

Article XIV.—*EOMOROPUS*, AN AMERICAN EOCENE CHALICOTHERE.

BY HENRY FAIRFIELD OSBORN.

With Eleven Text Figures.

1. *Triplopus amarorum* Cope, a new chalicothere type.
2. Resemblances to *Moropus*.
3. Early European chalicotheres.
4. Description of *Eomoropus*, type skull and skeleton.
5. Relations to the Perissodactyla.

1. *Triplopus amarorum* COPE, A NEW CHALICOTHERE TYPE.

The recognition of an upper Middle Eocene ancylopod or chalicothere in the type of *Triplopus amarorum* Cope is a matter of great interest: first, because it shows that a supposedly European family was established as early in America as in Europe and may have been of American origin; second, because geologically the family is carried back from the American Lower Miocene into the close of Middle Eocene times, the Washakie or Bartonian stage; third, the knowledge of considerable portions of the skeleton of this most primitive known chalicothere strengthens the relations of the Chalicotheres to the Perissodactyla.

The species *T. amarorum* has always appeared to the present writer quite distinct from the genus *Triplopus*, the type species of which is *T. cubitalis* Cope. Depéret was the last author to examine the type of *T. amarorum* and he pointed out the resemblance of its superior molar teeth, with their interrupted anterior crests, to those of his genus *Lophiaspis*. But *Lophiaspis* is a true lophiodont in the structure of the ectoloph of its superior molar teeth, which exhibits no mesostyle and a concave metacone.

The type specimen of *T. amarorum*, as described by Cope in 1884 in the 'Tertiary Vertebrata', was not thoroughly worked out from the matrix so that his description included chiefly the skull and the pes.

Three years ago in working over the Cope Eocene Collection Mr. Granger discovered that the matrix associated with the type specimen contained also a fore foot and the lower jaw, which have never been described; these parts prove to be truly chalicotheroid in structure. It was, however, the similarity in the top view of the skull (Figs. 1, 2) and in the structure of the second

superior molar tooth which led the writer first to observe the resemblance to *Moropus*, an observation which is thoroughly confirmed by such portions of the skeleton as compose the type specimen.

It is proposed, therefore, to make Cope's species *T. amarorum* the type of a new genus, **Eomoropus**, which proves to be distinct both from *Pernatherium* of the Bartonian of France and *Schizotherium* of the Stampian.

2. RESEMBLANCES TO *Moropus*.

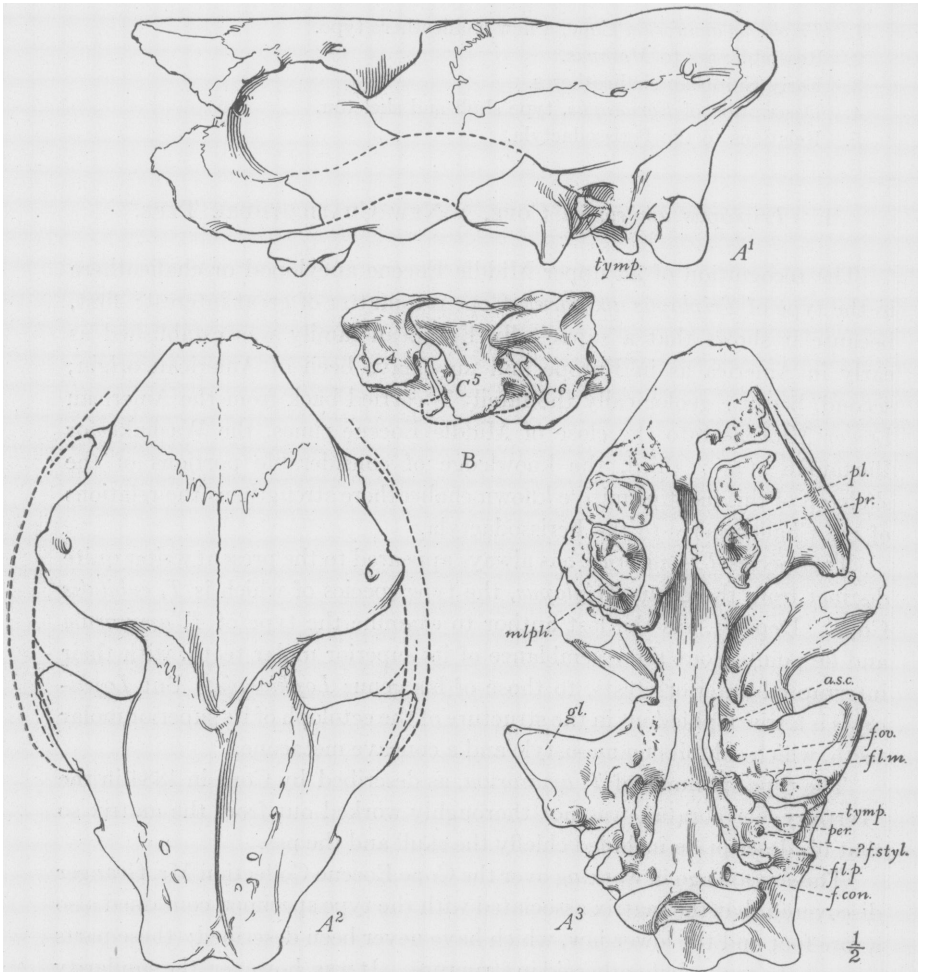


Fig. 1. Type skull of *Eomoropus amarorum*, Amer. Mus. No. 5096. A¹ Lateral view, A² superior view, A³ inferior view. B cervical vertebrae (?) 4-6. All one-half natural size.

The resemblances are strongest in the following parts of the animal: (1) superior region of the cranium (compare Fig. 1, A², Fig. 2); (2) the basi-cranial and auditory region; (3) characteristic structure of the superior and inferior molar teeth; (4) structure of the carpus (Fig. 4) and especially of the distal ends of the metacarpals (Fig. 5); (5) structure of the tarsus (Fig. 4).

The principal differences are in the primitive characters of the *Eomoropus* type, such as we should expect in a comparison of a Middle Eocene and a Lower Miocene species, namely: (1) small size, about equalling that of the domestic sheep, *Ovis aries*; (2) mediportal proportions of the skeleton as compared with the subgraviporta structure of *Moropus*; (3) slender innominate bones and narrow iliac crest (Fig. 8); (4) simple or unspecialized premolar teeth (Fig. 3); (5) tibia relatively longer and more slender than in *Moropus*, a primitive perissodactyl character. Attention should also be called to a specialized character in the hind limb which does not seem to be ancestral to the *Moropus* type, namely: (6) fibula relatively more reduced than in *Moropus*, perhaps with an incomplete shaft.

The systematic relations are as follows:

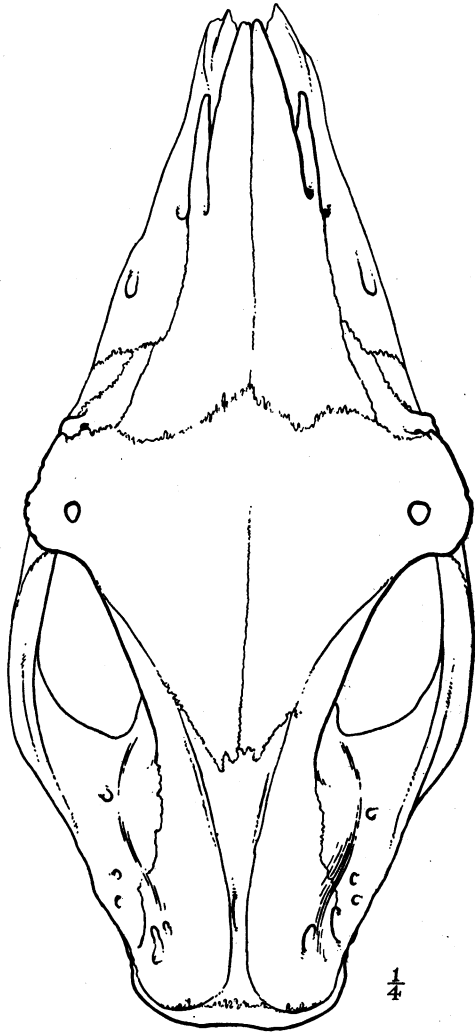


Fig. 2. Skull of *Moropus* ?sp. Amer. Mus. No. 14375. Superior view, one-fourth natural size.

Order PERISSODACTYLA OWEN.

Sup. Fam. CHALICOTHEROIDEA Osborn 1898.

This superfamily is equivalent to the order Ancylopoda of Cope:

Buno-selenodont perissodactyls, ambulatory, partly fossorial, with distally cleft ungual phalanges (D. IV-II), premolar series reduced, navicular broadly articulating with calcaneum and excluding cuboid from astragalus, phalangeal and sesamoidal facets at distal extremities of the metacarpals and metatarsals partly separated; cranium and dentition intermediate in type between that of Titanotheroidea and Hippoidea.

Eomoropus gen. nov.

Premolar crowns *simple*, premolar metaconids without metastylids, large hypocondilid on m_3 , fibula greatly reduced.

Type species, *Triplopus amarorum* Cope.

Distinctions from European genera.

Eomoropus is a much less specialized animal in the structure of its hind foot than the type of *Pernatherium rugosum* Gervais (1876), recorded as the oldest known chalicothere in Europe.¹ The type of *P. rugosum* as described by Gervais in 1876, consists of a left calcaneum and portions of two metatarsals consisting of a proximal, also of a distal portion of one of the same (Fig. 9). These remains were found in the Calcaire de Saint-Ouen lacustrine or brackish marls of the Paris Basin, referred by Depéret to the Bartonian stage, which has been correlated by Osborn with Bridger C. and D, Washakie A, Uinta A, or the Upper portion of the Middle Eocene. This undoubted chalicothere, *Pernatherium*, is a much larger and more specialized form than *Eomoropus*. The calcaneum is abbreviated and corresponds with a graviportal type. The supposed metatarsal IV differs widely both from that of *Eomoropus* and *Moropus* in the interruption of the cuboidal facet and the possession of a peculiar external process with a separate articular facet. The distal articulation of the other metatarsal is distinctively chalicotheroid.

¹ Gervais, Paul. "Indices d'un Nouveau Genre de Mammifères Édentés Fossile dans les Dépôts Éocènes dits de Saint-Ouen." Journ. de Zoologie, t. V, 1876, pp. 424-432, pl. xviii, figs. 1-3.

3. EARLY EUROPEAN CHALICOTHERES.

Figs. 9-11 (for Fig. 9, see p. 274).

The Upper Eocene or Lower Oligocene type of chalicothere is the genus *Schizotherium* of Gervais¹ (1876, *op. cit.*, p. 59), based upon the species of *Ancylotherium priscum* of Gaudry (1875).

Gaudry's type of *Ancylotherium priscum* was first mentioned² in the 'Comptes Rendus' of November 29, 1875. The type consists of three phalanges from the Phosphorites of Mouillac, Canton of Caylux, regarded as of Upper Eocene or Lower Oligocene age. They were subsequently described and figured by Gaudry.³ The figure (pl. xviii, 3-8) represents an undoubted chalicothere but one of much smaller size than the type of *P. rugosum*. The figure is reproduced herewith, Fig. 10.

Not knowing the identity of the feet and the teeth Gaudry shortly afterward⁴ described as *Chalicotherium modicum* a portion of a right superior maxillary containing five teeth (p^2-m^3) belonging to an animal of about the same size as *A. priscum*. This type was found at Bach, Canton of Lalbenque. Gaudry subsequently (*op. cit.*, Jour. de Zool., 1875, p. 523, pl. xviii, figs.

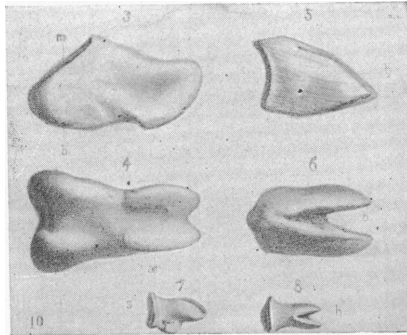


Fig. 10. Type of *Schizotherium* (*Ancylotherium*) *priscum* Gaudry. 3-4, first phalanx; 5-6, terminal phalanx; 7-8, terminal phalanx. Mus. d'Hist. Nat., Paris. Figs. 3-6 one-half natural size. After Gaudry.

13, 14) redescribed and figured this type. It belongs to an animal of about the same size as the type of *A. priscum*. The specific identity is possible but not demonstrable because the types come from different localities. The

¹ Gervais, Paul. "Zoologie et Paléontologie Générales." 2^e ser., 3^e livr., 1876, pp. 58-59. [Plate xi illustrating this type was never issued; with the closing text, following p. 72, it was not published owing to Gervais's death.]

² Gaudry, A. "Sur quelques indices de l'existence de l'Édentés au commencement de l'époque miocène." Comptes Rendus des Séances de l'Académie des Sciences, t. LXXXI, No. 22, 2^e sem., 29 Nov., 1875, pp. 1036-1038.

³ Gaudry, Albert. "Sur quelques Pièces de Mammifères Fossiles qui ont été trouvées dans les Phosphorites du Quercy." Jour. de Zoologie, t. IV, 1875, pp. 518-524, pl. xviii, figs. 3-8.

⁴ Gaudry, A. "Sur nouvelles pièces fossiles découvertes dans les phosphorites du Quercy." Comptes Rendus des Séances de l'Académie des Sciences, t. LXXXI, No. 25, 2^e Sem., 6 December, 1875, pp. 1113-1115.

same molar series was subsequently described and figured by Filhol¹ (1877, pp. 156–158). The type figure is reproduced herewith, Fig. 11.

The original systematic order of description of the ancient Eocene-Oligocene European chalicotheres was therefore as follows:

1. '*Ancylotherium*' *priscum* Gaudry, 1875, Comptes Rendus, Nov. 29, p. 1037.
2. '*Chalicotherium*' *modicum* Gaudry, 1875, Comptes Rendus, Dec. 6, p. 1115.

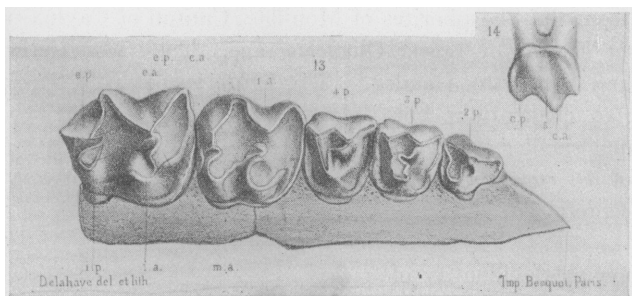


Fig. 11. Type of *Schizotherium* (*Chalicotherium*) *modicum* Gaudry. Two thirds natural size. 13, right superior maxilla; 14, fourth superior premolar. Mus. d'Hist. Nat., Paris. After Gaudry.

3. *Pernatherium rugosum* Gervais, 1876, Jour. de Zool., p. 424.
4. *Schizotherium* Gervais, 1876, type species *Ancylotherium priscum* Gaudry.
5. *Schizotherium* Filhol, 1880, Comptes Rendus, p. 1580.

The lower jaw in the Muséum de Lyon here figured (Fig. 3 B) is from the Phosphorites of Quercy; it is referred to the species *Schizotherium modicum* by Depéret.

It would appear that the species of *Schizotherium*, namely, *S. priscum*, *S. modicum*, represent smaller animals than the type of *Pernatherium rugosum* although the latter is regarded as from a geologically older horizon.

***Eomoropus amarorum* (Cope).**

Specific characters.— Inferior grinding teeth, $p_2-m_3 = 86$ mm. P_2 with rudimentary paraconid and hypoconid but without metastylid. Hypoconid well developed on p_3 ; p_4 with rudiment of metastylid, and an entoconid.

¹ Filhol, H. "Recherches sur les Phosphorites du Quercy, Étude des Fossiles qu'on y rencontre et spécialement des Mammifères." Ann. des Sciences Géologiques, t. VIII, 1877, pp. 1–340, pl. xx, fig. 343.

The absence on the premolars of the distinctive cusplets known as metastylids and the rudimentary condition of the talonids or basal portion of the crowns of the premolar teeth, serve to distinguish these teeth clearly

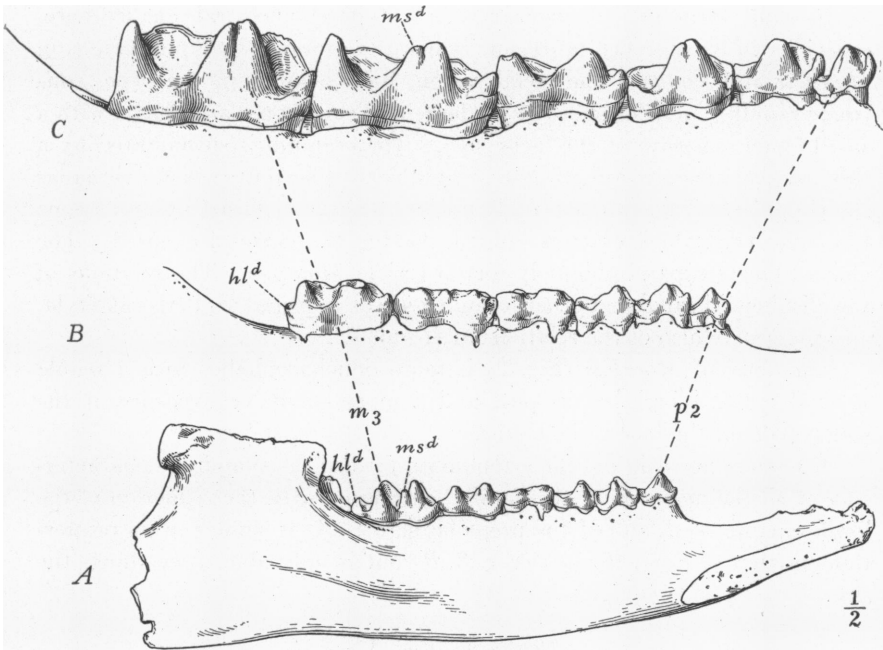


Fig. 3. Lower jaws of chalicotheres. C. *Moropus* ?sp. Amer. Mus. No. 14377. Lower Miocene. B. *Schizotherium* ?sp. (cast). Lower Oligocene Phosphorites of France. Lyons Museum. A. *Eomoropus amarorum*, type, Amer. Mus. No. 5096. Upper and Middle Eocene, Wyoming. All figures one-half natural size.

from those of the jaw referred to *S. priscum* (Fig. 3 B). In these and many other characters *E. amarorum* is by far the most primitive species of chalicothere known.

Geologic locality.—As described by Cope (Tertiary Vertebrata, 1884, p. 687) the type specimen was secured in 1873 from “Mammoth Buttes,” near the head of South Bitter Creek, Wyo., the same locality which furnished the type of *Triplopus cubitalis* and *Achænodon insolens* (*op. cit.*, p. 344). This geologic level is probably the base of Washakie B, or the Upper Washakie; it is the *Dolichorhinus hyognathus* zone of Osborn; its age is beginning of upper Eocene or close of Middle Eocene.

Type specimen.—The accompanying illustrations (Figs. 1–8) include all portions known of the type specimen, namely, Amer. Mus. No. 5096.

4. DESCRIPTION OF *Eomoropus*, TYPE SKULL AND SKELETON.*Skull and Jaws* (Figs. 1-3).

In skull structure *T. amarorum* is a typical ancestral chalicothere, especially in its supraorbital region, which is perforated by a foramen as in *Moropus* and *Equus*. The facial region, broken away in the type, contracts rapidly. Thus the orbits are large and contracted anteriorly, with a small facial exposure of the lachrymal. The cranium is surmounted by a thin sagittal crest, terminating in a high, narrow occiput, which overhangs the condyles. The wide external auditory meatus is closed by an osseous tympanic ring which extends inward, leaving the petrosal exposed. The glenoid facets expand obliquely forward as in *Moropus*. The relations of the alisphenoid canal and other foramina are as in primitive Perissodactyla, and suggestive also of the relations in *Moropus*.

The skull of *Moropus* (Fig. 2) is more dolichocephalic, with a sessile sagittal crest, a broader occiput, and a more extensive exposure of the lachrymals on the face as in *Equus*.

The lower jaw exhibits the attenuation toward the symphysis characteristic of all the members of this family, correlated with the reduction of the lower cutting teeth and of the premolar series. It is similar in its proportions to that of *Schizotherium* (Fig. 3, *B*) but is only about two thirds the size.

Dentition (Fig. 3).

The formula is: $I_{\frac{1}{3}}^1, C_{\frac{1}{1}}^1, P_{\frac{1}{3}}^1, M_{\frac{3}{3}}^3$. The incisors and canines form a single semi-procumbent series, followed by a considerable diastema, behind which is the simple p_2 with its rudimentary anterior and posterior cusplets. P_3 is more complex with a simple metaconid and hypoconid but without entoconid. P_4 is still more complex with a rudiment of the metastylid and a distinct entoconid. In m_{1-3} a characteristic duplicate metastylid is well developed as a cusp, distinct at the apex from the metaconid. A generic character is the well developed hypoconulid of m_3 . This hypoconulid (h^2) is vestigial in *Schizotherium* (Fig. 3, *B*) and absent in *Moropus* (Fig. 3, *C*).

The fragmentary superior molars, m^3 , as preserved, exhibit the sharp metaloph and interrupted protoloph with distinct protocone and protoconule characteristic of all the known chalicotheres.

Cervicals (Fig. 1 B).

The only vertebræ preserved are three cervicals (Fig. 1, B), apparently C. 4, C. 5, C. 6, distinguished from those of *Moropus* by the normal disposition of the centra, the moderate expansion of the lamellæ, and the prominent median keels.

Manus and Pes (Figs. 4, 5).

The *manus* exhibits four digits (II–V) with a slight reduction of Mtc. V and an enlargement of Mtc. III. The distal articulations of the metacarpals are typically chalicotheroid as in *Pernatherium* and *Moropus* (Fig. 5 A, B). This typical structure consists in a prominent posterior sesamoidal face, *s*, divided by a prominent median keel, *k*; this sesamoidal face is slightly convex while the anterior phalangeal face, *p*, is strongly convex and lacking in the median keel. Whereas in other Perissodactyla the

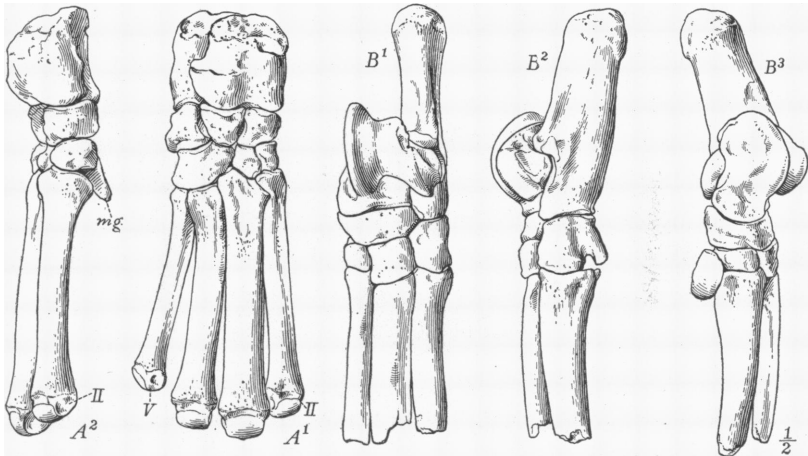


Fig. 4. Manus and pes of *E. amarorum*, type. A^1 anterior view of manus, A^2 internal view. B^1 anterior view of pes; B^2 external view; B^3 internal view. One-half natural size.

sesamoidal and phalangeal facets are continuous and evenly convex, in *Moropus* and *Eomoropus* these faces are more separate. This peculiar duplex-faceted structure of the distal ends of the metacarpals is undoubtedly correlated with the clawed, cleft ungues and fossorial function of the phalanges. Both manus and pes are mesaxonic as in the perissodactyls.

The *carpus* is absolutely typical of that of the primitive Eocene Perissodactyla, namely, magnum small, scapho-centrale entirely covering magnum,

lunar resting entirely on unciform, prominent posterior process of magnum (Fig. 4, A^2 , *mg*). These primitive characters are in a measure retained in *Moropus*.

The *tarsus* (Fig. 4, B^1 , B^2) also resembles that of the primitive *Perissodactyla* very closely; in proportions it is vertically elongate and laterally

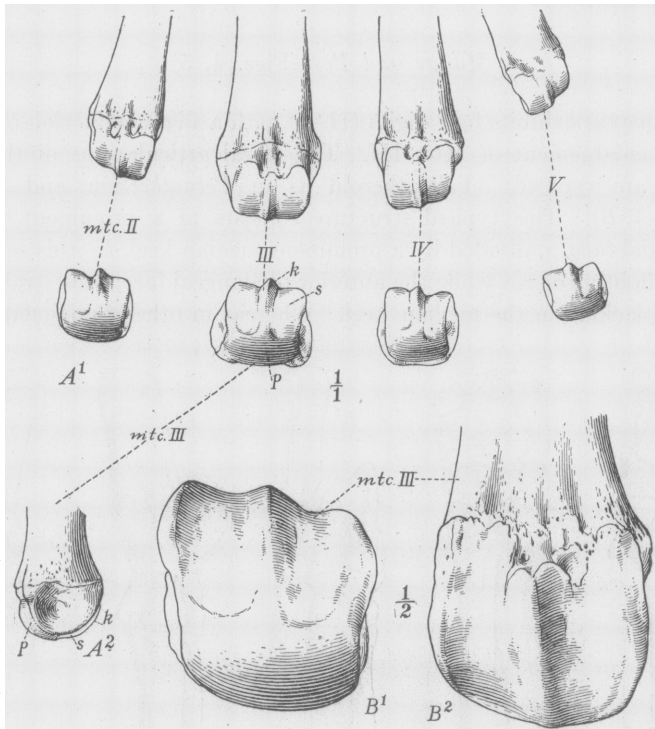


Fig. 5. Metacarpals of *Eomoropus* type and of *Moropus*, Coll. Amer. Mus. A^1 *Eomoropus*, posterior and distal views of metacarpals II-V. A^2 lateral view of metacarpal III. Natural size. B^1 *Moropus*, distal view of metacarpal III. B^2 posterior view of the same. One-half natural size.

compressed. A very distinctive chalicotheroid feature is that the navicular joins the calcaneum and widely separates the astragalus from the cuboid, whereas 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.

Femur and Tibia (Figs. 6, 7).

Only the central portion of the shaft of the *femur* (Fig. 6) is preserved, exhibiting the lesser and third trochanters. The shaft is somewhat crushed laterally but exhibits the subcursorial type characteristic of all early Eocene Perissodactyla.

The *tibia* (Fig. 7, A¹⁻³) also has a long relatively slender shaft, laterally compressed, with prominent cnemial process suggestive of that of *Moropus* (Fig. 7, B).

A distinctive feature is the marked reduction of the *fibula*; the lower portion of the shaft is so slender as to indicate that the central portion may have been incomplete. In *Moropus* the fibula has a complete shaft.

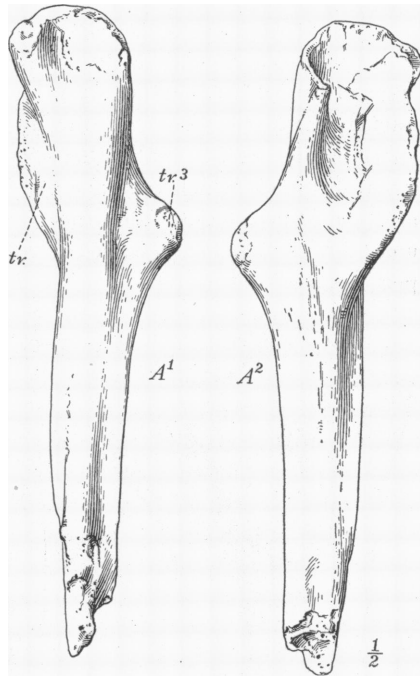


Fig. 6. Crushed femur of *Eomoropus*, type. A¹ anterior view. A² posterior view. One-half natural size. *tr.*, second trochanter; *tr3.*, third trochanter.

Pelvis (Fig. 8).

The portion of the right innominate bone preserved indicates also a subcursorial or relatively rapid-moving type in contrast to the slow-moving, graviportal type of *Moropus*. The figure illustrates the short, rather slender ilium.

Detailed comparison of this pelvic bone with that of *Moropus* reveals many close similarities of structure in the areas of muscular attachment, the borders of the ilium, and the shape of the acetabulum.

5. RELATIONS TO THE PERISSODACTYLA.

Gregory¹ (1910, pp. 397-400) has recently summarized all the characters observed by Depéret (1892), Osborn (1898), Peterson (1907), and himself which relate the chalicotheres to the Perissodactyla.

¹ Gregory, W. K. "The Orders of Mammals." Bull. Amer. Mus. Nat. Hist., Vol. XXVII, Feb., 1910, 524 pp.

The structure of *Eomoropus* absolutely confirms perissodactyl affinity in the dentition and skull, the manus and pes, and the sub-cursorial proportions of the limbs, which are now known to be among the primitive perissodactyl characteristics. At the same time *Eomoropus* points to early specialization of the chalicotheres in Lower or even in Basal Eocene times from the stock which gave rise to the Titanotheroidea, on the one hand, and the Hippoidea on the other. This separation justifies the establishment of the Chalicotheroidea as one of the five great branches of the perissodactyl stock.

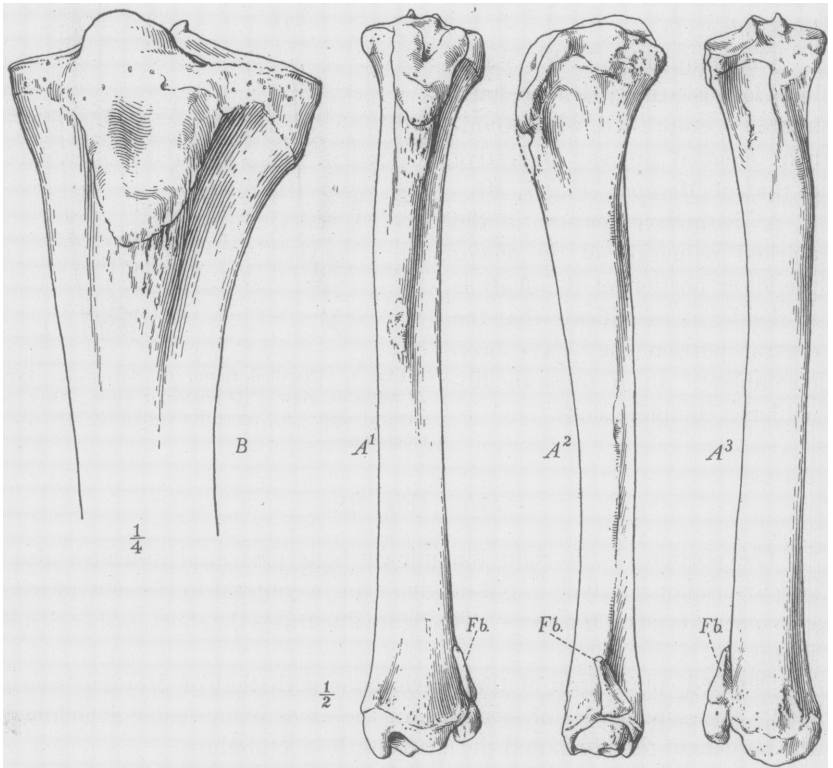


Fig. 7. Tibiæ of *Moropus* and *Eomoropus*. *A*¹ anterior view of left tibia. *A*² external view of the same. *A*³ posterior view of the same. One-half natural size. *B*. *Moropus*, anterior view of upper portion of tibia. One-fourth natural size.

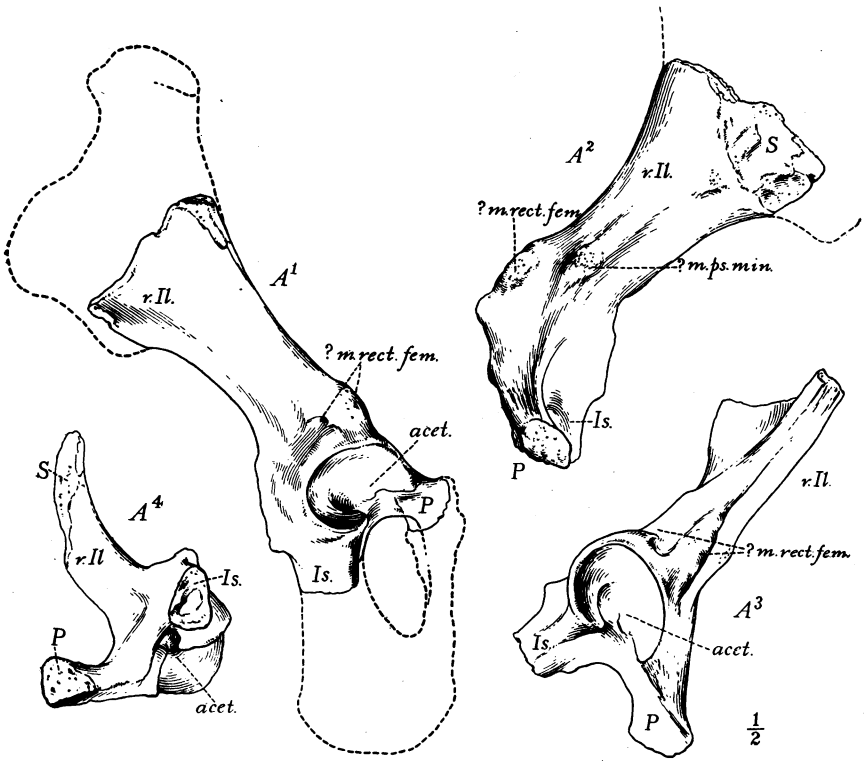


Fig. 8. Right innominate bone of *Eomoropus*, type. A¹ anterior external view. A² internal view. A³ direct external view. A⁴ horizontal view. One-half natural size. ?m. rect. fem., (?) tuberosity for the rectus femoris. ?ps. min., (?) tuberosity for the psoas minor muscle.

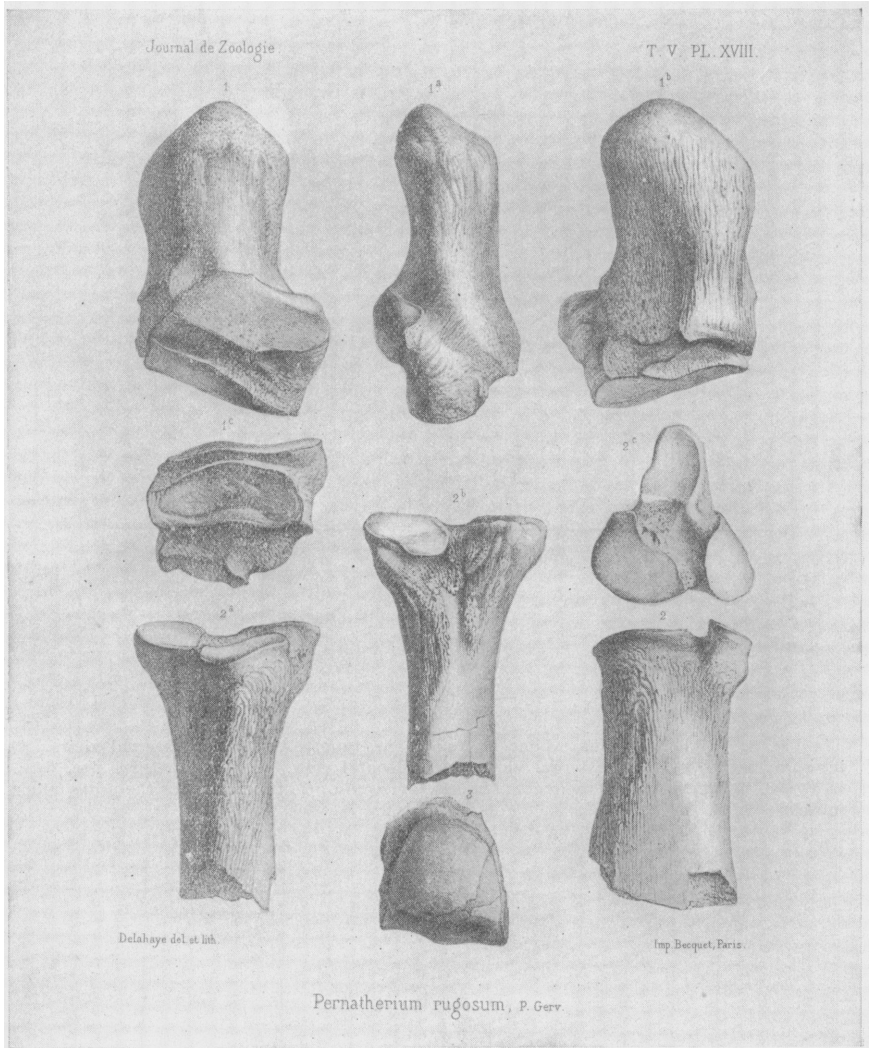


Fig. 9. Type of *Pernatherium rugosum* Gervais. 1, left calcaneum, anterior view; 1a, external view; 1b, posterior view; 1c, distal end; 2, left metatarsal ?IV, external view; 2a, oblique posterior view; 2b, posterior view; 2c, superior view; 3, metatarsal ?, distal extremity. One-half natural size. After Gervais.