CHALICOTHERES FROM MONGOLIA AND CHINA IN THE AMERICAN MUSEUM

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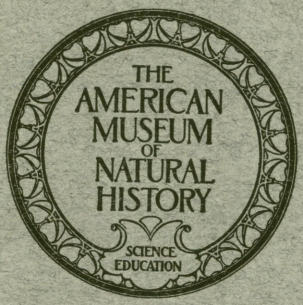
BULLETIN
OF
THE AMERICAN MUSEUM OF NATURAL HISTORY

VOLUME LXVII, 1934
ARTICLE VIII



NEW YORK
November 7, 1934

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Article VIII—CHALICOTHERES FROM MONGOLIA AND CHINA IN THE AMERICAN MUSEUM[1]

By Edwin H. Colbert

15 Text Figures

The Central Asiatic Expeditions of The American Museum of Natural History, during the course of several seasons of collecting in the Gobi Desert and in northern China, succeeded in gathering together a small but nevertheless an excellent series of fossils, representative of the Chalicotherioidea. The specimens comprising this collection were found in various geologic horizons, ranging from the upper Eocene to the lower Pleistocene, and naturally they represent several genera showing progressive stages in evolutionary development.

It was discovered, during the course of some studies on the chalicotheres from the Siwaliks of India, that to get a clear picture of the relationships of the Indian forms some attention must needs be given to the various chalicotheres found in other portions of the world, and this logically led to an investigation of the new material collected by the Asiatic Expeditions in Mongolia and North China. The author wishes to express his indebtedness to Dr. Walter Granger, Chief Palaeontologist of the Central Asiatic Expeditions, for permission to study and describe these Asiatic chalicotheres. The illustrations in this paper were made by Louise Waller Germann.

A CLASSIFICATION OF THE CHALICOTHERIOIDEA

A brief classification of the chalicotheres is included at this point, in order that the reader may keep in mind the general relationships of the Asiatic genera, to be described in the following pages. This classification is new, although it follows in its essential form the 1929 classification of Matthew[2] and the 1932 classification of Koenigswald.[3] The bases for this present classification will not be presented in the following pages, but will appear in a subsequent paper, which will consider in some detail the taxonomy and phylogeny of the Chalicotherioidea.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 129.

[2]Matthew, W. D. 1929. 'Critical Observations upon Siwalik Mammals.' Bull. Amer. Mus. Nat. Hist., LVI, pp. 519–520.

[3]Koenigswald, G. H. R. von. 1932. 'Metaschizotherium fraasi N.G. N. Sp., ein Neuer Chalicotheriide aus dem Obermiocän von Steinheim A. Albuch.' Palaeontographica, Supp. Band VIII, Teil VIII, p. 22.

Order **PERISSODACTYLA**

Superfamily **CHALICOTHERIOIDEA**

Family **CHALICOTHERIIDAE**

Aberrant perissodactyls with bunoselenodont cheek teeth and, in the advanced forms, clawed feet. Upper molars with W-shaped ectoloph and with hypocone joined to metacone by metaloph. Lower molars doubly crescentic, with separate metastylid.

Subfamily **EOMOROPINAE**

Primitive chalicotheres of small size. Quadrate, brachyodont upper molars; third lower molar with a talonid. Canines and first upper premolar present; incisor formula variable. Manus tetradactyl, pes tridactyl. Metapodials and phalanges not highly modified as in the later chalicotheres. Tail long.

Genera	**EOMOROPUS**	North America, North China
	GRANGERIA	North China, Mongolia

Subfamily **CHALICOTHERIINAE**

Advanced chalicotheres of medium to large size. Canines and first upper premolar absent. Third lower molar without talonid. Manus and pes highly modified.

Tribe **CHALICOTHERINI**

Advanced genera of medium to very large size. Quadrate, brachyodont upper molars. Manus and fore limb much longer than pes and hind limb. Trapezium wanting; astragalus with cuboid facet.

Genera	**MACROTHERIUM**	Europe, India, Mongolia, North America
	CHALICOTHERIUM	Europe
	CIRCOTHERIUM	India, China

Tribe **SCHIZOTHERINI**

Advanced genera of medium to large size. Elongated, relatively hypsodont upper molars. Manus and fore limb longer than pes and hind limb, but the disparity is not so great as in the Chalicotherini. Trapezium present; astragalus lacking cuboid facet.

Genera	**SCHIZOTHERIUM**	Europe, India, China, Mongolia
	METASCHIZOTHERIUM	Europe
	MOROPUS	North America
	PHYLOTILLON	Baluchistan

NESTORITHERIUM	Europe, Samos Island
POSTSCHIZOTHERIUM	China

Of uncertain position:

PERNATHERIUM	Europe

Geologic and Geographic Range of Chinese and Mongolian Chalicotheres

China	Mongolia
Pleistocene *Circotherium sinense* (Owen) *Postschizotherium chardini* von Koenigswald	
	Upper Miocene, Tung Gur formation *Macrotherium brevirostris*, new species *Macrotherium* sp.
?Oligocene (or Upper Eocene) *Grangeria canina* Zdansky	Oligocene, Ardyn Obo formation *Schizotherium avitum* Matthew and Granger *Schizotherium* sp.
Upper Eocene *Eomoropus major* Zdansky *Eomoropus minimus* Zdansky *Eomoropus quadridentatus* Zdansky	Upper Eocene, Irdin Manha formation *Grangeria gobiensis*, new species

SYSTEMATIC DESCRIPTIONS

GRANGERIA Zdansky, 1930

GENERIC TYPE.—*Grangeria canina* Zdansky, from the Oligocene (?) of Shantung, China.

Grangeria gobiensis, new species

TYPE.—Amer. Mus. No. 26645. A crushed skull and a mandible. Although the mandible was not actually found with the skull, the two came from a quarry and were deposited only a few feet apart. Furthermore, the perfect occlusion between the upper and lower dentitions, and in addition the identical wear on both sets of teeth, above and below, make it an almost absolute certainty that these two specimens represent one individual. These specimens are chosen as the type because of the completeness of the skull.

PARATYPES.—

Amer. Mus. No. 26644. A crushed skull and mandible, associated.

Amer. Mus. No. 26646. A crushed skull and mandible, associated. An aged individual, as shown by the extreme wear of the cheek teeth.

Amer. Mus. No. 26647. A crushed skull, and a mandible doubtfully associated with it. This mandible is the most perfect one in the collection.

Amer. Mus. No. 26648. Palate of a juvenile animal, with milk dentition, permanent molars erupting.

Amer. Mus. No. 26649. Crushed mandible with canines and cheek teeth.

Amer. Mus. No. 26653. A number of jaws in matrix, and associated broken teeth.

Amer. Mus. No. 26654. Portion of a left fore foot, with metacarpals II–V, a proximal phalanx, trapezoid and sesamoids.

Amer. Mus. No. 26655. Portion of a left hind foot, with metatarsals II–IV, ectocuneiform, mesocuneiform and a phalanx.

Amer. Mus. No. 26656. Right tarsus, with calcaneum, astragalus, navicular and entocuneiform.

Amer. Mus. No. 26657. Portion of a carpus.

Amer. Mus. No. 26658. Left metacarpals III–V, with five associated phalanges.

Amer. Mus. No. 26659. Various caudal vertebrae.

Miscellaneous carpal and tarsal bones and isolated phalanges.

HORIZON AND LOCALITY.—All of the specimens listed above came from the Irdin Manha formation, of upper Eocene age. They were found in a small quarry, near Camp Margetts, twenty-five miles southwest of Iren Dabasu, Inner Mongolia. Collected in September, 1930.

DIAGNOSIS.—

1. An Eocene chalicothere, about one-fifth greater in size than *Eomoropus amarorum*, and slightly smaller than *Grangeria canina*.

2. Dentition $\frac{2(?)-1-4-3}{1(?)-1-3-3}$.

3. First upper premolar separated by a diastema from the canine and from the second premolar. There are also diastemata between the upper incisors and the canine, and between the lower canine and the second lower premolar. The lower canine is more or less in series with the lower incisors, but it retains its caniniform shape and function.

4. Third and fourth upper premolars with two outer cusps, placed close together, and one inner cusp, and with transverse lophs. Third and fourth lower premolars with a high trigonid, composed of two transversely placed cusps connected by a cross loph, and with a low talonid consisting of a single crescent.

5. Upper molars quadrate and brachyodont. Protoloph and metaloph well developed, connecting the protocone-paracone and the hypocone-metacone respectively. The protoconule is large, as is the parastyle. The mesostyle is reduced, a distinctive character. Cingula are well developed. The lower molars are doubly crescentic; the metastylid is prominent. There is a well developed third lobe on the third lower molar.

6. Skull long and comparatively low. Maxilla fairly deep, and nasal opening not retracted. Preorbital portion of skull long. Basicranial foramina show the typical chalicotherine arrangement. Orbit open behind. Sagittal crest well developed.

7. Mandible long and slender, with a high coronoid and a well developed angle.

8. Manus tetradactyl. Trapezium present. Metacarpals and phalanges not modified as in the later chalicotheres.

9. Pes tridactyl. Astragalus articulating with the navicular only. Entocuneiform present.

10. Caudal vertebrae long and slender, indicating a long tail.

DISCUSSION

The various skulls, jaws, feet and miscellaneous portions of *Grangeria gobiensis* in the American Museum collection furnish us with fairly complete knowledge as to the structure and the affinities of this new species. All of the specimens are badly crushed, but since they are more or less supplementary to each other, they afford us when considered together, a rather clear picture of the anatomical characters that distinguish this new form.

The Skull

The skull of *Grangeria gobiensis* is, on the whole, not specialized along the lines characteristic of the later chalicotheres; that is to say, it shows the many primitive features of an Eocene perissodactyl. It is long and relatively low, and the preorbital and postorbital portions of the skull are approximately subequal in length. The maxilla has only begun to develop vertically in the manner so characteristic of the later genera of chalicotheres, and as a corollary to the primitive condition of the maxilla, the nasals are quite unretracted. The orbit is open behind.

The brain case is comparatively small, as would be expected, and in conjunction with this feature the sagittal and lambdoidal crests are high and sharp, thereby giving sufficient areas for the attachments of the muscles of mastication. It would appear as if the occiput overhangs the condyles to some extent, although the extreme crushing which all of the specimens under consideration have undergone, makes this point rather difficult to determine with accuracy.

The glenoids are shaped much as in *Eomoropus amarorum*, and they foreshadow the development in the later chalicotheres, namely, by extending forward somewhat on the zygomatic arches. The postglenoid process is heavy, again an evolutionary trend towards the later chalicotherine condition. The occipital condyles are rather small and rounded. The basioccipital and basisphenoid are rather flat, instead of having a sharp median keel. It would appear as if the bullae were of medium size.

The badly crushed condition of all the skulls in the American Museum collection makes the determination of the arrangement of basicranial foramina in this species a difficult problem. We can be sure, however, that there was an alisphenoid canal, and that the foramen ovale opened somewhat behind it, as in *Eomoropus*. On the basis of this re-

semblance, and considering the generic relationships existing between *Grangeria* and *Eomoropus*, it seems quite reasonable to suppose that the other basicranial foramina in *Grangeria gobiensis* were quite similar to those of *Eomoropus amarorum*.

The Mandible

The mandible of *Grangeria gobiensis* is long and the horizontal ramus is relatively slender. The ascending ramus is wide, and the angle is large and rounded, projecting below the lower border of the horizontal ramus. The coronoid extends to a considerable degree above the condyle which latter element is not raised to any great extent above the occlusal line of the cheek teeth.

One of the paratypes, Amer. Mus. No. 26646, shows that the mandibular symphysis is long and slender, extending back almost to the second lower premolar.

The Upper Dentition

The type skull, Amer. Mus. No. 26645, shows the root of one lateral incisor tooth. Judging from this root, the tooth was evidently of rather large size, and it was located near the canine. There are no evidences of a tooth having been between it and the canine. Median to the above described incisor root, there is, in the type specimen, a vertical concavity in the premaxilla, which has all the appearance of being the remnants of another incisor alveolus. Thus it would seem as if there were two incisors in the premaxilla in this species. The type, the only specimen showing the premaxilla to advantage, is too badly broken to offer definite proof about a third upper incisor medial to the broken alveolus (i.e., a morphological median incisor), but from the close approximation of the broken alveolus to what is seemingly the symphyseal border, it would appear as if only two upper incisors were present in this species.

There is a diastema between the outer incisor and the canine. This latter tooth is quite large, elliptical in cross section, and pointed. It is separated by a diastema from the first premolar, which latter is a two-rooted tooth having a single-cusped crown. The first premolar is in turn separated from the remaining cheek teeth by a diastema.

The second premolar consists of two closely appressed outer cusps and a single postero-internal inner cusp. The third and fourth premolars are essentially accentuations of the preceding tooth. In these teeth the two outer cusps are more separate from each other, and they are joined to the inner cusp by transverse lophs. In addition there is a well developed anterior parastyle and anterior and posterior cingula.

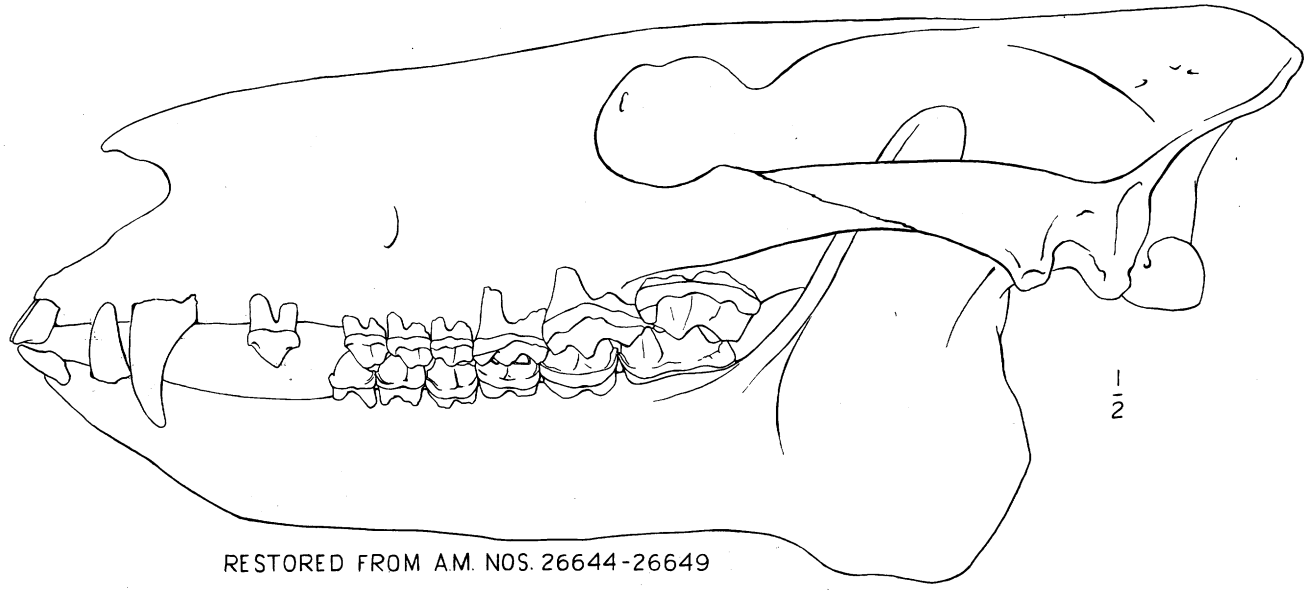

Fig. 1. *Grangeria gobiensis*, new species. Skull and mandible, as restored from several specimens, Amer. Mus. Nos. 26644-26649. Lateral view, one-half natural size.

The molars are quadrate and brachyodont. In these teeth the protocone and the paracone are joined by a protoloph, on which there is a well defined protoconule, and the metacone and hypocone are connected by a metaloph. There is a very large parastyle and a prominent anterior cingulum, but the mesostyle is greatly reduced on the first two molars, so that it is almost negligible. In this latter character *Grangeria gobiensis* is in marked contrast to the other chalicotheres, in which the mesostyle is well developed.

The Lower Dentition

Turning now to the lower dentition, we see that in one of the paratypes, Amer. Mus. No. 26647, there are but two incisors, one on either side. This specimen is the only mandible in the collection showing the incisors, and unfortunately we can not be quite sure whether or not there were more incisors originally present. It might be well to say, however, that a very careful search was made on the specimen being considered for further evidences of lower incisors. The bone of the symphyseal region was carefully removed from the area between the incisors and the canines in an attempt to determine if the germs of other teeth might be present. No signs of any other incisors were discovered, and from the lack of room in this jaw for any other incisor teeth besides those actually existent, it would seem very likely that the incisor formula was actually reduced to one on either side.

The two incisor teeth are separated from each other and from the canines, by very small diastemata, so it would be logical to assume that they are possibly the right and left second incisors. One would hardly expect such a reduction in the incisor formula in an Eocene form like this, particularly in view of the fact that *Eomoropus amarorum*, which is on the whole very close to *Grangeria*, possesses a full complement of lower incisor teeth. Continuing with our description of the lower incisors of *Grangeria*, it may be pointed out that these teeth are flattened, or rather "cupped" on top, and they are broadly spatulate.

The canines, which are fairly large and elliptical in cross section, are very close to the incisors, as is the case in *Eomoropus*.

A diastema separates the canine from the second premolar (the first tooth of the grinding series). This second premolar, which is doubly rooted, consists of a high cusp and behind it a low trenchant heel. The third premolar is made up of a high forward portion, consisting of two transversely placed cusps, and an incipiently crescentic talonid. The last premolar has almost attained a molariform condition. It is composed

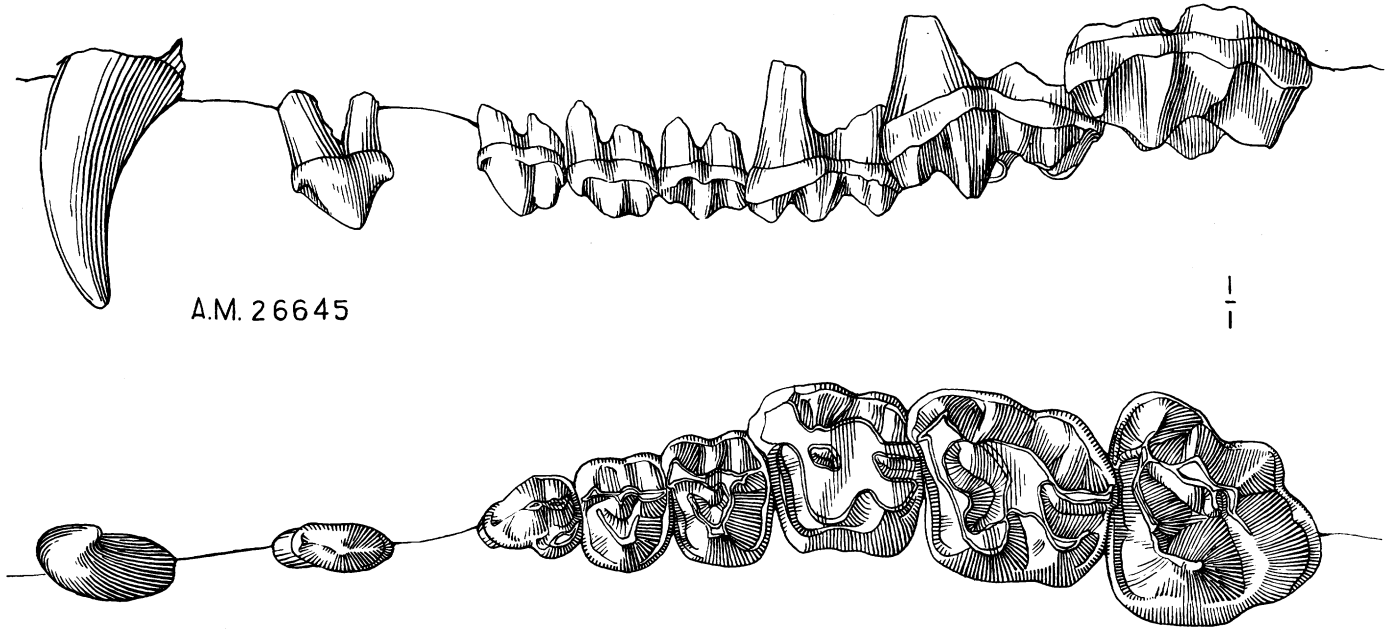

Fig. 2. *Grangeria gobiensis*, new species. Type, Amer. Mus. No. 26645. Upper dentition, left side. Lateral view above, crown view below. Natural size.

of two crescents, which are elevated at their junction in two cusps comparable to the metaconid and the metastylid.

The molars are doubly crescentic, and they are distinguished by the typical chalicotherine separate metastylid. The metastylid is not as prominent as in *Eomoropus amarorum*. There is a broad heel to the third molar which is relatively longer and wider than the similar element in *Eomoropus amarorum*.

Juvenile Dentition

The palate of an immature animal with the milk dentition in place (Amer. Mus. No. 26648) illustrates the characters of the upper deciduous teeth. The first milk molar is a single-cusped tooth of simple form. The second milk molar is somewhat more complex, consisting of a dominant

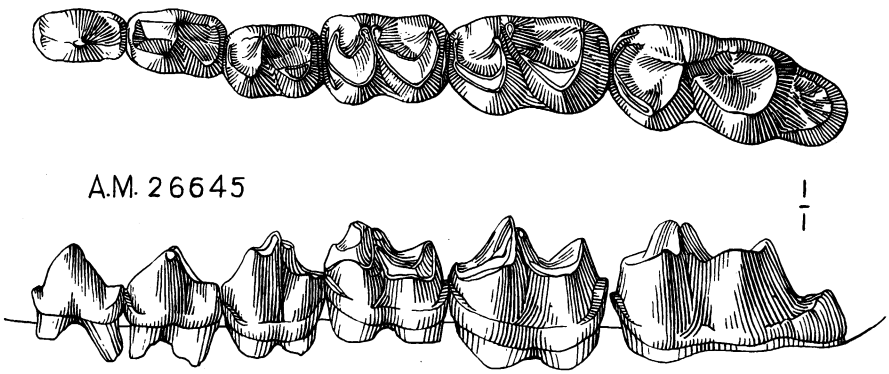

Fig. 3. *Grangeria gobiensis*, new species. Type, Amer. Mus. No. 26645. Lower dentition, left side. Crown view above, lateral view below. Natural size.

outer cusp and an anterior and a posterior cross loph running to the inside of the tooth. The third and fourth milk molars simulate the true molars, each having two transverse lophs and outer and inner cusps. Naturally these teeth are much smaller than the permanent molars.

In this specimen the first permanent molar is fully erupted, the second molar is fully formed and in the alveolus, and the canines are beginning to protrude.

Remarks

Reviewing the dentition of this species with regard to the relation of the upper teeth to the lower, it at once becomes apparent that an anomalous condition exists in that there are two upper incisors on either side opposed to one lower incisor. In *Eomoropus*, the genus most closely

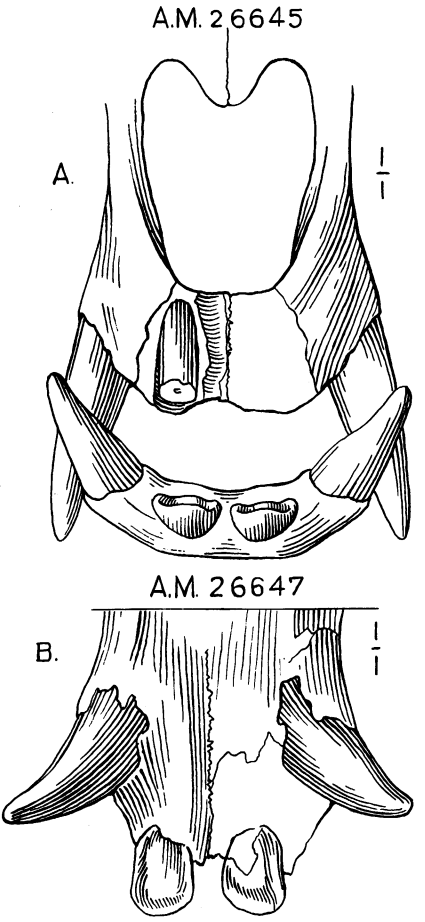

Fig. 4. *Grangeria gobiensis*, new species.

A. Anterior portion of skull and mandible, as restored from Amer. Mus. Nos. 26645, 26647. Front view, showing incisors and canine teeth. The premaxilla, near its symphysis, shows a concave area, as if for the reception of a root of an incisor. Lateral to this is the root of another incisor. The mandibular symphysis shows but one incisor on each side.

B. Anterior portion of mandible, Amer. Mus. No. 26647, showing incisors and canine teeth. Viewed from above.

Both figures natural size.

related to *Grangeria*, there is a full set of incisors, at least in the mandible. In *Moropus* there are seemingly no upper incisors, although the lower ones are present in their full number. *Macrotherium* and *Circotherium*, advanced Eurasiatic genera, would seem to be without upper incisors.

Thus it appears that the chalicotheres are typified by the diversity in the incisor development in the different genera. In this, they show their affinities to the titanotheres, which group is also characterized by a certain amount of diversity in incisor development.

The remarkable thing about *Grangeria* is the fact that it would seem to have more incisors in the premaxilla than in the mandible. Now the general rule among the ungulate mammals is that the lower incisors are more numerous than the upper incisors, if there is a differential reduction in the two series. Consequently, the seemingly more numerous incisors in the premaxilla than in the mandible in the species under consideration, offers us an example of aberrant development that is quite unusual among the perissodactyls.

Measurements

No attempt has been made to take measurements on the skulls of *Grangeria gobiensis* in the American Museum collection, since they are all badly deformed by crushing. Any measurements would be decidedly misleading. The reader is referred to the accompanying figure (Fig. 1) of the restored skull and mandible, for information as to the general configuration of these parts.

The Feet

As to the structure of the feet, *Grangeria gobiensis* demonstrates striking similarities to *Eomoropus amarorum* and to other primitive perissodactyls. There are, however, certain important differences to be seen, and these will be outlined below.

Manus

Like *Eomoropus amarorum*, *Grangeria gobiensis* is characterized by the presence of four toes in the manus. The manus is wider in the species under discussion than it is in *Eomoropus*, an adaptation for the support of weight, since *Grangeria* is an animal considerably larger than *Eomoropus*. This same increase in the relative width of the foot naturally holds for the pes of *Grangeria*. The carpal bones of *Grangeria* are, in the main, like those of *Eomoropus*, which in turn are typical of the primitive perissodactyl condition, a fact brought out by Osborn as follows:

"The *carpus* is absolutely typical of that of the primitive Eocene Perissodactyla, namely, magnum small, scaphocentrale entirely covering magnum, lunar resting entirely on unciform, prominent posterior process of magnum."[1]

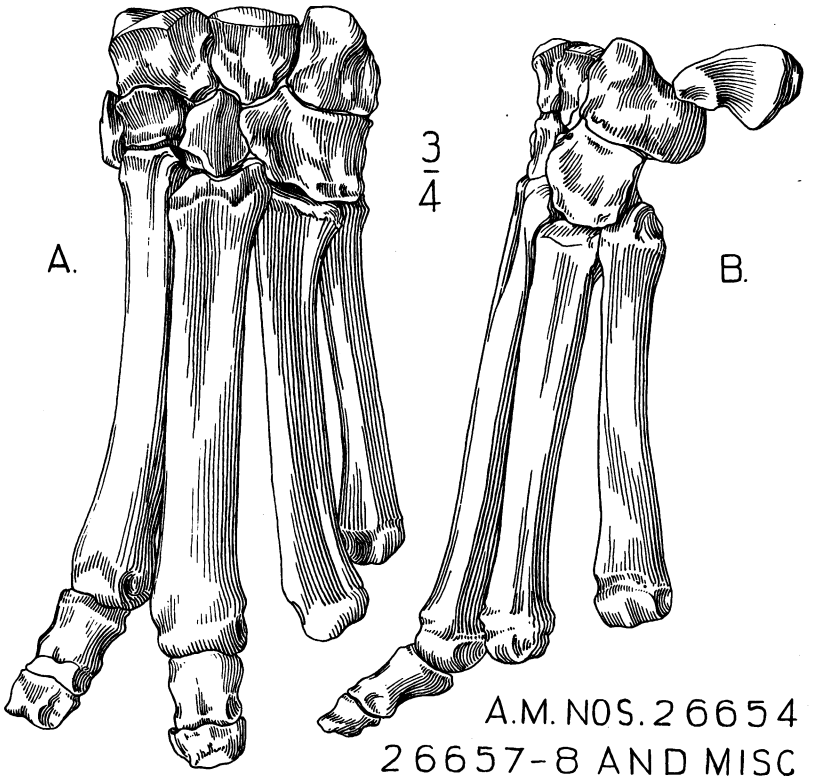

Fig. 5. *Grangeria gobiensis*, new species. Left manus, composite, as drawn from Amer. Mus. Nos. 26654, 26657–8, and miscellaneous bones.
A. Front view. B. External lateral view. Three-fourths natural size.

Grangeria shows an advance over *Eomoropus* in that the magnum articulates with both the scaphoid and the lunar bones. And conversely, the lunar rests partly on the unciform and partly on the magnum. This is a change of relationships quite definitely in the direction of the more advanced chalicotheres, such as *Moropus* or *Macrotherium*, and it is occasioned not so much by a shift in the position of the magnum as by a

[1]Osborn, H. F. 1913. '*Eomoropus*, an American Eocene Chalicothere.' Bull. Amer. Mus. Nat. Hist., XXXII, pp. 269–270.

Upper Dentition

	Grangeria gobiensis			*Grangeria canina*	*Eomoropus quadridentatus*	*Eomoropus annectens*	*Eomoropus amarorum*
	A.M. 26645	A.M. 26644	A.M. 26647	Zdansky pp. 68–69	Zdansky pp. 63–64	Peterson p. 140	A.M. 5096
C length	14 mm.	12 mm.	11 mm.				
width	9	7	9				
P^1 length	12.5	11.5	10.5	13 mm.	6.5 mm.		
width	6.5	5.5	5.5	7			
P^2 length	11.5	11	11.5	18.5	8.9	10 mm.	
width	11	10	11	13	8.9	9.5	
P^3 length	12	12	12	13.5		11	
width	15	15.5	14	17		12.5	
P^4 length	13	12	11	14	10.8	10	
width	17.5	16	16.5	20	12.3	13	
M^1 length	19	20	15.5		14.5	14	
width	21	20	19.5		14.5	13.5	
M^2 length	25	20.5	21.5		17	17.5	
width	25	24	24.5		17.8	18	
M^3 length	27	25			15.1	17.5	20 mm.
width	30	29			19.2	19.8	
P^{2-4}	36	38	31	46		31	
M^{1-3}	71	65	63	64		49	
Ratio: $\frac{P \text{ length}}{M \text{ length}}$	51	58	49	72		63	

	Grangeria gobiensis A.M. 26648
DM^1 length	10 mm.
width	
DM^2 length	9
width	8.5
DM^3 length	11
width	10.5
DM^4 length	13
width	15

Lower Dentition

	Grangeria gobiensis				*Grangeria canina*	*Eomoropus quadridentatus*	*Eomoropus amarorum*
	A.M. 26645	A.M. 26644	A.M. 26647	A.M. 26649	Zdansky pp. 70–71	Zdansky pp. 64–65	A.M. 5096
C length			9.5 mm.		22 mm.		10 mm.
width			9		18		7.5
P_2 length	12.5 mm.		12.5	12 mm.	13.3	8.8 mm.	10.5
width	6		7	6.5	8	4.6	6.5
P_3 length	13	13.5 mm.	12	12	13.5	12	11
width	9	9	8	8.5	8.5	6.3	9
P_4 length	12	13.5	12.5	13	15	10.9	11
width	19	10	10	10	11.4	7.1	9
M_1 length	17	18	17	18	18	13.5	14
width	11	11.5	12	11	12	8.1	9
M_2 length	20	21	21	22	22.8	14.5	16
width	13	12.5	13	13	14.5	9.3	10
M_3 length	30	29.5	26		30	19.7	23
width	13.5	13.5	13.5			9.4	11
P_{2-4}	37.5		38	37	42	31.7	32.5
M_{1-3}	67	69	64		70	47.7	53
Ratio: $\frac{P \text{ length}}{M \text{ length}}$	56		59		60	67	61

relative increase in the size of this element. The posterior process of the magnum, which is so prominent in *Eomoropus*, is broken off in the specimen under consideration, so one can not be certain of its size. From the appearance of the break it would seem as if this process might have been somewhat smaller in *Grangeria* than in *Eomoropus*.

The metacarpals are long, slender and straight, the fifth metacarpal being slightly reduced in size as compared to the others. Distally the metacarpals show the typical chalicotherine "ball and ridge" type of articular surface. That is to say, the phalangeal articular surface of each metacarpal is strongly convex and without a median keel, whereas the posterior sesamoidal face is but slightly convex and is divided by a prominent median keel. This development of the distal articular surfaces of the metacarpals is typical of the chalicotheres, and it is quite distinct from the other perissodactyls.

"Whereas in other Perissodactyla the sesamoidal and phalangeal facets are continuous and evenly convex, in *Moropus* and *Eomoropus* these faces are more separate. This particular duplex-facetted structure of the distal ends of the metacarpals is undoubtedly correlated with the clawed, cleft ungues and fossorial function of the phalanges."[1]

The phalanges of *Grangeria gobiensis* are short and of a primitive kind, as would be expected in an early form. The articular surfaces are almost at right angles to the median axis of the phalanges—a primitive character in the chalicotheres. The distal articular surfaces are not deeply grooved as in the more advanced genera.

Unfortunately no ungual phalanges were found, so the question as to whether or not they were cleft, must for the present remain unanswered.

Pes

The hind foot has three toes, as in *Eomoropus amarorum*. The tarsus, although like that of *Eomoropus* in its general structure, is especially interesting in that it is relatively wider in the form under consideration, a fact mentioned in the description of the manus. The tarsal bones are, on the whole, like those of *Eomoropus*, and they approximate the condition of a primitive perissodactyl. Osborn described the pes of *Eomoropus* as follows:

"The *tarsus* also resembles that of the primitive Perissodactyla very closely; in proportions it is vertically elongate and laterally compressed. A very distinctive chalicotheroid feature is that the navicular joins the calcaneum and widely separates the astragalus from the cuboid, whereas

[1]Osborn, H. F. 1913. Op. cit., p. 269.

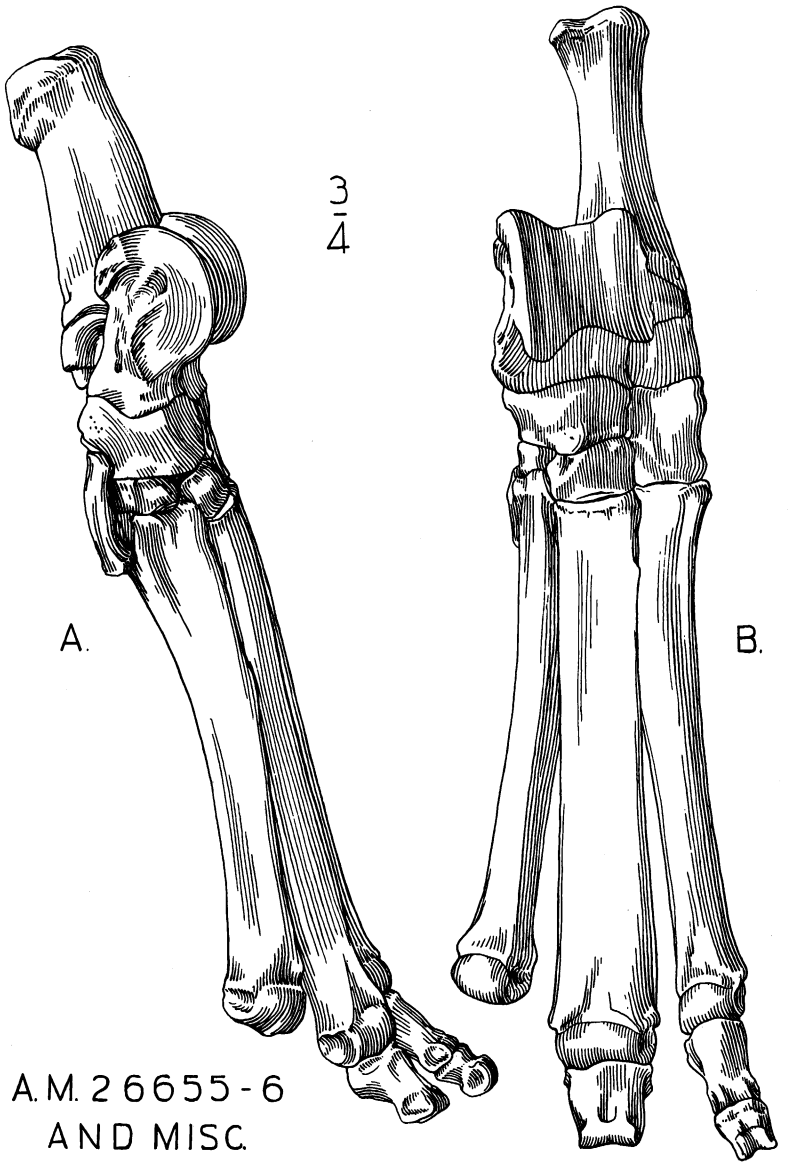

Fig. 6.—*Grangeria gobiensis*, new species. Left pes, composite, as drawn from Amer. Mus. Nos. 26655–6, and miscellaneous bones.

A. Internal lateral view. B. Front view. Three-fourths natural size.

in typical Perissodactyla the astragalus more or less broadly unites with the cuboid. Primitive features are the large quadrate ectocuneiform, the small abbreviate mesocuneiform, and the enlarged entocuneiform, which entirely lacks the facet for Mts. I. The metatarsals are compressed and apparently isotridactyl."[1]

In the above analysis, Osborn erred in supposing that the separation of the astragalus and the cuboid distinguishes all of the chalicotheres. In fact, the two groups of advanced chalicotheres, namely, the Schizotherini and the Chalicotherini, are partly distinguished from each other by the astragalus-cuboid relationship. In the Schizotherini the astragalus is definitely excluded from articulation with the cuboid, but in the Chalicotherini there is a cuboid facet on the astragalus.

Now it is an interesting fact that in *Grangeria* a small but nevertheless distinct cuboid facet occupies the postero-internal surface of the astragalus, whereas in *Eomoropus* the astragalus and the cuboid do not articulate with each other. Thus it would seem as if *Grangeria* is showing tendencies toward the Macrotherini group of chalicotheres—at least with regard to this particular anatomical feature.

The astragalar trochlea is broad and relatively shallow, as compared to the trochlea in *Eomoropus*. This is an adaptation to greater size and weight in *Grangeria*, as pointed out above.

The cuboid of *Grangeria* is broken, so it is not possible to be certain about the presence of a posterior process in this bone. Probably one was present, as is the case in *Eomoropus*. As in *Eomoropus* the ectocuneiform is large and quadrate and the mesocuneiform is quadrate but smaller. A bone associated with the *Grangeria* foot bones has been identified as an entocuneiform. This element is long and somewhat curved, with a concave articular surface at one end and a convex articulation at the other. There is a facet on the navicular, to which the concave articulation of the supposed entocuneiform fits rather nicely. When the entocuneiform is so placed, its convex articulation points down and fits a depression in the postero-internal surface of the proximal end of the second metatarsal.

It might be well at this point to say that in the figure of *Eomoropus amarorum*, the entocuneiform is seemingly placed in a reversed position. This bone actually articulates in the manner outlined above for the similar element of *Grangeria*. This relationship of the entocuneiform in *Eomoropus* and *Grangeria* was corroborated by a direct comparison, made under the supervision of Mr. H. A. Raven of the American Museum, with a dissection of the foot of a modern tapir.[2]

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[1]Osborn, H. F. 1913. Op. cit., p. 270.
[2]Osborn, H. F. Op. cit., p. 269, fig. 4.

The metatarsals of *Grangeria* are long and straight, as are the metacarpals, but in the pes these bones are slightly longer than the corresponding bones in the manus. This is an illustration of the primitive nature of *Grangeria*. It will be remembered that in the more advanced chalicotheres the manus becomes long and the pes short, as a corollary to the peculiar limb structure and the posture of these animals. The phalanges are like those of the fore foot. No ungual phalanges are known.

MEASUREMENTS

	Eomoropus amarorum A.M. 5096	*Grangeria gobiensis* A.M. 26654–26658
Length of Mc III	72 mm.	100 mm.
Width of astragalus (trochlea)	18	24
Greatest length of calcaneum	58	67
Length of Mt. III		103

CAUDAL VERTEBRAE

A number of caudal vertebrae were found in the same small quarry with the other remains of *Grangeria gobiensis*, and there is no reason for doubting the validity of their association with this species. They indicate that *Grangeria* had a very long tail, which of course might be expected in an Eocene ungulate.

SCHIZOTHERIUM Gervais, 1876

GENERIC TYPE.—*Schizotherium priscum* (Gaudry), from the Phosphorites of Quercy, Oligocene, of France.

Schizotherium avitum Matthew and Granger

Schizotherium avitum, MATTHEW AND GRANGER, 1923. Amer. Mus. Novitates, No. 98, pp. 3, 4, fig. 2.

ADDITIONAL REFERENCES.—

MATTHEW, W. D., AND GRANGER, WALTER. 1925. Amer. Mus. Novitates, No. 195, pp. 1, 2, figs. 1, 2.

MATTHEW, W. D. 1929. Bull. Amer. Mus. Nat. Hist., LVI, p. 519.

KOENIGSWALD, G. H. R. VON. 1932. Palaeontographica, Supp. Band VIII, Teil VIII, p. 22.

TYPE.—Amer. Mus. No. 19157, a right M_3.

REFERRED SPECIMEN.—Amer. Mus. No. 20384, a fragmentary mandibular ramus.

HORIZON AND LOCALITY.—Ardyn Obo formation, Oligocene of Mongolia. From Ardyn Obo, Sair Usu-Kalgan Trail, about 150 miles from Sair Usu and 350 miles from Kalgan. Outer Mongolia. Expeditions of 1922 and 1923.

TYPE DESCRIPTION.—"Size a little less than that of *S. priscum* (*-modicum*) of the Phosphorites; heel of M_3 narrow and more reduced, lacking the transverse cingular

crest on each side of it that characterizes *S. priscum*. Trigonid and talonid of subequal width, while in *S. priscum* the trigonid is wider than the talonid; length of tooth more than twice the width; in *S. priscum* it is somewhat less."[1]

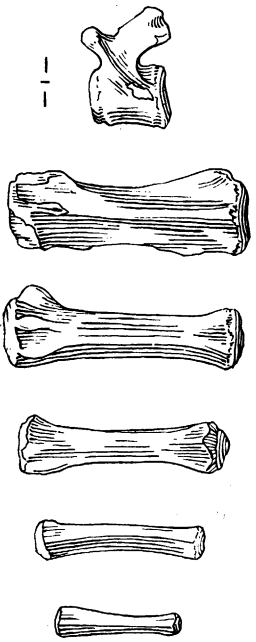

Fig. 7

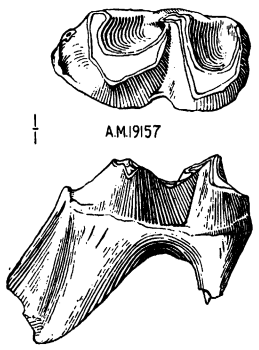

Fig. 8

Fig. 7. *Grangeria gobiensis*, new species. Amer. Mus. No. 26659. Caudal vertebrae. Natural size.

Fig. 8. *Schizotherium avitum* Matthew and Granger. Type, Amer. Mus. No. 19157. Third lower molar. Crown view above, external view below. Natural size. After Matthew and Granger.

Measurements

Schizotherium avitum, Amer. Mus. No. 19157. (Matthew, W. D., and Granger, Walter. 1923.) Amer. Mus. Novitates, No. 98, p. 4.

Length, of total, m_3	25.3 mm.
Length of heel (hypoconulid)	2.2
Width of trigonid	11.9
Width of talonid	12.1
Width of heel (hypoconulid)	4.0
Index, length to trigonid width	2.13:1

[1]Matthew, W. D., and Granger, Walter. 1923.

SCHIZOTHERIUM sp.

?Schizotherium species, MATTHEW, W. D., AND GRANGER, WALTER. 1925. Amer. Mus. Novitates, No. 195, p. 2, fig. 3.

SPECIMEN.—Amer. Mus. No. 20385, a fragment of a lower jaw with left DP_3 (?).

HORIZON AND LOCALITY.—From the Ardyn Obo formation, Oligocene of Mongolia. Ardyn Obo, Sair Usu-Kalgan Trail. Outer Mongolia. Expedition of 1923.

"The tooth has the construction of the *Schizotherium* molar, with a small transversed hypoconulid heel, not unlike the m_3 of *S. modicum;* but it is considerably smaller than the molars of *S. modicum* and *S.*

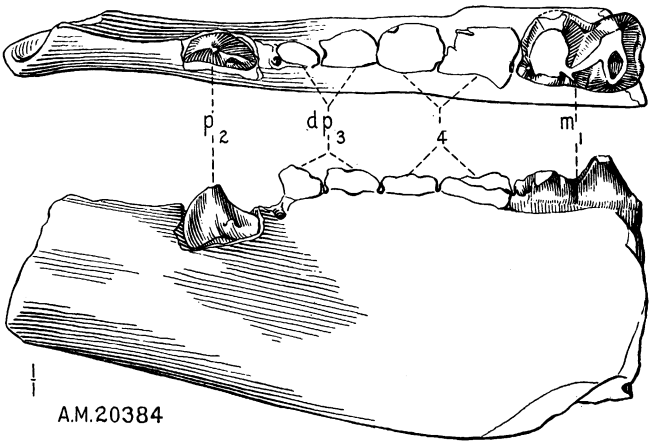

Fig. 9. *Schizotherium avitum* Matthew and Granger. Referred specimen, Amer. Mus. No. 20384. Part of immature lower jaw. Crown view above, internal view below. Natural size. After Matthew and Granger.

avitum, and the alveoli behind it indicate a considerably larger tooth. If a permanent tooth, it would necessarily be m_1, and the proportions of m_1 to m_2 would differ considerably from those of the known species."[1]

SCHIZOTHERIUM sp.

SPECIMEN.—Amer. Mus. No. 26188, a right third metacarpal.

HORIZON AND LOCALITY.—Presumably from the Baron Sog formation, of Lower Oligocene age. The specimen was found at Nom Khong Obo, Holy Mesa, in the Shara Murun region of Inner Mongolia. Expedition of 1928.

DESCRIPTION.—A long, straight and slender metacarpal. The proximal end is occupied by four articulating facets, an inner one for the magnum and the second metacarpal, an inner one for the unciform, and two intero-ventral facets for the fourth metacarpal. The distal articulating surface shows the typical chalicothere ball and

[1]Matthew, W. D., and Granger, Walter. 1925.

median ridge. There are two large protuberances on the front side of the bone, just above the distal articulation.

This specimen is too large and specialized to represent any of the Eomoropinae. It is too long and slender to be from any of the Chalicotherini. From its occurrence and size it is here allotted provisionally to the genus *Schizotherium*. The reader is referred to the accompanying figure.

MEASUREMENTS

Amer. Mus. No. 26188, right Mc.III.

Greatest length	145	mm.
Width of proximal end	25.5	
Width of distal end	32.5	

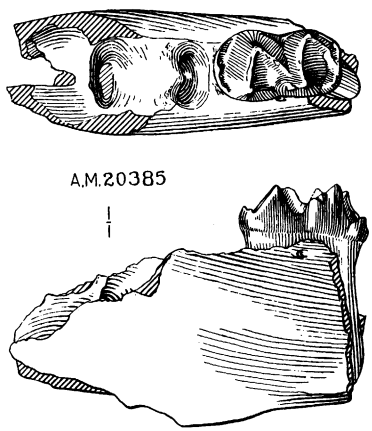

Fig. 10. *Schizotherium* sp. Amer. Mus. No. 20385. Fragment of lower jaw with tooth. Crown view above, internal view below. Natural size. After Matthew and Granger.

MACROTHERIUM Lartet, 1837

GENERIC TYPE.—*Macrotherium sansaniense* Lartet, from the Miocene of Sansan, France.

Macrotherium brevirostris, new species

TYPE.—Amer. Mus. No. 26518, a skull, complete on the left side except for the tips of the premaxillaries, and the postero-dorsal region of the cranium. The opposite side has to a great extent been weathered away. From 25 miles northeast of Gur Tung Khara Usu, Inner Mongolia.

PARATYPES.—

Amer. Mus. No. 26535. A series of foot bones, comprising:

1. Six proximal phalanges.
2. Two median phalanges, one from the manus and one from the pes.

3. A portion of the second ungual phalanx of the left manus, and an ungual phalanx from the pes.

All of these specimens were found 25 miles northeast of Gur Tung Khara Usu, Inner Mongolia.

Amer. Mus. No. 26581. A right metatarsal IV, a weathered phalanx and a right cuneiform from the manus. Found near Wolf Camp, near Gur Tung Khara Usu, Inner Mongolia.

HORIZON AND LOCALITY.—From the Tung Gur formation of Upper Miocene age. Northeast of, and near Gur Tung Khara Usu, and from 40 to 60 miles east of Iren Dabasu, Inner Mongolia. Expedition of 1930.

DIAGNOSIS.—

1. A fairly large chalicothere, somewhat smaller than *Macrotherium grande* or *Moropus elatus*.
2. Dentition $\frac{0(?)-0(?)-3-3}{}$.
3. Teeth brachyodont, molars quadrate.
4. Preorbital portion of skull very short; nasals retracted and nasal opening deep; maxilla very high.
5. Zygomatic arch very long, glenoid articulation produced forward.
6. Basicranial foramina showing the typical chalicotherine arrangement.
7. Bulla expanded. Mastoid extremely large. Paroccipital process long, and post-glenoid process heavy.
8. Pterygoids heavy; posterior nares large.
9. Occipital condyles expanded vertically.
10. Proximal phalanges short, with metapodial articulations approximately parallel to long axis of bone. Median phalanges short and high. Ungual phalanges deeply bifid.

DISCUSSION

THE SKULL

The skull, Amer. Mus. No. 26518, is well preserved on the left side. It shows that *Macrotherium brevirostris* was a fairly large chalicothere having certain well marked specializations.

Perhaps one of the most striking characters about this skull is the shortness of the face, that is, of the region anterior to the orbit. This brevity of the preorbital region is made especially apparent by the height of the maxilla and the retraction of the nasals, the points of which do not project beyond the second premolar. Of course, the genus *Macrotherium* is characterized by a short preorbital portion, but it would seem that in the species under discussion the region in front of the orbit is perhaps shorter than in other species of the genus.

The orbit is placed rather far forward, the front border being above the middle part of the second molar, whereas in *Moropus* and other long-faced chalicotheres it is located above the last molar. The infraorbital foramen is above the first molar, and consequently it is not far in front

of the orbit. As is characteristic of the chalicotheres, the orbit is quite open behind, and it would seem as if the postorbital processes were quite small.

The zygomatic arch is extraordinarily long, being almost half the length of the skull, and in this respect *Macrotherium brevirostris* differs somewhat from *Macrotherium grande*. The upper portion of the cranium is partially destroyed in the specimen under consideration, but it would appear as if the brain-case might have been rather low and restricted, with a consequent sharp sagittal crest along the midline of the cranium.

Looking at the ventral surface of the skull, it is seen that the palate is quite wide, even proportionately wider than in *Moropus*, and that anterior to the cheek teeth the premaxillaries are very narrow and presumably rather short. Unfortunately the tips of the premaxillaries are missing, but judging from the brevity of the face it would seem logical to suppose that they did not extend far forward. Very probably the upper incisors were reduced either in size or in number, or both. In fact, it is quite within reason to assume that the premaxillaries were edentulous. Such an assumption would have a considerable amount of evidence to rest upon, for we know that the loss of the upper incisors is a development occurring in many of the advanced chalicotheres. Long ago Dr. Hugh Falconer pointed out the fact that *Circotherium sivalense*, a Pleistocene chalicothere from India closely related to *Chalicotherium*, and therefore a rather direct descendant from *Macrotherium*, has edentulous premaxillaries. And a premaxilla of *Moropus* in the American Museum collection shows that this North American genus had no upper incisors. Therefore, from the seeming small size of the premaxillaries of the Tung Gur *Macrotherium*, it would seem very probable that this animal lacked the upper incisors.

The posterior nares of *Macrotherium brevirostris* are exceptionally large. In regard to the location of these openings, the form under consideration shows a certain likeness to *Moropus* rather than to *Macrotherium grande*, for they are situated far back, behind the posterior edge of the third molars. Holland and Peterson have shown that in the typical *Macrotherium* the posterior nares open at a point which is on a transverse line connecting the protocones of the opposite third molars.[1] In *Moropus* these openings are located at a considerable distance behind the last molar. The position of the posterior nares is, however, a variable character among species, and even among individuals, so that too great taxonomic significance must not be attached to it.

[1]Holland, W. J., and Peterson, O. A. 1914. 'The Osteology of the Chalicotheroidea.' Mem. Carnegie Mus., III, No. 2, p. 237.

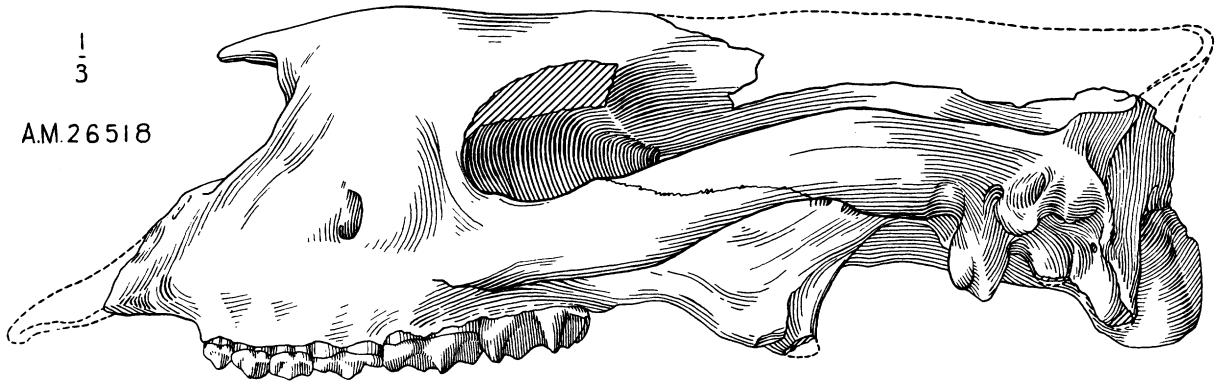

Fig. 11. *Macrotherium brevirostris*, new species. Type, Amer. Mus. No. 26518. Skull, lateral view. One-third natural size.

The pterygoids are very heavy, in distinct contrast to those of *Moropus*, showing that *Macrotherium brevirostris* had powerful internal pterygoid muscles for the purpose of moving the jaw laterally. A sharp ridge runs along the midline of the basioccipital and the basisphenoid, and it becomes confluent with the vomer in the nasal passage.

The condyle is vertically elongated as is typical of *Macrotherium*. The postglenoid process is very heavy, and on its anterior face is an articular facet which must have worked against the mandibular condyle. In connection with the mandibular articulation it might be well to mention the forward extension of the glenoid on the lower surface of the zygomatic arch, a chalicothere character. The paroccipital process is long and laterally expanded.

The bulla is badly crushed, but from the appearance of the tympanic region it would seem to indicate that the bulla was very large.

Depéret, in his detailed analysis of *Macrotherium grande* stresses the great size of the mastoid process in that species.[1] In the form under consideration the mastoid does not seem to show the expansions so characteristic of *M. grande*. The Mongolian *Macrotherium* resembles *M. grande*, however, in the expansion of the tube of the external auditory meatus, so that its lower border is rather bulbous. In *Moropus* there is a ridge running down from the lower border of the external auditory meatus to the bulla.

Turning now to the basicranial foramina, we see that in *Macrotherium brevirostris* they show the typical chalicotherine arrangement. The optic foramen is slightly behind the postorbital boundary. From it a long furrow runs back to the foramen lacerum anterius, which latter is placed directly above the foramen rotundum. There is an alisphenoid canal. The foramen ovale is placed slightly in front of the bulla, and behind the foramen ovale is the foramen lacerum medius. At the back of the bulla the foramen lacerum posterius and the condylar foramen are placed quite close together. There is a large stylomastoid foramen. This arrangement is quite identical with that of *Moropus*, and is essentially the same as in *Eomoropus*, an indication of the basic relationships existing between all of the chalicotheres.

The Upper Dentition

The upper premolars are quite small as compared to the molars, showing that this animal had not advanced beyond the primitive perissodactyl condition as regards the anterior cheek teeth. The second

[1] Depéret, C. 1892. 'La Faune de Mammifères Miocènes de la Grive-Saint-Alban.' Arch. Mus. Hist. Nat. Lyon, V, p. 66.

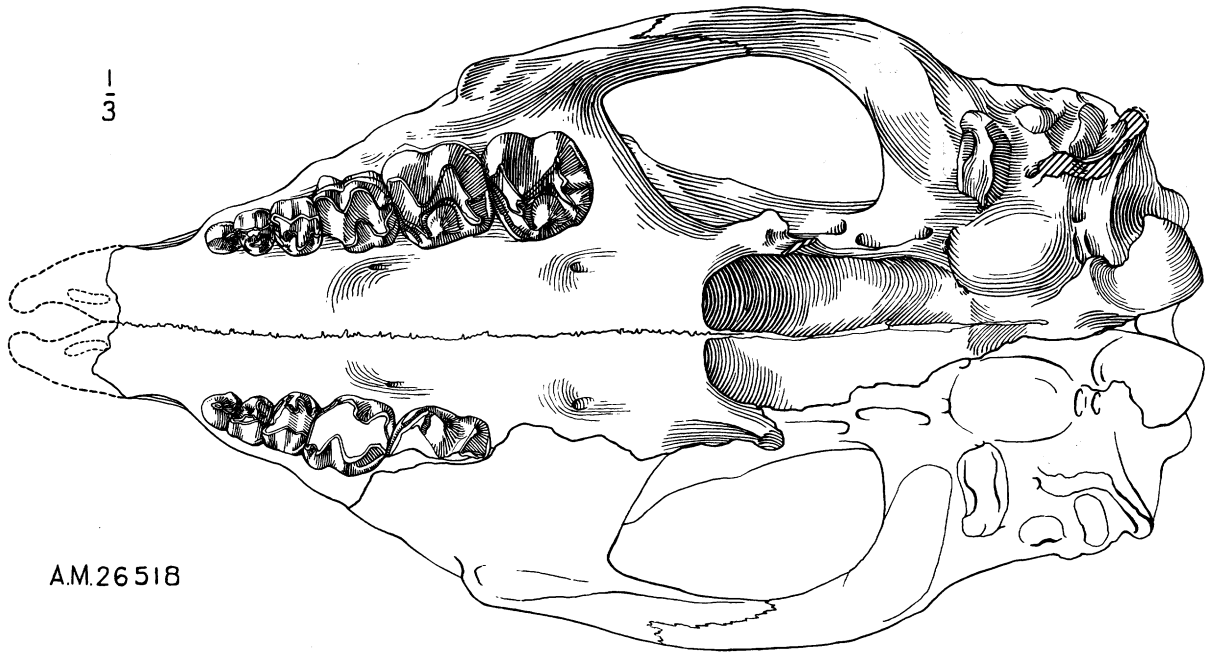

Fig. 12. *Macrotherium brevirostris*, new species. Type, Amer. Mus. No. 26518. Skull, ventral view. One-third natural size.

premolar consists essentially of a single large cusp and a postero-internal heel. The third and fourth premolars are tricuspid, there being two rather closely appressed cones on the ectoloph and an internal protocone. In addition, there are two transverse lophs in each of these teeth, joining the protocone with the two external cusps.

The molars are quite like those of *M. grande*, *M. salinum*, and other members of the genus. That is to say, they are quadrate and brachyodont. The paracone and metacone are located far in, towards the lingual side of the tooth, thus causing the ectoloph to slope markedly inward. This is a characteristic feature among the genera belonging to the Chalicotherini, and offers a distinct contrast to the Schizotherini, in which group the ectoloph is relatively vertical. The molars show the typical chalicotherine arrangement of cusps; the protocone and paracone, and the hypocone and metacone are joined by a protoloph and a metaloph respectively, and there is a well developed protoconule.

The Foot Bones

The series of foot bones listed above (Amer. Mus. No. 26535), which were found northeast of Gur Tung Khara Usu and not so very far away from the skull, are here referred to the species *Macrotherium brevirostris*. They are of medium size, and for this reason it is very likely that they belong to the same species as does the skull. They show the several characters of *Macrotherium*, which are listed below.

1. The proximal phalanges are short and wide, and the articular surfaces for the metapodials are approximately parallel to the axis of the bone.
2. The median phalanges are short, deep and narrow.
3. The ungual phalanges are relatively short, and as in the other chalicotheres, they are bifid.

Measurements

Amer. Mus. No. 26518, type skull	
Length of skull, P^2 to occipital condyles	387 mm.
Estimated length to tips of premaxillaries	450
Width across zygomatic arches, as restored	248
Preorbital length, estimated	195
Postorbital length	285
Length of zygomatic arch, front of orbit to front of postglenoid	188
Height of maxilla above M^1	142
Width across occipital condyles	65
Greatest width of posterior nares	60
Width of palate at P^2	56
Width of palate at M^3	77

Ratio, preorbital to postorbital length	68	
Length of premolar series		45
Length of molar series		109
Ratio, premolar to molar lengths	41	
	Antero-posterior diameter	Transverse diameter
P^2	12.5 mm.	12 mm.
P^3	15	18
P^4	17.5	23
M^1	29	32
M^2	39	40
M^3	41	41
Amer. Mus. No. 26535		
Proximal phalanx, length		57.5 mm.
Proximal phalanx, width		42
Median phalanx (manus), length		34
Median phalanx (manus), height		35
Median phalanx (pes), length		44
Median phalanx (pes), height		26
Amer. Mus. No. 26581		
Right metatarsal IV, length		89 mm.
Right metatarsal IV, greatest width		40

NOTE.—The bone (Amer. Mus. No. 26581) identified as a cuneiform from the right manus is of questionable relationships. It would seem to bear a great deal of similarity to the similar element in the Middle Tertiary rhinoceroses.

MACROTHERIUM sp.

Amer. Mus. No. 26536, four extremely large median phalanges. Tung Gur formation, Upper Miocene. From near Wolf Camp, southwest of Gur Tung Khara Usu, Inner Mongolia. Expedition of 1930.

Amer. Mus. No. 26229. Two extremely large proximal phalanges. Tung Gur formation, Upper Miocene. From near Gur Tung Khara Usu, Inner Mongolia. Expedition of 1928.

These specimens are representative of a species considerably larger than *Macrotherium brevirostris*. It is not thought wise, however, to create a new specific name on the basis of these foot bones alone. Measurements are given below.

MEASUREMENTS

Amer. Mus. No. 26229			
Largest proximal phalanx (Fig. 12 l, l')	length	96 mm.	
Smaller proximal phalanx (Fig. 12 h)	length	71	
Amer. Mus. No. 26536	Median phalanges	Articular length	Height
'a' (Fig. 12 k)		52 mm.	58 mm.
'b' (Fig. 12 m)		48	49
'c' (Fig. 12 n, n')		35	40
'd' (Fig. 12 o)		33	37

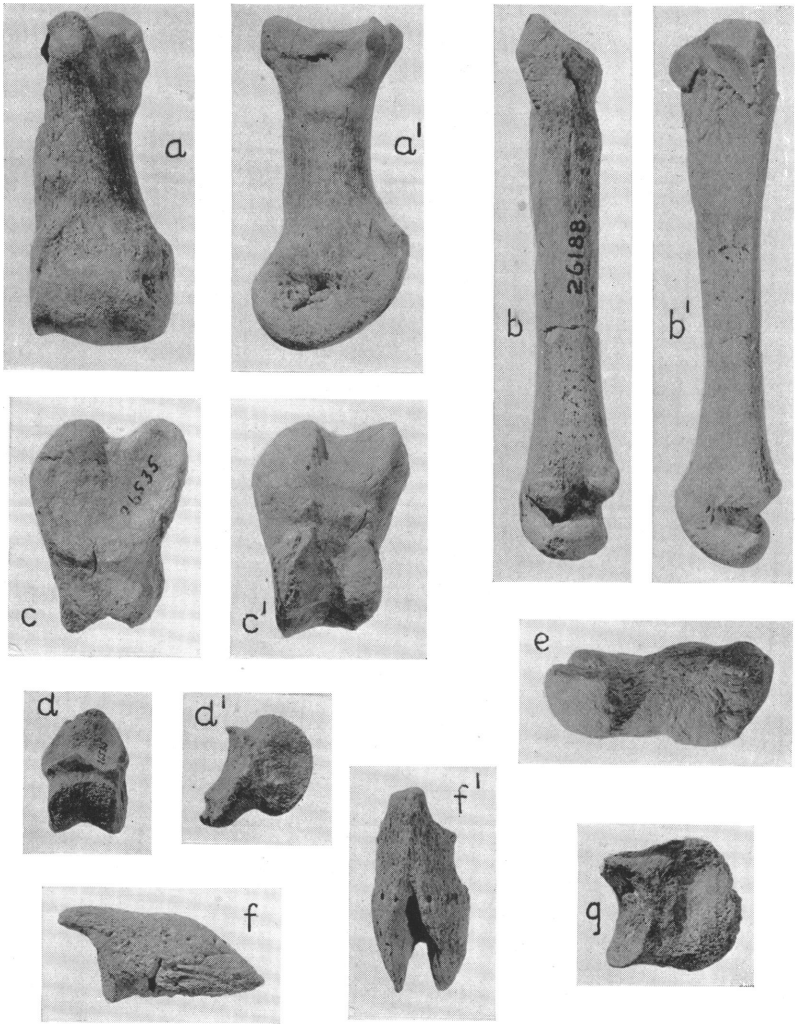

Fig. 13. Foot bones of Mongolian chalicotheres.

a, a′. *Macrotherium brevirostris*, new species. Amer. Mus. No. 26581. Right metatarsal IV, front and external views.

b, b′. *Schizotherium* sp. Amer. Mus. No. 26188. Right metacarpal III, front and external views.

c, c′. *Macrotherium brevirostris*, new species. Amer. Mus. No. 26535. Proximal phalanx, top and palmar views.

d, d′. *Macrotherium brevirostris*, new species. Amer. Mus. No. 26535. Median phalanx, top and lateral views.

e. *Macrotherium brevirostris*, new species. Amer. Mus. No. 26535. Proximal phalanx, lateral view.

f, f′. *Macrotherium brevirostris*, new species. Amer. Mus. No. 26535. Ungual phalanx, lateral and top views.

g. *Macrotherium brevirostris*, new species. Amer. Mus. No. 26535. Median phalanx, lateral view.

All figures one-half natural size.

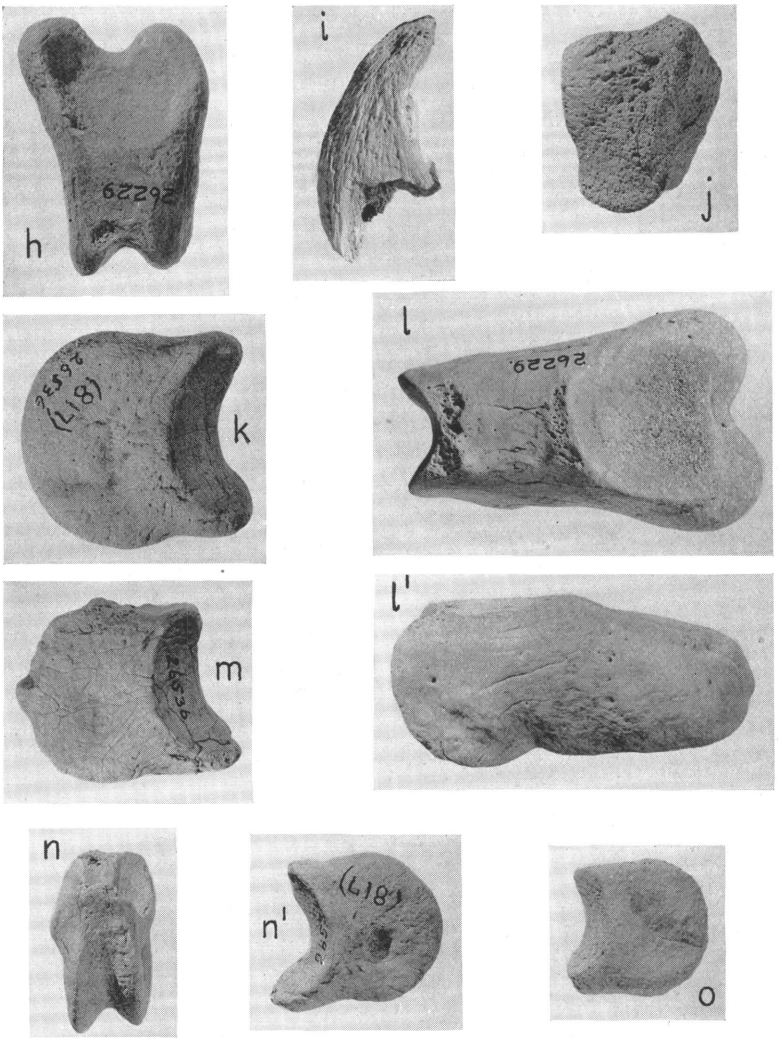

Fig. 14. Foot bones of Mongolian chalicotheres.

h. *Macrotherium* sp. Amer. Mus. No. 26229. Median phalanx, top view.

i. *Macrotherium brevirostris*, new species. Amer. Mus. No. 26535. Proximal portion of ungual phalanx of digit II of manus, lateral view.

j. *?Macrotherium* sp. Amer. Mus. No. 26581. Cuneiform of right manus (?).

k. *Macrotherium* sp. Amer. Mus. No. 26536. Median phalanx, lateral view.

l, l'. *Macrotherium* sp. Amer. Mus. No. 26229. Proximal phalanx, top and lateral views.

m. *Macrotherium* sp. Amer. Mus. No. 26536. Median phalanx, lateral view.

n, n'. *Macrotherium* sp. Amer. Mus. No. 26536. Median phalanx, top and lateral views.

o. *Macrotherium* sp. Amer. Mus. No. 26536. Median phalanx, lateral view.

All figures one-half natural size.

CIRCOTHERIUM Holland and Peterson, 1914

GENERIC TYPE.—*Circotherium sivalense* (FALCONER AND CAUTLEY), from the Upper Siwaliks, Pleistocene, of India.

Circotherium sinense (Owen)

Chalicotherium sinense, OWEN, 1870, Quar. Jour. Geol. Soc. London, XXVI, p. 429, Pl. XXIX, figs. 7–10.

Circotherium sinense, MATTHEW, 1929. Bull. Amer. Mus. Nat. Hist., LVI, p. 519.

ADDITIONAL REFERENCES:—

Lydekker, R. 1886. Cat. Foss. Mam. Brit. Mus., III, p. 165, fig. 21.

Holland, W. J., and Peterson, O. A. 1914. Mem. Carnegie Mus., III, No. 2, p. 218

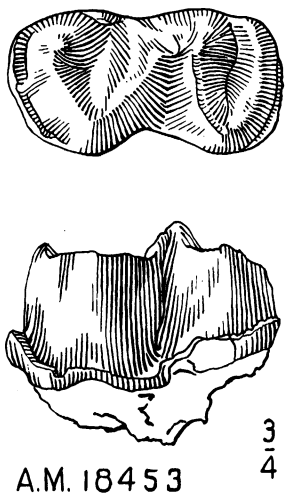

Fig. 15. *Circotherium sinense* (Owen). Amer. Mus. No. 18453. Left third lower molar. Top view above, lateral view below. Three-fourths natural size.

Matthew, W. D., and Granger, Walter. 1923. Bull. Amer. Mus. Nat. Hist., XLVIII, p. 573.

TYPE.—Brit. Mus. No. 41934, a third right upper molar.

HORIZON AND LOCALITY.—From the Pleistocene of Szechwan, China.

DIAGNOSIS.—(After Matthew, W. D. 1929. Bull. Amer. Mus. Nat. Hist., LVI, pp. 518–519.)

Larger than *C. sivalense*, of about the same proportions, and with the protoloph entirely absent on the molars. Protocone more clearly round-conical than in *C. sivalense*.

SPECIMEN IN THE AMERICAN MUSEUM.—Amer. Mus. No. 18453, a left lower molar, probably M_3. From the Lower Pleistocene, near Wanhsien, Szechwan, China. Expedition of 1921.

This specimen was briefly described by Matthew and Granger in 1923. Their description is quoted below.

"Our collection contains a single lower molar, No. 18453, probably m_3. It affords no especial light upon the relations to the Indian *C. sivalense.*"[1]

The tooth in the American Museum from Szechwan is here figured for the first time. It is rather large, being somewhat greater in size than the similar tooth in *C. sivalense.* It is characterized by a heavy posterior cingulum, and especially by the great reduction of the metastylid. This latter feature is characteristic of the progressive members of the Macrotherini.

MEASUREMENTS

Amer. Mus. No. 18453.	M_3
Length	47 mm.
Width	24
Height of metaconid	22

Olsenia mira Matthew and Granger

Olsenia mira, MATTHEW AND GRANGER, 1925. Amer. Mus. Novitates, No. 196, p. 3.

ADDITIONAL REFERNCE.—Matthew, W. D. 1929. Bull. Amer. Mus. Nat. Hist., LVI, p. 519.

Olsenia mira, type, Amer. Mus. No. 20303, an astragalus, which was provisionally referred to the chalicotheres by Matthew in 1929, may be regarded as probably representing some other order of the Mammalia. This genus and species were originally referred to the ?Mesonychidae.

CONCLUSIONS

Various stages in the evolution of the chalicotheres are to be found in the fossils representative of this group from Mongolia and China. *Eomoropus* (described by Zdansky) and *Grangeria*, the oldest of the Asiatic genera, would seem to be derived directly from *Eomoropus* of North America. Having become established in Asia, these primitive chalicotheres gave rise to more progressive and specialized groups, which enjoyed a broad adaptive radiation throughout Eurasia during Upper Tertiary times.

Schizotherium, the typical Oligocene genus of chalicotheres, would seem to have been present in Mongolia. Then in the Miocene, *Macrotherium* appeared, a genus that spread widely across Europe, India and Asia. The Mongolian representative of this genus, *Macrotherium*

[1]Matthew, W. D., and Granger, Walter. 1923.

brevirostris, would seem to be closely related to *Macrotherium salinum* of India.

Finally in the Pleistocene, *Circotherium sinense* made its appearance in China. This genus probably came in from India, where it is found in beds referable to the lower portions of the Pleistocene.

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