deposits of Texas west of the Trinity and Brazos rivers, or more properly west of the point where the Trinity river flows through Henderson and Anderson counites, belong to a single time rock unit. The fauna contains neither Aftonian nor Yarmouth horses and does contain Bison. It is possible that materials have not been recovered from every part of the gravel, sand, and clay of the Uvalde, Leona, Lissie, Beaumont complex but a considerable number of fossils from all parts of the area are in the University of Texas collections. These invaribly represent one and the same faunal group, whether the materials were derived from the Uvalde gravels, the various terrace levels at Austin, or from the Coastal Plain blanket. It seems improbable that Aftonian or Yarmouth age deposits are exposed anywhere in the area. If they are, they have yielded no fossils to date.

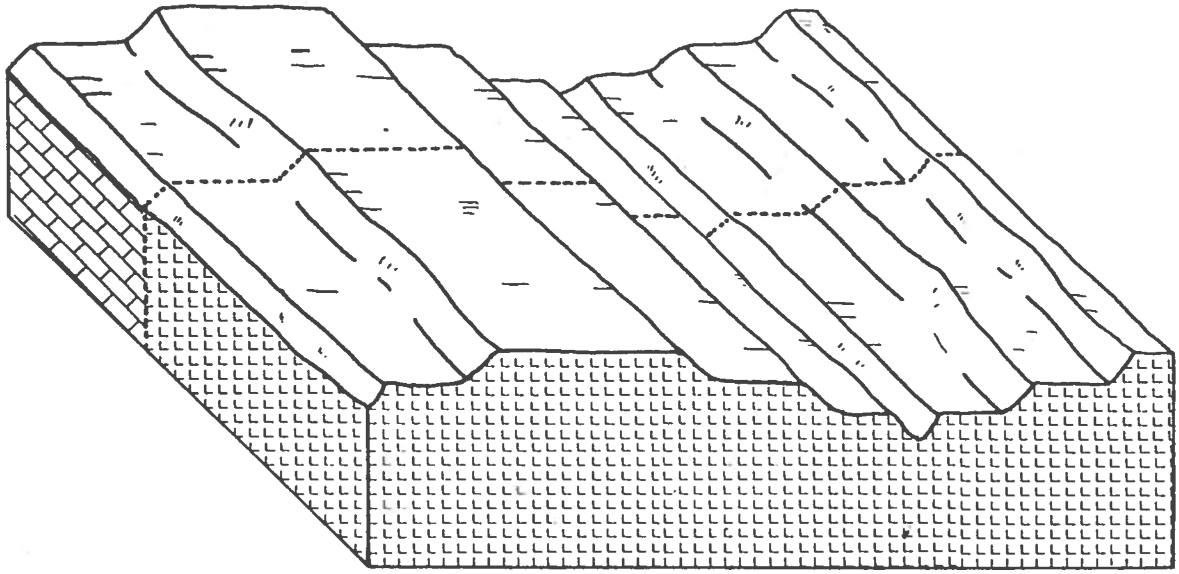

Fig 2

Figure 2. - Schematic block diagram of Colorado River in the vicinity of Austin, Texas, at the end of the third (Illinoian) glacial stage. 1. Late Cretaceous marl and chalk; 2. Balcones fault zone; 3. Edwards Limestone; 4. Upland or Uvalde "terrace" surface; 5. Escarpment of Nebraskan glacial stage; 6. Terrace of Aftonian interglacial stage; 7. Escarpment of Kansan glacial stage; 8. Terrace of Yarmouth interglacial stage; 9. Entrenchment of Colorado River during Illinoian glacial stage.

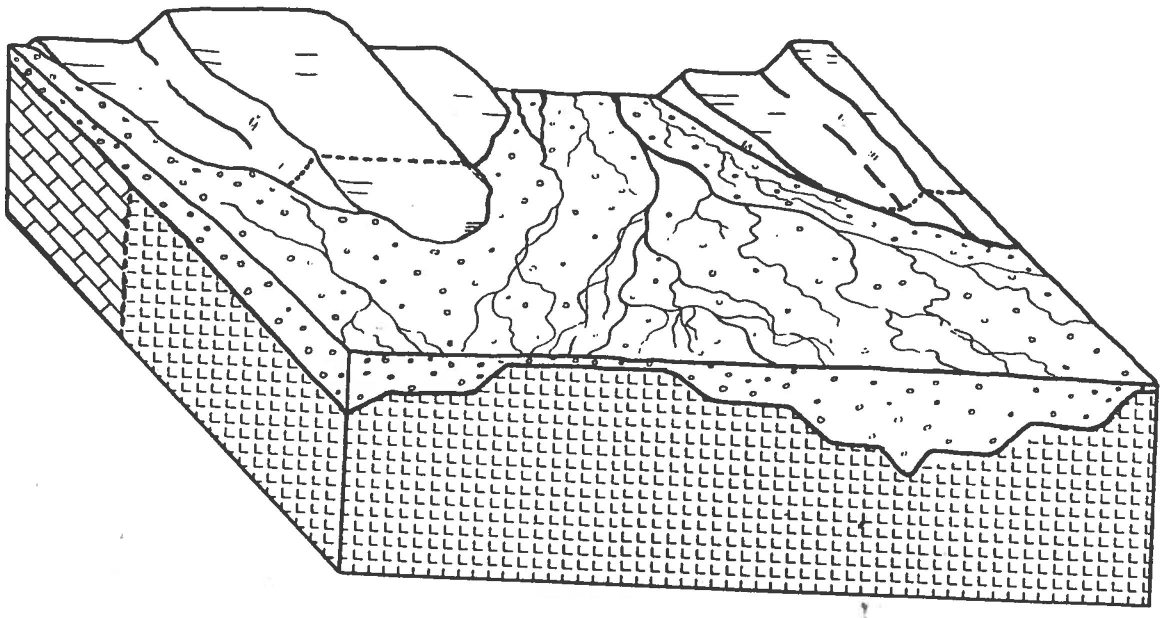

Figure 3. - Schematic block diagram of Colorado River in the vicinity of Austin, Texas at the end of the third (Sangamon) interglacial stage. Valley has been filled with gravel and sand during the arid Sangamon interglacial stage. (For legend see figure 2.)

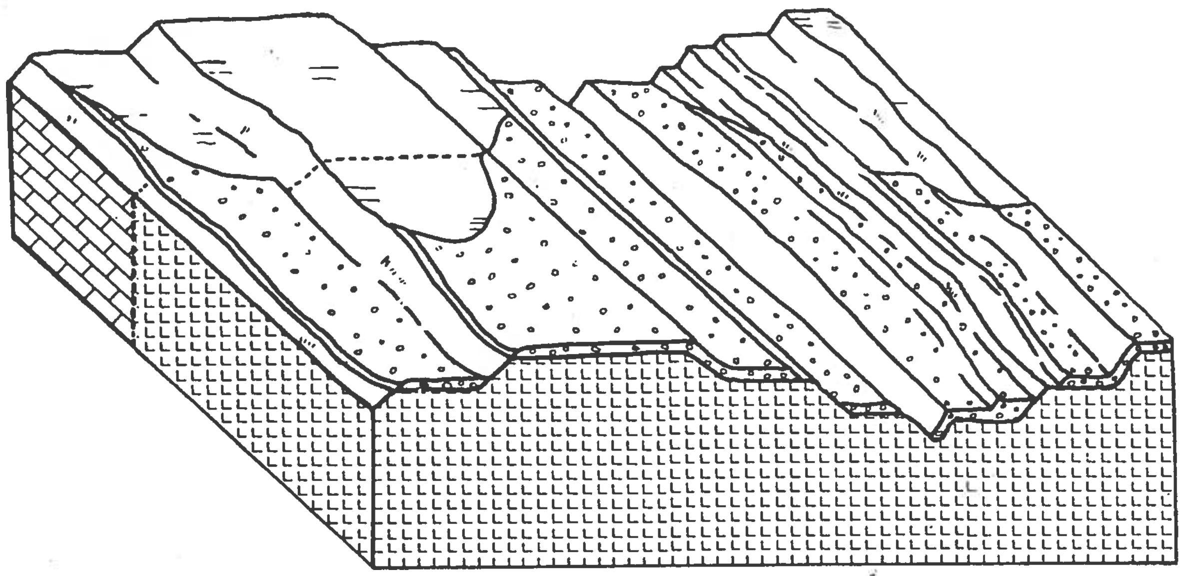

Figure 4. - Schematic block diagram of Colorado River in the vicinity of Austin, Texas at the end of the fourth (Wisconsin) glacial stage. The sand and gravel of figure 3, has been partially removed during pluvial parts of Wisconsin time secondary terracing is the product of Wisconsin substages. (For legend see figure 2.)

Unity of the deposits that have been assigned formational names listed above is borne out not only by their fossil content but also by their physical nature.

Johnson (1900, p. 613-656) discussed the derivation of late Tertiary deposits on the High Plains, explaining their presence in terms of materials deposted on a sloping continental surface by streams suffering progressive deterioration due to loss of water through infiltration and evaporation--in other words in an arid climate. He pointed out that deposits of this type can not be developed under humid conditions because water tables would be high and water would not be lost from streams by infiltration; likewise loss through evaporation would be reduced. Although his explanation of blanket-type continental deposits has been generally ignored, it appears to be the only logical interpretation of such deposits. This concept accurately fits the physical properties and areal distribution of the terrace and Coastal Plain materials (p. 57, figs. 2-4).

Presence of a widespread sheet of sediment of Sangamon age and absence of older similar materials presents a problem. One possible solution is that Aftonian and Yarmouth sediments were deposited and subsequently removed. It seems unlikely that, had there been such deposits, they could have been completely eroded away leaving no traces. It seems more probable that sediments of Aftonian or Yarmouth age were not deposited as a blanket on the Coastal Plain but that conditions were sufficiently less arid during those times to permit streams to maintain themselves, carrying their sediments into the Gulf. There is some support for this concept in the development of gumbotil in the glaciated regions. Gumbotil is a product of soil development which in turn is a product of weathering. Rate of weathering is very much accelerated by humid conditions and depth of soils depends on humidity and absence of active soil wash or degradation by erosion.

Thickness of gumbotil is therefore a function of climatic conditions as well as of time. According to Kay (1931), gumbotil formed on Illinoian till is about 5 feet thick, that formed on Kansan till is about 11 feet thick and that formed on Nebraskan till is some 8 feet thick. In terms of time, duration of the Sangamon interglacial stage is taken as about 135,000 years, Yarmouth 310,000 years, and Aftonian about 200,000 years. In terms of climate, depth of the gumbotil would indicate considerably greater humidity during Yarmouth time and greater aridity during Sangamon time, with conditions intermediate during Aftonian time. (At present there is little evidence, beyond the supposed time significance of the gumbotil, to indicate the relative duration of the interglacial stages, and this evidence does not appear to be at all reliable.)

Faunas. - The fauna of the Sangamon age deposits of the terraces and Coastal Plain have not been studied in detail. Stovall and McAnulty (1950) described a new species Megolonyx brachycephalus from Trinity River terraces, and presented the following faunal list:

TABLE

Boatright B.E.G. 30726-30907

Mastodon americanus	Megalonyx brachycephalus
Parelephas columbi	Didelphis
Onager complicatus	Spilogale sp.
*Onager fraternus	Castor sp.
Bison sp.	Graptemys sp.
Odocoiloeus cf. virginianus	Terrapene sp.

Camelops sp.	Bird
Tanupoloma sp.	
Platygonus sp.	*Homo, femur, and stone images, (Sellards, 1944, p. 23-29; 1952 p. 99-105.)
Canis sp.	
Holmesina sp.	

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* Added by the author

In addition Stovall and McAnulty listed Bison occidentalis as an isolated find. It probably does not belong with the above fauna but with later sub-Wisconsin deposits (Quinn, in press). They also listed 21 genera from Ingleside pit, San Patricio County, Texas, not found in the Trinity River terraces. These are: Cervus, Capromeryx, Canis, Smilodon, Felis, Ursus, Cynomys, Geomys, Lepus, Reithodontomys, Mylodon, Nothotherium, Dasypus, Boreostracon, Testudo, Cistudo, Trionyx, Amphisbina, Alligator, Lepisosteus, Amiurus, *Homo, artifacts (Sellards 1940, p. 1651-1653). (Sellards (ibid, p. 1652, table 3.) listed 12 genera from the Ingleside site, and 20 genera from Berclair Terrace.)

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* Added by author.

Stovall and McAnulty suggested the discrepancy in the faunal lists indicate difference in age between the Trinity River terraces and Ingleside pit. It seems more likely that the difference is a reflection of the differing nature of the two deposits. The terrace materials are fluvial gravel and sand. Ingleside pit is a pond or basin deposit and may have been a watering place.

Tahoka formation. - The Tahoka formation, according to Evans and Meade

(1945, p. 495-498), is the oldest deposit definitely recognized within the modern playa basins. The deposit occupies basins, presumably similar to those of the Blanco and Tule formations. The materials in a number of basins are similar and represent deposition during a humid stage. Subsequent events included two arid and two humid substages according to Evans and Meade (p. 449). They concluded that the Tahoka formation is of Wisconsin age. Seemingly it is of early Wisconsin age. This is indicated by the subsequent history cited by Evans and Meade.

Evans and Meade considered the Tahoka clay formation to be correlative of the Portales, New Mexico, deposits (p.) containing artifacts described by Sellards (1940) and others. Horses found in association with human remains near Midland (Wendorf et al., 1955) indicate unity with the Portales fauna, but there is not adquate evidence, faunal or otherwise, to definitely establish contemporaniety of the Portales and Tahoka deposits.

TABLE

Tahoka	Portales	Midland
Bison antiquus	Bison antiquus?	Bison
		Canis dirus
		Camelops
		Odocoileus
		Capromeryx?
		Platygonus alemonii
		Sylvolagus
		Lepus
	Asinus conversidens	Asinus conversidens
Equus?	Equus caballus caballus	Equus caballus caballus
	Equus caballus laurentius	Equus caballus laurentius
	Equus midlandensis	Equus midlandensis
mammoth	Elephas columbi	
		Cynomys ludovicianus
		Neotoma
		Citellus

SUMMARY AND CONCLUSIONS

Teeth and bones of horses from Texas substantiate the concept of distinct, large-mammal assemblages belonging to different stages of the Pleistocene. It is suggested that large mammals, e.g., horses, were unable to live through the climaxes of the glacial stages. They did not retreat before oncoming glaciers but were decimated by inclement conditions over nearly the whole of continental North America with the possible exception of extreme southeastern and western North America, Mexico, and Central America, which, together with the Old World, may have furnished replacement species after glacial climaxes had passed.

Horses of the genus Hippotigris (= Pleisippus) appear to be restricted between the Nebraskan-Kansan climaxes; Onager semiplicatus and Equus scotti--Equus niobrarensis, between the Kansan-Illinoian climaxes; Equus pacificus (and others) Asinus conversidens? (and others) Onager fraternus, O. complicatus, O. lambei, O. altidens, O. littoralis and Bison post-Illinoian climax. Equus c. laurentius is found in post-Illinoian sediments and seemingly survived through the Wisconsin stage, where it is found with remains of Equus caballus caballus, Equus midlandensis, and Asinus conversidens.

Earlier Pleistocene deposits are confined to the High Plains in northwest Texas. These are found in deflation basins excavated by wind during arid times, whick are correlated with interglacial stages. The basins were filled during ensuing pluvial times which are correlated with glacial stages. Thus Blancan deposits belong to a pluvial stage preceded and followed by arid stages. Presence of Hippotigris found elsewhere in beds belonging to the first (Aftonian) interglacial indicates the Blanco beds belong between Nebraskan and Kansan maxima and would be post-arid Aftonian or early pre-climax Kansan in age.

The same conditions apply to the Tule formation or Rock Creek beds. Presence of O. semiplicatus and E. scotti found elsewhere in beds of second interglacial (Yarmouth) age indicate the Tule formation belongs to postarid Yarmouth or early pre-climax Illinoian time. The Tahoka clay formation has a similar history and must belong to Wisconsin time. Events on the Coastal Plain and along the central Texas rivers followed a different sequence. It seems probable that during the first and second interglacial periods arid conditions were not so intense but that rivers draining the northwestern Texas area were able to carry their loads to the Gulf of Mexico and did not develop appreciable continental deposits in the Coastal Plain area. During the third interglacial, aridity was intense enough to desiccate rivers by evaporation and infiltration in the Coastal Plain area and they deposited their loads so that valleys were filled and a blanket of coarse detrital material was spread over the Coastal Plain, probably from the Rio Grande (at least beyond the Nueces River) eastward to or beyond the Brazos River. In eastern Texas, conditions may have been sufficiently less arid to prevent formation of these deposits.

Insofar as is known, no Pleistocene fossils have been found east or south of Palestine, Texas, on the Trinity River, or east of Navasota, Texas, on the Brazos River.

Subsequent to Sangamon interglacial time, only minor deposits relatable to substages of Wisconsin time were emplaced along the central Texas rivers, principally near the mouths. The Uvalde, Leona, Lissie, and Beaumont formations recognized in this area can only represent facies of a gravel, sand, clay blanket of the same age, for all contain fossils of the Sangamon age fauna.

The horses of the Sangamon age fauna represent three genera: Equus, Asinus, and Onager. The latter has formerly been treated as Equus (Hemionus) but Hemionus is antedated by Onager Brisson 1762. Therefore the earlier name is applied.

Equus caballus is recognized. There are two subspecies E. caballus caballus in no way different from the modern draft horse insofar as the materials preserved are concerned, and E. caballus laurentius, a pony-type caballine horse very much like the "Texas pony" of Gidley.

Finally, it is concluded, on the basis of the sedimentary record, that:

1. Glacial stages were markedly pluvial and that glaciation followed and was a product of pluviation, not the reverse.
2. Interglacial stages were markedly arid; the change from a pluvial condition to an arid one probably was abrupt but the change from arid to pluvial probably was much more gradual.
3. The pattern of intensity of precipitation over North America, remained essentially as it is now, with proportional decrease or increase in the amount of precipitation during the glacial-interglacial cycles.
4. Sediments produced during interglacial stages in nonglaciated areas were principally of coarse clastic materials. Sediments produced during glacial stages were essentially fine clastic materials.
5. Materials representing the first and second interglacial stages were not deposited on the Coastal Plain, as a result of moderately arid conditions. Materials of the third interglacial stage were deposited on the Coastal Plain, due to more arid conditions. This implies that the shallow depth of gumbotil in the glaciated regions formed during the third interglacial is a reflection of more arid conditions and not

necessarily a shorter period of time than that required for the development of thicker deposits of gumbotil during the first and second interglacial stages.

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PLATE I

All figures approximately natural size.

Figures	Pa

1-5. Onager altidens Quinn, new species, type

1. Upper right P.2-4 section of unerupted premolars B.E.G. No. 31186-36.

2. Upper right D.P.2-M.2, occlusal view, B.E.G. no. 31186-36.

3. Lower right P.2-P.4, section of unerupted premolars B.E.G. no. 31186-35, type.

4. Lower right D.P.3-M.2, occlusal view, B.E.G. no. 31186-35 type (figs. 3 and 4 of the same specimen)

5. Symphysis of lower jaw with I.1 and 2 (unerupted), D.I.2, occlusal view, B.E.G. no. 31186-35, type (figs. 3,4,5 of the same specimen. The alveolus of D.P.2 has been filled with plaster but its anterior border can be seen on figs. 4-5).

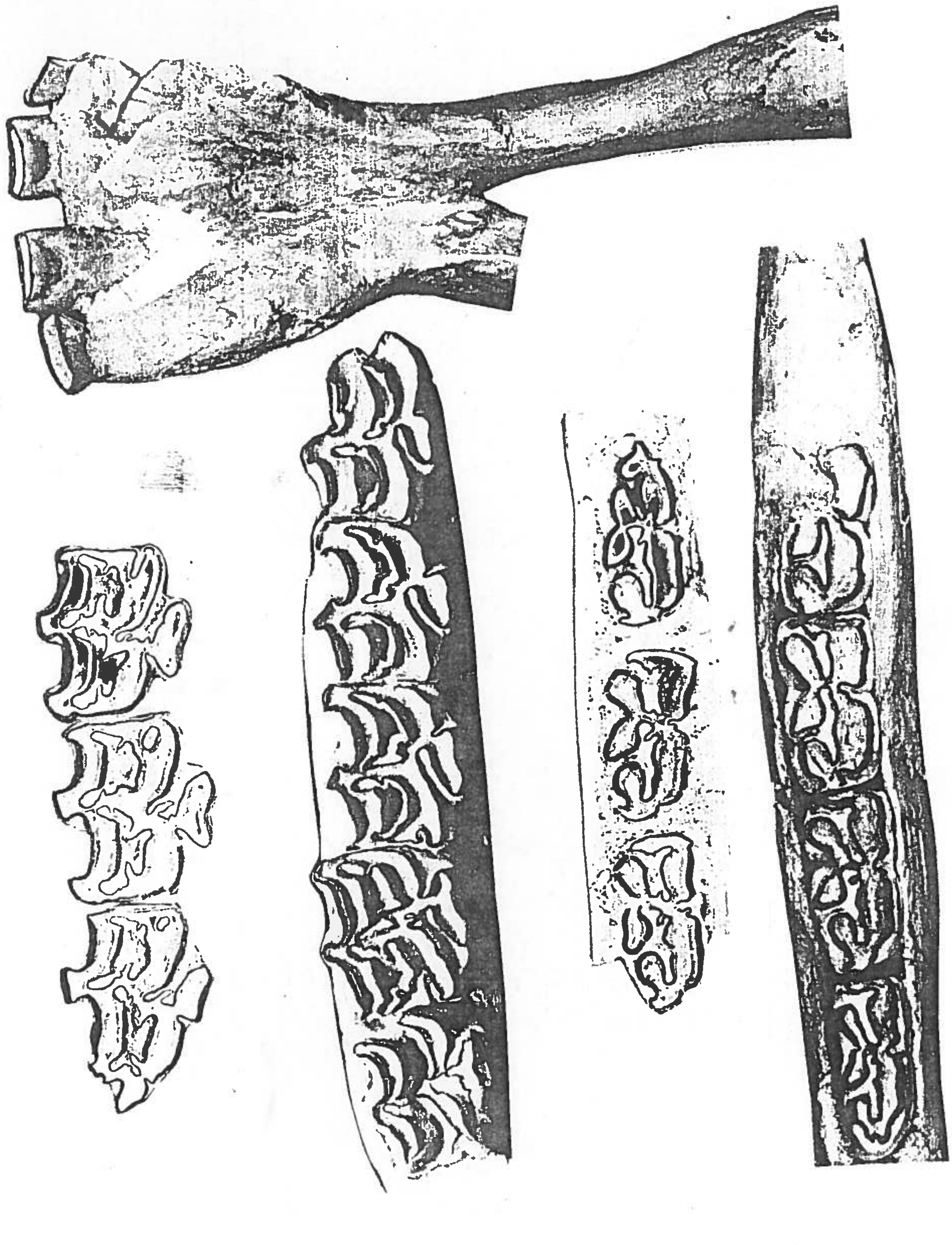

PLATE II

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Figures

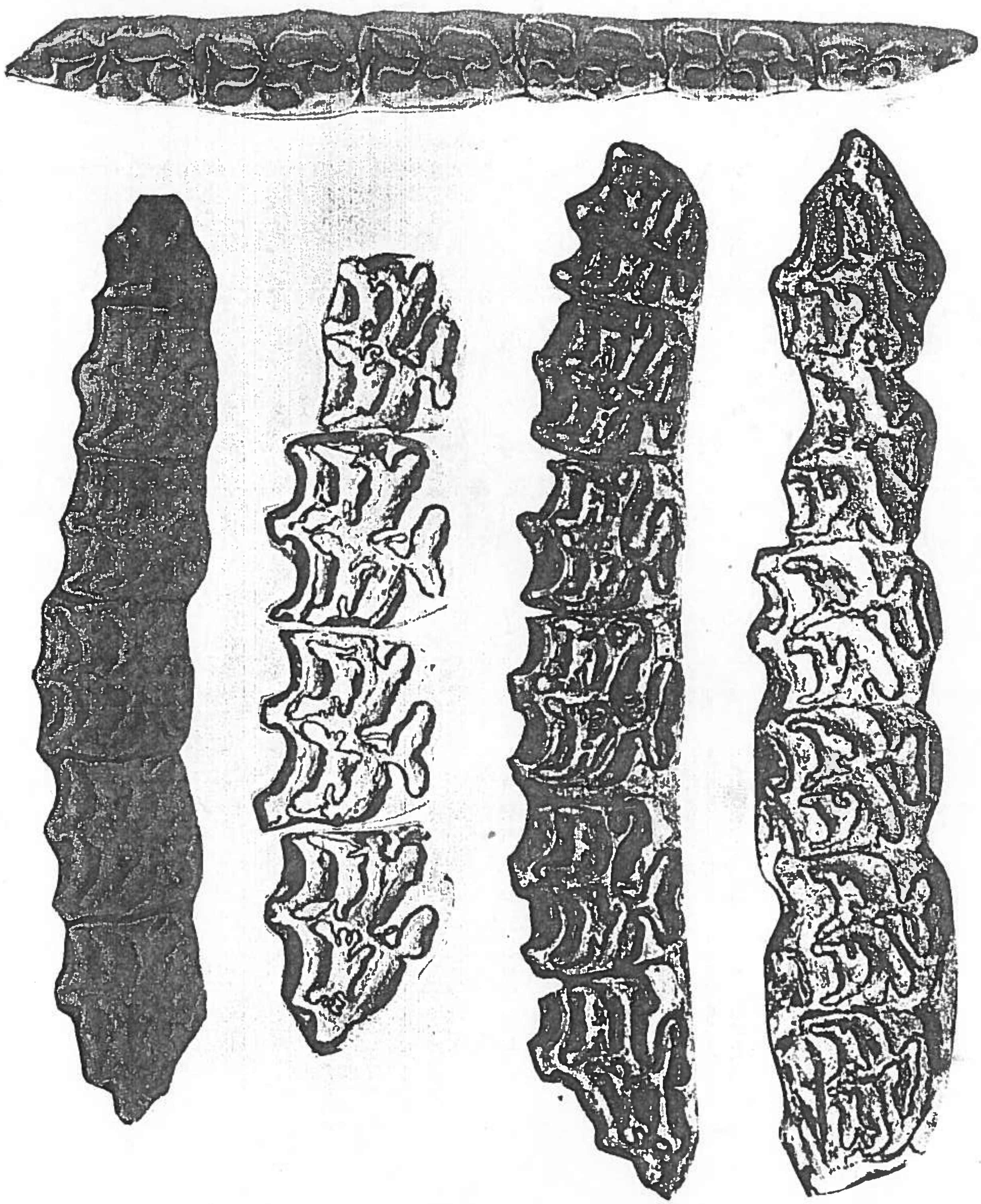

PLATE III

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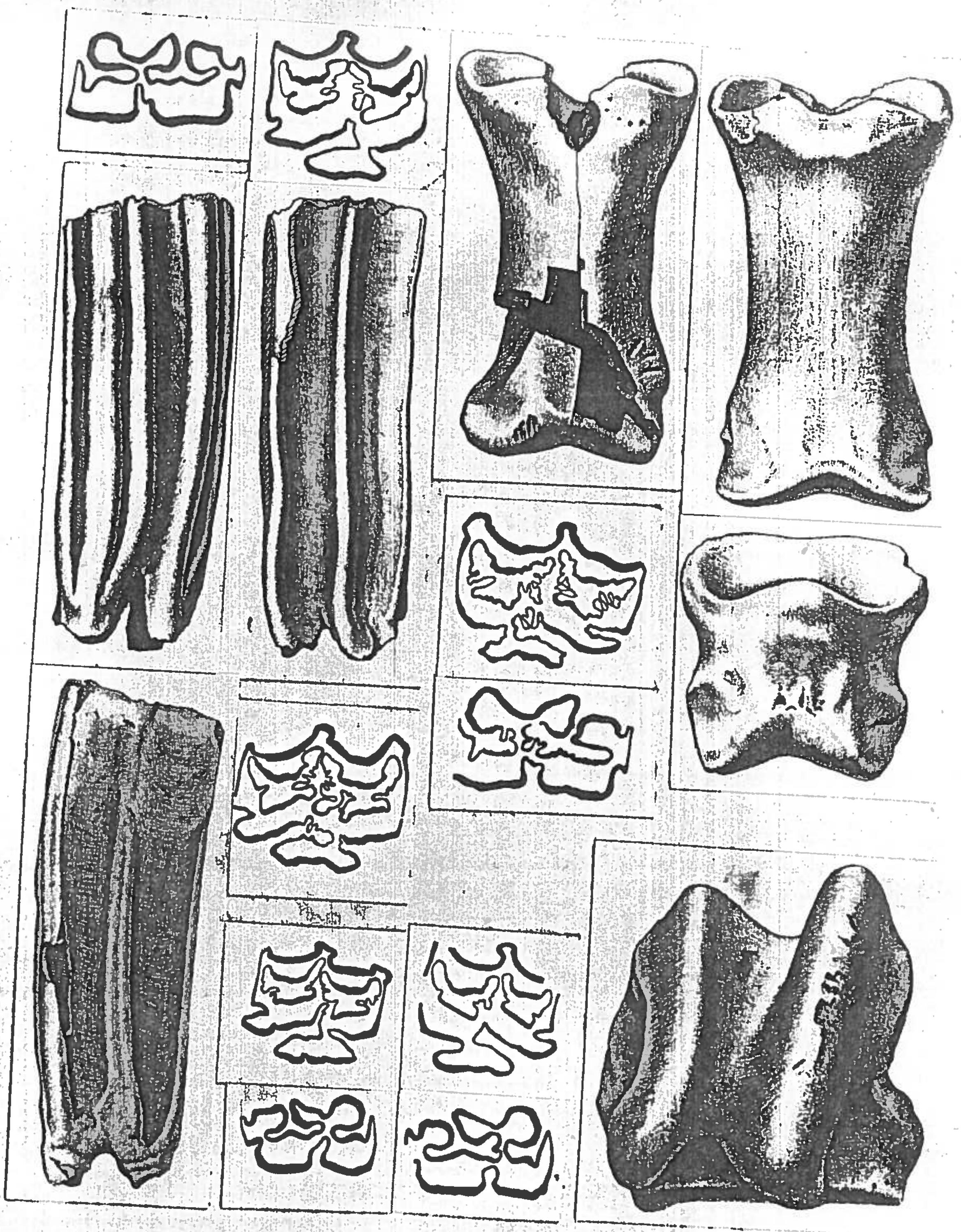

PLATE IV

All figures natural size

Figures		Page
1-6	*Equus caballus caballus* Linnaeus	
1	Upper left P.3, sectioned 20 mm below tip of mesostyle, T.M. no. 937-170.	
2	Upper left P.4, sectioned 20 mm below tip of mesostyle, T.M. no. 937-171.	
3-3A	Upper left M.1, occlusal and external view, T.M. no. 937-172.	
4-4A	Upper left M.2, occlusal and external views, T.M. no. 937-173 (believed to belong to one individual).	
5-5A	Right lower P.3 or 4, occlusal and internal views, T.M. no. 937-169.	
6	Right lower P.2, occlusal view, T.M. no. 937-192.	

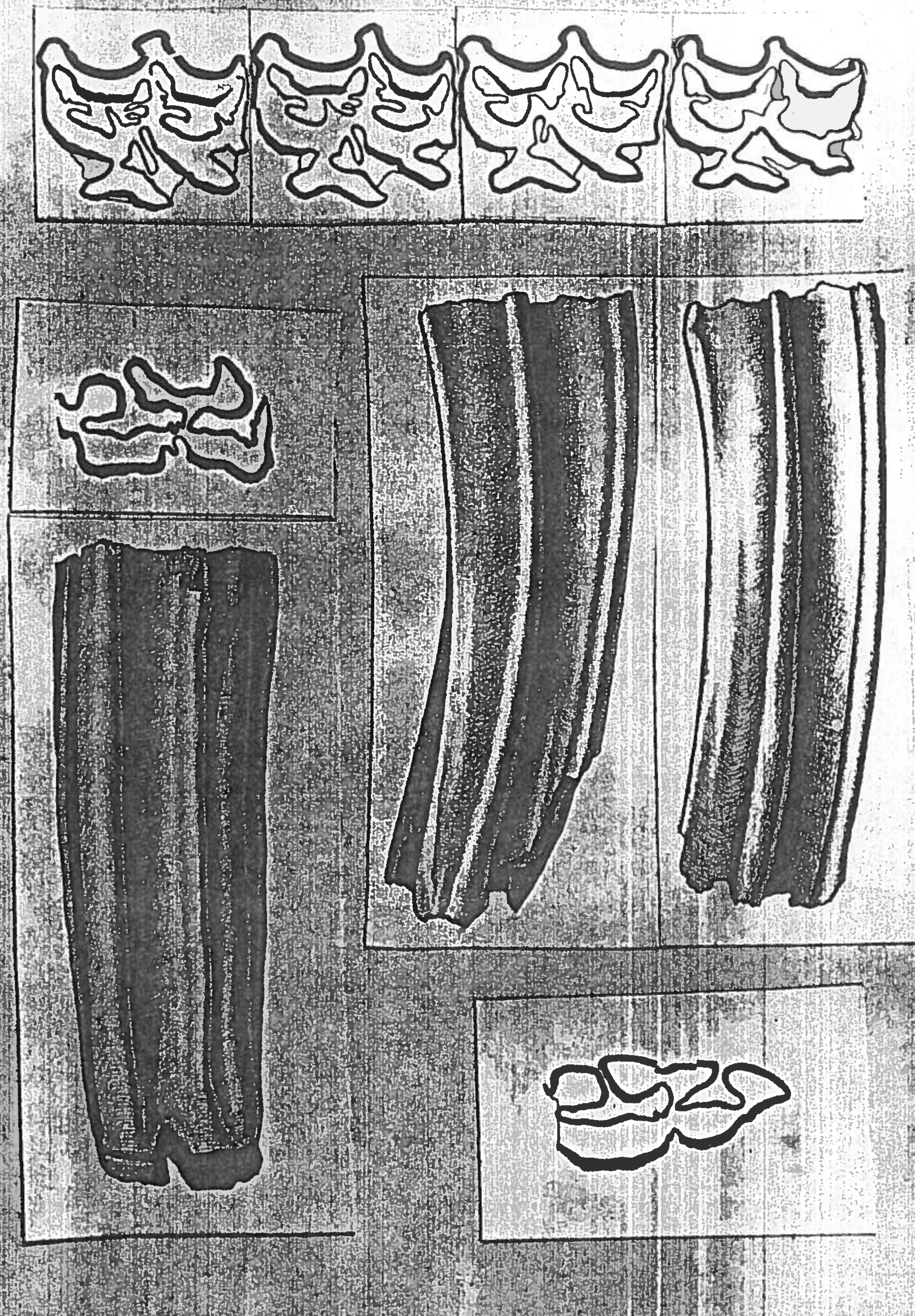

PLATE V

All figures natural size.

Figures | Page

1 *Equus caballus caballus* (Linnaeus) left metatarsal, T.M. no. 892-11.

2 *Equus midlandensis* Quinn, new species, right metatarsal, T.M. no. 998-3.

3 *Onager altidens* Quinn, new species, right metatarsal, B.E.G. no. 31186-7.

4 *Onager fraternus* (Leidy) right metatarsal, B.E.G. no. 30907-6.

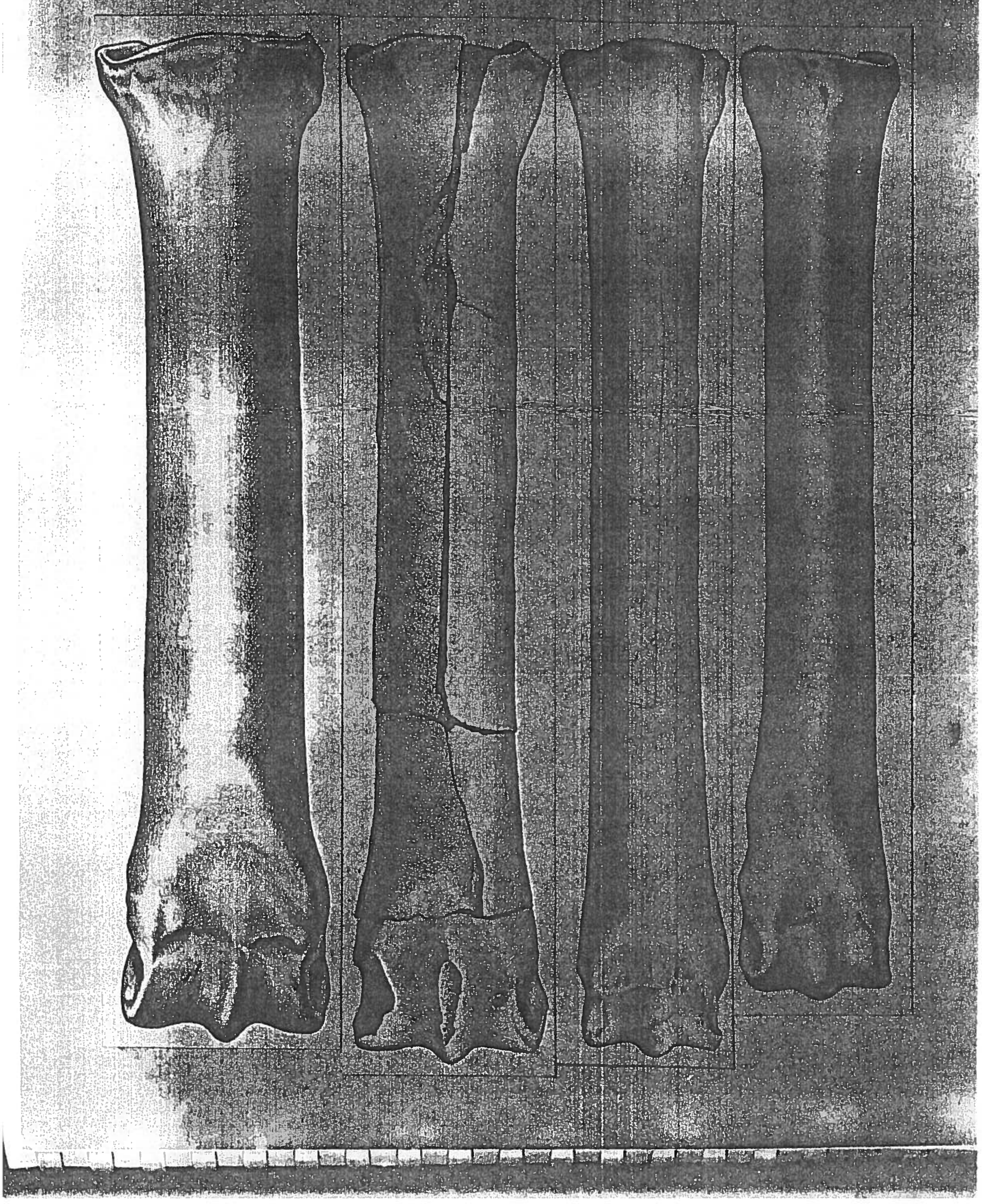

PLATE VI

All figures natural size

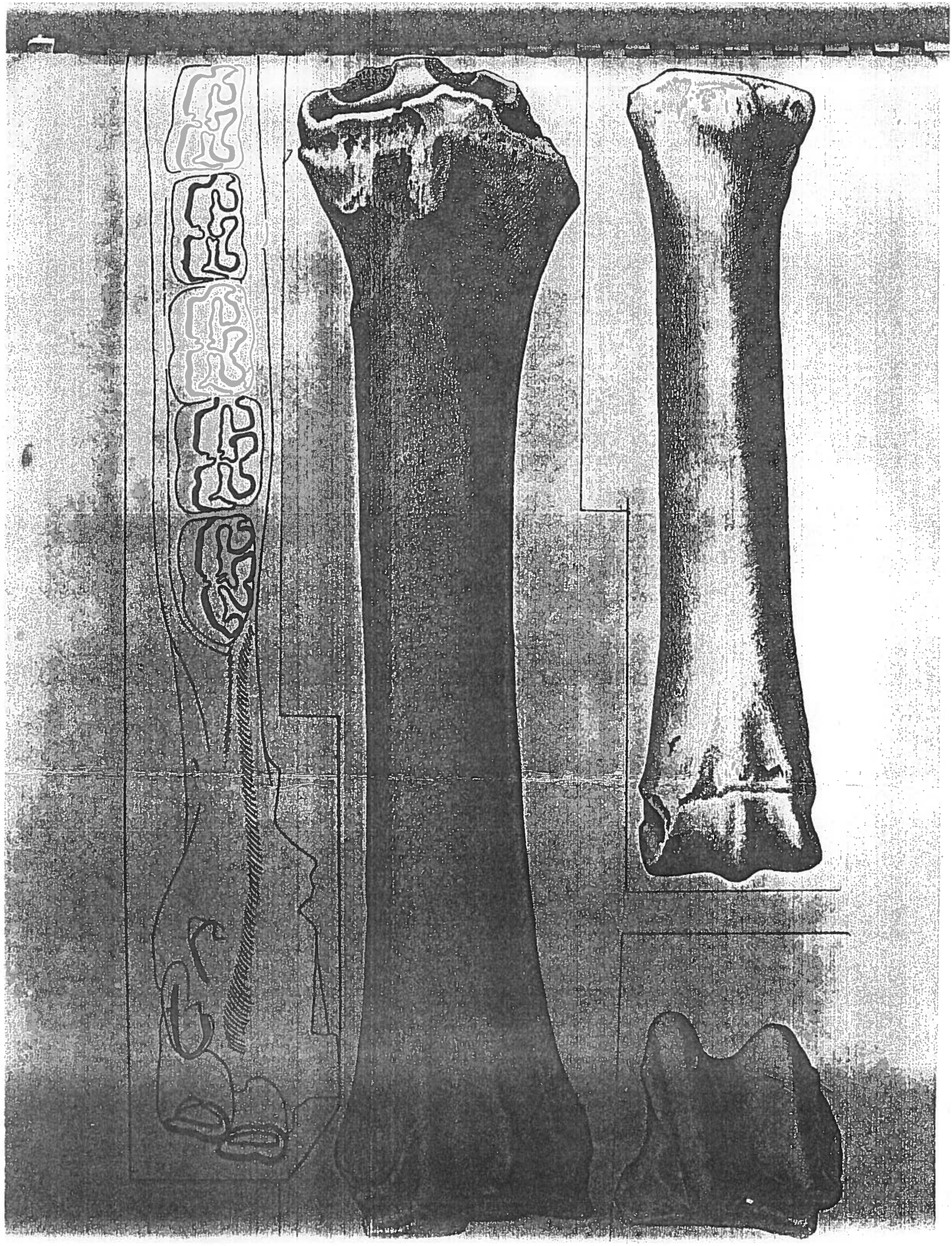

PLATE VII

All figures natural size