Fabrini of the Val d'Arno fauna, with much less reduction of $p\frac{3}{3}$, fourth cusp of p^4 quite rudimentary, no inner cusp on p^4 but a ridge with root supporting it, m^1 very small, oval. $P\frac{3}{3}$ much more reduced than in the Eppelsheim species, and as much more than in the Pikermi species of *Machærodus*. There is no evidence as to the exact length of the upper canine, but the dependent flange of the jaw is moderately developed, and the shallow and gently sloping masseteric fossa indicates a weak, shallow posterior region of the jaw, with small, short coronoid process and the conformation generally of a long-tusked machærodont. The flange was probably associated, as in *Smilodon* and *M. meganthereon*, with relatively considerable length of upper canine. As the affinities of the species appear to be with the latter, it is probable that the canine, as in the Mont Perrier type, was long but rather narrow, unlike the wide blade of *Machærodus* and *Smilodon*.

With *Meganthereon* the species shares:

1. Small two-rooted $p\frac{3}{3}$.
2. Fourth (anterior) cusp of p^4 rudimentary (absent in *M. meganthereon*).
3. Moderate development of anterior and posterior accessory cusps on p_4, the principal cusp much larger.
4. Moderate flange on lower jaw (indicated on type; better shown on *M. palæindicus*).
5. Very short upper jaw, large infra-orbital foramen.
6. M^1 reduced to small oval vestige.

This species appears to be on about as high a grade of development as the Mont Perrier and Val d'Arno forms, and would indicate a Lower Pleistocene stage of evolution.

These specimens all share a type of preservation that suggests their coming from the same strata as *Canis curvipalatus*.

Meganthereon palæindicus Bose

Drepanodon sivalensis Falconer and Cautley (in part).

Machærodus palæindicus Bose, 1880, Quar. Jour. Geol. Soc., XXXVI, p. 125, Pl. vi (in part); Lydekker, 1884, Pal. Ind., (X) II, p. 341 (in part).

The type, as fixed by Lydekker, is No 48436, the anterior part of a lower jaw with p_4 damaged and alveoli of the teeth in front of it. With this Mr. Bose associated a second jaw fragment, No. 48437 with $p_{3\text{-}4}$, and Lydekker a third fragment, No. M1567, with p_4 and the root of p_3. Two crania without teeth, both incomplete and much battered, are likewise referred to this species.

The two referred jaw specimens differ from the type in that they have no trace of flange on the jaw, although preserved far enough forward to indicate it; that certainly in No. M1567 and doubtfully in No. 48437 p_3 is two-rooted; and that the masseteric fossa is comparatively deep and abrupt as in true cats, instead of shallow and gently sloping as in machærodonts. Moreover the heel of p_4 is broad in both referred jaws instead of the rather narrow heel of the type. Both referred specimens appear to be true felines, but they represent distinct species. One or the other is probably the lower jaw of *Felis cristata*.

As to the skulls, they are valueless for species determination. They are machærodonts of large size.

Lydekker observed the absence of symphyseal flange in these two jaws referred to *palæindicus*, but attributed it to sex difference. No such differences occur among

Felidæ so far as I know, and the diversity in the teeth and other comparable parts should alone have prevented associating these specimens under one species.

M. palæindicus rests therefore solely upon the type. It is larger than *M. falconeri* with more robust p_4, the posterior accessory cusp relatively large; the jaw more massive with, so far as one can judge, considerably deeper symphysis. P_3 appears to have a single oval root, whereas in *falconeri* it is partly bi-fanged; but this is perhaps rather individual; at all events it is considerably more robust.

So far as one may judge from such meagre material, the species would appear to be rather nearly related to *falconeri*, but larger and more robust. It has the same sort of preservation as the usual 'boulder-conglomerate' specimens of the Siwalik, whereas all the specimens of *falconeri* come from a light-colored fine-grained sandstone or sandy loess. The type is only a partial exception, coming from a somewhat darker colored sandstone.

Machærodus sivalensis Lydekker

Pseudælurus sivalensis LYDEKKER, 1877, Rec. Geol. Sur. Ind., X, p. 83; (*Ælurogale*), 1884, Pal. Ind., (X) II, p. 317, Pl. XLIV, Figs. 7, 7*a*; (*Paramachærodus*) PILGRIM, 1915, Rec. Geol. Sur. Ind., XLV, p. 142.

TYPE.—Ind. Mus. No. D95, cast in British Museum No. M1560, lower jaw, right ramus with incomplete m_1 and alveoli of canine and premolars.

HORIZON.—Middle Siwaliks.

Pilgrim does not specifically designate any type for his genus *Paramachærodus* but apparently his intention was to take *Machærodus schlosseri* of Pikermi as typical. This is at least a species of which type and topotype material give an adequate knowledge. Pilgrim compares with this species two jaws from the Middle Siwaliks which in my opinion can hardly be co-specific and to judge from his figures are not at all related, one (D140) being a machærodont, the other (D141) a true cat. *P. sivalensis* is too imperfectly known to be certain of its affinities, but probably is near to the D140 jaw, differing chiefly in somewhat more shallow jaw, less vertical symphyseal ridge, presence of minute p_2.

Until better material is known it seems better not to erect more 'new species' for the two jaws figured as *Paramachærodus* cf. *schlosseri*, but to refer the one, No. D140, to *Machærodus sivalensis* Lydekker (not *Drepanodon sivalensis* Falconer and Cautley[1] which = *Megantereon falconeri* Pomel) and the other, No. D141, to *Pseudælurus* (*Metailurus*).

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[1] This confusion of names is a not uncommon result of the bad habit of naming Siwalik genera and species *sivalensis* and *palæindicus* in endless repetition. It is doubtful indeed whether my present reference of the species to *Machærodus* does not invalidate Lydekker's name. In the view of some stern prioriticians it would do so; but as the rule they follow would enable any man to invalidate most specific names by referring the species, however unwarrantably, to some genus in which the name had been used before—and a glance at Sherborn's Index will show how generally the usual run of species names *have* been previously applied somewhere—I regard such a rule as anarchistic and not tending in any degree to fixity of nomenclature.

The practice of this endless repetition of a regional name in the species of a fauna is, however, to be deprecated as not only liable to cause confusion but apt to mislead when the species is found elsewhere, and tending to encourage the multiplication of local 'species' which are mere geographical varieties or wholly baseless.

M. sivalensis may be rather closely related to *M. maximiliani* Zdansky from the Pliocene of China. The three species which Zdansky describes from this fauna appear to be properly referred to the genus as here limited, and his comparisons with *M. aphanista* and *schlosseri* of Pikermi sound.

V. NOTES ON SIWALIK RHINOCEROSES IN THE INDIAN MUSEUM

The Siwalik rhinoceroses in this collection are mostly fragmentary material. Skull of *Aceratherium perimense lydekkeri* is one of the few good specimens.

Aceratherium perimense Falconer and Cautley, 1868

TYPE.—"Some mostly imperfect molars and part of a lower jaw." Perim Island. British Museum. Presumably Middle Siwalik.

?SYNONYM.—"*Rhinoceros*" *planidens* LYDEKKER.

TYPE.—Two partial upper molars figured by Lydekker in Pal. Ind., I, p. 41, Pl. v, Figs. 7 and 9, from Gadari in Siwaliks, Nos. 56 and $\frac{N}{7}$. These are now renumbered C13 and labelled as from Padhri and Lower Siwalik.

Lydekker in 1878, (Rec. Geol. Surv., XI, p. 95), referred to this species "a large series of the upper and lower dentition" collected by Theobald in the Siwaliks of the Punjab, most or all from Hasnot. He does describe two of them at some length, m^2 and m^3 of right side, complete and moderately worn, contrasting them with *R. sivalensis*.

Type of *R. planidens* is therefore apparently Lower Siwalik and presumably does not preoccupy Pilgrim's *lydekkeri*, of which the type is Middle Siwalik.

These aceratheres are a group apart, perhaps descendant from the European *Aceratherium*, but the teeth considerably more advanced, higher-crowned, more complex pattern. There is little or nothing in the teeth except size to distinguish them from *Chilotherium*, but the skull differs considerably. Teeth have moderate development of crochet, weaker antecrochet, rudimentary or no crista, same tendency to pinch off protocone as in *Chilotherium* species but not so marked.

Skull is more distinctive, but not much like those of the true aceratheres, more like a specialized exaggeration of *Chilotherium*. Short, wide, flat-topped frontal region, the nasals more withdrawn than in *Chilotherium*, but reduced in somewhat similar manner.

A. lydekkeri is stated by Pilgrim to differ from *perimense* by the characters pointed out by Lydekker; but the only character I can find in his statement is that the cingula are more developed. Otherwise Lydekker says that the teeth "clearly belong to the same species."

Pilgrim reports an *Aceratherium* "very nearly allied to *A*. to *tetradactylum*" and "in the same stage of development" from the Chinji, but I have not seen the specimens.

Chilotherium intermedium Lydekker

TYPE.—No. C34, a second right upper molar from the Lower Siwaliks of Sind. Figured in Pal. Ind., (X) II, Pl. v, Fig. 2; and III, Pl. I, Fig. 3.

A fine series of upper teeth r. and l., from Chinji, No. $\frac{K16}{219}$; C100 agrees with this except for slightly smaller size.

This is close to *C. blanfordi* Lydekker of the Bugti Hills, differs chiefly in more prominent antero-external pillar and protocone less constricted off. Doubtful if really separable.

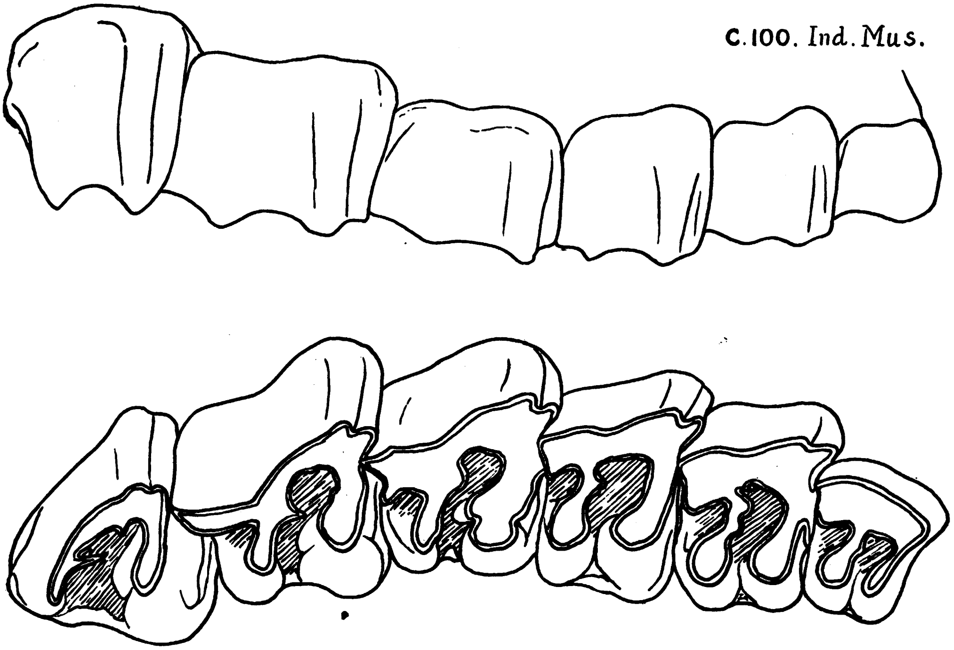

Fig. 32. *Chilotherium intermedium* Lydekker. Upper dentition of a referred specimen No. C100 in the Indian Museum. External and crown views of teeth, half natural size. Lower Chinji beds, Lower Siwaliks.

No. B293–294, p^3 preformed under milk teeth, is slightly larger than p^3 of No. C100 and the antero-external pillar somewhat more prominent.

On the other hand, the Middle Siwalik specimen figured by Lydekker in Pal. Ind., (X) II, Pl. VI, Fig. 1, as *R. palæindicus*, is something quite a bit different. Considerably smaller, teeth appear to have less transverse width, protocone less constricted, crochet more prominent. The postfossette on p^4 circular. This is from Niki, No. C 50.

A maxilla from Hasnot with extremely worn teeth comes nearer to the *blanfordi-intermedium* type, so far as one can judge from the remnants of pattern. It is somewhat smaller (not much, if allowance is made for wear), the *pr* is strongly constricted off on m^3, the antero-external pillar decidedly weaker, and a crest or basal cingulum at postero-external angle, making the form of the ectoloph quite different.

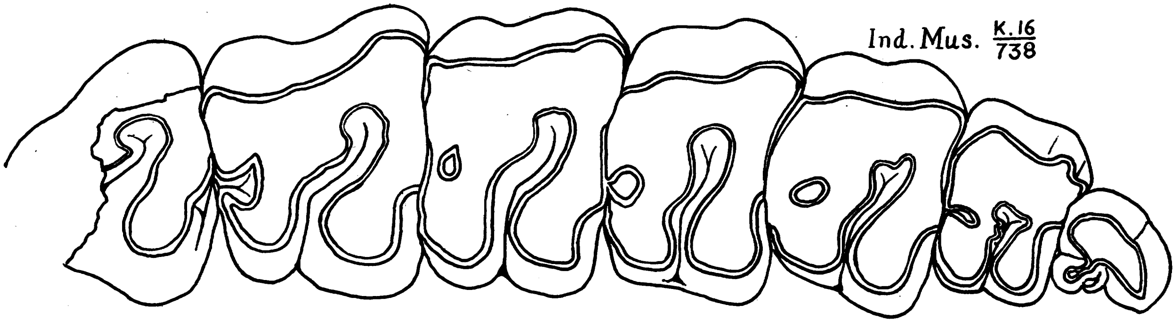

Fig. 33. *Rhinoceros ?sivalensis.* Crown view of upper dentition, half natural size, from a referred palate in the Indian Museum, No. $\frac{K16}{738}$. Middle Siwaliks.

Rhinoceros sivalensis Falconer and Cautley

No. $\frac{\text{K16}}{738}$ is a palate with some part of skull, all cheek teeth but m^3 l.; but m^3r. is shattered and incomplete. Larger than preceding, intermediate size between "*A.*" *lydekkeri* and *C. intermedium.* Horizon uncertain, gray sand matrix. Believed by Pilgrim probably Middle Siwalik.

Anteroexternal buttress is weak. Protocone not constricted off. Moderate crochet on m^3, the others are too much worn to show any. Postfossette retained on all teeth, valley open on all teeth although heavily worn. Total length of pms 1–4 slightly less than molars 1–3. The premolars are more molarized than in *intermedium;* the external face shows more of a buttress and is concave behind it in p^2-^{4}. This is also a marked distinction from *A. lydekkeri* upper jaw (Pal. Ind. (X) II, Pl. II).

This palate appears to agree fairly well with the type skull of *R. sivalensis,* so far as one can judge from the figures in Fauna Antiqua Sivalensis.

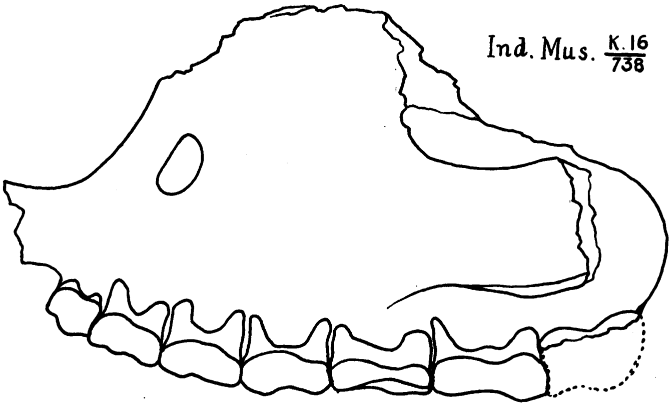

Fig. 34. *Rhinoceros ?sivalensis,* palate, No. $\frac{\text{K16}}{738}$ in the Indian Museum, left side view, one-fourth natural size. Middle Siwaliks.

"Diceratherium" naricum Pilgrim and **"D." shahbazi** Pilgrim

The construction of the teeth appears to be essentially the same as in "*Teleoceras*" *blanfordi.* M^2 in type of "*D.*" *shahbazi* appears of considerably less transverse width than in *blanfordi,* but there is little difference in the proportions of m^3, and the apparent difference in m^2 may be partly due to imperfection of the specimen. The premolar crests in *D. naricum* type are all completely separate; in *D. shahbazi* type p^4 is partly joined internally, and in smaller referred specimens p^2-^{3} and p^3-^{4} show this same imperfect separation even more markedly. Probably this is a highly variable character in these smaller species. The protocone of the molars is constricted off in the same manner as in *blanfordi,* and to about the same degree, although somewhat variable. Crochet moderately strong and disappears near base of tooth. Traces of true antecrochet on type of *D. shahbazi* only, limited to upper part of tooth, but no trace of it in other molars somewhat less worn than these. This, also, I take to be a variable character.

Heavy cingulum on molars on types of both species, absent on premolars of $\frac{K11}{676}$, which is of smaller size and otherwise peculiar. It is likely that there are different small species here, but not enough material to determine them.

I hardly think that these small, relatively brachydont rhinoceroses, with more primitive, although variable, construction in the molars, can be placed in the genus *Chilotherium*. They are probably a pro-*Chilotherium* group, but I do not know what name would apply. They may be congeneric with "*Diceratherium*" *pleuroceros* and *asphaltense.*

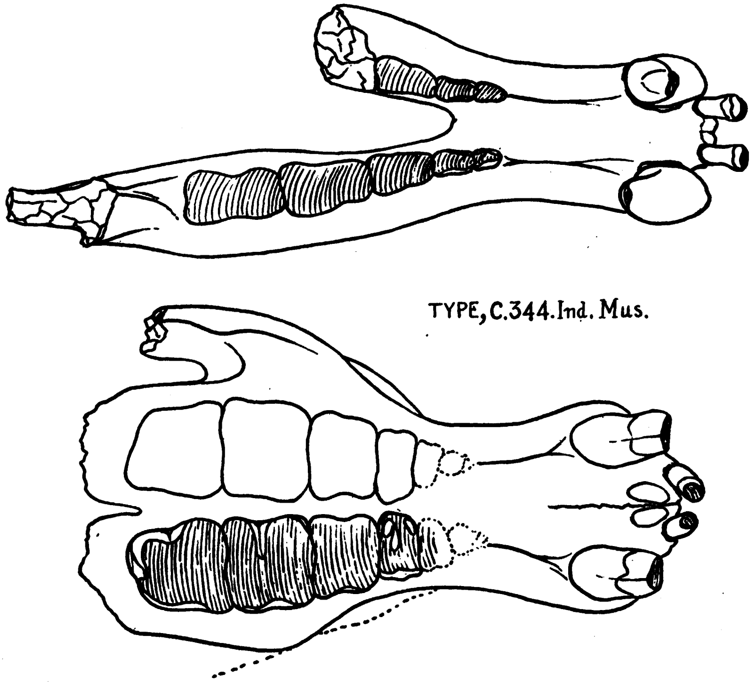

Fig. 35. *Paramynodon cotteri* (Pilgrim). Palate and lower jaws one-fourth natural size, crown views of dentition from the type specimen, Ind. Mus. No. C344. Upper Eocene, Pondaung beds, Burma.

There is a small rhinoceros (or more than one) in the Middle Siwaliks (upper jaw figured by Lydekker in Pal. Ind., (X) II, Pl. VI, Fig. 1) that is not much larger than the above forms, but may be descended from them. Note slit-like i.o.f. above anterior end of m^1, teeth relatively narrow transversely, protocone not so much pinched off, apparently, on m^2, posterior fossa on p^4 circular and *pr* and *hy* on p^4 slightly connate. Possibly No. C28 goes with this (p^2-^{3}l.), but not same individual.

VI. INDIAN MUSEUM NOTES UPON THE PONDAUNG FAUNA OF BURMA (UPPER EOCENE)

Paramynodon, new genus

"Metamynodon" birmanicus Pilgrim and Cotter

"Metamynodon" cotteri Pilgrim

?More hypsodont than *Amynodon.*

Certainly more hypsodont than *Orthocynodon.*

Incisors appear to be reduced to $\frac{2}{1}$ in place of $\frac{3}{3}$ as in our forms, and are short, stubby, wider anteroposteriorly than transversely.

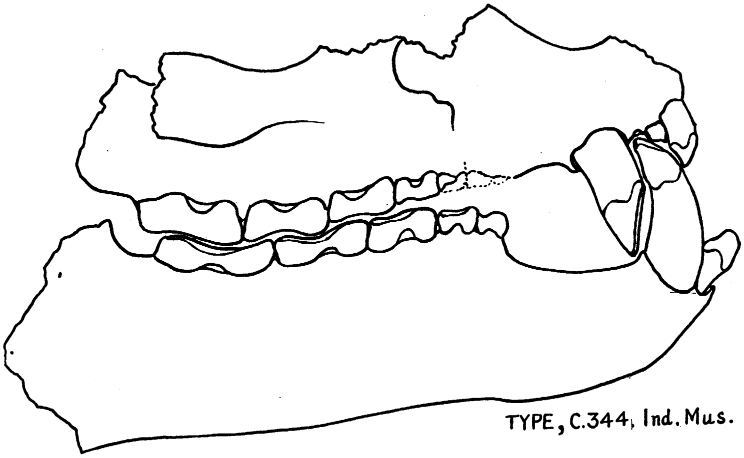

Fig. 36. *Paramynodon cotteri,* right side view of palate and lower jaws, type specimen No. C344, Indian Museum. One-fourth natural size. Pondaung Eocene, Burma. The number of upper premolars in this specimen is wholly uncertain in the present stage of preparation. Pilgrim thinks that p^1 is probably present; it would seem very doubtful at best. P^4 is large and broad, partly concealed by m^1. There are pretty surely three upper incisors, of which i^3 is quite small, represented only by the alveolus; the root of i^2 is present.

Canines wholly tagassuoid (peccary type).

Skull narrow and elongate, with long diastema.

Premolars considerably reduced, $p_{3\text{-}4}$ longer than m_1 but less than m_2.

Lower molars narrow, but transverse crests are not so oblique as in *Metamynodon,* more perhaps than in *Amynodon,* certainly more than in *Orthocynodon.*

Appears to be nearer to *Amynodon* than to *Metamynodon,* but a partly intermediate, partly aberrant genus.

The *Cadurcotherium* from Gaj beds is also of intermediate type between *Metamynodon* and the large *Cadurcotherium.*

Paramynodon cotteri

TYPE.—Palate and jaws, No. 344.

MEASUREMENTS.—

Length, i^1 to back of palate as preserved	326
Length, m^3 to c^1 inclusive	262
Length, m^{1-3} inclusive	136
Diameter of canine, a.-p.	30
Depth, m^2 to base of orbit	93.5
Depth, m^3 to top of zygomatic arch preserved	98
Depth diastema to floor of nares	61
Depth premax. crest to tip of canine	114
Depth zygoma behind orbit	47
Diameter i^1 a.-p.	16.8
Lower jaw, depth back of m_3	106.5
Lower jaw, depth m_1	102
Lower jaw, depth back of diastema	72.3
Lower jaw, depth front of diastema	47
Lower jaw, total length preserved	388
Lower jaw, cheek teeth in front of m_1	57.5
Lower jaw, total length cheek teeth	176.5
Lower jaw, length diastema	79
Lower jaw, diameter c_1 at base	30
Lower jaw, height c_1 above diastema	60.5
Lower jaw, diameter of incisor	17

The teeth of this specimen are greatly worn, so that the pattern is almost wholly obliterated on the molars and nearly gone on the premolars. The molars of the left side are clear, but on the right side the crowns of the lower molars are fast to the crowns of the upper teeth and have not been disengaged, so that neither is visible completely. Tips of canines have been considerably damaged and restored with plaster and the muzzle has been roughly cemented with plaster to the rest of the skull, covering up some of the construction. Skull is considerably crushed laterally and was broader than appears in the drawing, but is not so broad as *Metamynodon*, arch not so deep, muzzle longer, teeth more vertical (cf. *Orthocynodon*). Proportions and patterns of teeth appear to be intermediate in most particulars between *Amynodon* and *Metamynodon*, but premolars less pocketed than *Metamynodon*, much less than *Cadurcotherium*.

Contrasted in length of diastema, uprightness of canines, pocketing of molars, etc., with *Cadurcotherium mongoliense* as figured by H. F. Osborn. Should be a separate genus "*Paramynodon.*"

Lower Miocene *Cadurcotherium* (Bugti).
Upper Oligocene *Cadurcotherium* (Eur.).
Middle Oligocene *Cadurcotherium* (Eur.), *Metamynodon* (Amer.).
Lower Oligocene *?Cadurcotherium* (Mong.), *Metamynodon* (Amer.).
Upper Eocene *?Amynodon* (Mong.), *Amynodon* (Amer.), *Paramynodon* (Burma).
Middle Eocene *Orthocynodon* (Amer.).

Paramynodon birmanicus Pilgrim and Cotter

Figure 37

Metamynodon? birmanicus PILGRIM AND COTTER, 1916, Rec. Geol. Sur. Ind., XLVII, p. 65.

The type of this species is part of a lower jaw with five worn teeth; the paratypes are upper and lower teeth, mostly isolated; Nos. 345 and 346 were obtained later, and described by Pilgrim in a later memoir.[1] No. 346 shows M^2-^{3} of the left side and p^4-m^2 of the right side. The p^4 and m^1 are reversed in the drawing. It is a somewhat larger individual than No. 345, the teeth less worn; the premolar construction is the same in both but m^2 shows more apparent elongation; this may be due to greater size plus less wear.

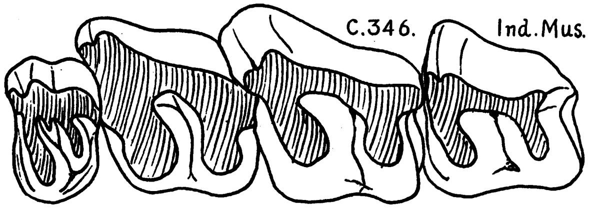

Fig. 37. *Paramynodon birmanicus.* Upper teeth, half natural size, crown views. From a referred specimen, No. C346, Ind. Mus., identified by Dr. Pilgrim; the teeth preserved are m^2-^{3} l., p^4-m^2 r. (p^4-m^1 reversed in drawing). M^3 has been figured by Pilgrim in Pal. Ind., N. S., VIII, No. 3, Pl. II, Fig. 3. This specimen is less worn than No. C345, but the construction of the teeth seems to be identical, the size slightly larger; m^2 shows more apparent elongation antero-posteriorly, but this may be due to larger size plus less wear. From the Pondaung Eocene of Burma.

Chasmotherium birmanicum Pilgrim

Figure 38

Founded on a lower jaw, the only specimen. Appears to be related to *Teleolophus* and *Deperetella* of the Mongolian Eocene. Smaller than *Deperetella* and lower crowned molars, premolar less fully molariform, and broader and shorter anteroposteriorly. The premolar is more advanced than in *Teleolophus,* the molars of about the same size, but the size of the teeth from p_4-m_3 is more uniform, less increase in size than in *Teleolophus.*

Probably this is not *Chasmotherium,* but careful comparison with Depéret's and Stehlin's material would be advisable. It is certainly distinct from *Indolophus.*

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[1] Pilgrim, 1925, Perissodactyls from the Eocene of Burma. Pal. Ind., N. S., VIII, No. 3.

Indolophus guptai Pilgrim

Figure 39

Founded on upper teeth, the only specimen. The teeth p^2-m^1 are almost unworn and compare best with *Parisectolophus* and *Isectolophus*. The pattern has some very primitive features, reminiscent of *Eohippus;* nothing like it in the Mongolian Eocene I should place it among the Tapiroidea, probably in the family Parisectolophidæ but not nearly related to any genus that I recall.

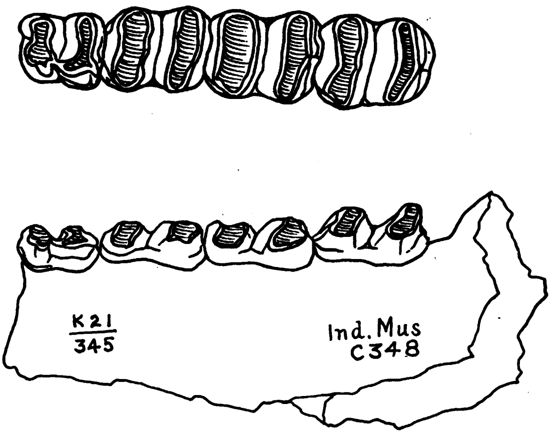

Fig. 38

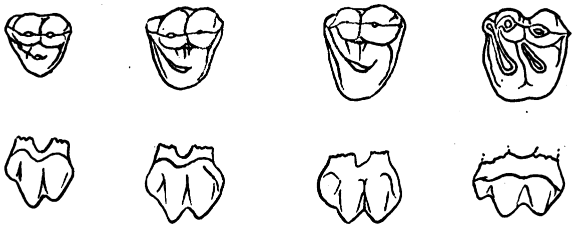

Fig. 39

Fig. 38. *'Chasmotherium' birmanicum* Pilgrim. Type specimen, Ind. Mus. No. C348, natural size, crown and external views of teeth. Pondaung Eocene of Burma. This species appears to be related to *Teleolophus* and *Deperetella* of the Upper Eocene of Mongolia, but its exact affinities are uncertain. It is probably not *Chasmotherium* and certainly distinct from *Isectolophus* of the American Upper Eocene.

Fig. 39. *Indolophus guptai,* upper premolars and first molar, natural size, crown and external views. Type specimen, Ind. Mus. No. C347, from the Upper Eocene of Burma. The affinities of this genus are probably with the *Parisectolophus* group of the American Eocene.

Undescribed Ruminant

Figure 40

A lower jaw fragment, Fig. 40, represents a small primitive ruminant about the size of *Archæomeryx* (Eocene, Mongolia) or *Tragulus.* Molars rather brachydont; premolar has doubled posterior ridge as in *Leptotragulus*, some camels, some "tragulids," etc. There is a slight trace of a metaconid on the inner ridge of p_4. Affinities are with Traguloidea or Tylopoda, exact position indeterminate.

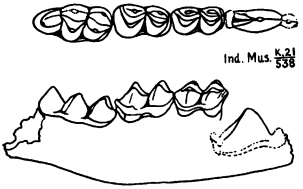

Fig. 40. Undescribed ruminant jaw from the Pondaung Eocene of Burma, Ind. Mus. No. $\frac{K21}{538}$. Natural size, crown and external views.

VII. CRITICAL OBSERVATIONS ON THE SIWALIK PERISSODACTYLS IN THE BRITISH MUSEUM

I. CHALICOTHERIIDÆ

Chalicotherium (Circotherium) sivalense Falconer and Cautley

?Anoplotherium posterogenium FALCONER AND CAUTLEY, 1835, Jour. Asiat. Soc. Bengal, IV; *ibid.*, VI, p. 358. [No description.]

Anoplotherium sivalense FALCONER (? and Cautley), 1836, Trans. Geol. Soc., (II) V.

Anoplotherium sivalense FALCONER AND CAUTLEY, 1843, Geol. Proc. No. 98, Pl. II; FALCONER, Palæont. Mem., I, p. 191.

Chalicotherium sivalense FALCONER AND CAUTLEY, 1847, Fauna Antiqua Sivalensis, Pl. LXXX; FALCONER, 1868, Palæont. Mem., I, p. 208.

The first valid description appears to be 1843, the earlier citations being merely nomina nuda. The type, B. M. 15366-7, is the right and left upper jaws of the same individual, Figs. 1 and 2 of the 1843 publication, Figs. 2 and 3 of Faun. Ant. Siv. Teeth preserved are p^2-m^3 l., p^4-m^3 r. The front of skull with p^2-m^1 and c_1 and p_2? is a referred specimen,[1] and so is a figured lower jaw with p_4-m_3 and alveoli of p_{2-3}.

Absence of both upper and lower incisors seems to be demonstrated; the extreme reduction of anterior part of muzzle as compared with *Moropus* is probably associated with this fact. The molars are quite near to having the size of *Moropus.*

Nothing preserved of skeleton.

NESTORITHERIUM Kaup

Cope (1881, Proc. Am. Phil. Soc., XIX, p. 396), says that there is no transverse ridge in *C. sivalense*, for which he retains the term *Nestoritherium* Kaup (1859, Beitr., Part IV, p. 3). Holland, however (1914, Rev. Chalic., Mem. Carn. Mus., III, No. 2), states that *Nestoritherium* applies primarily to the Pikermi genus and therefore cannot be used for *C. sivalense*, for which he therefore erects the new genus *Circotherium.*

Whether or not *Nestoritherium* can be used, as Holland uses it, for the Pikermi chalicothere, turns upon whether Kaup in 1859[2] based it

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[1] Original probably lost; cast in British Museum (Natural History), No. M2710.

[2] Beitr., Heft IV, p. 3.

upon Wagner's *Rhinoceros pachygnathus*, or upon an upper jaw referred to *R. pachygnathus* by Wagner. In the former case it is a rhinoceros related to *Atelodus*, if not a synonym of that genus. In the latter case—if Kaup distinguished the upper jaw from the type material of Wagner's species—it is based upon that unnamed upper jaw—not, as Holland has it in one place, upon *R. pachygnathus*. It is, however, properly citable as based upon '*R. pachygnathus*' Wagner, 1857, *in parte*, VII, Fig. 15. A genus is based upon a species, but this is a species without a name until it was synonymized with the earlier described *Macrotherium pentelici*, subsequently made type of *Ancylotherium*. It is really '*species innominata*, Kaup, 1859' that is the type of *Nestoritherium* under our second supposition.

I cannot verify from Kaup which is correct, as I have not access to the fourth section of his Beiträge at present.

Holland has made subfamilies out of these closely related genera upon what appear to me quite inadequate distinctions: presence or absence of a vestigial fifth digit in the manus, etc. As well place *Hipparion* and *Pliohippus* in separate subfamilies because the former has lost (in some species) the lateral rudiments of tm. and mc. V which the latter has retained—or *H. gracile* and *whitneyi* because of differences in the proportions of the feet.

Holland's classification is further untenable in that it places in the subfamily Schizotheriinæ the genus *Eomoropus* which is far more remote and primitive than *Schizotherium*, and *Phyllotillon* which is more advanced and close to *Moropus*.

Phyllotillon (Bugti horizon) is decidedly more hypsodont than *Macrotherium* and its allies, compares closely with *Moropus* in proportions of its molars, pattern, hypsodonty, etc.

MACROTHERIUM

Macrotherium salinum of Cooper (Chinji horizon) is brachydont like *M. grande* of Sansan, but slightly more primitive, as the anterior inner crest is somewhat better developed. It is a rather small species.

I think it may be taken for granted that Gervais' restoration of the feet of *Macrotherium* is wrong in many more points than those altered by Holland. The relative proportions of the metacarpals are as in *Moropus* and it is probable that phalanges 1 and 2 of digit II were united; phalanx 1 *must* have been more elongate to reach the ground; also doubtful whether the large claws given to phalanges 3 and 4 are correct. In the hind foot I *think* the phalanges were *all* much broader and shorter than in *Moropus*, as the metatarsals are known to have been.

Our specimens from the Colorado Miocene which I referred doubtfully to *Moropus* in 1899 and 1901 include teeth and foot bones; there are also a few foot bones and a lower molar from the Sheep Creek beds. These should be *critically* examined to see if they agree with *Macrotherium.* Also Merriam's Virgin Valley "*Moropus.*"

Macrotherium grande from Sansan is a little larger than *M. salinum,* equally brachydont, as are all the following series. The anterior transverse crest is slightly more reduced, the protocone almost wholly isolated, but there is still a strong crest that extends inwards to a point directly anterior to apex of protocone, and a faint ridge that connects this crest with the apex on m^3; hardly to be seen on m^1 or m^2. P^4 has the anterior ridge still strong, but short and not connecting with deuterocone (= *pr* of molars). The posterior ridge present as usual.

?SCHIZOTHERIUM

Schizotherium pilgrimi certainly is not the milk dentition of *Phyllotillon,*[1] and has every appearance of being permanent dentition of a brachydont chalicothere of quite small size and very primitive construction of the teeth, the anterior transverse crest being more normally developed and protocone less isolated and less shifted in position than in any Miocene genus. I suspect that Cooper's identification indicates that *Schizotherium* belongs, some species at least, in the chalicotheriine series as defined below, as the earliest stage of its development.

CHALICOTHERIUM

In *Chalicotherium goldfussi* from Eppelsheim (casts of type teeth in British Museum) the protoloph is further reduced than in *Macrotherium* and tends to end in a little conical cusp (protoconule) entirely separated from the protocone, which is somewhat crested anteroposteriorly, especially toward apex.

A fine palate from Nikolsburg in Moravia (figured as *C. goldfussi* in Abel's Lebensbilder a. d. Vorzeit, p. 119, Fig. 108) is intermediate between typical *Macrotherium* and typical *Chalicotherium* as judged from cast in British Museum.

CIRCOTHERIUM

Circotherium sivalense, also a brachydont type, is somewhat smaller than *Chalicotherium,* and the protoloph has entirely disappeared—certainly on m^3, apparently on m^2 and m^1. Also the anterior crest on all the premolars has disappeared.[2] In the lower jaw the anterior wing of the anterior crescent (protoselenid) is better developed than in the older genera. These seem to be adequate generic characters to validate Holland's genus *Circotherium.* Holland specifies certain characters as generic[3] none of which distinguish it from *Chalicotherium,* its nearest ally, although they distinguish it from '*Nestoritherium*' and *Moropus* (the hypsodont phylum). He does not seem

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[1] Compare milk teeth of *Moropus* which are quite unlike, both in proportions and pattern. *Phyllotillon* milk teeth ought to be very like those of *Moropus,* as are the permanent teeth.

[2] This presumably is what Pilgrim had in mind when he spoke of *Phyllotillon* having a double transverse crest unlike other members of the family. It *is* unlike the other Indian and Chinese chalicotheres. Holland could not understand Pilgrim's statement.

[3] Among them that m^2 is longer than broad. This is an error.

to have paid any attention to the disappearance of the protoloph, but it is difficult to interpret some of his observations[1] on the upper teeth of *Moropus* (*loc. cit.*, p. 246).

Circotherium sinense (Owen, 1870) is larger than *C. sivalense*, of about the same proportions, and the protoloph has wholly disappeared. The protocone is more clearly round-conical than in *sivalense*.

The real relations of the species of Chalicotheriidæ appear to be represented in the following table:

CLASSIFICATION OF THE CHALICOTHERIIDÆ

I. Eomoropinæ. Primitive genera with only a suggestion of chalicothere features in the molars, manus functionally tetradactyl, pes tridactyl, very slight if any compression of the ungues, dentition unreduced, m_3 with well developed third lobe, in all characters nearly related to the earlier Eocene Titanotheriidæ.

1. *Eomoropus amarorum* (Cope). Middle or Upper Eocene, Wyoming.
2. *Eomoropus* Peterson. Upper Eocene, Utah.

II. Chalicotheriinæ. Fully developed chalicothere dentition; upper incisors absent so far as known, upper molars anoplotheroid, with outer double crescents and two inner crests, the anterior of which (protoloph) curves around backward to join a semi-isolated conical protocone, or is more or less degenerate. No third lobe on m_2 (tiny vestige in early forms). Feet functionally tridactyl, with compressed, claw-like, fissured unguals, larger and more compressed on manus, and especially on the second digit.

A. Brachydont Series.

Molars short-crowned, width and length about equal. Fore foot tridactyl (vestigial mc.V and tm. in earlier forms), characters much as in *Moropus;* hind foot short, astragalus shallow, cuboid facet of uniform width from front to back (as in artiodactyls and Mesonychidæ), unguals of pes broader, little compressed.

? 3. *Olsenia mira.* Upper Eocene, Mongolia (provisional).[2]
?4. *Pernatherium rugosum.* Upper Eocene, France (provisional).
5. *Schizotherium priscum,* etc. Phosphorites, France.
6. *Schizotherium turgaicum.* Oligocene, Kirghiz, Siberia.
7. *Schizotherium avitum.* Lower Oligocene, Mongolia.
8. *Schizotherium pilgrimi.* Lower Miocene (Bugti), Baluchistan.
9. *Macrotherium salinum.* Upper Miocene (Chinji), India.
10. *Macrotherium grande,* etc.[3] Middle Miocene (Sansan), France.
?11. *Macrotherium* sp. Middle Miocene (Sheep Creek,) Nebraska.
?12. *Macrotherium matthewi.* Middle Miocene (Pawnee Creek), Colorado.
?13. *Macrotherium merriami.* Middle Miocene (Virgin Valley), Nevada.
14. *Macrotherium rhodanicum.* Upper Miocene (La Grive), France.
15. *Chalicotherium "goldfussi."* Lower Pliocene (Nikolsburg), Mähren.

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[1] *Inter alia* his use of *metacone* for the *antero-internal* cusp commonly known as protocone in the perissodactyls, points to some theory of the origin of the teeth that I do not understand, and which may have affected his interpretations in some unknown manner.

[2] There certainly are chalicotheres related to or identical with *Schizotherium* in the Upper Eocene (Irdin Manha or Shara Murun) of Mongolia; but it has not been determined whether the foot bones associated with these jaws are the same animal as the astragalus on which *Olsenia* was founded. If *Olsenia* belongs in the chalicotheres at all, the character of the astragalus throws it into the brachydont sequence.

[3] *M. sansaniense, magnum, giganteum, secundarium, minus,* from Sansan alone. There may be more than one species, but I doubt whether there are six.

?16. *Chalicotherium baltavarense.* Upper Miocene, Hungary.
17. *Chalicotherium goldfussi.* Lower Pliocene (Eppelsheim), Germany.
18. *Circotherium sivalense.* ?Lower Pleistocene (Upper Siwalik), India.
?19. *Circotherium sindiense.* Horizon uncertain. Siwaliks of Sind.
20. *Circotherium sinense.* Lower Pleistocene (Wanhsien), China.

B. HYPSODONT SERIES.

Molars higher crowned externally, length anteroposteriorly considerably exceeding width. Fore foot in *Moropus* (otherwise unknown) functionally tridactyl, with a small mc. V; length of metacarpals increasing from II to IV, the second digit most robust, with largest claw and coössified 1st and 2nd phalanges. Hind foot shorter than fore foot (but not so short as in the brachydont series), with more normally proportioned rhinocerotoid astragalus, but having slight or no cuboid articulation, claws of pes small but compressed, higher than wide.

(5*a*). *Schizotherium* sp. It is possible that some of the material referred to *Schizotherium* will fall into this series. See Holland, *op. cit.*, p. 247.

21. *Moropus senex.* Lower Miocene (John Day), Oregon.
22. *Moropus cooki.* Lower Miocene (Lower Harrison), Nebraska.
23. *Moropus elatus*[1]. Lower Miocene (Upper Harrison), Nebraska.
24. *Phyllotillon naricus.* Lower Miocene (Bugti), India.
25. *Nestoritherium pentelici.* Lower Pliocene (Pikermi, etc.), Greece.

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[1] Information from Mr. Harold Cook would appear to show that the locality whence the type material of *M. elatus* was secured for Professor Marsh was not, as Holland supposed, at or near Agate, Nebraska, but a small outcrop where early digging had been done near Marsland, Nebraska, and from which Mr. Harold Cook secured additional material of *Moropus*. This additional material is stated to resemble exactly in preservation and characters the typical material of *Moropus elatus*, although I do not understand that any actual fits of fragments have been made [fitting fragments would prove the point beyond cavil]. However, the Marsland locality was near to the recorded track of Hank Clifford, the finder of *M. elatus*, as shown by his letters to Marsh and other evidence, whereas the Agate locality is eighteen miles away from it, an unlikely distance for a collector to cover in casual sidetrips from his route in the pre-automobile days.

In a letter dated September 23, 1927, Mr. Harold J. Cook wrote as follows:

"A few years ago, my brother and I located a spot some eighteen miles east of Agate, Nebraska, in the hills along the Niobrara Valley, from which we obtained *Moropus* and other material, closely comparable to the Marsh types, and under conditions that made it seem most likely that this was the spot from which Hank Clifford had obtained the original *Moropus elatus* material which Professor O. C. Marsh described. . . .

"This fossil pocket, above mentioned, was found within a comparatively short distance of the old stage road crossing on the Niobrara, where Hank Clifford lived about the time he did that collecting for Marsh. The pocket had been somewhat excavated a good many years prior to the time we found it, (as testified by its condition, and the size of plant growth upon it, including old wood and plants of Sumac (*Rhus trilobata*) on the dump) and was in a situation and locality and condition which would agree with the probability of its being a spot worked by Clifford. There is no evidence, either direct or indirect, that he ever went as far off the usual trails, and as far away from the roads as the location of the Agate Springs Fossil Quarries would demand in doing his collecting; and at the time of the discovery of the Agate Springs Fossil Quarries, they showed no evidence of ever having been previously dug into by anyone. On the other hand, the location of this pocket is almost directly in line with Clifford's trip during which *Moropus* types were secured and sent to Marsh, whereas the Agate Springs Fossil Quarry locality is some fifteen to eighteen miles at right angles and to one side of the line of all usual travel at that time; and in a spot not at all likely to be prospected first by any collector examining the region. This pocket, which is something like six miles west of Marsland, Nebraska, is located in the lower part of the Upper Harrison beds, whereas the Agate Springs Fossil Quarries and the *Moropus* obtained there are some sixty feet below the top of the Lower Harrison beds. Compared with the Marsh types, the material we found in this pocket agrees very closely in type, color, and condition of fossilization; and might equally well be referred in type to either *M. elatus* or the Lower Harrison species.

"This material was sent on to the American Museum of Natural History for comparison, and was studied by Dr. Matthew."

If, however, the type of *elatus* came from Marsland, it is quite certainly from the Upper Harrison and not from the Lower Harrison of the Agate quarry. As the species of *Moropus* and of nearly all other mammals are distinct in these two faunas, it makes it practically certain that *elatus* is identical, not with the Agate *Moropus*, but with the distinct species from the Upper Harrison which Peterson has named *M. hollandi;* and that the Agate species, named *M. cooki* by Professor Barbour, is distinct from *elatus*.

TAXONOMIC VALUE OF SERIES A AND B

Holland attributes subfamily value to the differences between *Macrotherium* and *Moropus*, the only genera of the two series that are at all well known. This is much more defensible than the association of *Eomoropus, Schizotherium* and *Phyllotillon* in a third separate family. There is no question that the two series differ considerably and the usage of many authors would warrant giving subfamily rank to these differences. The difficulty lies in the disproportionate rank of the differences that separate *Eomoropus* from the rest as compared with the far closer structural resemblance throughout in series A and B. It might be maintained that *Eomoropus* represents a primitive ancestral group from which the others have specialized along closely parallel lines. But it is doubtful whether this is really the case, unless it is a little-altered survivor persisting in a marginal region of dispersal long after true specialized chalicothere characters had been fully assumed by the family in the region where they originated. For *Eomoropus* is only slightly (Peterson's species not at all) older than the Irdin Manha chalicotheres of Mongolia, which are fully specialized, yet it shows only the most rudimentary traces of the specializations peculiar to the family.

The current taxonomy of the perissodactyls insists on splitting up the primitive Eocene members, all much alike and little specialized, into the several specialized families of the later Tertiary to which each group or genus is thought to be related. In some cases this relationship is evident, in others doubtful or indirect, in others has been almost certainly wrongly determined. If we adhere to this 'phylogenetic' method we must place *Eomoropus* in the Chalicotheriidæ until some earnest phylogenist, discovering (what is perfectly obvious) that it is not a direct ancestor of the later chalicotheres, proceeds to erect it into a new family. Then he can quite logically hold to the subfamily value of our series A and B, or indeed erect them into separate families. This procedure has resulted and will continue to result in endless splitting up of families, with no gain to science (for the phyletic relations can be quite easily stated without altering the taxonomy) but with serious loss in the continually changing concept of the scope of a family, and in the varying concepts of that scope between families that have and families that have not been subjected to the attentions of the phylogenist.

A much more practical procedure, conformant with the standardized concept of the scope of families of the Mammalia, would be to combine most of the Eocene perissodactyls in a single family, Lophiodontidæ, as was done by Cope, Lydekker and others, on the basis of the well provable generalization that the divergence of the perissodactyl stocks in the Eocene had not yet attained 'family' value. Such a family is easily defined by structural facts; the phylogenetic families are only definable by what the earlier members are going to do (in the opinion of the student). This is essentially to substitute a theory of relationship for facts of structure—an unnecessary and dangerous procedure in taxonomy. A phylum or line of descent does *not* have to be identical with a family or natural group. A man's sisters and cousins are quite as closely *related* to him as his great-great-grandchildren, and the twigs and branches at the base of a tree are nearer to the trunk and to each other than they are to the distant topmost boughs. The palæontology of Gaudry's time suffered from insufficient emphasis upon exact phylogeny; the pendulum has swung far in the opposite direction and parallelism is carried to a degree far beyond its just proportion in taxonomy, and beyond what a true phylogeny requires or admits. In many cases it is carried to quite absurd extremes—as by some enthusiastic amateurs who would derive the different races of man from different genera of apes or monkeys, or even from different families of reptiles!

As this is not a revision of perissodactyl taxonomy I refrain from taking *Eomoropus* out of the family Chalicotheriidæ, leaving it as a subfamily; but in order to indicate the *relative* rank of the series A and B of specialized chalicotheres I am obliged to reduce them from the rank of subfamilies.[1]

HABITS OF CHALICOTHERES

Abel in 1920[2] published a discussion of the life habits of the chalicotheres that is very illuminating, although I think he goes beyond what the evidence warrants. The distinction between *Moropus* and *Macrotherium,* as based upon adaptation to feed on grasses or on leaves, etc., is probably sound in some degree, though the difference is not great enough to warrant a total difference in habit. The 'fossorial' adaptation is coupled with a number of differences from normal fossorial adaptations, which requires a special interpretation; I do not think Doctor Abel has hit upon it.

The limbs and for the most part the feet of *Moropus* are *not* fossorially modified; they have the same type of joints as rhinoceroses and

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[1] *Moropus* was made a separate family by Marsh, a procedure hailed as a "shrewd guess . . . that somewhat overshot the mark" by Dr. Holland. As Marsh called it an edentate and compared it with *Ancylotherium* (=*Nestoritherium*), which even Holland does not admit to subfamily distinctness from *Moropus*, it would seem rather to have been the procedure of which Marsh was so fond, that of erecting new genera, families and orders without knowing of any evidence to support them, but filing them on the chance that future discovery might prove them valid, and that the credit of discovery really due to later workers might through the workings of the law of priority adhere to Professor Marsh.

[2] Abel, 1920, Acta Zoölogica, Stockholm, I.

other large ungulates, adapted for locomotion over irregular ground or jungle. It is only in the claws, and in those parts of the tarsus and carpus and adjacent parts of the lower limbs to which the claw muscles are attached, that we observe the abnormal specialization. The phalanges, however, are attached to the metapodials in a peculiar manner. The proximal phalanges are very dorsal in position, large sesamoids occupying the palmar-plantar surfaces. The second phalanx is partly beneath the first, so that these two form a convex line. The dorsal process of the unguals projects strongly above the proximal and median phalanges, the whole arrangement being very suggestive of the phalanges of a large felid, but carrying the strong, stiff inter-phalangeal joints of fossorial mammals. Motion between phalanges 1 and 2 very limited (often coössified); between 2 and 3 extensive in a vertical plane, with stout processes for attachment of powerful muscles. Motion at distal ends of metapodials is a shallow ball joint giving great flexibility as well as motion in all directions at this point. Examination shows, however, that there is a definite notch median dorsal on the proximal facet of the phalanx of the second digit, and another lateral notch equally well defined on the external side, indicating two usual positions of the phalanges of this digit, which is the one that carries the large compressed claw, either vertical or pitched over to a lateral position at right angles, the claw turned outward (possibly slightly upward in retraction) and its point protected from wear while the weight rested on the pads beneath the sesamoids. The latter position was presumably for walking; when digging the claws were turned downward vertically. The lesser claws on the third and fourth digits could not be turned over in this way, but rested obliquely on the upper (external) surface of the second toe.

The stiff limbs and feet adapted for locomotion preclude the idea that *Moropus* could reach up and drag down branches like the ground sloths. Neither is there any probability that so limited a fossorial adaptation would indicate anything analogous to the fossorial insect-eating aardvark, anteater or armadillo, still less to the fossorial Carnivora. The teeth, of ordinary browsing type, preclude this. There remain two probable uses: *first,* in analogy to the 'rooting' habits of the pigs, to dig for tubers or other subterranean roots, to which as a *part* of the diet the teeth may be said to be fairly adapted, more so in the *Moropus* than in the *Macrotherium; second,* to dig holes for water in a dry stream-bed or pool, a habit of several types of ungulates in arid and semi-arid regions. Anyone who has seen an animal paw out a hole for water in a dried-up pool—there are some African moving pictures of game that show the process admirably, and the movement is more familiarly illustrated in the 'pawing' of horses or cattle—will realize how well adapted is the chalicothere foot for efficient action of this kind. Set vertically, the claw is a pick; set laterally, it is a shovel.

An animal of rhinoceros-like proportions, although with the slender neck and small head and inoffensive character of a horse, with the muzzle and front teeth of a ruminant, but with molars that combine the crescents of a browsing animal like a rhinoceros or giraffe with the bunodont cones of an 'omnivorous' animal like the pig or bear or ape, and with the singular type of feet discussed above, may be understood as of analogous habits to the rhinoceroses, lacking the defensive armor and offensive weapons of that group, but having in their stead certain advantages. The ability to dig for roots and tubers would enable him to supplement his food of leaves and twigs and coarse grasses, and the ability to dig in dry stream bottoms and pools would enable him to find water where the rhinoceros must travel farther or perish with thirst, and would doubtless enable him to extend his range to areas uninhabitable by rhinoceroses on account of scanty or uncertain water supply.

The difference in teeth between the *Moropus* and *Macrotherium* series I take to be that the latter used a larger proportion of roots, nuts or tubers in the diet, and the shorter hind limb points perhaps to somewhat less active or wide-ranging habits. I cannot ascribe to the differences between the two the wide diversity of habits that Abel has suggested, nor follow his interpretation in some other points. The above seems to me to be all that is justified by our present knowledge of these animals.

II. EQUIDÆ

Hipparion theobaldi (Lydekker, 1877)

Sivalippus theobaldi LYDEKKER, 1877, Rec. Geol. Sur. Ind., XII, p. 31.

Hippotherium theobaldi LYDEKKER, 1882, Pal. Ind., (X) II, 69, Pls. XI–XIII.

Hippotherium antelopinum, *loc. cit.*, not of Falconer and Cautley.

SYNONYM.—*Hipparion punjabiense* LYDEKKER, 1886, Brit. Mus. Cat. Foss. Mam., III, p. 60.

TYPE.—Ind. Mus. No. 153, upper jaw, young, with dp^{2-4} figured by Lydekker, 1882, *loc. cit.*, Pl. XI, Fig. 4.

NEOTYPES.—*Ibid.*, Fig. 3, Pl. XIII, Figs. 1–3, etc. Skulls in Calcutta Museum and skeleton in American Museum collection.

Lydekker founded the genus and species *S. theobaldi* on the mistaken belief that the type has permanent dentition. He retained the species in 1882 on basis of distinctions from the milk molars of specimens arbitrarily assigned to *H. antelopinum*, admitting that nothing except size distinguished the permanent teeth assigned to *theobaldi* from those assigned to *antelopinum.* But all the characters he specifies to distinguish between the milk molars of the two species are characters due partly or wholly to the different wear of the teeth consequent upon greater age of the individual figured as *H. antelopinum* as compared with type of *theobaldi.* The type of *theobaldi* has milk molars very slightly worn; the specimen assigned to *antelopinum* with which Lydekker compares it has well-worn milk molars (about half or three-fifths worn). The characters specified are:

(1) Greater size and more "oblong," less "square" form. But the size (antero-posterior length) of the milk molars reduces considerably during wear or from crown to base, the transverse diameter remaining more nearly constant. This and the following points are easily demonstrated on series of *Merychippus* jaws or on any series of *Hipparion* jaws sufficiently large to prove the case (e.g., Pikermi or Samos).

(2) Anterior pillar (protocone) compressed and oblique in *theobaldi,* round-oval in *antelopinum,* etc. Protocone has usually this form near top of crown in *Hipparion,* as also in some related genera, *Merychippus* (in part), *Protohippus, Pliohippus,* in all of them tending to change to round-oval form near the base.

(3) Posterior pillar (hypocone) extends back as far as hinder border of crown in *theobaldi,* not in *antelopinum,* etc. Also a difference of age, corresponding to (2).

(4) Hypocone stated by Lydekker to be united to posterior crescent in dp^2 of *theobaldi,* separate in other species. His figure does not bear this out. A small crest extends from *hy* to *ml* crescent, but does not unite. A ridge of this type is characteristic of *Merychippus* and probably of other genera, extending towards the crescent in little-worn teeth but not meeting it, and confined to near the tip of the crown; in moderate wear it often disappears wholly, and in extreme wear a broad union usually occurs between *hy* and posterior crescent.

(5) Enamel borders of fossettes relatively simple in *theobaldi,* much complicated in *antelopinum* and other species. Again a matter of wear. The complexity of lake borders in all teeth of all Equinæ is slight at the beginning of wear, increases to a maximum at about one-third or one-half worn teeth and decreases thence to the base.

None of the characters adduced by Lydekker to separate *theobaldi* from *antelopinum* appear to be valid specific distinctions. Nevertheless, the *type* of *theobaldi* is too large to represent the milk dentition of the *type* of *antelopinum,* and comparison of various permanent dentitions from the Siwaliks supports Lydekker's view that there are a larger and a smaller form, the former decidedly more robust and with heavier limb bones and larger lateral digits. The type of *antelopinum,* the palate figured on the same plate of Fauna Antiqua Sivalensis, the permanent dentition figured by Lydekker as *antelopinum* (Pal. Ind., (X) II, Pl. XI, Fig. 1), all agree fairly well in size, except that m^3 is smaller in the type, chiefly because less worn. These and some other specimens may be co-specific with the small form distinguished by Pilgrim as *chisholmi.* But most of the Indian material belongs to *theobaldi,* including skulls in the Calcutta

Museum, the upper and lower jaws and foot figured by Lydekker, *loc. cit.*, Pl. xi, Fig. 3; Pl. xii, Fig. 2; Pl. xiii, Fig. 3 (all one individual, Nos. 151, 159, 164, of Indian Museum); skull and feet from Dhok Pathan beds found by Barnum Brown, etc. It is a species larger than *H. mediterraneum* (=*gracile*) and with unusually stout lateral digits, deep and extensive lacrymal fossa.

Brown's specimens are from the Dhok Pathan horizon, Middle Siwaliks; Lydekker's type from the Siwaliks of Kaipar in the Punjab; his 151 and 159 from Niki in the Punjab (as is also his *antelopinum* upper jaw). Separation of *H. theobaldi* from the common larger European and Chinese *Hipparions* is not at all easy. It appears to be exceptionally large as compared with *H. gracile-mediterraneum*, and the lateral digits heavier than is usual at Pikermi or Samos. The lacrymal fossæ are deep and make a moderate approach—about 3 cm.—to the orbit. All of these characters seem to be variable. I cannot determine any very good characters in the molars; the protocones appear to be more flattened at corresponding stages of wear in the Indian species.

The Chinese *Hipparion*, *H. richthofeni*, appears to be in general smaller, with rounder and smaller protocone, shorter and more curved teeth—but again there is great individual variation in both species.[1]

Hipparion antelopinum (Falconer and Cautley, 1849)

Equus (*Hippotherium*) *antelopinum* (in part) FALCONER AND CAUTLEY, 1849, Faun. Ant. Sival., Pl. LXXXII, Figs. 13–18; Pl. LXXXIV, Figs. 5–12; Pl. LXXXV, Figs. 9–18.

Hippotherium antelopinum LYDEKKER, 1886, Brit. Mus. Cat. Foss. Mam., III, p. 59.

SYNONYM.—*Hipparion antelopinum* LYDEKKER, 1884, Pal. Ind., (X) III, p. 11, Pl. III. *Hipparion perimense* PILGRIM, 1910, Rec. Geol. Sur. Ind., XL, 66. =*H. punjabiense* auct. PILGRIM, 1913, ibid., XLIII, p. 321.

SYNONYM.—*Hipparion punjabiense* LYDEKKER, 1886, Brit. Mus. Cat. Foss. Mam., III, p. 60. ?*H. punjabiense* of PILGRIM, 1910, Rec. Geol. Sur. Ind., XL, p. 66.

SYNONYM.—*Hippodactylus chisholmi* PILGRIM, 1910, Rec. Geol. Sur. Ind., XL, p. 67.

Typical species of *Hippodactylus* Cope.

TYPE.—B. M. No. 2647, upper jaw, p^2-m^3, r. (Reversed in type figure.) Faun. Ant. Sival., Pl. LXXXII, Figs. 13, 13*a*.

Type of *H. perimense*, incomplete skull from Perim Island, with p^2-m^3 l., in Indian Museum.

Type of *H. chisholmi*, materials unspecified, from Dhok Pathan, Middle Siwaliks, in Indian Museum.

Owen in 1846 (Hist. Brit. Foss. Mamm., p. 395) referred part of the Siwalik fossil horses to *Hippotherium gracile*. Falconer recognized these

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[1] Sefve has quite recently split up the Chinese *Hipparions* into two genera and a dozen or more species. Most of them appear to be mere individual variations.

as a new species of the subgenus *Hippotherium.* Von Meyer in 1865 (Palæontographica, XV, p. 17) placed Falconer's species in the synonymy of *Equus primigenius = Hipparion gracile.*

Gaudry in 1873 (Animaux Fossiles de Mont Leberon, p. 40) observed characters in the foot bones attributed by Falconer to *H. antelopinum,* which in his opinion indicated that the species was monodactyl, viz.:

> . . . "Cependant, en examinant l'atlas de la *Fauna antiqua sivalensis,* ou en visitant, il y a quelques années, la collection du British Museum, j'avais été surpris de n'apercevoir aucun indice des petits doigts latéraux qui sont si remarquables chez l'hipparion. Étant retourné à Londres récemment, j'ai pu, grâce à l'obligeance du savant M. Davies, examiner de près les métacarpiens et les métatarsiens de l'*Hipparion antelopinum:* je n'ai pas vu sur les côtés de leur face postérieure les aplatissements qu'on observe chez l'*Hipparion gracile* (Pl. VII, fig. 1), dans la région où se posent les extrémités inférieures des petits métatarsiens et métacarpiens latéraux; ces aplatissements qui manquent chez les chevaux m'ont toujours permis jusqu'au présent de distinguer si une portion inférieure de canon provient d'un cheval ou d'un hipparion. Cela me porte à penser que l'*Hipparion antelopinum* était un équidé qui avait perdu dans ses pattes le caractère de son ancêtre l'hipparion, bien qu'il l'eût retenu encore dans sa dentition (2).
>
> "(2) Si ma supposition se vérifiait, quelques personnes seraient sans doute disposées à proposer un nouveau nom de genre pour un animal qui aurait eu des pattes de cheval avec une dentition d'hipparion. Il me semble pourtant préférable de conserver le nom d'hipparion aux animaux qui sont en voie de prendre la forme *Equus* jusqu'au moment où ils ont réalisé complètement le type de ce genre. En paléontologie, les noms d'espèces doivent autant que possible refléter les dégradations des formes interposées entre les espèces à caractères bien accusés qui constituent les types des genres."

Cope in 1888[1] separated *H. antelopinum,* on account of its supposed monodactyly, as the type of a new genus *Hippodactylus.*

Lydekker in 1877 and 1882 distinguished a larger form among the Indian hippotheres as *H. theobaldi.* While accepting Gaudry's conclusion that certain foot bones referred to *Hipparion antelopinum* indicated a monodactyl foot, he concluded that they pertained not to *Hipparion* but to *Equus.* In 1886 he re-examined these foot bones and concluded that they were in fact *Hipparion antilopinum;* and that therefore certain Indian specimens of a small, slender *Hipparion* in which the lateral digits were preserved must belong to another species, *H. punjabiense.*

Pilgrim in 1910 referred his new species *H. chisholmi* to *Hippodactylus,* distinguishing it from *antelopinum* by characters of very slight value, and stating that it was "probably monodactyl," but without specifying any evidence in support of this conclusion. He also distin-

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[1] Cope, 1888, Amer. Nat., XXII, p. 449.

guished *H. perimense* as a separate species, distinct from *H. punjabiense* by the shallower postorbital fossa, farther from the orbit; but in 1913, having examined and compared the types, he concluded that the two species were identical.

From a good deal of practical experience in identifying and cataloguing American three-toed and one-toed horses, I am quite certain that Professor Gaudry's criteria for distinguishing them by the characters of the cannon bone are not reliable; nor have I been able to find any feature or indication in the metapodial whereby to distinguish whether the animal has slender, complete lateral digits or splints only. I do not think therefore that there is any evidence that *H. antelopinum* was monodactyl or any reason to maintain the genus *Hippodactylus*. That the smaller and more slenderly proportioned *Hipparions* of India had reduced lateral digits as compared with the exceptionally heavy laterals of *H. theobaldi*, etc., is quite probable.

This being granted, there appears no evidence for maintaining *H. punjabiense* as distinct, and with it goes *H. perimense* auct. Pilgrim, 1913. *H. chisholmi* has not been distinguished from *antelopinum* by any characters of specific value—the greater size of the m^3 and 'squareness' of the teeth are both probably due to greater wear as compared with the little worn type teeth of *antelopinum*. [I am, nevertheless, somewhat doubtful as to *H. perimense* being really identical specifically with *H. antelopinum*. The difference is quite considerable in size, and Lydekker's figure indicates some differences in the orbital fossa.]

Separation from the smaller species described at Samos and Pikermi, Crimea and elsewhere in Europe, and from the smaller Chinese *Hipparions*, is not satisfactory until better figures or specimens can be compared.

BEARING OF HIPPARION ON CORRELATION

Two well-proved conclusions:

I. Republican River as old as Upper Chinji.

II. Santa Fé = Sansan.

Equinæ in Europe appear first in the Pontian, unless some of the French localities of *Hipparion* are older. This is on the supposition that Eppelsheim is Pontian, also other more or less doubtful German (and Italian) localities where *Hipparion* appears in the fauna.

First known Chinese occurrence is in the fauna described recently by Upsala.

First known occurrence in India is Upper Chinji (Pilgrim).

In all the Old World occurrences *Hipparion* appears suddenly, without ancestors, replacing *Anchitherium* in Europe, contemporary with *Hypohippus* in China.

All the Old World *Hipparions* (except possibly some French species) are progressive, aberrantly specialized types with highly complex enamel. Most of them have the lateral digits secondarily enlarged (larger than *Merychippus*). Primitive types approximating *Merychippus* are unknown. Pavlow's view, that *Hipparion* is an aberrantly specialized genus that could not have given rise to *Equus*, holds perfectly true for the Old World species so far as known.

In the New World, *Hipparion* covers a much wider range, and includes several subgenera which can be directly derived from species of *Merychippus* through various intermediate species or mutations, so extensively known through abundant material that it is practically impossible to draw any hard and fast line.

Merychippus may be similarly derived in America from *Parahippus*, with equally overwhelming evidence.

I conclude therefore that the Equinæ are surely of American evolution and dispersal and appeared in the Old World as immigrant types. If this be so, by all homotaxial principles, they should be at least as advanced, and usually more advanced, in America at synchronous horizons. Nothing in the Valentine horizon of the American succession is as advanced as the *Hipparions* of the Old World; even in the Upper Chinji the *Hipparions* are more advanced than anything in the Valentine, and equivalent rather to the Republican River species (although I know of no American species that have the secondarily enlarged lateral metapodials).

I think that Pilgrim may be mistaken in setting his correlations of Indian horizons so far back as he does. It would seem probable to me that India had, as it still has, the characters of a partly relict fauna, where older types survive than in the Holarctic world. On the other hand, the American succession has been judged younger than it is. If Santa Fé = Sansan, as Frick's work seems to indicate, then Republican River may = Pontian. I do not see how it can be any later, although it could be earlier on a general review of the fauna.

But I do not see under the circumstances how any portion of the Siwalik fauna that carries *Hipparion* can be older than Pontian, unless we accept the highly improbable and quite unsupported theory of Pilgrim that *Hipparion* appeared earlier in India than in Europe—and, as matters now stand, earlier than it did in China.

The conclusion will be that the base of the Upper Chinji beds is to be correlated with the beginning of the Pliocene as now accepted by the majority of authorities.

At the other end, the occurrence of the genus *Equus* begins in North America with the base of the Pleistocene. It appears first in those formations that indicate the renewal of sedimentation caused by the beginnings of glaciation, after the pause and partial cessation or transfer that characterizes the later Pliocene over most of the central Plains. These beds, if correctly interpreted as the beginnings of the glacial outwash, would be basal Pleistocene on that evidence, if the Pleistocene is assumed to begin in America as it appears to begin in Europe, with the first glaciation.

In Italy the Val d'Arno and Asti mammal faunas are stated to occur in beds that have a similar relation, that represent the first beginnings of the glacial outwash from Alps and Apennines. They are therefore considered by various modern writers as earliest Pleistocene, not, as formerly supposed, Pliocene. If this be so, the first occurrence of *Equus* in Europe is in the Pleistocene, as in America. It is hardly tenable that *Equus* occurred earlier in India than in Europe or America. The Siwalik horizons in which *Equus* occurs should therefore be regarded as Pleistocene.

The Boulder Conglomerate and Pinjor zones should therefore be wholly referred to the Pleistocene, not to the Upper Pliocene as Pilgrim has it.

Equus sivalensis Falconer and Cautley

Equus sivalensis Falconer and Cautley, 1849, Faun. Ant. Sival., Pls. lxxxi, Figs. 1–4; lxxxii, Figs. 1–6; lxxxiv, Figs. 1–4; lxxxv, Figs. 1–8. Lydekker, 1882, Pal. Ind., (X) II, p. 87 (type fixed).

Type.—B. M. No. 16160, Faun. Ant. Sival., Pl. lxxxi, Fig. 1, a skull broken across front of palate, p^3-m^3 r.

Dist. Characters, auct. Lydekker.—Protocone of premolars small, never larger than in m^2. This distinguishes from *E. caballus;* resembles *E. hemionus*, but larger size and p^1 less reduced.[1] A distinct trace of a preorbital fossa ("larmial cavity" of Lydekker, but it certainly is not the larmier of ruminants). Muzzle shorter than in *E. caballus*, jaw deeper, thereby approaching *hemionus*. Limbs and feet also are relatively slender.

The short muzzle and deep jaw are characteristics of early Pleistocene species, both in America and the Old World, as compared with *E. caballus*. They are in varying degree approached by *E. prjevalskii*, the zebras, etc.

Equus namadicus Falconer and Cautley

Equus namadicus Falconer and Cautley, 1849, Faun. Ant. Sival., Pl. lxxxi, Figs. 5–7; Pl. lxxxii, Figs. 1–6; ?Pl. lxxxiv, Figs. 13, 14.

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[1] **Lydekker calls this tooth the first milk molar.**

Equus palæonus FALCONER AND CAUTLEY, 1849, *loc. cit.*, Pl. LXXXII, Figs. 9–11. Fig. 11 is milk dentition.

E. namadicus LYDEKKER, 1882, Pal. Ind., (10) II, p. 92. *E. palæonus* regarded as a synonym.

TYPE.—British Museum No. M 2683. Faun. Ant. Sival., Pl. LXXXI, Fig. 5. Skull broken obliquely across palate, p^2-m^3 l., m^1-^{3} r.

DIST. CHARACTERS, auct. Lydekker.—Protocone of both premolars and molars much longer.

Lydekker refers to this species a number of specimens from the Upper Siwalik beds, and considers it as related more nearly to *Equus caballus* than to *E. hemionus.*

The distinction cited is not well borne out by the remainder of the specimens figured by Falconer and Lydekker, which suggest that this character varied a great deal as between different teeth of the same jaw as well as between different jaws.

I regard the species as of rather doubtful status, but perhaps tenable as a progressive mutation of *sivalensis* occurring in later Pleistocene beds than the Siwalik proper, chiefly in Nerbudda valley.

III. RHINOCEROTIDÆ

Rhinoceros sivalensis

?Rhinoceros angustirictus FALCONER AND CAUTLEY, 1835, Jour. Asiat. Soc. Bengal, IV, p. 706. Nomen nudum.

Rhinoceros indicus fossilis BAKER AND DURAND, 1836, Jour. Asiat. Soc. Bengal, V, p. 486. Based on a complete skull, various teeth and limb bones, figured and described.

[*?Rhinoceros*] ROYLE, 1839, Illust. Bot., etc., Himalaya Mountains, Pl. VI, Figs. 3, 6 [= Faun. Ant. Sival., Pl. LXXIV, Fig. 5].

Rhinoceros sivalensis FALCONER AND CAUTLEY, Faun. Ant. Sival., Pl. LXXIII, Figs. 2–3; Pl. LXXIV, Figs. 5–6; Pl. LXXV, Figs. 5–6. Figs. 2 of Pl. LXXIII is indicated as the type, as being the first (and best) of the figured specimens; but the B. M. catalogue has selected as types a middle portion of a skull, not figured in Faun. Ant. Sival. except for the teeth of the right side, and the front of skull figured by Royle and refigured in Faun. Ant. Sival., Pl. LXXIV, Fig. 5 (and Pl. LXXIII, Fig. 3). These have the teeth somewhat better preserved as regards the ectoloph. Fig. 2 is therefore only a *neotype*, owing to Lydekker's unfortunate selection.

Rhinoceros palæindicus I regard as a synonym. See notes under that head.

Rhinoceros palæindicus Falconer and Cautley

No description published by Falconer and Cautley; the species rests upon the figures in Faun. Ant. Sival., auct. Lydekker (Pal. Ind., (X) II, 42).

Teste LYDEKKER, *loc. cit.*, the distinctive characters are:

(1) One large nasal horn.

(2) Superior outlines of skull much curved, though less than in *R. sivalensis.*

(3) Wider across frontals than *R. sivalensis.*
(4) No parastyle buttress on molars and flat ectoloph (dist. from *R. sivalensis*).
(5) Crochet distinct, crista absent (as in *R. sivalensis,* dist. from *R. platyrhinus*).
(6) Crochet frequently unites with protoloph, enclosing a fossette.
The type is the skull figured in Faun. Ant. Sival., Pl. LXXIII, Fig. 1.

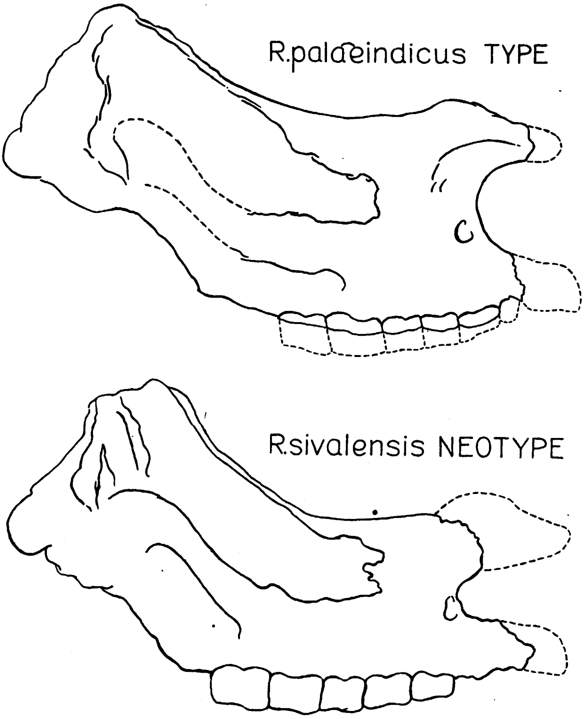

Fig. 41. Skulls of *Rhinoceros palæindicus* and *R. sivalensis* in the British Museum, one-eighth natural size. Upper Siwalik beds. Figured in Fauna Antiqua Sivalensis.

So far as the type is concerned there is no evidence at all of (4). The outer borders of the molars are gone and the crowns are much worn; apparently (5) is shown in the type. As regards (3) the difference appears slight and unimportant; (2) is more considerable, but exaggerated by the difference in wear of teeth, perhaps also by crushing, and may be individual. The two skulls are apparently nearly related, may well be of a single species; both at all events are referable to *Rhinoceros* s.s., combining characters of *sondaicus* and *indicus.*

Rhinoceros (Opsiceros) etruscus

FALCONER, 1868, Pal. Mem., II, p. 356, Pls. XXVI, XXVII.

Characterized from the Florence skull as flat, long, somewhat overhanging occiput, long septum between nostrils, two-horned, teeth worn down but were evidently low-crowned. Smaller and more slender than *R. sumatrensis.*

Cranium elongate, not elevated posteriorly.

Nasal bones more elongate than in *bicornis.*

Apparently no upper incisors, certainly no lower ones.

Viewed from above the skull is very like that of *R. tichorhinus* (more primitive in less occipital overhang, less complete septum, lower-crowned teeth, etc.).

Rhinoceros (Opsiceros) hemitœchus Falconer, 1868

R. leptorhinus OWEN (*nec* Cuvier), the "Clacton skull," B. M. No. 27836.

SYNONYM.—*R. protichorhinus* Duvernoy, 1854.

?SYNONYM.—*Atelodus aymardi* Pomel, 1853.

Falconer rejects Duvernoy's name as an "*ad interim* designation" and "manifestly inadmissible." He is unable to determine whether it is identica with some of the materials of *R. merckii* of Kaup or *Atelodus aymardi* of Pomel.

Certainly differs from type of *leptorhinus* and from skulls of *megarhinus.*

Partial skulls from various English caves are referred to this species. Specimens from Minchin Hole.

Northampton rhinoceros skull, B. M. No. 20013, referred here by Falconer. Only back and part of top, no palate or teeth.

Rhinoceros (Opsiceros) leptorhinus Cuvier, etc.

TYPE.—A skull in Milan Museum, from Monte Zago near Piacenza, discovered in 1805 by Cortesi.

This skull was referred by Cortesi to *R. bicornis.* Figure sent to Cuvier and published by him as *R. leptorhinus.*

No bony partition between nostrils. Cranium shorter than in *R. antiquitatis,* occiput not so extended backward. Orbit above m²; nasal bones free; premaxillæ short and peculiar in shape.

SYNONYM.—*R. megarhinus* Christol, type from Pliocene of Montpellier. Christol, 1835, Ann. Sci. Nat. (2ᵉ Sér.), t. IV, p. 44.

SYNONYM.—Rhinoceros de Montpellier, *R. monspessulanus* de Blainville (Marcel de Serres, 1819, in vernacular). Also from Pliocene of Montpellier. Marcel de Serres, 1819, Journ. de Physique, etc., t. LXXXVIII, p. 388 seq.

SYNONYM.—*R. elatus* Croizet et Jobert, 1828, based on fragmentary material from Puy-de-Dôme, Velay. Croizet and Jobert, 1828, Recherches sur les Ossemens fossiles du Dép. du Puy-de-Dôme, p. 155.

Status indeterminate auct., Falconer.

SYNONYM.—*R. kirchbergense* Jäger, 1839, based on two upper and one lower molar from Kirchberg in Württemberg; Pleistocene.

Synonym.—*R. merckii* Jäger in Kaup, 1841—name altered for the same type as the preceding. Various new materials added.

Synonym.—*R. lunellensis* Gervais, in Paléontologie Française. Type is remains from cave of Lunel-viel previously referred by Marcel de Serres, Dubrueil and Jean-Jean to *R. minutus* and later to *R. africanus*. "Hardly if at all distinguishable from the black rhinoceros."

Synonym.—*Atelodus aymardi* Pomel, based on materials from Puy?

(The above are doubtful synonyms—mostly *teste* Falconer. Some may prove to be valid species.)

Rhinoceros (?Cœlodonta) platyrhinus Falconer and Cautley

Type.—B. M. No. 36662, a front part of the skull, much battered, with the molars completely gone, and (B. M. No. M2731, paratype or part of type) an occiput and back part of skull. If these two belong to the same individual, as is suggested by the dotted lines connecting them on Pl. lxxii of Faun. Ant. Sival., the specimen checks up well with the neotype, a nearly complete skull by Sir. W. F. Baker, B. M. No. 36661.[1]

The earliest figure of this complete skull appears to be in the Catalogue of the Ward series of casts at Rochester, N. Y., 1866, p. 28. It is refigured by Lydekker, a restoration of the skull with no indication of the parts missing. (Pal. Ind., (X) II, Pl. ix, Fig. 2.) Both figures are upon a small scale.

It is by no means certain that the neotype is identical with the type and paratypes. There is no especial indication in the Faun. Ant. Sival. plate that the lower jaw referred to *platyrhinus* belonged to the same individual as the type skull, but it may have done so. In such case the affinities with *sumatrensis* might be quite close, *but* probably the neotype skull would *not* belong with the type.

In absence of any kind of evidence to settle the above point it seems better to hold to Lydekker's revision, which makes it necessary to ignore the types and depend wholly upon the neotype for the characters of the species.

On this basis the characters of *platyrhinus* associate it, as Lydekker observed, with the African rhinoceroses, *Opsiceros* in particular—see also *etruscus*, *leptorhinus*, *hemitœchus*, *pachygnathus* and other extinct species of this group. But it is an exceptionally high-crowned species, approaching *Cœlodonta* to a considerable degree in teeth though not in

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[1] This skull is recorded in the B. M. catalogue as presented by the Secretary of State for India, 1860; the No. 36662 is recorded, as are the following figured specimens referred to the species, as Cautley Collection, presented 1842 (1840 according to B. M. records). But as regards No. 36662 (only) this record is struck out in pencil and the record of No. 36661 substituted by a pencil line and "ditto," in the B. M. copy of the catalogue. This correction is difficult to understand, but is nevertheless fully substantiated by the original record; if the printed record is correct it explains why the perfect skull was not figured in Fauna Antiqua Sivalensis, but if the type and the neotype were both presented in 1860 it is difficult to see why the type and paratypes were figured in 1847, but the neotype only in 1881.

skull. It is in any case quite different in dentition from any other Siwalik species—possibly related to *R. deccanensis*, etc., of the Pleistocene of India.

The premaxillæ certainly are heavy and long and almost certainly bore tolerably large incisors. I cannot at all believe that they were toothless, as Lydekker assumes. In the species where upper incisors are absent the premaxillæ are reduced to a short or moderately long, thin, flat plate tapering to a digitate end. In the species which have incisors the premaxilla is trihedral, longer, stouter, somewhat enlarged toward anterior end. It is all there in *R. platyrhinus* neotype. The type affords no evidence whatsoever on the matter.

Schlosser regards this species as a probable ancestor of *Cœlodonta antiquitatis*. Possibly; at all events the teeth well represent an earlier stage that might lead into those of *antiquitatis*. But (1) I should expect this stage in the Miocene, not in the Pliocene, and (2) I should expect it to be associated with a reduced or absent incisor, a tendency toward internareal plate, and more suggestion of posterior overhang in the occiput. This looks to me more like a related side branch that had survived in India; the *"Baluchitherium" grangeri* of the Loh formation in Mongolia is far older, but ? equally advanced in dentition toward the *Cœlodonta* type.

VIII. INDIAN MUSEUM NOTES ON SIWALIK GIRAFFIDÆ

Propalæomeryx sivalensis Lydekker

Type of genus and species is m^3 figured by Lydekker, No. B337, formerly in Rurki Museum, now in Calcutta, and (I think quite correctly) believed by Pilgrim to be from the Chinji beds. Pilgrim states[1] that it is a first molar, but it is quite certainly m^3. No. B492, a lower jaw fragment with m_3, figured (*loc. cit.*, Pl. I, Figs. 3) by Pilgrim, is much too large to be referred to this species.

Giraffokeryx punjabiensis Pilgrim, Lower Siwaliks

The species is founded upon a group of co-types, including upper molars, upper and lower premolars isolated, and fragments of lower jaws. The first specimen *mentioned* in the detailed description is No. B502, called m^3, but it shows at back the scar for another tooth, and hence is m^1 or m^2, probably m^2 to judge from its proportions. It has been considerably split in preservation and increased in width about 3 mm. at base, 1½-2 mm. at crown, in this manner; its present measurements exaggerate the width (tr.) to about this extent, and the antero-posterior diameter about 2 mm. at outer side, about 1-1½ mm. at inner side. Figured in Pl. II, Fig. 8 of Pilgrim's memoir cited above. I select it as lectotype.

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[1] Pal. Ind., N. S., IV, Mem. I, p. 5.

A second specimen, B505, figured on Pl. II, Fig. 11, as the second molar, appears to be m^3. It is a little smaller than m^2, and well preserved, little worn. Both this and the preceding have the pocket on posterior wing of posterior inner crescent.

No. 504, figured by Pilgrim in Pl. II, Fig. 10, not found; the specimen marked as 504 and on exhibition with label indicating it as that figure is not the one figured. This "No. 504" is an unworn m^3, smaller than No. 505, nearly agrees in size with *Propalæomeryx sivalensis* type, and is possibly the Chinji molar mentioned by Pilgrim as referred to that species.

Several m^3 of intermediate size and proportions in lot No. $\frac{K13}{708}$. They vary in development of pocket on posterior lobe of metaconule (postero-internal crescent).

No. $\frac{K16}{152}$, a single upper molar, m^2, differs in opposite direction from lectotype of *Giraffokeryx*, being larger; posterior wing of metaconule has greater development of pocket, with the inner slope of the crescent extended into a sort of buttress at postero-internal angle of tooth in place of the slighter angulation seen in type.

Several molars, m^1 or m^2, with lot $\frac{K13}{708}$, of smaller size than *Giraffokeryx* lectotype, show either wide variation in size and characters or two or three species mixed.

No. $\frac{K14}{571}$, m^{2}-^{3} l., well preserved, differs from No. 505 in the more quadrate m^3, smaller size, more rudimentary pocket on postero-internal crescent.

Nos. $\frac{K16}{151,152}$ and one tooth out of No. 160 may be m^1, m^2 and m^3 of same individual, a very large one for *G. punjabiensis*.

There are several fragments that can be fitted to No. 497, p_3 r., giving anterior half of p_4 and perfect m_1 and m_2. This indicates large premolars and molars, corresponding well with B495, p_4-m_1. This is slightly smaller than a lower jaw with $m_{1\text{-}3}$ r., $\frac{K16}{455}$, and larger than lower jaw No. B540, p_2-m_3 r.

All these may represent one species agreeing with the type (lectotype) of *G. punjabiensis*.

A smaller species with narrower, smaller molars and distinctly smaller, narrower premolars of simpler construction than the preceding is best represented by a lower jaw, No. $\frac{K16}{598}$, with p_2-m_3 (heel of m_3 missing) all unworn teeth, the premolars not emerged fully from the jaw. With this agree lower jaws B493 and B494 figured by Pilgrim, and various fragmentary jaws and upper molars mostly isolated. The "504" (? tooth from Chinji referred by Pilgrim to *P. sivalensis*) agrees in proportions with this and probably represents it. It is very doubtful, however, whether the type of *P. sivalensis*, a tooth of unknown horizon or locality, belongs to the same species. It lacks the pocket on the posterior wing of the posterior inner crescent, represented only by a very rudimentary crestlet, and it rather appears to be more brachydont. It seems better to hold it indeterminate and give a new name to the smaller Chinji form, as it appears probable that a fine skull in the American Museum collection belongs to this form, in which case it should be the type. I distinguish it here as "sp. indesc."

MEASUREMENTS OF LOWER TEETH

	Dp_4	P_2	P_3	P_4	M_1	M_2	M_3
G. sp. indesc.							
$\frac{\text{K}16}{398}$ (unworn premolars, lightly worn molars)		17.0 × 9.2	21.5 × 11.3	21.4 × 12.4	25.6 × 16.6	25.8 × 17.9	16.8
B494 (lightly worn teeth)	25.7 × 12.0			23.2 × 11.0	23.9 × 16.0	27.5 × 17.5	
B493 (moderately worn molars)						24.5 × 16.6	35.3 × 16.9
$\frac{\text{K}16}{143}$ (moderately worn teeth)			21.3 × 13.0	23.0 × 13.9	26.2 × 16.9	27.9 × 19.3	
B540 (moderately worn teeth)		17.7 × 9.8	21.1 × 13.6	24.4 × 15.0	26.0 × 17.9	26.9 × 18.7	37.0 × 18.2
G. punjabiensis							
B497 (half-worn molars, moderately worn premolars)			22.4 × 15.2	23.5	26.5 × 19.2	26.9 × 21.1	
B495 (moderately worn premolars)				24.2 × 15.1	26.4 × 19.5		
$\frac{\text{K}16}{453}$ (lightly worn molars)					28.2 × 18.5	28.3 × 19.7	41.0 × 19.4

Giraffokeryx sp. indesc.

Provisionally I have refrained from giving a specific name to this smaller form. No. $\frac{\text{K}16}{398}$ will be type if the American Museum skull does *not* belong. A large number of teeth and jaw fragments agree fairly well with this. No. B540 is slightly larger, but also falls in here.

$\frac{\text{K}14}{571}$, m^{2}-^{3} in jaw fragment, agrees pretty well except for the more quadrate teeth, less reduction of posterior inner crescent of m^3, imperfect pocket on same crescent, etc. M^3 is also rather larger relatively.

The difference from *G. punjabiensis* is about comparable to the difference between *Palæotragus microdon* and *cælophrys* as figured by Bohlin, 1926, *loc. cit. infra*, Pl. III.

Giraffa priscilla

TYPE.—No. B511, "*Giraffa* sp.," of Pilgrim, figured in Pal. Ind., N. S., IV, Mem. I, Pl. II, Fig. 17. M^3 l. Field number was $\frac{\text{K}13}{454}$.

REFERRED.—No. $\frac{\text{K}14}{25}$, m^3 r., m^2 l.; $\frac{\text{K}13}{459}$=B492, "*Progiraffa sivalensis*" of Pilgrim, figured (*loc. cit.*, Pl. I, Fig. 3), jaw fragment, m_3 l.

Distinguished from *Giraffokeryx* by the broader and more brachydont teeth, prominent styles (especially note metastyle), prominent anterior rib; in m_3 the more oblique-set inner crescents, broader third lobe with strong accessory basal cusp in front of it, as well as shorter crown.

All from Upper Chinji zone.

Bohlin, in his review of the Chinese Giraffidæ[1], refers *Giraffokeryx* to *Palæotragus*, on account of the agreement in teeth as observed in Pilgrim's figures and certain original specimens in Stockholm. There is undoubtedly a great deal of resemblance in the teeth; but if Brown's 'antelope' skull is *Giraffokeryx*, it differs from *Palæotragus* in having two pairs of fully developed, well separated horns, as well as in proportions of skull, etc. *P. quadricornis* from Samos has a rudimentary second pair of horns close to the base of the principal pair.

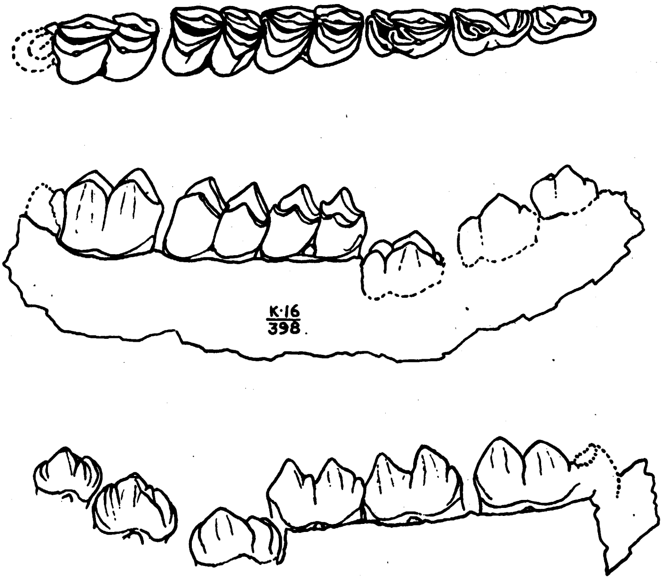

Fig. 42. *Giraffokeryx* sp. indesc. Lower jaw fragment. Indian Museum No. $\frac{\text{K 16}}{398}$, external view, with crown and inner views of the teeth, half natural size. Lower Siwalik beds. The animal was somewhat immature, the premolars preformed but not yet wholly emerged, and the molars very little worn.

Bohlin also remarks that the tooth here noted as *?Giraffa priscilla*, referred by Pilgrim to *Progiraffa sivalensis* and figured in his memoir,

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[1] Bohlin, 1926, Palaeont. Sinica, (Ser. C) IV, Fasc. I, p. 41 et seq.

"ist den Molären von "*Giraffokeryx*" *punjabiensis* völlig gleich, nur stärker abgenützt"—which it certainly is not; so that I am not so sure of the dependability of his assertion of identity of structure between *Giraffokeryx* teeth and those of *Palæotragus*. Probably they represent about the same stage of evolution in the Giraffidæ, but distinct genera.

As for '*Giraffa*' *priscilla*, it may belong to any one of several genera —it might be a primitive *Giraffa* ("*Orasius*" Wagner), but more probably is a palæomerycine.

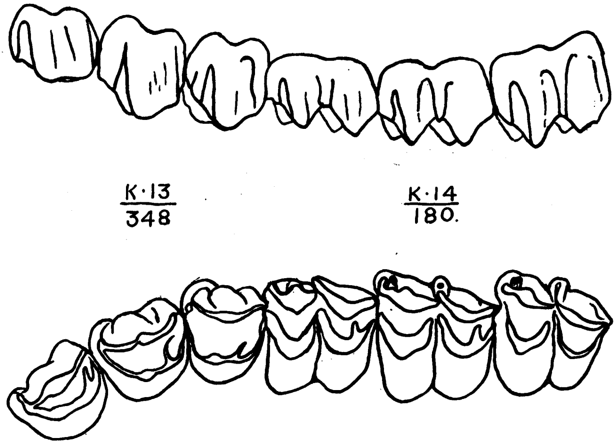

Fig. 43. '*Giraffa*' *punjabiensis* var. Upper teeth, crown and external views, half natural size, from a specimen in the Indian Museum, Middle Siwaliks of Hasnot. The premolars and molars bear different numbers, but they are parts of the same individual. The teeth differ considerably from those of the type of *G. punjabiensis* in the direction of "*Vishnutherium*" sp. (*infra*) and may very likely belong to a distinct unnamed species.

Giraffa punjabiensis Lydekker, Middle Siwaliks

TYPE.—Upper and lower jaws, p^3-m^3 r., m^1-^{3} l., p_4-m_1 and m_3 r., probably all one individual, Nos. 184 and 173.

Referred to this species, but varying somewhat from the type, Nos. $\frac{K13}{349}+\frac{K14}{181}+$ B182$+\frac{K14}{193}$ (part), almost surely one individual although collected in different years; upper jaws with more or less of palate and adjacent parts of skull, p^2 and p^4-m^3 r., p^2 and p^4 and m^1-^{3} l.

Differs from type in lack of metastyle on m^2, slightly weaker ribs throughout on molars, m^1 slightly larger.

Nos. $\frac{K14}{180}$ and $\frac{K13}{348}$ may be same individual, and if so give p^2-m^3 l., practically unworn premolars and little-worn molars.

I have figured these two specimens. The type is figured by Lydekker, Pal. Ind., (X) II, Pl. xvi, Figs. 1, 2, and 5.

All these are from Hasnot in Punjab.

Nos. $\frac{K13}{659}$, m^3, and $\frac{K15}{612}$, m^1, agree more closely with type.

Bohlin, 1926,[1] refers *G. punjabiensis* to his new genus *Honanotherium*, type *H. schlosseri* from the Chinese Pliocene and referred species *Camelopardalis sivalensis* Falconer and Cautley, 1843, remarking that *punjabiensis* comes from an older horizon than *sivalensis* but that the series of minor differences in teeth that separate the two is not perhaps of much importance.

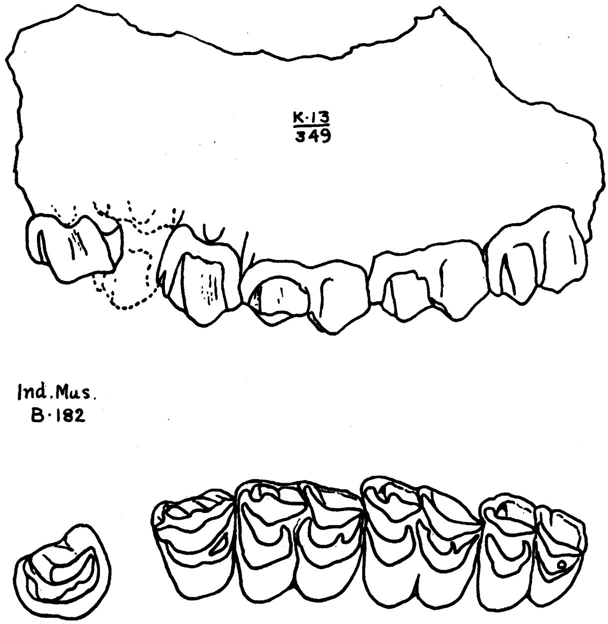

Fig. 44. *Giraffa punjabiensis* var. Upper jaw, external view, and crown view of teeth, half natural size. Drawn from Ind. Mus. No. $\frac{K13}{349}$ which is probably the same individual as No. B182. This specimen represents the same species as Fig. 40 and comes from the same horizon and locality.

H. punjabiensis, if it really belongs to the genus, which I consider extremely doubtful, is very much smaller than *H. schlosseri*, teeth appear more brachydont, premolars not so wide transversely. It agrees better

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[1] Bohlin, 1926, Palæont. Sinica, (Ser. C) IV, Fasc. I, p. 122.

with *H. sivalensis*, but has not the peculiar third lobe of m^3 (if that be normal). Appears not at all unlikely that it may be the same as "*Orasius*" from Pikermi, teeth figured by Wagner, casts in British Museum. At all events, it serves to approximate "*Orasius*" and *Honanotherium*, and makes both rather subgenera of *Giraffa* than well distinguished genera.

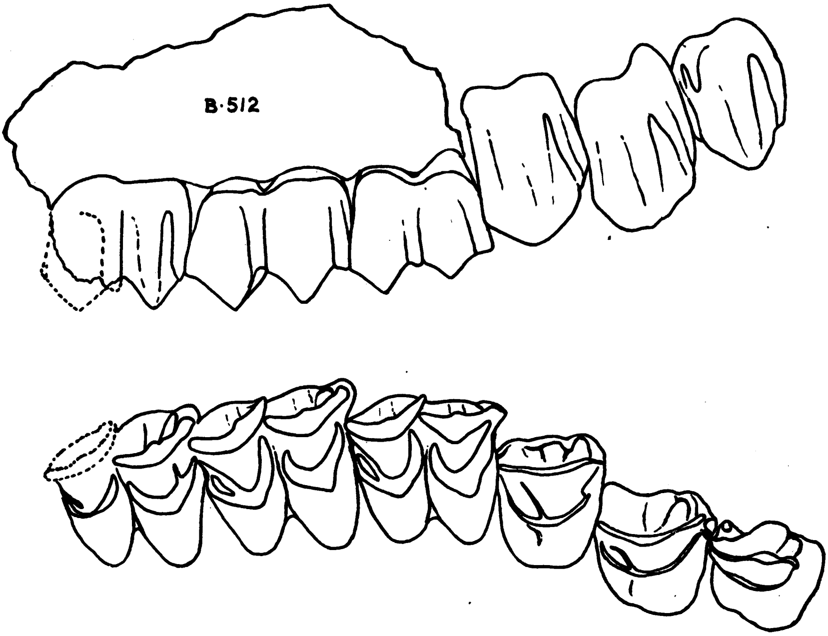

Fig. 45. *Hydaspitherium megacephalum* Lydekker. Upper teeth, external and crown views, half natural size. Indian Museum No. B512, from the Middle Siwalik beds, Dhok Pathan. This is the immature (and incomplete) skull figured by Pilgrim as *Helladotherium grande* (Pilgrim, 1911, Pal. Ind., IV, Pl. III) except for the p^2 which is omitted from his figure.

Hydaspitherium megacephalum Lydekker

Type is a skull, D150, figured by Lydekker in Pal. Ind., (X) I, Pls. XXVI, XXVII. These figures are on a reduced scale and very unsatisfactory. They agree with two upper molars, No. B139, referred by Lydekker to this species. Also apparently with No. B512, referred by Pilgrim to *Helladotherium grande* (Lydekker), consisting of p^2-m^3 and p^{3}-^{4} (premolars not fully emerged, molars lightly worn). This in turn agrees with the young skull referred by Pilgrim to *H. grande*, No. B513. I do not see any serious difficulty in deriving the adult *Hydaspitherium* skull from a young skull of this type; on the contrary, it does not seem to me that the young skull indicates a long giraffine or helladotherine type of adult skull.

Nos. 131, 132, isolated upper molars.

Very few lower teeth of this type. No. $\frac{K13}{592}$ is m_3, also B153, m_3 moderately worn, B154, m_3 little worn, the last abnormal in basal cusp between second and third outer crescent.

Cast of *Bramatherium* maxilla, p^4-m^3 (battered), from Perim Island, B169, agrees rather nearly with this species, the only distinction being the more prominent ribs on anterior external crescent. Size identical.

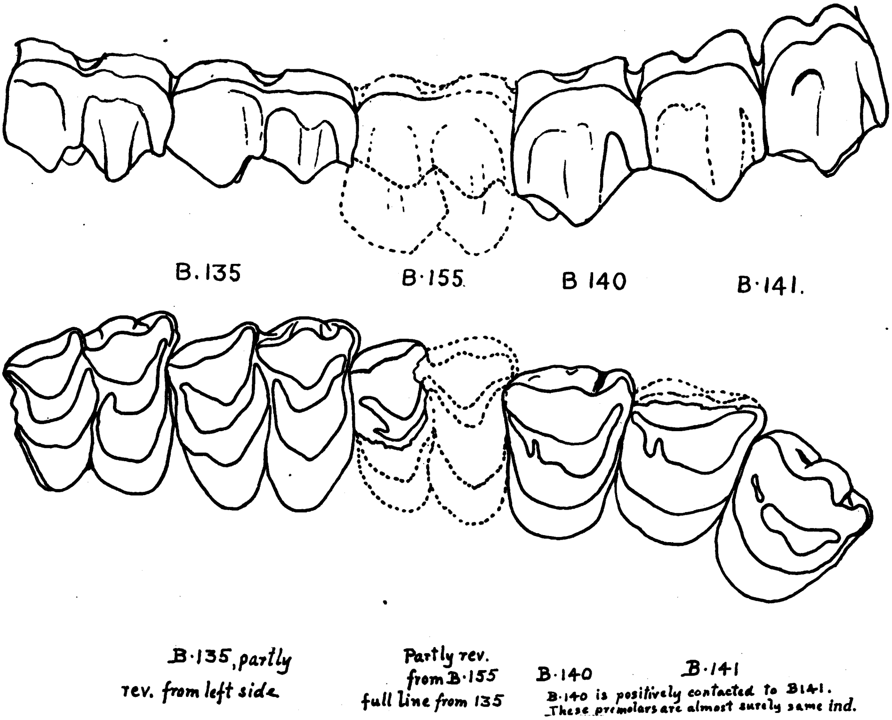

Fig. 46. *Hydaspitherium grande* Lydekker. Upper teeth, external and crown views, half natural size. Middle Siwaliks, Punjab (presumably Hasnot). The dotted outlines are those of the little-worn type molar, Ind. Mus. B155, modified to show the change in form resulting from wear to a corresponding degree with the remainder of the series. The molars No. B135 were figured by Lydekker as *H. megacephalum;* the premolars Nos. B140, B141, although separately catalogued, fit together by unmistakable contact as parts of the same individual, and are almost certainly the same individual as the molars, although no contacts can be made.

Hydaspitherium grande Lydekker

TYPE.—No. B155, an upper molar, unworn, identified by Lydekker as m^2 but agrees better in proportions with m^3.

REFERRED.—B135, m^{2-3} r. and l.; B140–141 (part only), p^{2-4} l., the premolars probably of same individual as molars; B156, dp^4-m^1 l.; also B133–134, 136–137, isolated upper molars.

Lower jaw No. 142, referred by Lydekker to *H. megacephalum*, belongs here. No. 151 is referred by Lydekker to *H. grande* and contrasted by him with No. 142; but the characters he cites are partly due to preservation and partly to individual differences, I think; they are very much exaggerated as presented by him.

Difference in thickness and depth of jaw is due to flattening and broadening of jaw of 151 under pressure. Greater length of molars in No. 151 is a matter of less wear; if the measurements are made at corresponding parts of the tooth they are nearly identical. Difference in p_4 is partly less wear and partly individual. Altogether I see no sufficient reason for separating either of these from *H. grande*. Certainly both are much too large for *megacephalum* and neither agrees with *magnum* of Pilgrim.

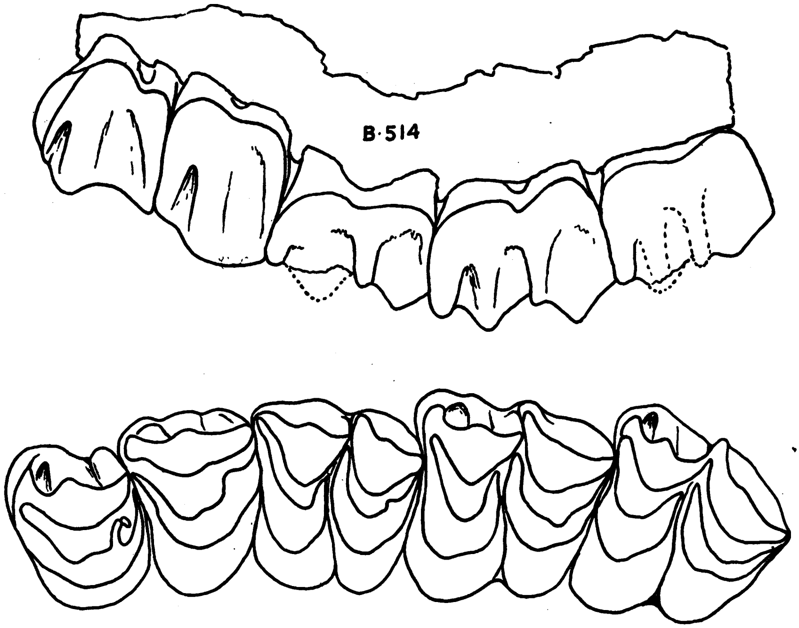

Fig. 47. *Hydaspitherium magnum* Pilgrim. Upper teeth, external and crown views, half natural size. From the type specimen, No. B514 Indian Museum. Middle Siwaliks of Hasnot. The type specimen also includes a lower jaw with p_3 and m_{1-3}.

Nos. 143–144, m_2 and m_3; 145, p_{3-4} l.; 151, lower jaw with m_{1-2} and part m_3 r., are moderately worn.

No. 275, lower jaw with p_2-m_2 l., greatly worn, appears as though with much shorter premolars; but this is certainly due in part, and may possibly be due wholly to crushing, as well as to natural shortening of length by extreme wear. If not, it represents an unknown genus, size of *H. grande* and with shortened premolars.

Hydaspitherium magnum

Type.—Upper and lower jaws, p^3-m^3 l., No. 514; m^{2-3} l., No. $\frac{K13}{349}$; left lower jaw, m_{1-3}, No. B515; and p_3 l., No. B516. Pilgrim states that the upper and lower jaws belong to the same individual; and the right and left uppers certainly do.

Referred.—No. 141, an upper premolar, p^4.

Molars larger and more robust than *H. grande*, and p^4 more trihedral in form. Lower teeth broader and somewhat longer; the difference in depth of mandible I do not take seriously.

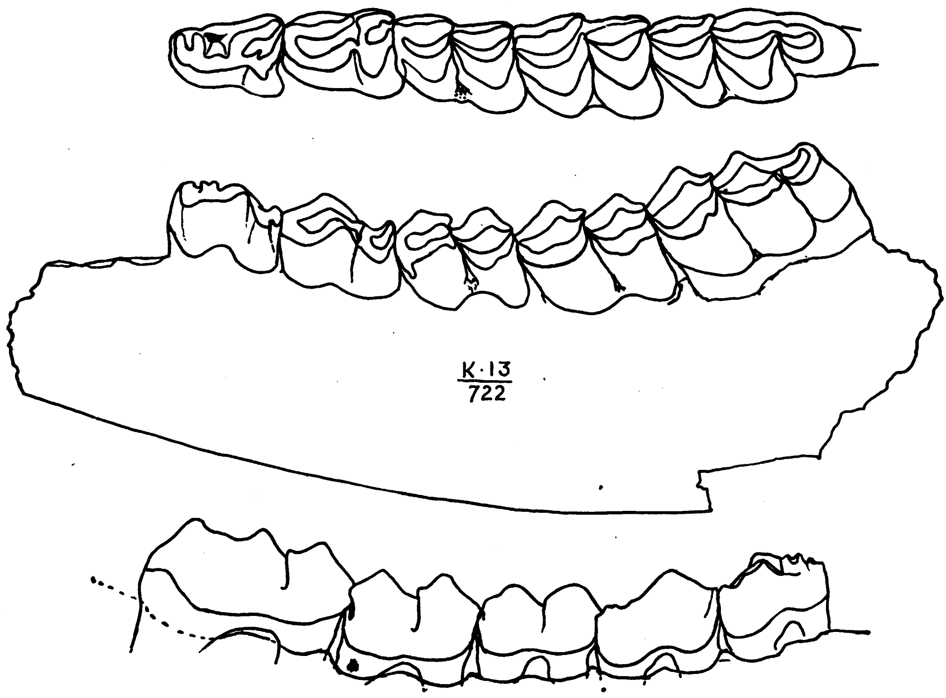

Fig. 48. *?Vishnutherium* sp. Lower jaw, external view, with crown and inner views of teeth, half natural size. Indian Museum No. $\frac{K13}{722}$.

Vishnutherium Lydekker

The type of the genus is *V. iravaticum* from the Irawaddy series in Burma, and appears very doubtfully separable from *Hydaspitherium megacephalum*. In absence of adequate topotypes the genus and species are practically indeterminate. There are several jaws and fragments of jaws in the Indian Museum intermediate in size between *Hydaspitherium megacephalum* and "*Giraffa*" *punjabiensis* but more nearly related to the former genus, although nearer in size to *Giraffa*. It is possible that they are a small species of *Hydaspitherium*, but they are provisionally referred to the indeterminate genus *Vishnutherium* pending the discovery of their real affinities. They are distinct specifically from *V. iravaticum* but I refrain from giving the species a name, hoping that better specimens may be found either by the Indian Survey staff or among the Brown collections in this Museum.

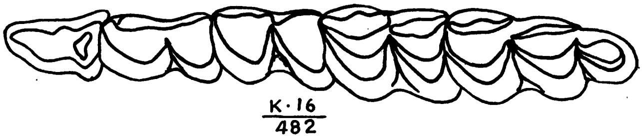

Fig. 49. ?*Vishnutherium* sp. Lower teeth, crown view, half natural size. Ind. Mus. No. $\frac{K\,16}{482}$. Middle Siwalik beds, 1500 feet above base. The premolars are reduced in width by crushing.

IX. BRITISH MUSEUM NOTES ON SIWALIK GIRAFFIDÆ

The family appears to be a group of specialized survivals of the Middle Miocene Palæomerycinæ, of which *Dromomeryx*, the American genus, is the only one known from complete skulls and associated skeletons. The horns of *Dromomeryx* are of giraffoid type, long, straight, probably skin-covered, non-deciduous, supra-orbital, and with a basal wing that suggests the later complications in the sivatheriines. Teeth quite close to *Palæotragus* and *Giraffokeryx*.

Schlosser would derive giraffes from Protoceratinæ, but this does not seem to be a tenable phylogeny. The protoceratines are an early specialized group of Traguloidea, with no approach to the Pecora in foot-characters. The Giraffidæ are true Pecora, fully developed as such in the feet, and nearly related through Palæomerycinæ to the primitive Cervidæ (cf. *Eumeryx* of the Stampian Oligocene of Mongolia).

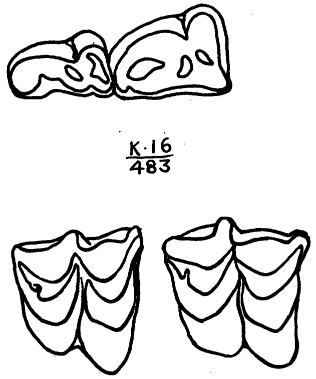

Fig. 50. ?*Vishnutherium* sp. Upper molars and lower premolars, crown views, half natural size. Ind. Mus. No. $\frac{K\,16}{483}$, same locality and horizon as lower jaw, Fig. 49.

The group is divided by Bohlin into four sub-families, making *Ocapia* a separate subfamily, which seems to me unnecessary. Better to fall into three:

Palæotraginæ
Palæotragus, Samotherium, Giraffokeryx, Ocapia
Giraffinæ
"Orasius," Giraffa, Honanotherium
Sivatheriinæ
Helladotherium + Bramatherium, Hydaspitherium, Sivatherium + Indratherium

Giraffokeryx may, however, prove to be entitled to rank in a separate subfamily.

PALÆOTRAGINÆ. Antelope proportions; simple spike-horns on frontals above and behind orbits; long skull, long slender muzzle; teeth moderately brachydont, external ribs and cusps moderate, premolars not enlarged, enamel sculpture fine.

GIRAFFINÆ. Giraffe proportions; simple knob-ended horns on frontals above and behind orbits; skull moderately long, deep medially, median frontal horn; teeth brachydont, external ribs and cusps prominent, premolars little enlarged, enamel sculpture moderately coarse.

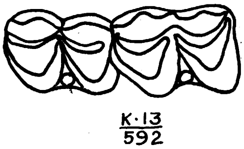

Fig. 51. *Giraffa punjabiensis*, lower molars, crown view, half natural size. Middle Siwaliks, Nila, Ind. Mus. $\frac{K\,13}{592}$. Figured for comparison with the lower teeth of *"Vishnutherium."*

SIVATHERIINÆ. Massive proportions; postorbital horns on frontals and a second pair on occipital crest or parietals; short muzzle, short, wide skull, deep medially; teeth longer-crowned, with coarse enamel sculpture and enlarged premolars.

GIRAFFA Brisson, 1756

SYNONYM.—*Camelopardalis* Gmelin, 1788; *Orasius* Oken, 1816.

The genus *Orasius* is attributed to Wagner by Lydekker in 1882, Pilgrim 1911 and Bohlin 1926, with the type *O. eximius* Wagner = *speciosus* Wagner = *Camelopardalis attica* Gaudry from Pikermi. It is really Oken's genus, however, and the type is the modern giraffe. Whether Wagner intended to erect it as a separate genus or merely to cite Oken's genus as a synonym of *Camelopardalis*, is unimportant; in either case the name is untenable for the Pikermi giraffe. It is not possible to apply Wagner's *Panotherium* to this genus; it was based upon *Helladotherium* lower teeth figured by him in an earlier publication.[1] There is also a possibility that the unfortunately named and most inadequately based *Propalæomeryx* Lydekker may belong to this genus. Bohlin has shown fairly adequate grounds for separating *"Orasius"* from the modern *Giraffa*, and if Lydekker's name is not applicable one might call it *Bohlinia*. Until this is cleared up, I will call it *"Orasius."* The only way of clearing it up would be a more definite determination of the locality of the *"Propalæomeryx"* type upper molar (m^3, not m^1 as Pilgrim identi-

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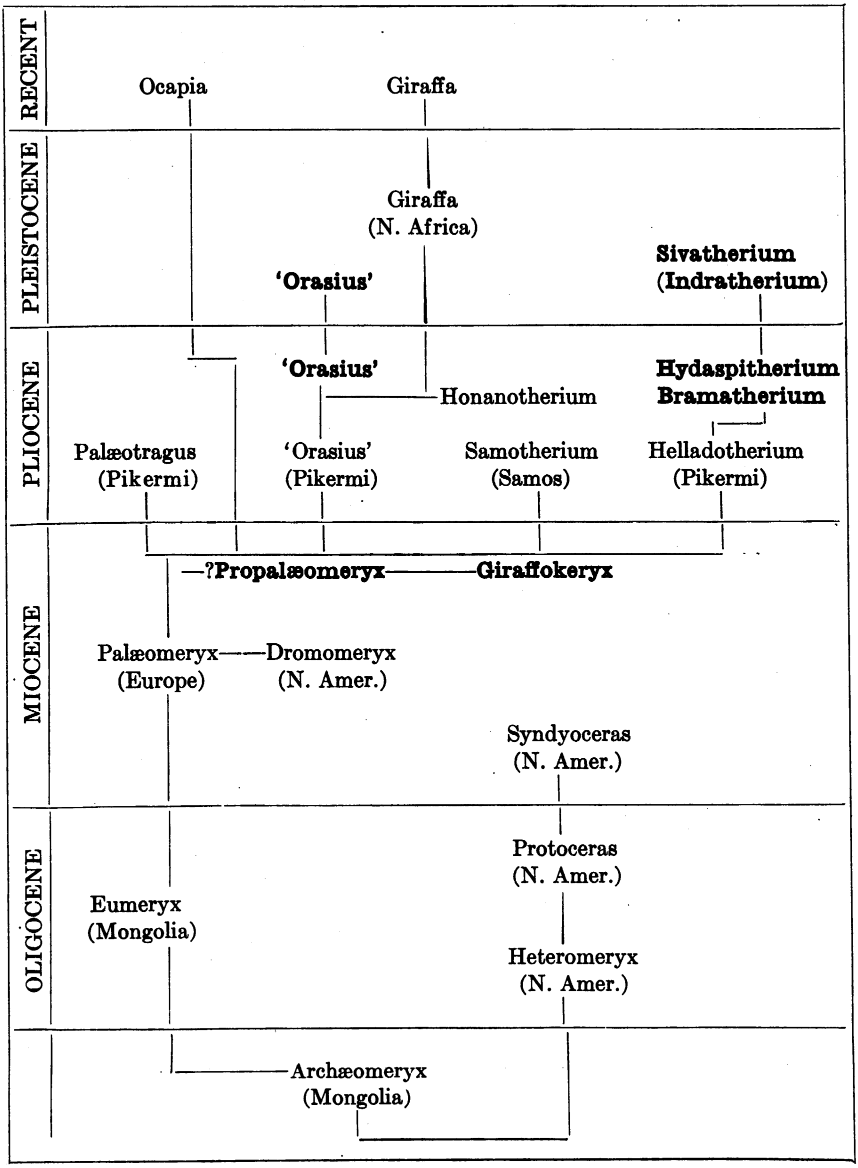
[1] Wagner, 1860, Abh. k. bay. Ak. Wiss., VIII, Pl. VII, Fig. 23.

PHYLOGENY OF THE GIRAFFIDÆ

(Indian genera in heavy-faced type)



fied it), and obtaining adequate topotypes to determine its characters. If it really is from the Chinji beds as Pilgrim thinks, such topotypes might be discovered; but the m_3 that Pilgrim has referred to it certainly cannot belong to the species, though it may be a larger species of the same genus.

"ORASIUS"

Orasius ? WAGNER non OKEN; type *O. speciosa* (*eximia*) from Pikermi.

?Propalæomeryx LYDEKKER, 1883, Pal. Ind., (X) II, p. 173; type *Palæomeryx sivalensis* Lydekker.

The upper dentition figured by Wagner is represented by a cast in the British Museum. It is of smaller size than "*O.*" *punjabiensis;* the m^3 differs remarkably in having a sort of third lobe; not shown in his *C. vetustus*, which is perfectly normal and more like the *punjabiensis* type in less extreme brachydonty, flatness of posterior external rib, etc. Of the various other specimens from Pikermi referred to *G. attica* none shows this abnormal construction of m^3; and the type of Wagner's species has the m^3 raised above the level of the other teeth as though it were a tooth of some other animal artificially set. The cast does not, however, indicate this otherwise; the matter could be finally determined by examination of the Munich original. If, as appears probable, the tooth really does belong to the type, it is most likely an abnormality.

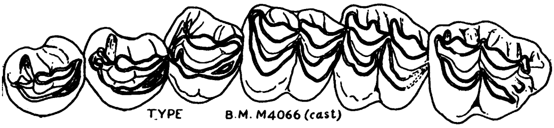


Fig. 52. *Orasius speciosa* Wagner = *?Giraffa attica* Gaudry. Crown view of upper teeth of type specimen, half natural size. From a cast in the British Museum. Original from Pikermi, in Munich University Museum.

The large, short-crowned, strongly rounded premolars are characteristic. Molars as short-crowned as *Propalæomeryx*, but rib of metacone prominent, while in *Propalæomeryx* it is absent. Premolars have well developed accessory crest postero-internal to inner crescent, as in *G. punjabiensis*.

"Orasius" sivalensis Falconer and Cautley

Ruminant, cf. Giraffidæ, CAUTLEY, 1838, Jour. As. Soc. Beng., VII, p. 658.

Camelopardalis sivalensis FALCONER AND CAUTLEY, 1843, Proc. Geol. Soc. London, IV, pp. 243–4. Type, a cervical vertebra.

Camelopardalis affinis FALCONER AND CAUTLEY, *loc. cit.*, p. 246. Type (lectotype, Lydekker, 1883), upper jaw fragment, m^{2-3} l.; co-types, m^3 r., m_3 l., p_4 l., p^3 r., p^2 r.

=*C. sivalensis* LYDEKKER, 1882, Pal. Ind., (X) II, p. 103.

Giraffa sivalensis PILGRIM, 1911, Pal. Ind., N.S., IV, p. 10.

Honanotherium sivalense BOHLIN, 1926, Paleont. Sinica, (C) IV, Fasc. I, p. 121.

HORIZON.—Upper Siwaliks.

The species differs so considerably from the Middle Siwalik "*Giraffa*" *punjabiensis* that Pilgrim's procedure in separating the latter as a distinct species seems well warranted. Pilgrim has specified a number of distinctions. *G. sivalensis* seems to be more specialized in the peculiar construction of m_3 than the modern giraffes—but cf. *G. biturigum* infra—and is, according to Pilgrim, of larger size (this I do not see). It is quite possible that if the giraffes are of Holarctic origin the Pleistocene species of Northwestern India would be more advanced than the modern survivors in equatorial Africa, and would be closest to North African or Northeast African species not so far from the center of dispersal.

I cannot see any good ground for referring *sivalensis* to *Honanotherium*. In most particulars it agrees better with *Giraffa* or "*Orasius*."

?**Giraffa biturigum** Duvernoy

Camelopardalis biturigum DUVERNOY, 1843, Ann. Sci. Nat., (3) I, p. 36, Pl. II.

TYPE.—A lower jaw found associated with fragments of pottery, etc., at bottom of a well in an ancient donjon of fourteenth century in Issoudun, Département de l'Indre, France.

There seems to be no reason for regarding this jaw as prehistoric, still less pre-Pleistocene, nor for associating it with *Helladotherium*, as was done by Owen in 1860. It is presumably a modern giraffe, of a northern species most probably. The characters by which it differs from the Central and East African giraffes are of interest, because in several points they are quite like "*G.*" *sivalensis*. Duvernoy's figure of m_3 might almost have been drawn from Falconer's specimen, both differing somewhat from the modern giraffe in the peculiar degree of reduction and *transverse* cresting of the third lobe of m_3. (Falconer states, however, that m_3 of *affinis* (*sivalensis*) is precisely like that of the modern giraffe "with the same development of its third barrel or heel, which is always found in ruminants"—a remark difficult to understand, as the third lobe in *G. affinis* is very peculiar, and is *not* like any modern giraffe that I have seen —the character may be a variable one among the modern giraffes.)

HELLADOTHERIUM Gaudry

Helladotherium GAUDRY, 1860, Comptes rendus, LI, p. 804.

Panotherium WAGNER, 1861, Sitb. k. bay. Akad. Wiss., (C) II, p. 80.

?SYNONYM.—*Bramatherium.*

TYPE.—*Helladotherium duvernoyi* Gaudry, 1860, based on a nearly complete skull and jaws from Pikermi.

Type of *Panotherium,* a lower jaw from Pikermi, figured by Wagner[1] as *Antilope pallasii* in 1860, original in Munich, cast in British Museum.

It appears not at all improbable that *Helladotherium* may be the female of *Bramatherium* or *Hydaspitherium.* The teeth are indistinguishable, and the skulls are by no means as diverse in degree, but differ in the same manner, as *Sivatherium* and "*Indratherium*" of the Upper Siwaliks.

At all events, it appears certain that Pilgrim's "*Helladotherium grande*" (not *H. grande* Lydekker) is the young of *Hydaspitherium megacephalum.*

If it be considered that *Helladotherium duvernoyi* with its relatively long (primitive) skull is the oldest, that *Hydaspitherium* ("*grande*") *megacephalum* is younger, and *Sivatherium* much younger, the progressive shortening of the skull in the three stages is obvious.

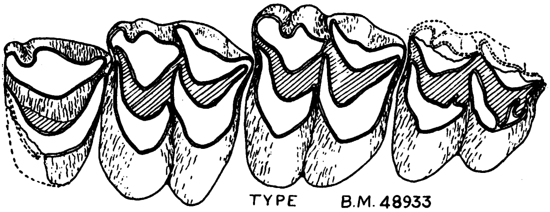


Fig. 53. *Bramatherium perimense.* Upper teeth, crown view, half natural size. From the type specimen, British Museum No. 48933. Middle Siwalik beds, Perim Island.

BRAMATHERIUM

The type of *Bramatherium* is an upper jaw which cannot be distinguished from *Helladotherium* upper jaw.

Bramatherium FALCONER, 1845, Quar. Jour. Geol. Soc., I, p. 363; 1868, Pal. Mem., I, p. 399; BETTINGTON, 1845, Jour. Roy. As. Soc., VIII, p. 340; LYDEKKER, 1876, Pal. Ind., (X) I, p. 42; 1882, *loc. cit.*, II, p. 130; 1885, Brit. Mus. Cat. Foss. Mam., part 2, p. 69 (type fixed); PILGRIM, 1911, Pal. Ind., N.S., IV, p. 19.

TYPE.—(Lectotype), B. M. No. 48933, upper jaw, p^4-m^3 l., from Perim Island, Middle (or Lower) Siwaliks.

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[1] 1860, Abh. k. bay. Akad. Wiss., VIII, Pl. VII, Fig. 23.

A specimen in the British Museum, No. 37259, from Perim Island and referred to *Bramatherium*, has p^3-m^3, the outer borders of all teeth badly rolled. It is nevertheless decidedly smaller than the *Bramatherium* type, with narrower teeth transversely and smaller premolars, which show the accessory crest within the fossa much as in Giraffinæ. It is too large for *G. punjabiensis*, compares better with *Honanotherium schlosseri;* but may most probably refer to *Hydaspitherium*, as it is not much smaller than *H. megacephalum*. The accessory crest of the premolars is absent in *Bramatherium* type.

HYDASPIDOTHERIUM Lydekker, 1876

Hydaspidotherium Lydekker, 1876, Rec. Geol. Sur. Ind., IX, p. 154. November, 1876.

Hydaspitherium Lydekker, 1878, Pal. Ind., (X) II, p. 159.

Type.—A skull, in the Indian Museum, from Middle Siwaliks near Hasnot.

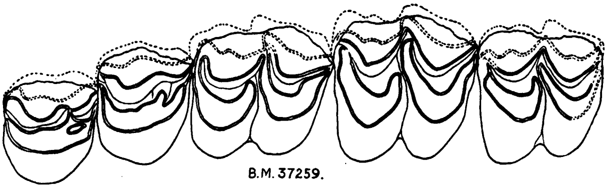

Fig. 54. *Hydaspitherium?* near *megacephalum*. Upper teeth, crown view, half natural size. British Museum No. 37259, from Middle Siwalik beds, Perim Island, referred to *Bramatherium perimense*.

SIVATHERIUM

Sivatherium Falconer and Cautley, 1836.

Synonym.—*Indratherium* Pilgrim, 1910, Rec. Geol. Sur. Ind., XL, p. 69; =*Sivatherium* ♀, auct. Falconer, 1868, Murie 1871, Bohlin 1926. Referred to *Helladotherium* by Gaudry 1862, Rütimeyer 1881, Lydekker 1882; to *Hydaspitherium* by Major 1891, Schlosser 1903.

Type.—*S. giganteum* Falconer and Cautley, *loc. cit.*, based on a skull from the Upper Siwalik beds.

Type of *Indratherium*, *I. majori* Pilgrim, *loc. cit.*, based on a skull from the Upper Siwalik beds.

Sivatherium is well distinguished from any of the other genera by superior size, prominent external ribs and styles on upper molars, extreme rugosity of enamel and exceptional size and massiveness of premolars. It is the only Upper Siwalik (Pleistocene) genus, and much shorter and more massive-limbed, with more developed horns, peculiar proportions of skull, etc. If *Indratherium* really is the female, as earlier authors believed, and Bohlin has recently supported this view after careful and thorough study of the type skull, then there is an extraordinary difference in skull between male and female. The teeth of *Indratherium* certainly are *Sivatherium* teeth, and the reference to *Helladotherium* or to *Hydaspitherium* is wholly untenable.

Pilgrim refers the "*Indratherium*" skull to the Palæotraginæ for no very convincing reason, as it differs sharply from *Palæotragus* and agrees with *Sivatherium* in all the tooth characters and many of the features of the skull, the others being naturally associated with absence of the great horns and other sex differences. Pilgrim's reasoning, however, is very curious. He is quite obsessed with the idea of parallel evolution, and having noticed, or thought that he noticed, certain characters as progressive between ancestor and descendant in one or two instances where he considers this relation to be proved, he assumes apparently that similar changes must occur in all other lines of descent in the family. He lists in this way nine "progressive characters of the family which, whether rapidly or slowly, seem to have been developed in every phylum." I am quite unable to validate his observations, even in some of the specific cases that he cites; and would not regard such lines of progress as necessarily to be expected in other lineages even if evident in one or two. But in fact the Giraffidæ seem to have one persistently primitive phylum ending in *Ocapia*, one long-legged and mesocephalic in *Giraffa*, and one stout-legged and brachycephalic ending in *Sivatherium;* and the skull and tooth characters are rather divergent than parallel. *Ocapia* has considerably reduced the premolars, *Sivatherium* greatly enlarged them. Its basicranial and basifacial axes are rather less than more inclined in comparison with the palæomerycines; again in sharp contrast with *Sivatherium.* It is no larger than the earliest giraffids. Its molar and premolar patterns are simpler than in *Palæotragus,* not more complex; nor in fact are the patterns in any of the later giraffids more complex than in some of the earlier species. In fact I find it necessary to set aside most of Pilgrim's phylogeny-building and come back to the facts of the matter, which are on the whole admirably set forth in Bohlin's memoir. I find some difficulty in validating a few of Bohlin's statements—it is not easy to see why he has placed such a gap between '*Honanotherium*' and *Samotherium,* or why he associates the former with *Giraffa* if *Samotherium* is considered as so far away. I do not in fact think that the Giraffidæ are an old family, or that any of them are very wide apart in spite of the diversity of skull structure. The lack of diversity in tooth structure is,