
Critical Observations Upon Siwalik Mammals

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Article VII.—CRITICAL OBSERVATIONS UPON SIWALIK MAMMALS

(Exclusive of Proboscidea)

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I. INTRODUCTION

During the winter of 1926–27 I spent six weeks at the Indian Museum in Calcutta and two months at the British Museum (Natural History) in London making a critical re-examination of the type collections of the Siwalik Fauna preserved in those two institutions. The object of this study was to check up in the light of modern palæontological evidence the classic researches and descriptions of Falconer and Cautley and of Lydekker, and the admirable later work of Pilgrim, as a basis for researches and description of the collections obtained for the American Museum by Mr. Barnum Brown in 1921–1923. The expenses of making this study were defrayed from funds provided by Mrs. Henry Clay Frick, as a part of her gifts to the American Museum for Siwalik collecting, preparation and research work.

To the President and Trustees of the American Museum I desire to

express my high appreciation of the opportunity and privilege of making this research, involving release from Museum duties over a period of several months. I am likewise deeply indebted to the friendly aid of Director Pascoe, Superintendent Pilgrim and others of the staff of the Geological Survey of India, to Doctor Bather and Mr. A. T. Hopwood and other good friends at the British Museum, who placed the collections wholly at my disposal for study and comparison, provided every facility for examining the specimens and referring to the published literature and the museum records, and aided and enlightened me upon various obscure points.

The accompanying series of notes and criticisms are by no means to be regarded as final conclusions. They represent principally an attempt to verify, revise and supplement the type descriptions with the aid of subsequent palaeontological knowledge, to point out doubtful or erroneous identifications or conclusions as to the affinities of certain types, and to reconsider the correlation of the Siwalik faunas with those of Europe and America. The views here expressed upon the affinities of various Siwalik mammals, and especially upon the faunal correlation, will call for a further and more careful criticism when the monographic researches upon Mr. Brown's collections have been completed. They represent the present personal viewpoint of the author, and no attempt is made at this stage to bring them into conformity with the conclusions of Professor Osborn based upon his proboscidean researches, or those of Doctor Pilgrim based upon his extensive and detailed studies of the stratigraphy and faunas of the Siwalik region.

II. CORRELATION OF THE SIWALIK FAUNAS

The fundamental necessity in any discussion of correlation is to have some definite and fixed standard of comparison. This standard is of necessity the stratigraphic and faunal succession in Europe, as the terms in universal use are of European origin and were applied primarily to European formations and faunas. Unfortunately the current usage of terms and correlation by European authorities is not wholly settled or consistent. The classic faunas of Pikermi, Samos and Eppelsheim are referred by some authorities to the Pliocene, by others to the Miocene. The equally classic fauna of Val d'Arno, formerly regarded as Pliocene, is considered by some of the best modern Italian and French authorities as early Pleistocene contemporary with the beginnings of Pleistocene glaciation; and with it are closely associated other important mammal faunas, Senèze and Perrier in France and the Red Crag of England. I do not

profess to have sufficient knowledge of the stratigraphy of these European formations to decide such problems on their merits, and have thought better to adopt as a standard the results of the Tertiary correlation studies made by Dr. T. W. Vaughan and his associates and published in the Bulletin of the Geological Society of America in December, 1924, and Haug's Treatise on Geology. In correlating European with American mammal faunas I pointed out in the G. S. A. Bulletin, above cited, certain relations which make it necessary either to revise the American succession downward, or the European succession upward. Accepting in that paper the older standards for the European faunas, it seemed necessary to suggest that the commencement of American glaciation would have to be placed in the Pliocene. If, however, the upper Val d'Arno and equivalent formations containing the first *Equus* fauna also represent, as do the Sheridan and other corresponding beds in the Plains region of America, the outwash of early glaciation, the renewed activity in erosion and sedimentation conditioned by the same combination of elevation and increased rainfall that brought about the glaciation of the higher and more northerly lands, then it would seem in every way suitable to place them both at the beginning of the Pleistocene. The appearance of the *Equus* fauna in the United States and in Europe marks a great migration movement, its center of dispersal apparently the more northerly regions of Eastern Asia and North America. This migration is due presumably to a change in climate, conditioned no doubt by diastrophic movements, and would naturally coincide with the onset of glaciation in more northerly centers and the mountain regions, as well as with a renewal of erosional activity and sedimentation.

If these relations are verified by more intensive stratigraphic and faunal studies, it would seem that they provide an acceptable line of division between Pliocene and Pleistocene, at the expense of shifting into the Pleistocene certain classic European faunas which have generally been regarded as Upper Pliocene. The alternative would seem to involve placing not only the "*Equus* Fauna" but also a part of the glacial period in the Pliocene.

The appearance of *Equus*, with its very characteristic associated fauna, in the United States, in Western and Southern Europe, Southwestern Asia, India and China, is taken therefore as the beginning of the Pleistocene in the faunal succession, as the onset of glaciation in the regions to the north of these marks the beginning of the Pleistocene in the geologic record. Whether the term be thus limited or not it appears that

the faunal, climatic and diastrophic changes were associated and dependent the first upon the second, the second upon the third.¹

The boundary between Miocene and Pliocene is an equally difficult one to standardize. While I follow Dr. Vaughan in his reference of the Pontian to the Miocene, it is not by any means clear that the *Hipparion* fauna of the Old World occurs in the Pontian proper. On the contrary it seems that the appearance of *Hipparion* in the Old World, distinctly and unmistakably an invading type of American origin, is a proper and convenient indication of Pliocene age. Again the question of whether it is called Pliocene or not seems less important than the fact that it marks another great migration movement, due to change in climate, dependent in turn upon diastrophic movements.

Without therefore undertaking to decide whether the first appearance of *Equus* and of *Hipparion* in the Old World faunas coincides exactly with the opening of Pleistocene and of Pliocene time respectively, according to this or that usage or definition, I think they accord approximately, and that they mark well-defined faunal changes that are a logical base for epochal divisions as they are conditioned by major geologic changes of widespread extent and world-wide influence.

The line between Oligocene and Miocene I regard as similarly definable by the appearance of the *Anchitherium* fauna in the Old World and in the United States (the American "*Kalobatippus*" being equivalent to the early species of *Anchitherium* and very probably indistinguishable generically). This with other evidence tends to place the American John Day fauna at the base of the Miocene rather than the top of the Oligocene, a much more satisfactory arrangement, as its relations to the Lower Miocene faunas are much closer than to the Oligocene White River faunas. The European Aquitanian faunas, which have much in common with the John Day and Rosebud-Harrison faunas of America, are equally well marked in distinction from the Oligocene (Stampian) mammal faunas.

Older Tertiary mammal faunas are not known from India, but in Burma the Pondaung Eocene is fortunately so related to the marine Yaw series that its age is not open to question. The Irawaddy series in Burma has yielded a number of fragmentary remains which would indicate that it covers a considerable period, Miocene to early Pleistocene, but further study is needed before any exact correlations can be made.

¹Berry, in his able philosophic discussion of correlation, appears to me unduly skeptical of the value of diastrophism. It is not, in my mind, satisfactory as directly observable in special regional work. But indirectly, in its influence upon erosion and sedimentation, climate and faunal migration and extinction, it appears to me not merely a fundamental cause but a very practical and necessary explanation in interpreting these phenomena.

COMPARATIVE VIEWS OF SIWALIK CORRELATION

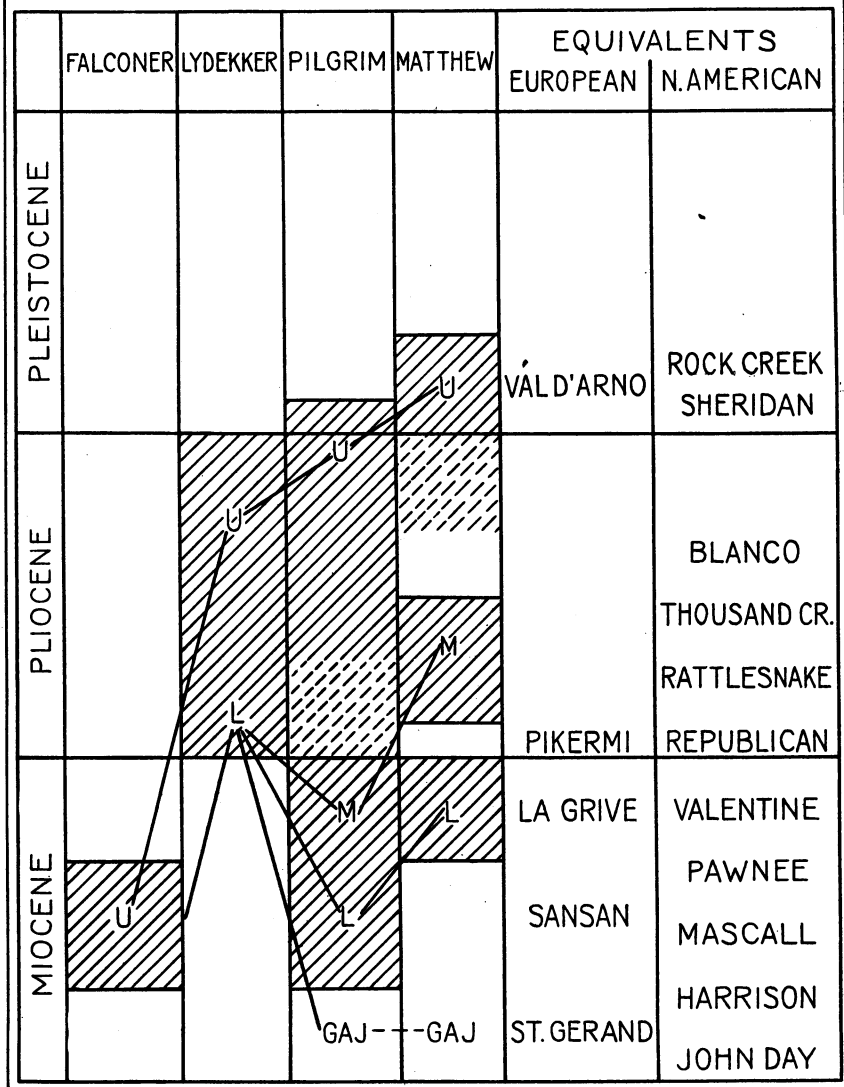


Fig. 1. Comparative Views of Siwalik Correlation.

The terrestrial "bone-beds" of Java, outcropping on both sides of a long east-west anticline and immediately overlying Pliocene marine marls, have yielded fossil mammals at many points, but the collections are mostly undescribed or inadequately described, except for those made by the Selenka expedition at and near Trinil on the Solo River. These, in the opinion of the German geologists, are Lower Pleistocene, although regarded by Dubois and by some other Dutch authorities as Upper Pliocene. The fauna has considerable resemblance to the Upper Siwalik fauna of India, and this resemblance is closer in some undescribed collections than in those obtained at Trinil. It may be that the "bone-beds" are not everywhere of the same geological age, although their relations to the anticlinal uplift are apparently identical. More field study and collecting and study of the mammals at various localities are necessary to decide.

The Siwalik fauna was regarded by early writers as Miocene, and it so appears in all the older text-books. Lydekker in his studies of 1876-1884 regarded it as Pliocene, but indicated that it was not a unit fauna. Pilgrim, as a result of extensive field work and intensive studies of the collections, separated it into three major divisions, Lower, Middle and Upper, with a series of subordinate local unit faunas. The Upper Siwalik he regarded as Pliocene, the Middle as Upper Miocene, the Lower as Middle Miocene.

Nearly all of the Siwalik fauna as known to Falconer and other earlier writers was the Upper Siwalik fauna as now known. A few genera (*Hyænarctos*, *Hipparion*, *Bramatherium*) came from what is now known as Middle Siwalik. Lydekker made considerable additions to the Middle Siwalik fauna and partly recognized it as representing an older fauna, which he called Lower Siwalik; with this he also placed a few fragments from what is now known as Lower Siwalik and some specimens from the Gaj fauna. Pilgrim was the first to make clear distinctions between the successive faunas, and added very largely to the faunas, Lower Siwalik (Chinji) and Gaj (Bugti) faunas. Cooper made considerable further additions to the Gaj or Bugti fauna from collections in Baluchistan.

In venturing to modify the results of Doctor Pilgrim's very thorough studies I am guided by the following considerations:

1. The appearance of new invading elements in a fauna is a safer guide to its correlation than the disappearance of old elements or the average composition of the fauna as a whole. The appearance of these new elements must be interpreted in the light of what is known of their origin and dispersal. When this is as directly recorded and fully docu-

mented as it is in the case of Tertiary Equidæ or Camelidæ, the evidence appears not open to any effective challenge. But more often the appearance of new elements in a fauna may be explained in several ways, the relative probability of which is not easy to test.

2. India and the Oriental region generally are today characterized by the survival of many primitive types of mammals as well as by the absence, scarcity, or recent appearance of some of the most progressive and specialized mammals. It compares in these respects with West Africa and tropical America. While it does not necessarily follow that this was true during the later Tertiary, yet it should be so considered until evidence proves the contrary; and so far from proving the contrary I believe that all of the evidence conforms with this assumption and much of it is difficult to explain in any other way. It should be added that the faunas of the Siwalik hills, of Burma, and of Java, should on this assumption contain progressively more and more of these relict elements or primitive survivors from earlier northern faunas, and that the indications that these fossil faunas were archaic, not ancient, should in the same sequence be progressively more marked.

A. THE UPPER SIWALIK, FAUNAL LIST AND COMMENTS

Pilgrim in his correlation paper lists a large fauna as from the Boulder Conglomerate. This is practically the Siwalik Fauna of the earlier writers, only a few types withdrawn which are known or inferred to come from the Middle Siwaliks. In recent work Pilgrim has, however, regarded this great fauna as coming from the Pinjor zone.

FAUNAL LIST: MAMMALS

- | | |
|---|---|
| <i>Simia satyrus</i> . | } Fragmentary and rare, but appear to be nearly related to modern Primates. |
| <i>Semnopithecus palæindicus</i> . | |
| <i>Papio falconeri</i> . | |
| * <i>Ursus theobaldi</i> . Battered skull, probably related to modern sloth bear, <i>Melursus</i> , of India. | |
| <i>Hyænarctos sivalensis</i> . ¹ A Pliocene genus, but doubtfully from Upper Siwalik. | |
| * <i>Mellivora sivalensis</i> . More primitive than modern ratel, more progressive than <i>Eomellivora</i> of Chinese Pliocene. | |
| * <i>Lutra palæindica</i> . More primitive than modern otters. | |
| * <i>Enhydriodon sivalensis</i> . ² . Horizon uncertain. | |
| † <i>Vulpes curvipalata</i> . Related to <i>V. bengalensis</i> . | |
| † <i>Canis cautleyi</i> . Related to Indian wolf. | |
| * <i>Viverra bakerii</i> . Related to <i>V. civetta</i> and <i>genetta</i> . | |
| * <i>Viverra durandi</i> . | |

¹The matrix is not like that of the known Upper Siwalik fossils, but a peculiar chocolate brown.

²Reported by Pilgrim from Middle Siwalik; but the matrix of the typical specimens is characteristically like that of many known Upper Siwalik specimens. Much more specialized than *E. bamboli* of ? Miocene (probably Pliocene) of Italy.

†*Hyæna bosei*¹. Near *H. striata*.

**Hyæna colvini* Lydekker.

†**Hyæna sivalensis* Falconer.² Near *H. spelæa*, etc., *sinensis*.

†*Meganthereon falconeri* Pomel.³ Cf. *M. meganthereon*, Perrier, Val d'Arno.

**Meganthereon palæindicus*.

**Felis cristata*. Cf. *F. tigris*, Pleistocene and recent.

†*Cynælurus brachygnatha*, ? = *C. pleistocænicus*, Pleistocene, China.

Felis subhimalayana.

Nesokia cf. *hardwickii*.

Hystrix sp. Near *H. leucurus*. Distinct from *H. sivalensis*.

Rhizomys sp. Cf. *R. troglodytes*, Pleistocene, China.

Caprolagus sivalensis.

**Stegodon ganesa*. Syn. *S. insignis*. *S. sinensis*, Pleistocene, China, *S. airawana* of Java said to be more specialized.

Elephas planifrons. Of Pliocene type, but only in Lower Pinjor.

**Elephas hysudricus*. Cf. *E. meridionalis*, Val d'Arno, etc.

Dicerorhinus platyrhinus. Cf. *R. etruscus* of Val d'Arno, etc.

**Rhinoceros sivalensis*. } Doubtfully separable. Related to modern Oriental

**Rhinoceros palæindicus*. } rhinoceroses but also to Pliocene species.

†*Equus sivalensis*⁴. Syn. *E. namadicus*, doubtfully separable. Cf. *E. stenonis* of Val d'Arno and Pleistocene Holartetic species.

†*Chalicotherium sivalense*. Cf. *C. sinense*, Pleistocene, China.

Sus falconeri.

Potamochoerus hysudricus.

Potamochoerus giganteus.

Potamochoerus magnus.

*†*Hexaprotodon sivalensis*. More primitive than Pleistocene hippopotami of Europe.

†*Camelus sivalensis*. Syn. *C. antiquus*, doubtfully separable. Typical *Camelus*, more advanced than Pliocene American Camelidæ.

Moschus sp. Inadequate type.

Cervus sivalensis.

Cervus.

†*Giraffa sivalensis*.

**Sivatherium giganteum*. Syn. *Indratherium majori*.

Hemitragus sivalensis. Pleistocene and recent.

Bucapra daviesi.

Boselaphus sp. Pleistocene and recent.⁵

¹ = *H. sivalensis* Bose (not Falconer). See notes.

² = *H. felina* Bose. See notes.

³ = *Machærodus sivalensis* Falconer and Cautley. See notes.

⁴ *Equus* first appears in North America in the Pleistocene.

⁵ Cf. also *Duboisia*, Pleistocene of Java.

Bubalis palæindicus.
Hippotragus sivalensis.
Cobus patulicornis.
Cobus palæindicus.
Cobus gyricornis.
Hemibos antilopinus.
Hemibos triquetricornis.
 ?*Amphibos acuticornis.*
Buffelus palæindicus.
Buffelus platyceros.
 †*Bos acutifrons.*
 †*Bos planifrons.*
Bos platyrhinus.
Bison sivalensis.

Pleistocene and recent.

Pleistocene and recent.

These genera and species need revision. They are mostly comparable to Pleistocene and recent species; some compare with the Upper Val d'Arno species.

*Hard gray sandstone matrix, black enamel, bone dark or black, specimens often badly chipped, rolled, or battered.

†Soft, light, sandy matrix, teeth and bones light-colored.

In reviewing the above list I can find no valid reasons for referring the Upper Siwalik fauna to the Pliocene. Some of the species are nearly related to those of the Val d'Arno; but, as already noted, the Pliocene age of the Val d'Arno fauna is doubtful. *Hyænarctos* is certainly a Pliocene genus, but it appears doubtful whether the Indian species is really from the Upper Siwalik beds; if it is, it would have to be regarded as a survival, in view of the general character of the fauna. The Siwalik *Stegodon* appears to be a more primitive type than the Pleistocene species from China and Java. This, if verified, might be similarly explained, and would parallel the relations of the Indian elephant to the mammoths of late Pleistocene. *Elephas planifrons* is a primitive species, but occurs only in the base of the Upper Siwaliks (auct. Pilgrim).

On the other hand most of the fauna belongs to modern genera unknown in the Tertiary, and the species are related to modern species about as one would expect in an early Pleistocene fauna. The occurrence of *Equus* and *Camelus* appears to me very convincing evidence of Pleistocene age. For the Equidæ occur in the Old World only as invading types—*Hyracotherium*, *Anchitherium*, *Hipparion*, *Equus*, in no case leading up from one to another through intermediate types. On the other hand, the American Tertiaries record a long series of intermediate stages leading insensibly from one to another (as has been elsewhere described) and this series has in recent years been so perfected through new material discovered in the later Tertiary (noticed and partly described, especially by Childs Frick and myself), that there seems to be no reasonable doubt of the evolution of *Equus* in North America and its

dispersal thence into the Old World and South America. But true *Equus* is not fully developed in North America until the beginning of the Pleistocene. The Upper Pliocene species are transitional. It could not appear in India before it had evolved in North America; and this holds true equally of Italy. Pilgrim has suggested, following an older view of my own, that the dispersal center of *Equus* was in northern Asia, and that it reached India before it appeared in North America. But there is no evidence to support this hypothesis and the abundant fossil record is wholly against it. My own suggestion was based upon an uncritical acceptance of the Pliocene age of *Equus stenonis*; and subsequent discoveries have piled up overwhelming contrary evidence. Abel has maintained that the Old World *Equus* is derived from *Hipparion* and the New World *Equus* ("Neohippus") from *Pliohippus*. But this view, also based upon the supposed Pliocene age of the Old World species of *Equus*, seems even less defensible. For there is no intermediate series between *Hipparion* and *Equus* in the Old World; on the contrary, the Old World species are all more or less aberrantly specialized, as shown by Pavlow. And the Old World and New World species of *Equus* are quite too much alike in every detail of their underlying structure to be the results of convergent evolution. If they were so, the Old World species would certainly inherit in common certain characters of *Hipparion*, the New World species certain characters of *Pliohippus* and *Plesippus*, that would upon careful study become apparent, and serve to distinguish the one group from the other. The history of the past, as Dollo has observed, is never wholly obliterated in the structure of animals, and the evidence of diverse ancestry could certainly be detected. Abel and Antonius have not adduced any such proof of their theory, nor have I been able to find any. *Equus* seems to me very certainly a unit genus, derived from a single source, although it is quite possible that its ancestor may have been related to certain North American species of *Hipparion* of the *H. whitneyi-occidentalis* group, as well as to *Pliohippus* and *Plesippus*. And I cannot regard it as other than North American in origin.

Camelus affords equally strong evidence for Pleistocene age of the Upper Siwalik beds. The Camelidæ are generally recognized as a group of North American origin and dispersal, and as regards the later Tertiary this is hardly open to any question. *Camelus* itself is not certainly recognized in America; Gidley has reported it from Alaska, Wortman from Nebraska, but in neither case is the evidence conclusive. The Pleistocene genera in North America are *Camelops* and "*Lama*," equivalent to *Camelus* in the progressive reduction of the teeth, and *Eschatius*, slightly further

advanced. In the Pliocene no camel has got beyond the "*Pliauchenia*" stage; in the Miocene all are in more primitive stages in tooth reduction and specialization—*Oxydactylus* in the Lower Miocene, *Protolabis* in the Middle, *Procamelus* in the Upper, with early "*Pliauchenia*" stages appearing just at the end of the Miocene. Now the Siwalik *Camelus* is not a primitive species, but it represents a stage of evolution in the dentition which was attained in North America only at the beginning of the Pleistocene. It is not credible that this stage of camelid evolution could have reached India in the Pliocene before it evolved in North America. This is not a conclusion based merely upon a count of premolar teeth. The entire character and degree of specialization of teeth and skull support it fully.

I cannot therefore regard *Equus* and *Camelus* in the Upper Siwalik as any older than Lower Pleistocene. The associated species of other genera differ so much from their nearest modern relatives that I could not regard the fauna as any later, if indeed it be a unit fauna.

It should be observed, however, that the Upper Siwalik types which I have examined in the British Museum show two diverse types of fossilization. In one group, to which *Equus* and *Camelus* belong, and others marked with a dagger (†), the matrix is soft and the teeth and bone light-colored and not very hard. It is significant that most of the modern types (nearly all the larger bovids) are in this type of preservation. On the other hand, a second group, marked with an asterisk (*), shows a very different preservation, flinty, hard and black, in a hard gray sandstone, and very often rolled and battered. There are some suggestions that these may belong to an older horizon; on the other hand the records show that the *Camelus* specimens were obtained in the vicinity of Moginand, and came from the upper part of the Pinjor exposures. Possibly this is true of most or all of the similarly preserved material, and if so the evidence would not preclude referring the group of types marked (*) to an older horizon, perhaps Pliocene. This would bring into conformity the proboscidean evidence which seems to indicate that some at least of the Proboscidea are Pliocene and decidedly older than the early Pleistocene of Java, China, etc. However, I do not see any sufficient evidence to warrant making such a division at present. It might be verified or disproved by field work; but experience shows that hasty splitting up of faunas upon such insufficient evidence is quite likely to be largely or entirely in error, and has been the basis of a great deal of entirely worthless phylogenetic speculation. It is better to play safe, to keep an open mind on doubtful points, but not attempt to decide them without sufficient evidence.

B.—THE MIDDLE SIWALIK, FAUNAL LIST AND COMMENTS

Nearly all this fauna is from Dhok Pathan and Hasnot. It is the fauna discovered by Theobald in the Siwaliks of the Punjab, and described by Lydekker.

FAUNAL LIST

<i>Palæopithecus sivalensis.</i>	
<i>Semnopithecus hasnoti.</i>	
<i>Macacus sivalensis.</i>	
<i>Indarctos punjabiensis.</i>	} Cf. <i>I. oregonensis</i> , Rattlesnake, Oregon. <i>I. lagrelii</i> of Chinese Pontian decidedly more primitive.
Syn. <i>I. salmontanus.</i>	
<i>Hyænarctos palæindicus.</i>	
<i>Amphicyon lydekkeri.</i>	One upper molar. Specialized; doubtfully <i>Amphicyon</i> .
<i>Potamotherium hasnoti.</i>	} I have not seen these types. No good descriptions or figures.
<i>Enhydriodon cf. sivalensis.</i>	
<i>Mellivora punjabiensis.</i>	No evidence that this belongs to <i>Mellivora</i> . See notes.
<i>Mellivorodon palæindicus.</i>	More probably feline than mustelid. Quite indeterminate.
<i>Lutra bathygnathus.</i>	Genus indeterminable.
<i>Palhyæna sivalensis.</i>	} Cf. <i>hipparionum</i> of Pikermi.
<i>Palhyæna hipparionum.</i>	
<i>Palhyæna indica.</i>	
<i>Hyæna macrostoma.</i>	} Cf. <i>H. chæretis</i> , <i>eximia</i> .
<i>Hyæna cf. eximia.</i>	
<i>Hyæna gigantea.</i>	
<i>Machærodus cf. schlosseri.</i>	} Two jaws, one of which is near to <i>M. schlosseri</i> of Pikermi; the other is a feline.
<i>Machærodus sp.</i>	
<i>Æluropsis annectens.</i>	Practically indeterminate feline.
<i>Felis sp.</i>	} Not described or figured, and I have not seen the specimens.
<i>Felis sp.</i>	
<i>Rhizomys sivalensis.</i>	Smaller than the species from the Pleistocene of China, but otherwise similar.
<i>Hystrix sivalensis.</i>	Appears to be intermediate between the Pikermi species and the Pleistocene <i>Hystrix</i> ; see notes.
<i>Dinotherium indicum.</i>	} List as given by Pilgrim.
<i>Tetrabelodon corrugatus.</i>	
<i>Tetrabelodon punjabiensis.</i>	
<i>Mastodon hasnoti.</i>	
<i>Mastodon latidens.</i>	
<i>Mastodon aff. latidens.</i>	
<i>Stegodon cliftii.</i>	
<i>Stegodon bombifrons.</i>	
<i>Hipparion antelopinum.</i>	} Near to the larger and smaller types of Pikermi and Samos, but appear somewhat more specialized. See notes.
Syn. <i>H. punjabiense.</i>	
<i>H. chisholmi.</i>	
<i>Hipparion theobaldi.</i>	

- Aceratherium lydekkeri*. } Not *Aceratherium*. Probably related to *Chilo-*
Aceratherium sp. } *therium* Ringström.
Teleoceras sp. Not *Teleoceras*. May be *Chilotherium*.
Rhinoceros aff. *sivalensis*. See notes.
Chalicotherium ? sp. Not found.
Tetraconodon magnus.
Sus punjabiensis.
Potamochærus titan.
Potamochærus.
Listriodon sp.
Microbunodon silistrense.
Merycopotamus cf. *dissimilis*.
Merycopotamus sp.
Hippopotamus iravaticus.
Dorcatherium majus. Inadequate type of no correlation value.
Cervus simplicidens. } Inadequate type of no correlation value.
Cervus triplicidens. }
Hydaspitherium megacephalum.
Syn. *Helladotherium grande* Pilgrim, non Lydekker.
Hydaspitherium grande Lydekker, non Pilgrim.
?Syn. *H. magnum* Pilgrim.
Giraffa punjabiensis. See notes.
Tragocerus indicus. } Compared by Pilgrim with *T. amaltheus* Pikermi,
Tragocerus sp. } but differs very considerably in the teeth.
Strepsicerine antelope, n.g.
(—— *latidens* Lydekker).
?*Boselaphus lydekkeri*.
Palæoryx sp.
Gazella sp.
Proleptobos birmanicus.

PRIMATES.—With few exceptions, every specimen of an anthropoid primate found in the Siwaliks or other Tertiary formations has been made the type of a new species. Genera are equally abundant in proportion. While this excessive splitting may be desirable in view of the important status of such documents in discussions of the origin of man, the very scanty material has no great weight as correlation evidence, in spite of the imposing array of names.

URSIDÆ.—*Indarctos* points apparently to a later date for the Dhok Pathan than the Lower Pliocene of China, but about equal to the Rattlesnake of Oregon. The *Hyænarctos* might be ancestral to the supposed Upper Siwalik *H. sivalensis*, but is quite closely allied. It is *slightly* nearer to the Sansan and Santa Fé *Hemicyon*, from which the *Hyænarctos* group is in my opinion rather directly derived.

MUSTELIDÆ.—All the material that I have been able to examine is so fragmentary as to be valueless for correlation, and for the most part the generic attributions are doubtful at the best.

HYÆNIDÆ.—Two or three doubtful species of *Palhyæna*, all allied to *P. hipparionum* of the Pikermi-Samos fauna, but the material that I have seen is very fragmentary. *Hyæna* comprises, as at Pikermi and Samos, a number of species related to the modern *striata* and *crocota* respectively, but less differentiated, the species more or less intermediate.

FELIDÆ.—The *Machærodus* and *Ælurictis* groups appear to be represented by fragmentary material allied to the Pikermi-Eppelsheim species, but insufficiently known to be of much use in correlation.

RODENTIA.—Too incomplete to be important in correlation; related to Pikermi and later Pliocene and Pleistocene species.

DINOTHERIUM.—Palmer has shown that *D. indicum* and *D. pentapotamixæ* and *D. giganteum* of Eppelsheim are doubtfully separable on present evidence. The genus certainly occurs in both Middle and Lower Siwaliks, and a more careful re-study of the material may bring to light valid distinctive characters in place of the erroneous ones predicated by Lydekker. The remaining Proboscidea I have not studied.

HIPPARION is abundant and characteristic in the Dhok Pathan. A number of skulls and articulated limbs have been obtained and the characters are thoroughly comparable with the Pikermi-Samos *Hipparions* as well as those of China. There are two distinct types, as at Pikermi and Samos, and, while there may be more, the supposed evidence upon which additional names have been based consists wholly of erroneous observations or interpretations. The larger, more robust *H. theobaldi* has a much larger and longer skull, heavier limbs and feet and relatively larger lateral digits than *H. gracile*, *mediterraneum* or *crassum* (if these be distinct species and not mere geographic races). The lateral digits are heavier than in any of the species of *Merychippus*, as well as any American *Hipparion*; the complication of the enamel on the lake borders is equally extreme. The same relations hold true when comparison is made with *H. richthofeni* of the Chinese Pliocene. All the Old World *Hipparions* belong to a single group with round to round-oval protocone, highly complex enamel, deep lacrymal pits, relatively large lateral digits with considerable facet for the inner cuneiform on the head of metatarsal III, and various other characters. These are carried to a maximum in the Indian species as compared with other well known species. *H. antelopinum* is smaller and slenderer than *theobaldi*, but belongs quite unmistakably to the same group. Certain American species, *H. mohavense*, *H. gratum*, show an approach toward this Old World *Hipparion* but are distinctly more primitive, especially *H. gratum*. The Florida species belong to an entirely distinct group, *Nannippus*, which I have elsewhere characterized.

The inference from this is that the Old World or typical group of *Hipparion* presents the following successive stages in specialization:

4. *Hipparion theobaldi*; *antelopinum*. Middle Siwalik, India.
3. *H. gracile* (Eppelsheim); *H. mediterraneum*, *H. matthewi* *H. proboscideum*, etc. (Pikermi-Samos); *H. crassum* (France); *H. richthofeni* (China).
2. *H. mohavense*. California. Ricardo formation.
1. *H. gratum*. Nebraska, etc. Valentine beds.

The later stages of this series are probably also represented by imperfectly known species in North America and Europe, etc., but the species cited are abundant and well known, so that their skull and foot structure can be compared. *Hipparion gratum* is in turn derivable from a certain group of species of *Merychippus* of the Mascall-Deep River-Pawnee Creek Miocene (*M. isonesus* group) through intermediate stages found in the Santa Fé of New Mexico and Barstow of California.

As *Hipparion* is distinctly an invading type everywhere in the Old World, while its ancestry is fully represented in the American succession, I can find no other explanation of the above relations than that the Middle Siwalik is distinctly later than the so-called Pontian fauna of Pikermi, Samos, Maragha and China, which in turn are later than the Ricardo and much later than the Valentine (commencement of the "*Hipparion* fauna" in America).

RHINOCEROSSES.—The so-called *Aceratheria* from India were referred to *Aceratherium* by Lydekker on the quite arbitrary ground that they were hornless. They appear to me to be gigantic species of *Chilotherium*, and whether or not they are placed within that genus (the skull differences are considerable) they have nothing to do with the true *Aceratherium*, but belong in the Oriental rhinoceros group. To *Chilotherium* is more definitely referable the so-called *Teleoceras* of the Mid-Siwalik. It has nothing to do with the true *Teleoceras*, and probably no especial relations with *Brachypotherium* of the older Miocene of Europe. The species of the Middle Siwalik may be compared with certain species of Pikermi-Samos, and with most, if not all, of the Chinese "Pontian" rhinoceroses as described by Ringström. It is not apparent that the Mid-Siwalik species are any later than Pikermi, but they lack the African rhinoceros group, which did not appear until Upper Siwalik and then only one species,¹ *R. platyrhinus*.

SUIDÆ.—*Listriodon* is reported by Pilgrim upon very doubtful evidence as surviving in the Middle Siwalik. I have not seen it. The remaining Suidæ I have not studied.

¹*R. deccanensis* and *karnulensis* of the Indian Pleistocene, referred to this group, are of somewhat doubtful position. See notes.

HIPPOPOTAMIDÆ.—*Merycopotamus* is chiefly found in the Middle Siwaliks, also in the Tatrot zone of the Upper Siwaliks. It represents the last survival of the anthracotheres, but is not ancestral to *Hippopotamus* as has been suggested. *Hippopotamus* is derived from the Suidæ.

TRAGULIDÆ AND CERVIDÆ.—The material is too inadequate to have any correlation value.

GIRAFFIDÆ.—The revised identifications of the Siwalik genera and species make a revised comparison with other Giraffidæ necessary. I find no evidence of *Helladotherium* or *Samotherium* in the Middle Siwalik, and *Hydaspitherium* and *Bramatherium* appear distinctly more advanced and specialized than anything found in Pikermi, Samos, Maragha or China, although much less specialized than *Sivatherium*+*Indratherium* of the Upper Siwalik. But these later stages do not appear to have been attained outside of India (unless Abel's *Sivatherium* from Adrianople is really of that genus). The more typical Giraffinæ are represented in Pikermi and supposed to be represented in India; but of this there is no certain evidence; the teeth of "*Orasius*" *attica* and those of "*O.*" *punjabiensis* are not very much alike except in size, and no limb bones of giraffe proportions are recorded in the Dhok Pathan. True giraffes do apparently occur in the Upper Siwalik beds, but even there the evidence is fragmentary and not wholly conclusive.

ANTELOPES.—There is a considerable variety of genera and species, and their remains are the most abundant fossils in the Siwalik beds. They are referred to Pikermi and later Pliocene or Pleistocene genera, mostly on rather insufficient grounds. *Tragocerus indicus* is one of the few well-based types, and is similar in horn-type to the Pikermi *Tragocerus*, but the teeth are somewhat more hypsodont, anterior premolars with simpler pattern. The remaining genera recorded must all be regarded as provisionally identified, and until the antelopes are more carefully revised no correlations can safely be based upon them. When that is done, they should afford some of the best correlation evidence.

In general the evidence of the Dhok Pathan fauna appears to me to indicate an age somewhat later than Pikermi, Samos or the Chinese Lower Pliocene, and it may be as late as Middle Pliocene. But it appears to be related to the Palæarctic faunas in the same way as are the Pleistocene and modern faunas of the two regions, although not to the same degree. India was then, as it is now, a refuge where primitive types survived after they had disappeared from the northern world.

C. THE LOWER SIWALIK, FAUNAL LIST AND COMMENTS

This is the fauna of the Chinji Zone, first described by Pilgrim and practically unknown to earlier writers.

FAUNAL LIST

- Dryopithecus indicus.*
Dissopsalis carnifex. } A remarkably primitive type of creodont, in about
 Syn. *D. ruber.* } Upper Eocene evolutionary stage.
Amphicyon cf. giganteus. } A single molar. Valueless for exact correlation.
Amphicyon palæindicus. }
Amphicyon chinjiensis. }
Haplogale sp. } Undescribed. Not seen.
 ?*Potamotherium* sp. } Possibly the *Potamotherium* is the same as a very
 good otter jaw in the Brown Collection. If so, it is
 nearer to *Lutra* than to *Potamotherium*.
Progenetta proava. }
Æluropsis chinjiensis. } The genus is close to *Ælurictis* (Miocene-Pliocene,
 Syn. *Sivæluxus* Pilgrim. } Europe and North America). The type species is from
Æluropsis sivalensis. } the Middle Siwaliks.
Machærodus sp. } Not seen.
Dinotherium sp. } Probably not separable from *D. giganteum*. See
Dinotherium pentapotamiz. } notes.
Trilophodon angustidens. } Not examined. All sorts of things have been re-
Trilophodon falconeri. } ferred to "*Mastodon angustidens*."
Trilophodon macrognathus. }
 ?*Chilotherium intermedium.* } These rhinoceroses belong to the
 modern Oriental group, and are most, if
 not all, referable to *Chilotherium*. They
 are certainly neither *Aceratherium* nor
Teleoceras.
 ?Syn. *Aceratherium* aff. *tetradactylum.* }
 Syn. *Teleoceras* sp. }
Phyllotillon sp. } The several Chinji chalicotheres teeth that I have
 seen are certainly not *Phyllotillon* but *Chalicotherium* or
Macrotherium.
Hyotherium cf. sindiense.
Sus sp.
Sanitherium schlagentweitii.
Listriodon pentapotamiz. } Near to *L. splendens* of the later Miocene of Europe.
Listriodon sp. }
Microbunodon silistrense. } Anthracotheres. The phylogeny of this group and
Hemimeryx pusillus. } identification of genera and species have been so bedevilled
 by hasty and incomplete studies that they are hardly
 usable for correlation.
Dorcabune sp.
Dorcatherium anthracotherioides.
Dorcatherium minus. } The types are too fragmentary to be identifiable
Dorcatherium sp. } even generically. They are probably traguloids of the
Dorcatherium majus. } *Dorcatherium* group.

<i>Dicrocerus</i> sp.	Not seen.
<i>Propalæomeryx sivalensis</i> . ??Syn. " <i>Giraffa</i> sp."	Valueless for correlation. See notes.
• <i>Giraffokeryx punjabiensis</i> .	A characteristic genus of four-horned primitive giraffids near to <i>Palæotragus</i> and <i>Palæomeryx</i> in many respects.
<i>Protragocerus</i> , 2 sp.	} Antelopes of several genera related to the Pikermi-Samos antelopes are found in the Chinji, but have not been exactly studied.
Strepsicerine antelope.	
<i>Gazella</i> sp.	

The Chinji fauna cannot be adequately compared until it has been critically revised throughout. I was able to study a part of the type material in Calcutta and London, and have reviewed some of Mr. Brown's collections in New York, but can make only partial comparisons.

The above list is taken from Pilgrim, 1913, with some modifications based on his later publications and my own notes herewith. Many of the species are represented by very scanty and fragmentary material and their generic position is by no means certain. Some I have not seen, and Doctor Pilgrim has published no descriptions or even statements of the nature of the types.

PRIMATES.—Too rare and fragmentary to be safe guides in correlation.

CREODONTA.—*Dissopsalis* is a remarkable survival, much more primitive than the Oligocene *Hyænodon*.

CANIDÆ.—A few isolated teeth and jaw fragments referred to *Amphicyon* are the only representatives of this family. Similarly fragmentary amphicyonines found in the American Miocene and Pliocene would be quite indecisive for correlation. So far as I have seen, the material most resembles *A. giganteus* and *frendens*, the former being the genotype and associated with *Dinotherium*; but what the relations may be to the better known species, *A. major* of Sansan, *sinapius* of the American Middle Miocene and *Pliocyon gidleyi* and *mæandrinus* of the American Pliocene, can be determined only when better material is available.

MUSTELIDÆ.—I do not know upon what evidence Doctor Pilgrim predicates *Haplogale* in the Chinji fauna. His *Potamotherium* I have not seen, but two jaws of otters in the Brown collection are better referred to *Lutra*. They are a large species with progressive teeth suggestive of *Aonyx*. I am equally unfamiliar with his *Progenetta*.

FELIDÆ.—*Sivæluxus chinjiensis* appears to me to be a species of the *Ælurictis* group, an archaic rather than primitive type, for it occurs in the American Pliocene, and probably the same genus as the type specimen of Lydekker's *Æluropsis sivalensis*. I have not seen any true *Machærodus*

in the Chinji, but it would be likely to occur. It is typical in the Eppelsheim and Pikermi faunas.

PROBOSCIDEÆ.—*Dinotherium* appears to be limited to the Lower Siwalik. The two described Indian species are very doubtfully separable either from each other or from *D. giganteum* of Eppelsheim. The "*Triphodon*" I have not examined critically.

RHINOCEROTIDÆ.—Most of the Chinji rhinoceroses that I have seen could very well be referred to *Chilotherium* Ringström, but represent one or more somewhat primitive species. I do not see any particular affinities in this genus to the *Teleoceras* phylum; although the teeth maintain the rather primitive indifferent characters of the European members of that group (*Brachypotherium*), there is no indication in the Chinji of brachypodine rhinoceroses. The Chinji rhinoceroses may well be ancestral to those of the Middle Siwalik, and through *R. sivalensis* to the modern Indian and Sonda rhinoceroses, and through other intermediates to the Sumatran species. The Chinji species do not appear to include any of the atelodine group that appears in the Pikermi fauna, nor have I seen anything that suggests the true aceratheres of the European Miocene and early Pliocene. There is a small narrow-headed type with long nasals, small, brachyodont, simple teeth that may be a primitive precursor of the Sumatran rhinoceros group and allied to "*Diceratherium*" of the Chinese Pliocene (which is certainly not true *Diceratherium*).

CHALICOTHERIIDÆ.—These are rare in the Chinji as in most Tertiary formations. Pilgrim reports *Phyllotillon*, but I do not know upon what evidence. The typical *Phyllotillon* is closely allied to *Moropus* of the American Lower Miocene. All the Chinji chalicotheres that I have seen belong to a different phylum, the *Macrotherium-Chalicotherium-Circotherium* series, and are small and rather primitive, comparable to the smaller species of *Macrotherium*, distinctly more primitive than *Chalicotherium* of Eppelsheim, much more so than *Circotherium*, which occurs in the Upper Siwalik and in the Pleistocene of China.

SUIDÆ.—*Listriodon* is the most characteristic genus, and the Chinji species is related to *L. splendens* of the Middle and Upper Miocene of Europe. Concerning the remaining Suidæ I am unable to formulate any views at present. Doctor Pilgrim has recently monographed the Indian Suidæ, but his methods appear to me to place too much weight upon one or two unsupported differentiation characters, allowing not enough for individual variation, and resulting in an extraordinarily complex arrangement which would be far more complex if the same methods were applied to all the Old and New World suillines, instead of only to the Indian groups.

ANTHRACOTHERIIDÆ.—Anthracotheres are not common in the Chinji, and appear to be all tetracuspids.

TRAGULOIDEA.—A number of small ruminants, probably related to *Dorcatherium* of Eppelsheim, but their exact position has not been determined.

GIRAFFIDÆ.—“*Propalæomeryx*,” based upon a single upper molar, is at present not supported by any correctly referred specimens. It may be the same as certain short-crowned ? giraffids not yet studied. *Giraffokeryx* is the common and characteristic genus of the Chinji. A fine skull in the Brown collection shows that, while the teeth are primitive, the skull is a rather elongate four-horned type of probably aberrant character, quite distinct from *Palæotragus* with which Bohlin is disposed to identify the genus. It might conceivably stand ancestral to sivatheriines, ocapines, samotheriines and giraffines, but very rapid and extensive diverse specializations would be necessary to bring about the changes, and there is hardly room between Lower and Middle Siwalik for so much diverse specialization. It appears more probable that the Chinji Giraffidæ included a considerable number of types with similar dentition, but with the earlier stages of diversification in skull and horn characters, and that the *Giraffokeryx* skull is a side line.

ANTELOPES.—There are several genera of antelopes in the Chinji, and jaws and teeth are the most abundant fossils there, but not much is known of the skulls. One type appears to be ancestral to *Tragocerus punjabiensis*, but the pertinence of that species to the Pikermi-Samos *Tragocerus* is open to question. I am unable to see much affinity to *Protragocerus* in any Chinji antelopes that I have examined; but certainly there are antelopes with the tragocerine and strepsicerine types of horn, as also small species that cannot be distinguished from *Gazella* by the scattered horn-cores, jaws and other fragmentary material.

The fauna has a distinctly Miocene aspect in such genera as *Listriodon*, the primitive stage of the antelopes, absence of large giraffids, of progressive rhinoceroses and chalicotheres, of several advanced types of Carnivora, but most especially in absence, save doubtfully near the top, of *Hipparion*. Negative characters are not the best indications, but I see nothing in the fauna to prevent its being regarded as Upper Miocene, equivalent to La Grive and associated faunas. I hardly think it can be much older, for it seems rather nearly related to the Hasnot fauna, and partly ancestral. Pikermi-Samos-Eppelsheim intervene as to age, but they are in many instances less closely related. In the *Tragocerus*, *Gazella*, *Macrotherium*, *Hydaspitherium*, “*Orasius*,” *Rhinoceros*, *Lutra*,

Hyæna and probably many other phyla, the Middle Siwalik stage has a somewhat more primitive *representative* type in the Pikermi fauna, but a directly *ancestral* type (so far as appears) in the Chinji. This does not prove that India was the center of dispersal of these types, but that it was accessible to them both in Chinji and Dhok Pathan, more so, one would judge, than Western Europe, and less so than the present Ægæan region.

III. PRELIMINARY REVIEW OF SIWALIK COLLECTIONS IN INDIAN MUSEUM, CALCUTTA

PROBOSCIDEA.—*Dinotherium*, skull. Palmer, 1924, Pal. Ind., N.S., VII, No. 4. Partial skull coll. Pilgrim, 1912, Lower Chinji.

All that is saved is the basicranial region and set of teeth. Basicranial agrees so far as stated with Eppelsheim skull. No condyloid foramen. An alisphenoid foramen. Postglenoid and posttympanic processes unite, enclosing a "false meatus" better developed than in *Elephas*, *D. indicum* and *D. pentapotamix*.

Type of *D. indicum* is part of a molar identified by Lydekker as hinder part of m^1 . It is, according to Palmer, front part of m^1 . Probably is from Lower Siwalik beds of Dera Ghazi Khan.

Type of *D. pentapotamix*, p^3 , probably Lower Siwalik, near Attock. Agrees rather closely with corresponding tooth of Palmer's skull, which is intermediate in size between Lydekker's type and *D. giganteum*. Such differences as there are may be regarded as indicating one rather variable species. Specimens of p^4 , m^1 and m^2 from the Chinji beds also show much variability in the characters used by Lydekker to distinguish *pentapotamix* from *giganteum*.

Type of *D. naricum* Pilgrim from Gaj was subsequently referred by its author to *D. indicum* as only a variant. It was described as an "upper true molar, probably the last," but is m^2 . Does not differ materially from *D. giganteum*.

CARNIVORA.—*Pterodon bugtiensis*. Gigantic jaw, front complete, 2 molars; front teeth are broken off but alveoli complete. Also a part lower jaw with m^2 -3. Doubtful p^4 .

If correctly restored, jaw is nearly two feet long. Probably exaggerated, as jaw of this genus is short and deep.

Also one upper molar in jaw fragments, m^2 . *Pterodon* sp.

Dissopsalis. Pretty fair upper jaw, p^3 - m^2 . Upper jaw p^2 -4; upper jaw m^2 and part m^1 ; several separate teeth.

Nothing in this that shows different from our specimen, but the upper jaw should be figured for comparison.

Amphicyon shahbazi. Jaw fragment m^2 , m^1 , with trigonid broken off, alveolus of m^3 . Peculiar species. Figured Pal. Ind., IV, Mem. 2, Pl. III, Fig. 2.

Amphicyon palæindicus. Upper molar. Medium size, rather smaller than *giganteus*, compares with our Lower Sheep Creek species in size.

Rest of *Amphicyon* removed by Dr. Pilgrim.

Canis cauleyi. *Maxilla, p^4 - m^2 . Upper Siwaliks. Pretty fair *Canis*. Should be carefully refigured. Figured in Pal. Ind. (X) II, Pl. XXXII, Fig. 3.

No other *Canis* in this collection.

Hyænarctos palæindicus. *Upper jaw. Middle Siwaliks. P^4 - m^2 . The m^2 is sub-square; needs figuring. M^1 still somewhat trigonal.

H. punjabiensis. Upper jaw. Middle Siwaliks. Slightly elongate m^2 , more squared m^1 . Apparently belongs with mandible. The m^2 is on a referred specimen, probably of *palaeindicus*; the type m^2 of *Indarctos* belongs to this species.

H. punjabiensis. Mandible. Appears to be correctly referred to the species.

H. sivalensis. Cast of cranium (original in B.M.), also of femur, radius and ulna.

Indarctos salmontanus. Middle Siwaliks, Hasnot. Much elongate m^2 .

Melursus theobaldi. Skull. Upper Siwaliks. Teeth appear to be battered off, but skull is pretty good. Figured in Pal. Ind., (X) II, Pl. xxviii, Figs. 1, 2.

Ursus namadicus. Cast of upper jaw from Narbada.

Mellivora. Cast of cranium. Also casts of skulls of *Enhydriodon*, *Lutra* and *Viverra*. Originals in B.M.

Herpestes, etc., Karnul Caves. Some at least of this material is very recent. Other specimens appear to be older. With a supposed atelodine rhinoceros; but I am a bit skeptical of absence of tusks being normal.

Palhyæna cf. *hipparionum* and *indicus*. * 3 lower jaws. Middle Siwaliks.

Lycyæna macrostoma. Skull. Middle Siwaliks. Figured Pal. Ind., (X) II, Pls. xxxvi and xxxvii. Lower jaw, p_4 - m_1 and roots of remaining teeth also figured in following plate.

Rest of *Palhyæna* removed by Pilgrim.



Fig. 2. *Conohyus indicus*. P_{3-4} and m_3 . Siwalik specimen in Indian Museum, Calcutta.

Hyæna colvini. *Skull, also *palate and *left maxilla. All from Upper Siwaliks. Should be drawn. All figured.

*Left mandibular ramus. Upper Siwaliks.

Hyæna felina. Left lower jaw. Uppermost Siwaliks. Jamu. Right lower jaw. Upper Siwaliks. All figured.

Æluropsis annectens. Lower jaw, p_4 . Figured by Lydekker.

Sivælurus chinjiensis. Fine upper jaw, lower jaw doubtfully referred. Figured by Pilgrim.

Sivælurus sivalensis. Good lower jaw. Figured by Pilgrim.

Paramachærodus cf. *schlosseri*. Two lower jaws. Figured by Pilgrim.

These genera fall into the same groups as our "*Pseudælurus*" and "*Heterofelis*."

Machærodus. Very clearly distinct by the reduced p_3 . M_1 practically heelless, a very minute rudiment only to represent the ?metaconid.

M. sivalensis. Lower jaw. Upper Siwaliks. Rurki Mus. Coll.

Felis cristata is a species about size of tiger. Casts of two skulls, the originals in B.M. One marked *F. palæotigris*, the other *F. cristata*. A third cast is of an imperfect skull, palate mostly gone.

Felis rubiginosa. Upper and lower jaws from Karnul caves. Look pretty modern. Size of small domestic cat.

SUIDÆ.—*Conohyus*. Upper and lower jaws figured of *chinjiensis* (small sp.), Chinji zone; of *indicus* (larger sp.), Nagri zone; *sindiensis*. Premolars are somewhat enlarged in fashion of *Tetraconodon*, but by no means extreme.

Tetraconodon. Exaggerated premolar enlargement. The molars when unworn are quite of suid type.

T. minor from Burma, Irawaddy series. Has p^4 very little enlarged, smaller than molars, but of same general form, with protocone and deutocone of subequal size. Lower jaw fragment shows much enlarged premolars (but no molars). I do not see how these lower premolars can belong to the same species as the upper jaw.

Sivachærus. Large robust type, premolars not inflated, but molars relatively stout. Comes from Hasnot and from Siwaliks and Burma (Pakokku, ?Irawaddy series). Also Tatrot zone.

Propotamochærus is more normal pig, p^4 has strong triticocone, p^3 is broadened at posterior end with three roots, small postero-internal heel. Lower premolars are all rather compressed.

Lophochærus, a diminutive animal with simple cusps, little or no extra cuspules, slight tendency to transverse crestring, very small heel on m_3 .

Listriodon has strong transverse crestring, large simple heel on m_3 ; p_4 has very distinct metaconid. P^4 has distinct triticocone and posterior cingulum enlarged internad into a rudimentary hypocone; p^3 a heavy postero-internal cusp.

Dicoryphochærus. P^4 and molars have strong tendency to polybunus, otherwise not so unlike *Propotamochærus*.

Dicoryphochærus titan. Fine big skull and jaws. The middle pair of incisors large, long, spatulate teeth. Lower canines are rather large, but not in proportion to size of skull; back of skull notably high.

Several other parts of skull with heavily worn teeth may belong to this or smaller Suidæ.

Some species of *Dicoryphochærus* are large and massive. Lower jaw B539 has stout incisors, small canines; rather short diastema is between p_1 and p_2 , p_3 has anterior and posterior cusps, p_4 also has a strong internal cusp. Molars suggest a preliminary stage to *Phacochærus* in the numerous highish cusps, especially on m_3 . This is *Sus titan* of Lydekker. Metacarpals associated here are separate, moderate length, massive, strong keels extending over upper surface. Fine skull and jaws in wall case.

Sus falconeri carries the above characters a little further, the crown of molars $\frac{3}{4}$ being higher, also polybunous. This is Upper Siwalik. *Sus indicus* of smaller size, with narrower teeth, is from Pleistocene.

Sanitherium is very small, with narrow molars, rather simple and shorter crowned, only lower molars known. Lower Siwalik, etc.

Sivahyus is also very small; narrow molars, higher crowned and compressed cusps suggest ancestry of *Hippohyus*.

Hippohyus larger, size of domestic pig, polybunous, with high, laterally compressed cusps. Lower premolars quite trenchant; upper premolars have several pockets.

These come mostly from Tatrot zone, some from Dhok Pathan zone at Hasnot.

Bugthitherium. Possibly related to *Entelodon*, but not determinable in absence of crowns of any teeth and any trace of molars.

"**TRAGULIDÆ.**"—"Tragulus" *sivalensis*. Upper molar from Hasnot, Middle Siwaliks. This has some resemblance to *Mennina*, none to *Tragulus*, but there is no

evidence that it is a tragulid. A lower p_4 and m_3 also placed here; they do not belong together, neither belongs to "*T.*" *sivalensis*, and the premolar is certainly not tragulid; the molar is peculiar, not like known tragulines. Also three jaw fragments with molars only, molars rather high-crowned, rugose enamel, simple heel.

Dorcatherium majus seems to be somewhat of an aggregate of several different animals. Premolars on one jaw from Middle Siwaliks, p_4 has double posterior crest like ?*Leptotragulus*. Heel of m_3 has large external crescent, enfolding a small basal cusp, the latter absent in some other specimens. Moderately high crowns. Middle and Lower Siwalik.

Dorcabune has much the same construction in bunodont, thick-enameled teeth, short-crowned, rugose enamel. Larger size than "*Dorcatherium*," comes from Lower Siwalik, some also from Middle Siwalik.

Prodremotherium and *Gelocus* from Gaj, only m_{2-3} known. Both I think are the same genus, but it is not *Prodremotherium* or *Gelocus*. Strong looped heel on m_3 .

GIRAFFIDÆ.—*Propalæomeryx*. M_{2-3} from Gaj of "*P.*" *exigua*; m_3 of *P. sivalensis* from Lower Siwaliks. The latter has a heavy basal external cusp between 2nd and 3rd lobes, transverse pitch of anterior inner crescent exaggerated, size larger and broader.

Giraffa punjabiensis from Middle Siwaliks, p^3-m^2 , m^2-3 , etc. These are typical giraffid teeth, whatever their generic position.

G. sivalensis is much the same.

Giraffokeryx is smaller, with narrower molars, less specialized, but similar.

Hydasphitherium. Skull. Middle Siwaliks, Hasnot. This is one of the most perfect skulls of this group. Smaller and less massive than *Sivatherium* and lacks the anterior pair of horns. The posterior pair is postorbital but quite clear of the lateral angles of occipital crest. Elongated anteroposteriorly in a form much like *Bramatherium* skull cast, but the horns are broken off close to base so that their form and separation are not preserved.

The angles of occipital crest project but do not form a rounded horn as in *Bramatherium*; however, the occiput is quite wide. This specimen has not been restored at all, but it is not completely cleaned around arches. It is by no means so high and short as *Sivatherium*, much nearer the giraffine proportions. Palate nearly in line with condyles.

Hydasphitherium megacephalum. Lower jaw, p_2-m_3 , Jabi, Punjab. P_4 has complete, full-sized inner and outer crescent in anterior half; the posterior half reduced and obliquely set but completely formed pair of crescents. P_3 has three major and two smaller cross crests, inner crests on p_2 also well formed. Molars have strong overlap of anterior on posterior inner crescent; also on m_3 the posterior inner crescent has a crest on outer side that goes forward to meet the posterior margin of anterior exterior crescent. Heel consists of main cusp large and much curled around, and a couple of subsidiary inner cusps in front of it.

H. magnum. Upper jaw, P^3-m^3 . Middle Siwaliks. Complete inner and outer crescents on p^3 and p^4 ; inner crescent has an accessory crest in its posterior half directed postero-externad.

Various upper and lower teeth identified as *Hydasphitherium*.

Cervical vertebræ quite short, bovid proportions.

Metapodials and foot bones about proportions of *Samotherium*, but larger.

Sivatherium. Larger size than *Hydasphitherium*. Appears to be characteristic of Upper Siwaliks as *Hydasphitherium* is of Middle. P_4 has relatively smaller and less

perfect posterior crescents, the tooth as a whole wider. Cervicals short, with bovid proportions, but gigantic; ball of centrum about $2\frac{1}{2} \times 3$ inches, arches 8 inches wide. Limb bones size of *Mastodon productus* or larger.

EQUIDÆ.—*Hipparion punjabiense*. Fine palate p^2 - m^3 r. and l. This is a little larger than *H. occidentale*, the protocone is more or less lenticular except on p_2 in which it is oval; highly complex enamel foldings.

H. theobaldi. Fine palate, dp^2 - m^2 and p^1 r.

H. theobaldi. Upper jaw, p^4 - m^3 l., upper jaw, dp^{2-4} .

I cannot see any serious differences between these species not accounted for by difference in age and wear of teeth. Specimens referred to *theobaldi* show the stout metapodials and large lateral digits same as Brown's. Skull has rather deep lacrymal pit, well forward of orbit (2 inches). Practically all material is Middle Siwalik.

Equus sivalensis. Much elongate protocone in one maxilla, but a skull shows relatively short protocones.

Other maxillæ with more or less intermediate characters.

RHINOCEROSSES.—*R. unicornis*, *deccanensis*, *carnuliensis*. Pleistocene and recent. These are represented by fragmentary material and do not appear to be separable from the ordinary Indian rhinoceros. A jaw of *R. carnuliensis* has a little of the symphysis preserved, which draws in anteriorly as though incisor were small or absent; but not enough is preserved to be sure on this point. But premolars are little reduced, alveolus of p_2 shows two large roots, p_3 is large and p_4 almost size of m_1 . This is an old animal.

R. palæindicus certainly has large lower tusks; casts also show small median pair of incisors. Broad, heavy, flat symphysis, ?procumbent tusks. Isolated median incisor from Lehri Punjab.

R. sivalensis. Lower jaws, one showing alveoli of tusks, closer together than *palæindicus* and no incisor apparently. Also p_2 is large and two-rooted, with imperfect anterior but complete posterior molariform loph. Upper molars with fairly strong straight crochet, no trace of crista or antecrochet, prominent external pillar. This holds of a number of separate teeth. Referred milk molars have long crochet, strong antecrochet, only a trace of crista.

"*Teleoceras*" *blanfordi* from Gaj. Weak crochet, strong antecrochet, p^3 with moderate crochet, double crista, no antecrochet; p_4 with weaker crochet and crista. Also from Middle Siwaliks.

T. fatehjangensis does not appear particularly different, allowing for age and individual difference. The type is a palate with p^4 - m^2 well worn, badly preserved and not cleaned.

"*Diceratherium*" *shahbazi* from Gaj. Smaller and more brachydont than the preceding species, with weak crochet and antecrochet, strong external pillar, somewhat quadrate m^3 , p^{2-4} molariform, unreduced.

These have nothing to do with *Diceratherium* or *Teleoceras* of America. A lower jaw of "*T.*" *blanfordi* from Gaj has p_3 - 4 , m_1 complete, m_2 broken off, m_3 not yet erupted. Alveoli for good-sized tusks (but possibly these are milk molars 2-4).

Aceratherium perimense. Gigantic species with rather short-crowned teeth, lower molars narrow and compressed, almost metamynodont. Very large lower tusks, not procumbent; p_2 small, triangular, p_3 large, but reduced anteriorly; p_4 molariform, nearly as large as m_1 . Upper tusk also very large. Weak to strong crochet and weak antecrochet on molars, strong external pillar, moderately high-crowned upper molars,

flat-surfaced behind the pillar. Heavy cingulum around inner and anterior face of protocone in some upper molars. Mostly from Lower Siwaliks.

Aceratherium lydekkeri. Maxilla from Middle Siwaliks, p^1 - m^2 . Does not seem very different from *A. perimense*; crochet perhaps stronger and a crista present on m^2 . P^{2-4} have the cross crests complete and well developed; p^1 is non-molariform. Minor crests almost absent on P^{2-4} , only rudiment of crista on p^3 and of crochet on p^4 ; cingulum around protocone prominent.

"*Aceratherium*" *bugtiense* from Gaj. This is *Paraceratherium* and quite distinct in the imperfectly molarized premolars; larger size molars lack the minor crests, shorter crowns, lower molars not compressed laterally ("metamynodont"), conical lower incisor.

"*Aceratherium blanfordi* var. *minus*." Lower Siwaliks. This seems to be the same as "*Diceratherium*" *shahbazi*. Good series of upper teeth. It is from Gandvi in Bugti hills.

Cadurcotherium indicum. Size of *Metamynodon* and closely resembles it. Upper jaw p^4 - m^3 , lower jaw m_1 - 3 . Lateral compression of molars strongly accentuated on m_3^3 ; p^4 relatively small, with something of a median pocket.

Dicerorhinus deccanensis. Lower jaw apparently complete, has no tusks. Premolars un-reduced. Molars are rather brachydont.

"*Dicerorhinus*" *platyrhinus*. Cast of skull, Upper Siwaliks. The teeth are rather closely related to *Celodonta* and *Ceratotherium*, not to *Dicerorhinus*. Large anterior and small posterior horn core, no supporting septum in nasals.

Rhinoceros sivalensis. Middle Siwaliks. Top of skull only, no teeth. Anterior horn core rather small, not terminal. No trace of second horn core. Occiput elevated, the top of cranium strongly concave.

Aceratherium lydekkeri. Skull. Flat top, rather broad frontal region, nasals withdrawn, reduced, and rounded in cross-section. Size gigantic, corresponding to teeth noted on another page. The occiput does not appear to rise in the usual rhinoceros way, but to carry on backward in line with top of flat frontal region.

Metamynodon birmanicus and *M. cotteri*. Upper Eocene, Burma. Quite small, about the size of *Amyrnodon* and molars scarcely any more compressed. Inner crescents of upper molars undivided. This is in all respects much nearer to *Amyrnodon* than to *Metamynodon*. Incisors, however, are reduced to $\frac{1}{2}$ of fairly large size. Canines large, vertical, the lower recurving and worn to a flat surface against anterior face of upper canines. Quite a long diastema and long muzzle pinched in between canines and premolars. Might stand as a separate genus near to *Amyrnodon*.

Sivatitanops and *Eotitanotherium*. These are too fragmentary for generic determination. The best specimens are two or three complete teeth, three premolars and one true molar (upper). They are titanotheres, however, safely enough.

Indolophus guptai and *Chasmotherium birmanicum*. Probably closely related to *Teleolophus*, or perhaps partly intermediate between *Indolophus* and *Deperetella*.

Chalicotherium. The only Siwalik material referred is two or three lower teeth. Quite a small animal, the size of *C. sivalense*.

Phyllotillon is larger, about the size of *Moropus*; fair upper jaws, parts of lower jaws and individual teeth preserved. Molars have continuous anterior and posterior crests, the former curving sharply around at inner end and rising to a prominent protocone behind it.

PRIMATES.—**Palæopithecus sivalensis*. Palate, p^4 - m^3 r., well preserved. Middle Siwaliks.

**Sivapithecus indicus*. Lower jaw, p_4-m_2 preserved. Comes close to *Dryopithecus cautleyi* jaw, allowing for its being more worn. Lower Siwaliks.

Dryopithecus punjabicus. M_2 and m_3 on jaw fragments, distinctly smaller and less inflated cusps. Upper jaw p^3-m^2 r. from Middle Siwaliks also seems a bit too small. Lower Siwaliks.

Sivapithecus indicus. Jaw symphysis, left half, from Middle Siwaliks. I should doubt this going with the jaw from Lower Siwaliks. Too big and heavy. Might go with *Palæopithecus sivalensis* palate from Middle Siwaliks.

Cercopithecus hasnoti and *Macacus sivalensis*. Upper teeth and jaw fragments. Middle Siwaliks. These are macaques, but need careful identification.

ANTHRACOTHERES.—*Merycopotamus*. Two fronts of skulls, several upper jaw fragments, parts of lower jaws, foot bones, etc. This is *Ancodus* with the mesostyle loop farther widened out, the fifth cusp lost and crowns of teeth somewhat lowered, and enlarged flaring canine tusks. Specimens from Upper Siwaliks are larger, canines heavier, but are referred to same species as "males."

Hemimeryx (*Chæromeryx* incl.). Differs from *Merycopotamus* in somewhat smaller size, less separation of mesostyle loop, inner crescents less concave and anterior one (protocone) incomplete posteriorly.

Chæromeryx. Represented only by a poor milk tooth, cast of two others. Look like milk teeth of one of the other genera.

Telmatodon. Bugti (Gaj). Large, brachydont, no distinct trace of 5th cusp on molars, but appears to be an anthracothere. The mesostyle loop is narrow and angulate, even more than in *Hemimeryx*; the posterior flange of protocone similarly incomplete, splitting into two divergent branches; the hypocone posteriorly has an outer flange replacing the posterior wing. Premolars are the normal anthracothere type, jaw elongate, with canine and large incisors making a rather flaring front.

Gonotelma. Has same construction, but a distinct trace of fifth cusp on anterior wing of protocone. Smaller size. Also from Gaj.

Hyboöps. Mostly Lower Siwaliks. Has more distinct 5th cusp and posterior wings of inner crescents complete.

Merycops. Gaj beds. Has stronger 5th cusp, and tooth is of less transverse width, posterior wing of hypocone normal, that of protocone divided, somewhat as in *Gonotelma* and *Telmatodon*.

Brachyodus "*africanus*" from Gaj. The fifth cusp is well distinguished; crown short, mesostyle loop fairly wide, outer cusps are conic, with crests coming up their sides from the styles, the inner cusps also robust, *hy* (*ml*) with something of the completed crescent, but only anterior wing on 5th cusp, and protocone with hardly any crescentic form.

B. hyopotamoides. Larger, with somewhat lower crown and more robust cusps, the molars increasing a good deal from first to third, p^4 hardly any larger than *B. africanus*.

B. giganteus. Very similar in teeth. Wider heel on m_3 . Larger size of skull.

"*Anthracotherium*" *siliistrense*. Upper molars have very slight parastyle, almost vestigial mesostyle, no metastyle, five cusps, the paraconule strong, crescentic, protocone imperfectly so. Metaconule crescentic, but with extra crest anterior and slightly inward. Moderately low crown. Lower molars show a corresponding degree of crescentic and crested structure. Pilgrim refers this to *Microbunodon*, but it is remarkably selenodont for an anthracotheriine, as much so as *Brachyodus*, etc. These are Lower Siwalik. A smaller species, *A. mus*, in Gaj, doubtfully related.

Anthracotherium bugtiense. A gigantic (true?) anthracothere with mesostyle well developed, crested, not split, pa^1 strong and well separated, strong para- and meta-styles, heavy cingula on upper molars, the cusps not much crescentic, robust and rounded, especially when worn. Premolars simple, almost entelodontoid when worn. Gaj horizon.

Anthracotherium crassum and *pangan* from Eocene are even shorter-crowned, but with weak or vestigial styles, cusps more bunodont.

Anthracohyus rubricæ is very like the above; *A. chæroides* is distinctly more conic bunodont in form of cusps and the styles are wholly absent. Also from Eocene.

Anthracokeryx has more angulate cusps, but small and low, the styles weak, the paraconule less clearly separate, tending to form a transverse crest with the protocone. Eocene, Burma.

BOVIDÆ.—*Tragocerus perimensis*. Horns and adjacent part of skull. Lower Siwaliks.

T. punjabicus. Back of skull, l. horn, no palate or muzzle.

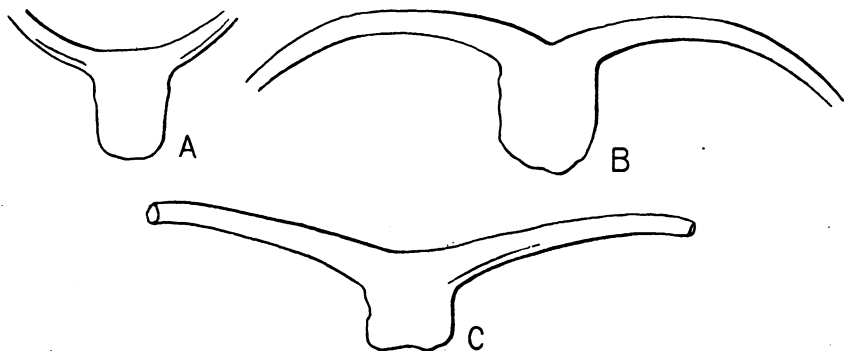


Fig. 3. Horn-cores of bovids. A—*Bubalis platycerus*; B—*Bos acutifrons*; C—*Bos planifrons*. Siwalik specimens in Indian Museum, Calcutta.

T. punjabicus. Upper jaw. Middle Siwaliks. Upper teeth short-crowned, moderately rugose enamel, simple structure, anterior exterior rib stronger, posterior exterior rib rather weak. P^2 and p^3 almost oreodontoid, but only p^4 with crescents complete. Horns are much like the Samos species, so far as I can judge, but perhaps heavier, straighter, shorter.

Bubalis palæindicus. Upper Siwaliks. Two skulls. Horns round, straight, little divergent. Teeth narrow, hypsodont, enamel smooth, $p^{3,4}$ with complete inner crescents, p^2 smaller, ?? similar structure. Skull moderately arched, muzzle rather long, occiput shorter than *Tragocerus*.

Cobus patulicornis. Upper Siwaliks. Only proximal ends of horns preserved with fragment of skull. Seems rather inadequate for identification.

Gazella porrecticornis. Middle Siwaliks. Fragmentary horn-cores, lower jaws. Premolars not molariform, enamel smooth, moderately high crowns. P_2 is somewhat reduced, has median and posterior inner crests.

Hippotragus sivalensis. Upper Siwaliks. Skull, with bases of horns. Horn-bases round-oval in cross-section, muzzle short and concave, with broad antorbital fossæ. Skull strongly arched, back longer than *Bubalis*, more as in *Tragocerus*. Very little of the teeth preserved in this specimen; another skull ? taken by Pilgrim.

Boselaphus lydekkeri. Jaws and teeth. Middle Siwaliks. Nearly size of small cattle. Hypsodont teeth, smooth enamel, no cement, basal pillars between inner crescents of upper molars and between outer crescents of lower molars, but not so heavy as in Bovinæ. External ribs moderately convex, styles prominent, narrow. Heel of m_3 simple.

B. palæindicus. Lower jaw. Niki, Punjab. P_4 has median and two posterior internal crests, the anterior blade straight, simple, somewhat reduced.

B. namadicus. Back of skull, Pleistocene. Horn bases are wide apart and seem to point laterally. Other specimens (jaws, etc.) missing.

Taurotragus. Upper jaw, p^3-m^2 ; upper teeth. Middle Siwaliks. Very like *Boselaphus lydekkeri*; I cannot see the difference. Skull borrowed out (by ? Pilgrim).

Strepsiceros falconeri. Punjab. Upper molars. Much like *Taurotragus* and *Boselaphus*, but ? shorter crown and ? weaker inner pillar.

Bubalis platycerus, with flat-topped horns concave backward. (Fig. 3A).

Bos acutifrons, with round horns concave forward. (Fig. 3B).

B. acutifrons. Skull. Slight median sagittal crest between the horns, part preserved has spread of about 8 feet.

B. planifrons. Skull has horns straighter in basal portion. Very little upward curve in either this or the preceding. (Fig. 3C).

Bos namadicus. Pleistocene. Differs from the two preceding in a strong upward curve in horns, especially toward tip. Cf. *Urus*.

Two or more other fine gaur skulls near to *Bubalis platycerus*.

CHELONIA.—*Emyda*. Various fragments showing strongly pustulate sculpture, prominent pustules all over carapace, especially on nuchal, marginal and costal plates, more or less flattened out on plastron.

Trionyx. Incomplete carapace and various fragments showing the usual pitted sculpture. Some very massive and large, indicate a giant species ? 3 feet long.

Colossochelys. Episternal and one or two other fragments. "Gen. non det." Another giant tortoise indicated by fragments of episternal lacking the great wing processes of *Colossochelys*.

Caulleya. Part of marginal plate only.

Testudo. A few poor fragments, episternals and hyposternals. Neither this nor the preceding seems very well demonstrated.

Clemmys. A half dozen good shells, four alleged species 4"×6". None of them have the three crests of *C. palæindica*, which are prominent in the casts of both young and adult shells of that species.

Pangshura, with one strong median crest, two good carapaces.

Batagur. Fine cranium, part of a much smaller carapace, separate plates, large animals.

Other fine specimens in wall case not yet examined.

IV. CRITICAL NOTES ON SIWALIK CARNIVORA IN THE BRITISH MUSEUM

MUSTELIDÆ

MELLIVORA and MELLIVORODON

Mellivora is represented by two fine skulls from the Upper Siwaliks, one in the British Museum collections, No. 40184, the other in the Science and Art Museum in Dublin; the latter has a lower jaw associated, supposed to be same individual.

Originally figured and described as *Gulo* (then including *Mellivora*) by Baker and Durand, 1836, Jour. Asiat. Soc. Beng., V, p. 581, Figs. 4-8, but not named, though regarded as a species allied to, but distinct from, the Indian ratel, *Mellivora indica*.

No. 40184 is figured in Faun. Ant. Siv., unpublished plate q (Brit. Mus., Nat. Hist.), plate description under name of *Ursitaxus sivalensis* in the Desc. Plates Faun. Ant. Siv., p. 553 of Volume I of Falconer's Memoirs, 1868.

Refigured by Lydekker, Pal. Ind., (X) II, Pl. xxvi (B.M. No. 40184) and p. 182, Fig. 1 (part of Dublin skull) under name of *Mellivora sivalensis*.

Lydekker states that p^2 and p^3 are slightly larger, and the inner half of m^1 less expanded in *sivalensis* than in *indica*; correspondingly p_3 is larger, while m_1 is smaller.

There seems to be no doubt that these belong properly to the existing genus and are rather close to the existing species; the difference about what one would expect with a Lower Pleistocene form.

Mellivora sivalensis resembles Zdansky's *Eomellivora* in the character of p^4 and m^1 ; but not in the skull characters, according to Zdansky's account of them (his figure does not indicate the excessive shortness of skull specified in his description). *Eomellivora* also retains p_1^1 , lost in *M. sivalensis* as in the modern *Mellivora*.

I do not see any adequate basis for Zdansky's attempt to set apart *Mellivora*, *Mellivorodon* and *Eomellivora* as a separate group descended from *Palæogale* and *Bunælorus* independently of the rest of the Mustelidæ. As to *Mellivorodon*, it is quite as likely to be a cat as a mustelid. *Mellivora*, *Eomellivora* and *Gulo* would form a possible group, along with *Ælurocyon* and *Megalictis*; but the gap between them and *Bunælorus* is still pretty wide, and *Oligobunis* would come into nearer association. *Bunælorus* may, so far as the evidence goes, be a common ancestral type for this group, the putoriines and some others; but also it may be a side twig from a common mustelid ancestor of the Middle Oligocene.

Mellivora sivalensis

(Fig. 4). The type differs much more from *M. indica* and *capensis* than these do from each other. Teeth are very distinctly more primitive. M^1 much less expanded internally, the inner half about $\frac{2}{3}$ width of outer half, whereas in both modern species it is about twice as wide (a.-p.). The transverse width of m^1 about the same. P^4 is much more carnassiform, the blades longer and more compressed, antero-external angle of tooth more angulate, not rounded off as in the modern species, the protocone (deuterocone) much smaller and narrower, projecting equally far inward, but more anteriorly set. The premolars, especially p^3 , are more compressed. The front teeth

do not show any marked differences. The palate does not extend so far backward behind the molars (6 mm. as against 12.5–16 mm.).

Skull is heavy posteriorly, carries a considerable raised sagittal area bounded by postorbital crests near together towards anterior part, widening out posteriorly to enclose a triangular plateau. Posttympanic process prominent, (lateral to bulla), lambdoid and occipital crests strong. These cranial characters are probably all male characters; the two modern skulls especially compared being female, and an incomplete male resembling the fossil skull.

The tooth characters, however, are important.

Mellivora punjabiensis is known only from a fragment of lower jaw showing p_3 - p_4 much worn, and somewhat battered roots of front teeth and carnassial. It may be, and very likely is, a distinct species from *sivalensis*, but the type does not prove it; the differences in the premolars may be

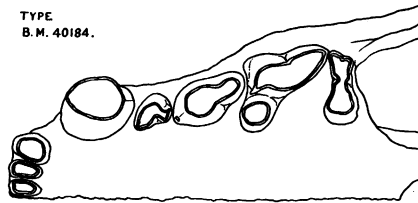


Fig. 4. *Mellivora sivalensis*. Upper teeth, crown view, natural size. From the type skull in the British Museum. Upper Siwaliks.

largely due to wear, as compared with the little-worn teeth of *sivalensis*; the difference in line of tooth row is partly because the drawings are not taken in exactly the same vertical plane, and is not of much importance; the size of canine is a highly variable individual character, as is the overlap of p_4 on m_1 .

MELLIVORODON

Based upon two jaw fragments of very doubtful status. The type looks more like a cat than a mustelid. Whether the second specimen referred to it by Lydekker (it is not a paratype) belongs to the same species, genus or family appears to me to be wholly indeterminable. But Lydekker's type figure agrees with the cats and differs from the larger mustelids in the following particulars:

1. Only two premolars, large, subequal, somewhat spaced.
2. Premolars compressed and elongate.
3. Molar carnassial narrow and long, as for the compressed shearing flanges of a cat, unlike the massive carnassials of *Gulo*, *Mellivora* or other larger mustelids.

4. Straightness of the lower border and slight angulation at the symphysis.
5. Arrangement of mental foramina. Cf. Pilgrim, 1915, Rec. Geol. Soc. Ind., Pl. v, Fig. 2.

The only point carrying doubt as to felid relationship is the apparent lack of posterior accessory cusp and heels on p_4 , and this may be due to wear or battering. They are not always strongly developed in Felidæ, though their absence is a good distinction of Mustelidæ if demonstrated.

If the second specimen really belongs, it would prove that the genus belongs to the *Ælurictis* group of Felidæ.

This type of *Mellivorodon* shows some points of resemblance to a specimen figured by Pilgrim in 1915¹ under the name *Paramachærodus* cf. *schlosseri*, although the diastema behind the canine is much less

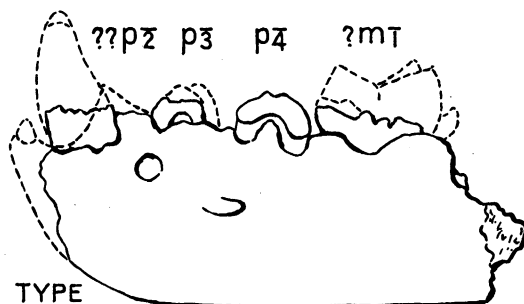


Fig. 5. *Mellivorodon palæindicus*. Sketch of type lower jaw, natural size, external view. Ind. Mus. No. D21. Middle Siwalik beds.

(perhaps in part due to the battering that has destroyed the alveolar border of the canine). If there really was a p_2 as Lydekker states, the felid resemblance would still be of possible significance, as this tooth does sometimes occur in late Tertiary Felidæ.

Although resembling both Felidæ and Mustelidæ, it is not impossible that this jaw might represent an aberrant (short-jawed) canid or viverrid (cf. *Cynodon* group). As there is no evidence that the second jaw fragment attributed to *Mellivorodon* belongs to it or is in any way related to or resembling it, save for the quite uncharacteristic features of being about the same size and having about the same width of *blade* in the carnassial (a character repeated in numerous genera of several

¹Rec. Geol. Sur. Ind., XLV, Pl. v, Fig. 2.

I find it difficult to understand from Pilgrim's figures how the specimens of "*Paramachærodus* cf. *schlosseri*" can belong to the same species. The upper one appears to me a fairly typical machærodont, the lower a true felid. As to Pilgrim's remarks on my failure to indicate the detailed phyletic evolution of each of the two groups of the Felidæ, I did not do so because I do not think it practicable.

families), it seems to be quite indeterminate. No additional and more characteristic specimens having been referred to the species or genus, it appears that both should be suppressed.

Lutra palæindica

Two described species from the Siwaliks, *L. palæindica* Falconer and Cautley, based on a skull and part of mandible in the British Museum; and *L. bathygnathus* Lydekker.

It appears doubtful, in view of the difference in size, in robustness of the carnassial and character of its heel, whether *L. bathygnathus* belongs to the same genus as *palæindica*, which is pretty closely allied to the modern otters. *Palæindica* is from the Upper Siwaliks (Pleistocene), *bathygnathus* from the Middle Siwaliks of the Punjab.

Compared with *L. vulgaris* the skull of *palæindica* is smaller, decidedly narrower throughout, with much weaker crests, the occipital crest very slight, the lambdoid

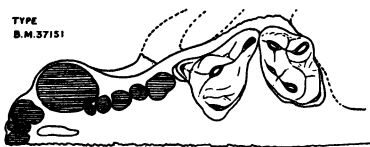


Fig. 6



Fig. 7

Fig. 6. *Lutra palæindica*. Upper teeth, crown view, natural size. Type specimen, Upper Siwalik.

Fig. 7. *Lutra palæindica*. Lower teeth of the type specimen, crown view, natural size.

crest almost obsolete, and no sagittal crest distinguishable. Muzzle narrower, and infraorbital foramen appears to have been much less enlarged. It is nearer throughout to *L. sumatrensis*.

Condyles relatively small. Basicranium broad, but bullæ not so much flattened, standing out somewhat more prominently on the base of the cranium. Palate is not so wide as in *vulgaris*, its backward extension about the same.

TEETH.— M^1 has much the proportions of *vulgaris*, but metacone is less prominent postero-externally, giving a more oblique set to the outer part of the tooth. P^4 is decidedly longer, the protocone (deuterocone) set more anteriorly and smaller and more compressed; the angle between exterior lines of p^4 and m^1 is much greater in *palæindica* than in *vulgaris*. The antero-external angle of p^4 is somewhat more prominent, and the cusp (parastyle) more distinct. The alveoli of the anterior premolars appear to agree with those of *vulgaris*, somewhat smaller as would be expected. Canine and incisors appear from their alveoli to have been of about the same size as in *vulgaris*, but the canines considerably less wide apart, the diastema separating i^3 and c^1 much smaller, and the c^1 less external to i^2 , more behind it.

Fig. 7. In the lower jaw the carnassial is distinguished from that of *vulgaris* by considerably larger trigonid, the talonid being of nearly the same size and construction. Alveoli of other teeth do not show any marked differences. Jaw is somewhat smaller, much shallower and weaker. Pohle¹ puts the species into the *sumatrana* group.

"Lutra" bathygnathus Lydekker

TYPE.—(Fig. 8.) A lower jaw fragment, Ind. Mus. D33, with damaged p_4 , m_1 and alveoli of front teeth. M_2 was probably present but concealed by matrix, teste Lydekker.

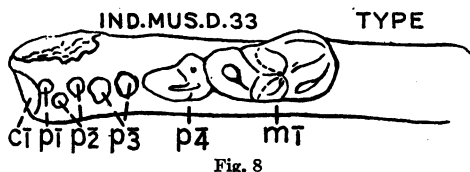


Fig. 8

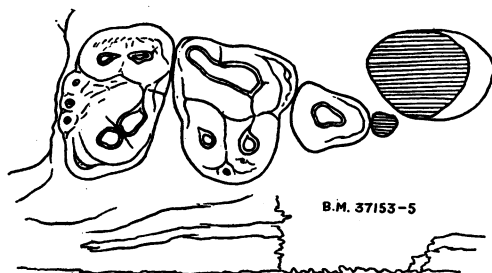


Fig. 9

Fig. 8. "*Lutra*" *bathygnathus*. Sketch figure of type lower jaw, natural size. Middle Siwalik beds. Probably not *Lutra*, but its real affinities uncertain. Compare *Brachypsalis*.

Fig. 9. *Enhydriodon sivalensis*. Upper teeth, crown view, natural size. Composite drawing from three co-type skulls, B. M. Nos. 371 53-5. Upper Siwalik.

ker. The describer refers to this species a second jaw fragment, showing alveolus of m^2 but nothing of the teeth in advance of it. This reference appears to me too doubtful to have any weight in determining the character of m_2 in the type. Pohle (*loc. cit.*, p. 26) refers the species to *Potamotherium*, on the formal basis of its retaining all the premolars. It might compare better with *Brachypsalis*; but until the character of m_2 is known it is too uncertain for generic reference. The crown of p_4 in the type is broken off, the protoconid of m_1 chipped and the metaconid broken. In view of the imperfection of the type and doubtful status of the species, such statements as that it is especially related to the Cape otters are quite unwarranted by evidence. It is "such stuff as (palæogeographic) dreams are made of."

¹Pohle, 1919, *Archiv. f. Naturgesch. (A)*, Vol. IX, pp. 1-246.

ENHYDRIODON

Amyxodon FALCONER AND CAUTLEY, 1836, Jour. Asiat. Soc. Bengal, IV, p. 707 (*nom. nud.*); ROYLE, 1839, Illustr. Bot. Himal., I, p. 31 (*nom. nud.*).

Enhydriodon FALCONER, 1868, Palæont. Mem., I, p. 331, Pl. xxvii, Figs. 1-5; and of later authors generally.

= *Lutra* LYDEKKER, 1884, Pal. Ind., (X) II, p. 195.

TYPE.—(Fig. 9.) *E. sivalensis* Falconer, 1868, *loc. cit.*, based upon a skull and two anterior parts of skulls, Nos. 37153-55, British Museum Collection, of which No. 37153, complete skull, is selected as type.

Although reduced by Lydekker to the rank of a sub-genus at most, *Enhydriodon* has generally been accepted as a distinct and well marked genus. It differs from all the otters and skunks, and resembles the badger group, in the well developed tetartocone (hypocone) on p^4 ; and the skull and teeth present no apparent characters to associate it with otters rather than badgers. Pohle, in his review of the *Lutrinæ*¹, recognized the peculiar characters of the premolar, and accepts the genus as valid, but does not doubt its pertinence to the otters.



Fig. 10. *Enhydriodon campani*. Upper teeth, crown view, natural size. From cast of the type specimen in the British Museum. Original from Monte Bamboli, Italy.

***Enhydriodon sivalensis* Falconer, 1868**

Enhydriodon sivalensis FALCONER, 1868, Palæont. Mem., I, Pl. xxvii, Figs. 1-5. *E. ferox*, *ibid.*, p. 552 (Faun. Ant. Sival. plate descriptions).

Enhydriodon ferox FALCONER AND CAUTLEY, Faun. Ant. Sival., unpublished plates, Pl. p, Figs. 4-6. In British Museum, Natural History.

This is a very large animal, one of the largest known *Mustelidæ*. The construction of m^1 is lutrine, but in p^4 the protocone has a quite different position and form, and the large hypocone has no analogy in the *Lutrinæ*; it occurs only in *Melinæ* among *Mustelidæ*.

Enhydriodon campani of Monte Bamboli is notably different, though apparently related, and much more primitive. While in *sivalensis* p^4 has attained a full quadrate form (cf. *Procyon* among *Procyonidæ*), in *E. campani* it retains much of the primitive construction, the protocone (deuterocone) anterior, the hypocone (tetartocone) added on as a heavy ridge, still partly crested, though nothing like so much as in Lydekker's drawing; and the tooth has an irregularly trapezoidal form. In m^1 the protocone shows no trace of the twinning apparent in *sivalensis*. And p^2 is a functional tooth instead of a vestigial remnant, the jaw much longer. The relations of these two are

¹Pohle, 1919, *loc. cit.*

about what one would expect from an early Pliocene and an early Pleistocene type. *E. bamboli* should, however, be made a distinct genus on the above differences in teeth. Neither probably has anything to do with the otters; they are separately descended from some primitive type allied perhaps to *Megalictis* and other Lower Miocene genera, —not to *Potamotherium*, which is the ancestral type for otters.

Lutra aönychoides Zdansky of the Chinese Pliocene is in some respects the type from which *Enhydriodon campani* might be derived. The p^4 appears to show a semi-separate cingulo-cusp that might develop into the postero-internal cusp of *E. campani*; and while m^1 is rather wide anteroposteriorly on the inner side, its form somewhat approaches that of *E. campani*. Zdansky's remark that *L. sivalensis* and *L. campani* are "in der Richtung gegen *Enhydra* zu spezialisiert, kommt daher hier nicht weiter in Betracht"—seems to me misleading; it does not appear that the specialization of *Enhydriodon* is in the direction of *Enhydra*, nor was it so considered by Falconer.

Enhydriodon sp.

Fig. 11. Falconer in his notes intimates that he recognized a second and smaller species of the genus, apparently upon the evidence of an upper carnassial which should have been in the British Museum collection but could not be found when Lydekker catalogued it. The tooth here figured is probably the missing carnassial, and as may be seen differs enough from the typical *Enhydriodon* to suggest a second species smaller and more primitive. If this tooth, now bearing the museum number M4847, is from the Middle Siwalik bed, it is very likely the species reported by Pilgrim from that horizon.



Fig. 11. *Enhydriodon* sp. Upper carnassial p^4 , left side; crown view, natural size. Siwalik beds.

URSIDÆ

URSUS

Ursus theobaldi Lydekker

Ursus theobaldi LYDEKKER, 1884, Pal. Ind., (X) II, p. 211, Pl. XXVIII.

TYPE.—Ind. Mus. D17, a skull, badly battered and showing only part of the roots of the teeth.

The distinctive characters as indicated by Lydekker are the strong vaulting of the palate and its extension farther backward behind m^2 than in any other bear, *U. labiatus* approaching most nearly. But the anterior cheek teeth are less reduced apparently than in *labiatus*.

HORIZON.—Boulder Conglomerate zone, Upper Siwaliks.

LOCALITY.—Kangra.

Additional material of this species which would make it possible to determine the tooth construction, etc., would be very desirable. Provisionally at least it may be regarded as a species of *Melursus* distinguished from *labiatus* by the points cited by Lydekker. It may, as Lydekker insists, have been a direct ancestor of the modern sloth-bear, but I should want better evidence to really prove it.

***Ursus namadicus* Falconer and Cautley¹**

Ursus namadicus CAUTLEY AND FALCONER, Palæont. Mem., I, p. 321, footnote, Pl. xxvi, Fig. 5, p. 552 (Faun. Ant. Sival. Plate Descriptions); LYDEKKER, 1884, Pal. Ind., (X) II, p. 216, Pl. xxviii, Fig. 3.

The type is figured in one of the unpublished plates of the Faun. Ant. Sival., in the British Museum (Nat. Hist.), designated Pl. o, and referred to as such in the Faun. Ant. Sival. plate descriptions. Lydekker's figure and the one in Falconer's Memoirs appear to have been copied from the figure. It is Fig. 8 of the unpublished

B. M. 32916.

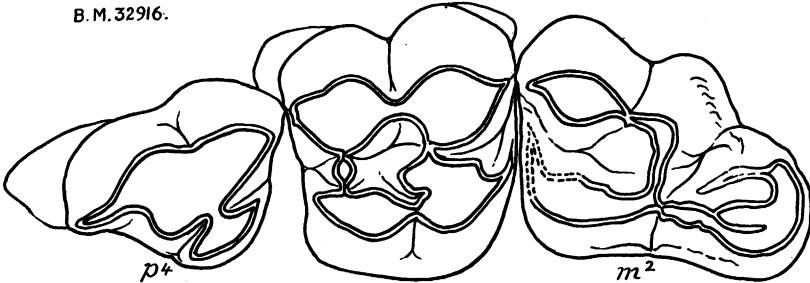


Fig. 12. *Arctotherium bonærense*. Upper cheek teeth, crown view, natural size. From the skeleton in the British Museum.

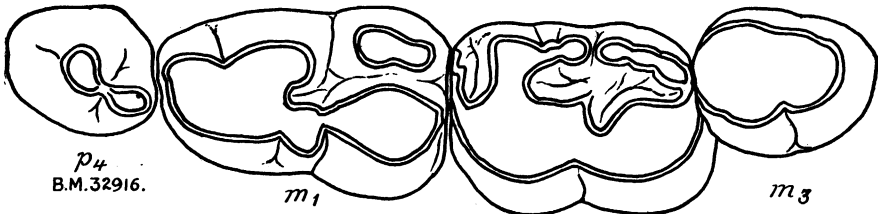


Fig. 13. *Arctotherium bonærense*. Lower cheek teeth, crown view, natural size. Same specimen as Fig. 12.

plate; Fig. 9, a referred tibia, also figured by Lydekker, *loc. cit.*, Pl. xxix, Fig. 3 (copy reversed from Faun. Ant. Sival.), does not belong to a bear.

Lydekker, after careful comparisons, concludes that the species is nearest to *U. 'torquatus'* (= *tibetanus*). It seems a rather primitive species with some points of affinity to *etruscus* and *arvernensis*, and like them belongs among the species of true *Ursus*.

ARCTOTHERIUM, PARARCTOTHERIUM, INDARCTOS, HYÆNARCTOS

Skull and jaws of *A. bonærense* in British Museum, No. 32916, with large part of skeleton. Cast of type skull of *Pararctotherium*.

¹Ascribed to the joint authorship in the type reference p. 552.

Arctotherium is surprisingly different from the true bears. *A. simum* probably does not belong to this genus,¹ and is provisionally separable as *Tremarctotherium* Kraglievich.

The true *Arctotherium* is much closer to *Hyænarcos*, the distinctions being in less specialized characters, listed under *Hyænarcos*. *Pararctotherium* is near to *Arctotherium*, but smaller and more specialized ursid in the rugosity of enamel on inner half of molar, squaring up of m^1 , reduction of p^4 with disappearance of its inner and reduction of its posterior cusp.

Indarctos is more like *Arctotherium* and *Pararctotherium* in m^2 , but heel of m^2 is less differentiated. M^1 is narrower than in *Arctotherium* or *Pararctotherium*, approaching the true bears to some degree.

HYÆNARCTOS = AGRIOTHERIUM²

Agriotherium WAGNER, 1837, Gelehrt. Anzeig. k. bay. Akad., V, p. 335.

Sivalarctos DE BLAINVILLE, 1841, Compt. Rend., XIII, p. 165.

Amphiarctos DE BLAINVILLE, 1841, Ostéographie, II, *Subursus*, p. 96.

Hyænarcos FALCONER AND CAUTLEY, in Owen, 1840-45, Odontography, p. 505, Pl. CXXXI (subgenus); Gervais, 1859, Zoöl. et Paléont. Franç., 2^e Éd., p. 208 (genus); CAUTLEY AND FALCONER, in Falconer, 1868, Pal. Mem., I, p. 321, Pl. XXVI (subgenus); LYDEKKER, 1884, Pal. Ind., (X) II, p. 219, Pls. XXX, XXXI.

TYPE.—(Of all the above), *Ursus sivalensis* Falconer and Cautley, 1836.

Hyænarcos is clearly related to *Arctotherium*, and separated by:—

1. Lack of any posterior extension of m^2 , which is either quadrate as in the type, or the posterior half reduced in transverse width as in *H. palæindicus*, but not extended backward as it is in *Indarctos*, *Arctotherium*, *Pararctotherium* and the various modern bears.
2. P^4 less reduced, the parastyle prominent (weak in *H. punjabiensis*), notch between blades strong and deep, the whole tooth retaining much more its primitive carnassial character.
3. Anterior premolars less crowded.
4. Zygoma from opposite m^2 instead of from between m^1 and m^2 .
5. Postorbital process much further backward, opposite posterior nares instead of opposite m^2 .
6. Considerable sagittal crest; brain-case not so large and the skull as a whole less shortened.

¹V. Kraglievich, 1926, Anal. Mus. Nac. Buen. Air., XXXIV, pp. 1-16, September 28. But I had come to this conclusion independently on seeing the *A. bonariense* skull before knowing of Kraglievich's article.

²It is generally admitted (see Gervais, *loc. cit. infra*, Lydekker, *loc. cit. infra*) that Wagner's name has priority over *Hyænarcos* and those proposed by de Blainville. *Hyænarcos* has been generally used in spite of that well known fact, much as *Oreodon*, *Mastodon* and numerous other names have been retained. The 'strict constructionists' of modern nomenclature apparently are under the impression that they have discovered a lapse of priority usage not known to their predecessors; but it is not so; and in fact most of their revivals of obsolete names are or might have been copied from Leidy, Lydekker and other writers, although they make no acknowledgment of such indebtedness. Wagner specifies as reasons for separating *U. sivalensis* that the teeth indicate a more carnivorous adaptation, nearer to the normal carnivore dentition.

H. punjabiensis comes nearer to *Indarctos*, and appears to be a species of that genus rather than *Hyænarctos* proper.

H. palæindicus is more primitive than *H. sivalensis*.

***Hyænarctos sivalensis* Falconer and Cautley, 1836**

Ursus sivalensis FALCONER AND CAUTLEY, 1836, *Asiat. Research.*, XIX, p. 193. (*Agriotherium*) WAGNER, 1837, *loc. cit. Sup.*; (*Sivalarctos*) DE BLAINVILLE, 1841, *Compt. Rend.*, XIII, p. 165; (*Amphiarctos*) DE BLAINVILLE, 1841, *Osteog.*, II, p. 96; (*Hyænarctos*) OWEN, 1841-45, *Sup.*, Pl. CXXXI; GERVAIS, 1859, *loc. cit. Sup.*; CAUTLEY AND FALCONER, 1868, *loc. cit. Sup.*; LYDEKKER, 1884, *loc. cit. Sup.*, p. 220, Pl. XXX, Fig. 5 (copied from unpublished figure in *Faun. Ant. Sival.*, Pl. o, Fig. 1c); PILGRIM, 1914, *Rec. Geol. Sur. Ind.*, XLIV, p. 225 et seq.

TYPE.—B. M. No. 39721, a damaged skull, and 39722, lower jaw, from the Siwalik Hills. Placed by Pilgrim as Upper Siwalik, but of uncertain horizon. As all other specimens of *Hyænarctos* come from the Middle Siwaliks it seems probable that the type was from low down in the Upper Siwalik series, not from the Boulder Con-

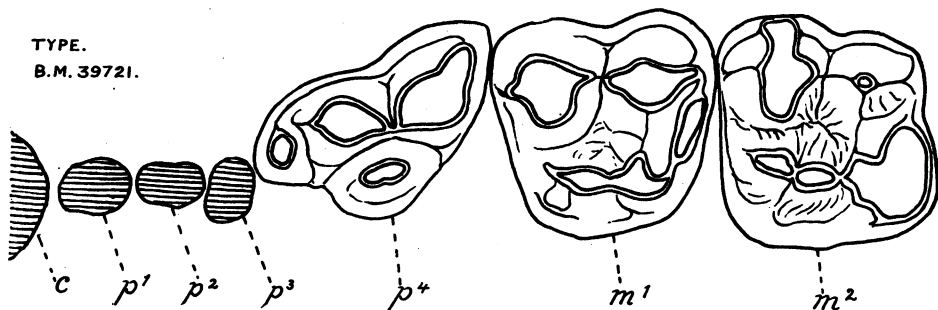


Fig. 14. *Hyænarctos* (= *Agriotherium*) *sivalensis*. Upper teeth, crown view, natural size. From the type skull in the British Museum.

glomerate zone. There is no indication that skull and jaw belong together; Falconer speaks of the jaw as having been found first and the skull subsequently; however, under the conditions of collecting in India, especially in the earlier days, this would not preclude their belonging to the same individual.

The matrix of the type skull is a uniform gray sandstone, moderately hard, the bone and teeth of a rather light chocolate brown, not black, but dark brown in places where weathered or otherwise altered. The jaw is similar but weathered on outer side to a puce-color and the teeth a lighter brown on weathered side. Jaw a good deal collapsed by crushing; teeth not perceptibly broken in crushing, but must be considerably changed in transverse diameters. They appear to be quite uncrushed.

Identification of the upper teeth as $p^1, ^2, ^3$, each single-rooted, is on analogy with *Arctotherium* and *Pararctotherium*, in which this is certainly the interpretation of the alveoli, as a one-rooted p^3 is preserved on *Pararctotherium* (type), and a one-rooted p^1 on the British Museum *Arctotherium* skull, the relationships of the alveoli being identical in *Pararctotherium* and *Arctotherium*. In the *Hyænarctos sivalensis* skull the premolars are not crowded or displaced, and a suggestion of two roots is observable.

P^4 is of about the same length as in *A. bonærense*, but less breadth; postero-external shear less reduced, parastyle a stout, prominent cusp, absent in *Arctotherium*. Notch between the blades deep, almost to level of valley separating protocone (deuterocone), whereas in *Arctotherium* and *Pararctotherium* it is obsolete and shallow. Internal cusp (protocone, = deuterocone) is larger than in *Arctotherium*, less posterior in position, centering a little in advance of the inter-blade notch. The inner cusp wholly absent in *Pararctotherium*, and tooth much smaller.

M^1 smaller than *Arctotherium*, size of *Pararctotherium*, but inner half smaller than outer half, instead of quadrate as in *Pararctotherium*; *Arctotherium* is intermediate, but nearer *Pararctotherium*. Inner half of tooth less flattened than *Arctotherium*, lacks the rugosities of *Pararctotherium*, the two inner cusps less separate than in *Arctotherium*.

M^2 is nearly square, with the external side drawn in moderately so as to make rather a trapezoid. Metacone, however, is very nearly as large and high as paracone. Protocone twinned, hypocone separate and a posterior cingulum behind it, broad, low inner cingulum obscure, anterior and narrow external cingulum. All cusps are broad and low, and the unworn enamel appears to indicate some rugosity, but not noticeable.

Proportions of skull and palate appear to be about as in *Arctotherium*, except for less extreme shortening, probably smaller brain-case and well developed sagittal crest. Palate appears more excavated, but this may be due to crushing; but it is of the same broad type, a little extended behind, heavy short canines and large stout incisors (alveoli only, which indicate teeth as large as in *Arctotherium*).

Position of postorbital process considerably further back than in *Arctotherium* and *Pararctotherium*; the zygomatic arch springs from opposite m^2 instead of between m^1 and m^2 as in *Arctotherium* and *Pararctotherium*.

Zdansky, in his description of *Indarctos* from China, makes the remark in a footnote (v. Zdansky, *loc. cit. infra*, p. 17) that Dames "kam zu seinen richtigen Ergebniss durch die irrige Annahme dass p^1 - p^3 einwurzellig gewesen waren." Dames, however, was quite right so far as I can judge from the alveoli of the type skull, and Zdansky's supposed anterior alveolus for p^3 observed in Lydekker's drawing¹ is really only a slight depression in the palate. Lydekker's drawing is not at all accurate in representation of any of the premolar alveoli.

Hyænarctos palæindicus

Hyænarctos palæindicus LYDEKKER, 1878, Rec. Geol. Sur. Ind., XI, p. 103; 1884, Pal. Ind., (X) II, p. 232, Pl. xxx, Figs. 1 and ? 3, Pl. xxxi, Figs. 2 and 3; PILGRIM, 1914, Rec. Geol. Sur. Ind., XLIV, p. 228.

TYPE.—Ind. Mus. No. D16, upper jaw p^4 - m^2 r.

LOCALITY AND HORIZON.—"Siwaliks of the Punjab," Middle Siwalik, probably Hasnot or Niki.

Differs from *sivalensis* in the more trihedral form of p^4 , with stronger protocone (deuterocone) and shorter outer crest, more evenly divided by the inter-blade notch, owing to less proportionate development of paracone (protocone). Also, and more notably, in the reduction of the metacone and postero-external angle of m^2 . The closer setting of inner and outer rows of cusps on m^1 and m^2 noted by Lydekker is partly or

¹Zdansky, 1924, Pal. Sin., (Ser. C), II, Fasc. II, p. 18.

wholly due to difference of wear. The species shows some approach to *Dinocyon* (not to "*Amphicyon* and the dogs," as has been repeatedly stated); but not enough to cast doubt on its generic reference.

The lower jaw associated with this species by Lydekker is stated to have no evidence of m_2 . Whether this is due to individual difference or accident or to the jaw fragment being broken off too low down to show the root of m_2 (which lay probably partly on the ascending ramus, as the last molar frequently does in most Carnivora, and with a root that curves strongly backward and does not penetrate deep into the horizontal ramus), is not important to determine. In any case it is quite unlikely that m_2 was *normally* absent in this or any other species of *Hyænarctos*.

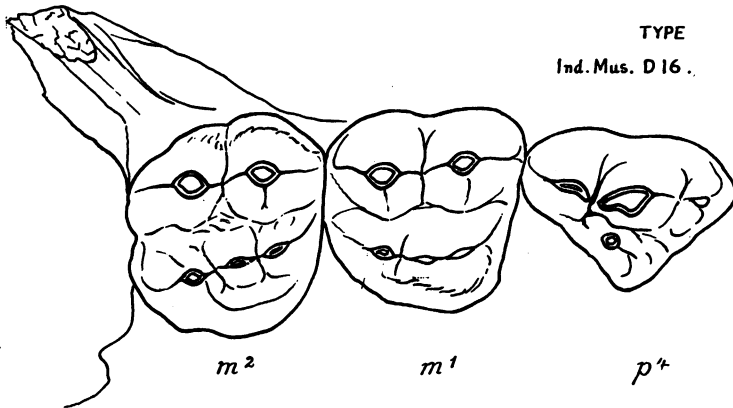


Fig. 15. *Hyænarctos* (= *Agriotherium*) *palæindicus*. Upper teeth, crown view, natural size. Type specimen, Indian Museum.

But it is wholly uncertain whether this lower jaw really belongs to *Hyænarctos* rather than to *Indarctos*. Pilgrim's acceptance of Lydekker's view has, I think, led him astray in some other matters (vide *H. punjabiensis* notes). In fact no carnivore with that much extension of posterior molars above and of heel of m_1 below is in the least likely to lose m_2 normally. Compare *Hemicyon*, *Cephalogale*, *Procyonidæ*, etc. The upper dentition of *H. palæindicus* and *sivalensis* demands an m_2 of about the size of that in the supposed lower jaw of the type of *sivalensis* in order to correspond to the upper teeth. The m_2 in *H. palæindicus* ought to be more oval but scarcely shorter than in *sivalensis*; that of *Indarctos salmontanus* ought to be oval, rather longer than in *Hyænarctos sivalensis* and to some slight extent approaching the type of m_2 in *Ursus*. The lower jaw of *punjabiensis* fits it very well.

I think it likely that the lower jaw attributed by Lydekker to *palæindicus* belongs more probably to *Indarctos punjabiensis*, but that the m_2 was not normally absent in the species and probably was present in this specimen, but tooth and root broken away.

INDARCTOS

This genus is in many respects rather close to *Arctotherium* and *Paracrtotherium*. As based upon the type specimens (or specimen) of *I. punjabiensis* and *salmontanus* it differs from them in:

1. P^4 little reduced.
2. Molar cusps, especially the inner ones, tending to definite a.-p. ridges as in the true bears, more than they do in either *Arctotherium* or *Paracrtotherium*.

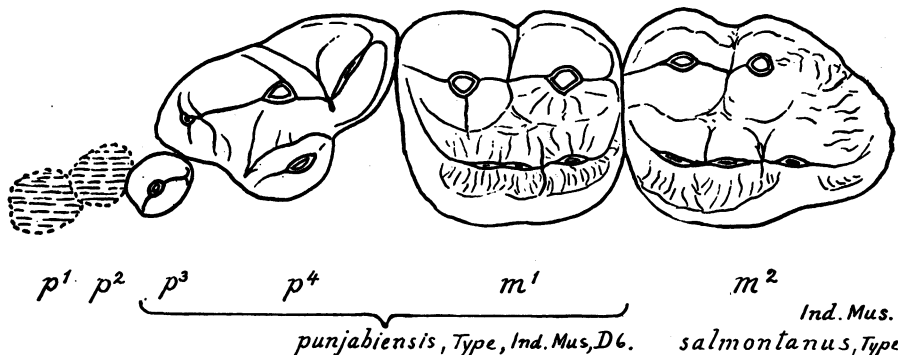


Fig. 16. *Indarctos punjabiensis*. Upper teeth, crown view, natural size. Type specimen, Indian Museum. The second molar from the type of *I. salmontanus* Pilgrim, which is believed to be the same individual.

3. Heel of m^2 less differentiated from the rest of the tooth.
4. M^1 somewhat narrower transversely.

It agrees with them and differs from *Hyænarctos* in:

1. Large heel on m^2 .
2. M^1 more quadrate, inner half as wide antero-posteriorly as outer half.
3. Reduction of parastyle on p^4 (absent in *Arctotherium* and *Paracrtotherium*).
4. Zygomatic arch springs from anterior part of m^2 and from m^1 (from posterior part of m^2 in *Hyænarctos*; in *Arctotherium* and *Paracrtotherium*, between m^1 and m^2 and forward on m^1).
5. If the lower jaw ascribed to *H. sivalensis* belongs really there, and the teeth are uncrushed, there is a notable difference in the transverse width of the lower teeth, much broader in *Indarctos* than in *Hyænarctos*, proportioned as in *Arctotherium*.

***Indarctos (Hyænarctos) punjabiensis* Lydekker, 1884**

SYNONYM.—*Indarctos salmontanus* Pilgrim.

Hyænarctos punjabiensis LYDEKKER, 1884, Pal. Ind., (X) II, p. 226, Pl. xxx, Fig. 2; PILGRIM, 1914, Rec. Geol. Sur. Ind., XLIV, p. 228 et seq.

?*Indarctos salmontanus* PILGRIM, 1914, loc. cit., p. 225, Pl. xx.

*TYPE.—Ind. Mus. No. D6, crowns of upper teeth p^4 - m^1 r. and l., ? p^2 l.; doubtfully part of type, a lower jaw, c, and m_{1-3} r. and l. complete, Ind. Mus. No. D8. Both from the Middle Siwaliks of Hasnot, but stated to have been collected in different years.

Type of *I. salmontanus*, upper jaw fragment, m^2 and root of m^1 l., also from Middle Siwaliks of Hasnot, and may be, in my opinion, a part of the same individual as Lydekker's type. Whether it is or not could be decided by finding whether m^1 l. of Lydekker's type is a tooth with roots or merely a crown; and if the latter, whether it does not fit on the root of Pilgrim's type. If not the same individual, it is pretty certain that they are the same species, as the characters of m^1 and m^2 correspond, and the proportions of teeth are the same.¹

Indarctos lagrelii Zdansky² from the lower Pliocene of North China is quite nearly related to *I. punjabiensis*, but more primitive in a number of particulars. It is a smaller species, and the premolar reduction has not gone so far; p_3 is still two-rooted but in *I. punjabiensis* it is one-rooted; p^3 is two-rooted, but in *I. punjabiensis* the roots are more closely connate, and in *Hyænarctos sivalensis* they are united into one, the tooth turned completely transverse, whereas in *Indarctos lagrelii* it is at an angle of 45° to the fore-and-aft line. The relative size of the premolars is greater throughout in *I. lagrelii*, which would stand very well as a direct ancestor of *I. salmontanus* and, so far as I have compared them, of *I. oregonensis*.

As this Chinese fauna appears to be correlated rather closely with the Pontian, this would suggest a somewhat post-Pontian age for the Dhok Pathan zone of the Siwaliks, and equally for the Rattlesnake beds of Oregon, both more or less equidistant from the supposed palæarctic center of dispersal of the Ursidæ.

***Hyænarctos anthracites* Schlosser, 1890**

Amphicyon laurillardi (in part?) MENEGHINI, 1862, Atti. Soc. Ital. Sci. Nat., IV, Pl. IIa. Not *A. laurillardi* POMEL, Cat. Meth. Vert. Foss., p. 72, from Sansan, which is a synonym of *A. major* Blainville, auct. Lydekker, Pal. Ind., (X) II, p. 248.

Hyænarctos GERVAIS, 1875, Zoöl. et Pal. Gen., (II), p. 22; LYDEKKER, 1884, Pal. Ind., (X) II, p. 248.

Hyænarctos anthracites SCHLOSSER, 1890, Beit. z. Pal. Oest. Ung., VIII, p. 81.

TYPE.—A lower jaw from Pliocene of Monte Bamboli, Italy, cast in British Museum (Natural History).

¹Doctor Pilgrim has kindly examined the original specimens in Calcutta since the above was written, and informs me that the two specimens cannot be the same individual, as there is a certain amount of duplication in the teeth.

²*Indarctos lagrelii* Zdansky, 1924, Palæont. Sin., (Ser. C) II, Fasc. I, p. 16, Pl. iv, Figs. 1-4.

PHYLOGENY OF THE URSIDÆ (PROVISIONAL)

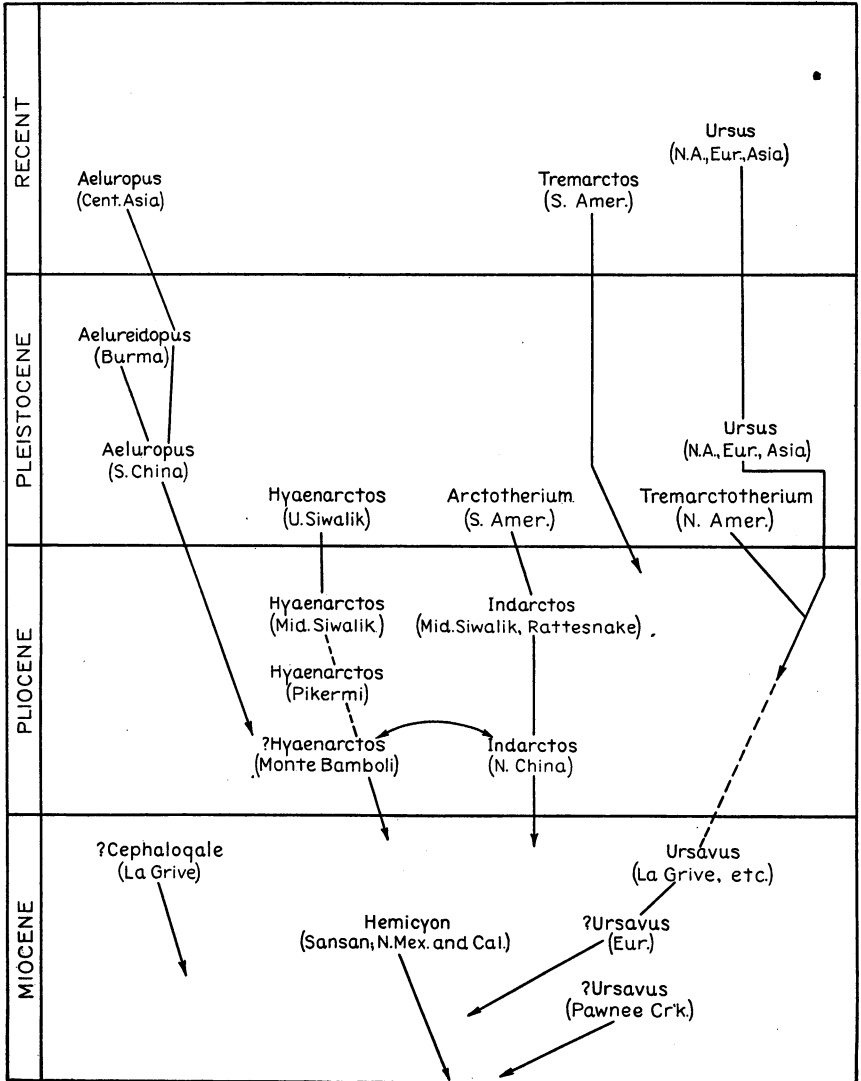


Fig. 17. Phylogeny of the Ursidæ.

This is a small species which makes quite an approach to *Ursus bockhi* Schlosser, with which it should be compared. Relations of this species to *Indarctos* and to the more primitive species of modern bears require revision.

The horizon of Monte Bamboli is regarded as between Pikermi and La Grive, but there is very little faunal evidence to go on.

CANIDÆ

AMPHICYON Lartet, 1836

Chien gigantesque d'Avary près de Beaugency, CUVIER, Ossements Fossiles.

Canis giganteus SCHINZ, 1825, in Cuv. Thierreich, IV, p. 342.

Amphicyon LARTET, 1836, Bull. Soc. Géol. Franç., VII, p. 219.

Amphicyon giganteus LAURILLARD, 1843, Dict. Univ. Hist. Nat., III, p. 567.

TYPE.—*Amphicyon major* Blainville, 1841, Ostéog., Subursus, Pls. xiv–xv, upper jaw and other materials from Sansan. Blainville states that Lartet founded the genus upon Sansan material. I have not seen the type reference.

A. giganteus Laurillard, 1843, is probably Cuvier's "chien gigantesque de Beaugency," which in Schinz's German translation of Cuvier had already been named *Canis giganteus*. This species name should therefore date from 1825, based on an upper molar tooth.

Cuvier, Ossements Fossiles, p. 466, IV of 1823 ed.

Measurements given of the upper molar as .043 and .032.

Associated with bones of mastodon, rhinoceros and "gigantic tapirs" = *Dinotherium*.

Amphicyon major as represented by the upper jaw, etc., figured by Blainville (cast in British Museum, also in American Museum) is considerably smaller, though still larger than Lydekker's species. Teeth more quadrate.

The numerous species referred by European and early American writers to *Amphicyon* belong mostly in other genera.

A. giganteus is quite as likely to be *Pliocyon*, but its generic position is uncertain, lacking topotypes or a more careful study of the type.

A. lemanensis should be compared with *Daphænodon*.

A. ambiguus, etc., of the Phosphorites need comparison with *Daphænus* and *Daphænodon*; they are pretty surely not *Amphicyon*.

Agnotherium Kaup, 1833,¹ is cited by Lydekker as a *synonym* of *Amphicyon*, admitting that it is the older name. Kaup's description shows that Fig. 4 of his plate, a lower carnassial, is the type. What this carnassial may be is not very clear, but it does not agree well with *Amphicyon*, even allowing for pretty bad figuring. It is fairly safe to say that *Agnotherium* is more or less indeterminate, but not a *synonym* of *Amphicyon*.

Amphicyon lydekkeri Pilgrim, 1910

Amphicyon lydekkeri PILGRIM, 1910, Rec. Geol. Sur. Ind., XL, p. 64; *ibid.*, p. 199.

TYPE.—"M₁" (cast is actually m²) from Middle Siwaliks of Padhri (stated as Hasnot on p. 199; and cast stated to be type has that locality on label).

Distinguished by Pilgrim from *A. palæindicus* by its greater size and squareness.

¹Kaup, 1833, Oss. Foss. Darmst., Carn. Foss., p. 28, Pl. I, Figs. 3–4.

Compared with *A. major*, the m^2 is rather near, but distinguished by more symmetrical and lower crown, the paracone smaller and lower and less skewed around in a postero-external direction. Crown lower and more flattened as a whole, size and proportions much the same otherwise.

This is a species with more flattened and ursoid molar than *A. major*, but nothing can be said positively of its affinities without more evidence as to other teeth. Its position in the genus is provisional; it might be a *Pliocyon*. Does not fit well in *Dinocyon*, but should also be compared with that genus.

Amphicyon palæindicus

Amphicyon, sp. innom., FALCONER, 1868, Pal. Mem., I, p. 416.

(*Amphicyon palæindicus* FALCONER, on label of type specimen).

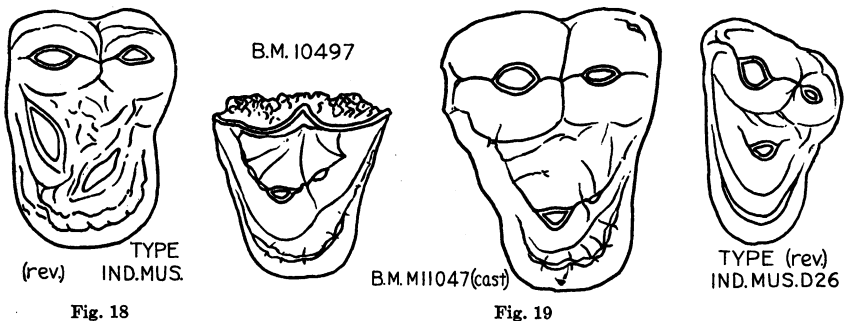


Fig. 18

Fig. 19

Fig. 18. '*Amphicyon*' *lydekkeri* Pilgrim. Upper molar, crown view, natural size. Middle Siwalik beds, Hasnot. Doubtful whether this species belongs to the genus.

Fig. 19. Upper molars of *Amphicyons*: B. M. No. 10497, an incomplete upper molar, m^1 , from the Gaj formation, Bugti Hills; B.M. No. 11047, cast of a similar molar from the Lower Siwaliks, original in Indian Museum; Ind. Mus. D26, type of *Amphicyon palæindicus*, m^2 reversed in figure for comparison with No. 11047, which is probably the type of tooth compared by Pilgrim with *A. giganteus*. Both may well represent the same species.

Amphicyon palæindicus LYDEKKER, 1876, Pal. Ind., (X) I, p. 66, Pl. VII, Figs. 5, 8, 12; 1884, *ibid.*, II, p. 248, Pl. XXXII, Figs. 4, 5, 8.

TYPE.—Upper molar tooth, m^2 , Ind. Mus. D26, from "Middle" Siwaliks, Kushalghai, Punjab. Paratype, a lower jaw fragment, Ind. Mus. D23, from Nurpur, with dp_4-m_1 . Both are Lower Siwalik, auct. Pilgrim.

The species is near to the size of *A. major*, but distinguished by the less quadrate teeth, higher hypoconid crest and low, small entoconid crest. Inner part of carnassial has the surface pitched obliquely, not sub-parallel to palate. (In these features it approaches type of *A. frendens* of Snake Creek beds—and probably various other species.)

The above from Lydekker's description. Comparing the type tooth with *A. major* it is very notably different, so that I would be rather doubtful of its belonging to the genus. The tooth is decidedly smaller, the inner half less expanded, the metacone much smaller in proportion, and the tooth is considerably 'broken-backed.' The protocone is much reduced and not so distinctly crescentic, its wings having nearly disappeared.

Two additional specimens may throw light on affinities.

1. M11047 of British Museum collection, plaster cast of m^1 from Chinji beds, Lower Siwaliks. Original in Indian Museum (No. $\frac{K9992}{13}$ = D155 Ind. Mus.).

This is a very large tooth, larger than m^1 of *A. major*, considerably smaller than *giganteus*, and differs from *major* and, to a less extent, from *giganteus* in higher and more conical paracone and metacone. The inner half of the tooth is a good deal like that of *giganteus*, but the outer half much smaller. The tooth is somewhat broken-backed, as is *giganteus*, unlike *major*. In *A. major* the inner half has cingulum less developed and more limited to postero-internal side, and the outer cusps are smaller and lower.

2. M1557 of British Museum collection, plaster cast of dp_4-m_1 from Nurpur—Lower Siwaliks in Pilgrim's correlation.¹ Original in Indian Museum.

This is about the size of *A. major*, but differs in more compressed trigonid, higher and equally wide talonid, the entoconid much more reduced, the hypoconid more of a median crest.

The characters of all these teeth rather suggest *A. frendens* and similar species; in some points like *Dinocyon*, but with much smaller tubercular teeth. The m^1 is very large compared to the m^2 , but this would conform to the rapid reduction in size of outer cusps in m^2 from front to back, so that they may belong to the same species despite the apparent incongruity. On the other hand, the lower carnassial trigonid seems small for the large m^1 (although it registers well enough). This may, in short, be a species trending from the *A. frendens* type towards such types as *Hyænocyon*. But until associated material has been found, no conclusions can be safely drawn as to its affinities.

***Amphicyon shahbazi* Pilgrim**

Cephalogale shahbazi PILGRIM, 1910, Rec. Geol. Sur. Ind., XL, p. 199 (no description); 1912, Pal. Ind., (N. S.) IV, Part 2, p. 11, Pl. III, Figs. 1, 2; *Amphicyon*, 1913, Rec. Geol. Sur. Ind., XLIII, p. 74.

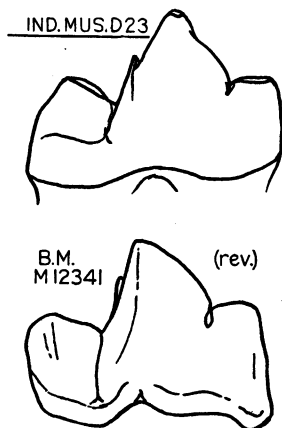


Fig. 20. Lower carnassials of *Amphicyon*; the upper figure from the jaw fragment, Ind. Mus. No. D23, figured by Lydekker, Lower Siwalik beds; the lower a specimen in the British Museum, No. 12341, discovered and described by Forster Cooper from the Bugti beds (reversed in figure).

¹Pilgrim, 1910, Rec. Geol. Sur. Ind., XL.

Four specimens of '*Amphicyon*' in the British Museum collection, from the Bugti Hills, of which one, M12341, figured by Cooper, 1923 (Ann. Mag. Nat. Hist., (IX) XII, p. 260, Fig. 1B), is referred to *palæindicus*. Differs from the paratype of *palæindicus* in broader, more robust trigonid, slightly smaller metaconid, rather larger entoconid shelf, and hypoconid not quite so high. On the whole, a more 'normal,' less specialized tooth, but rather near, and might be listed as *Amphicyon* aff. *palæindicus*?



B.M. 12339.

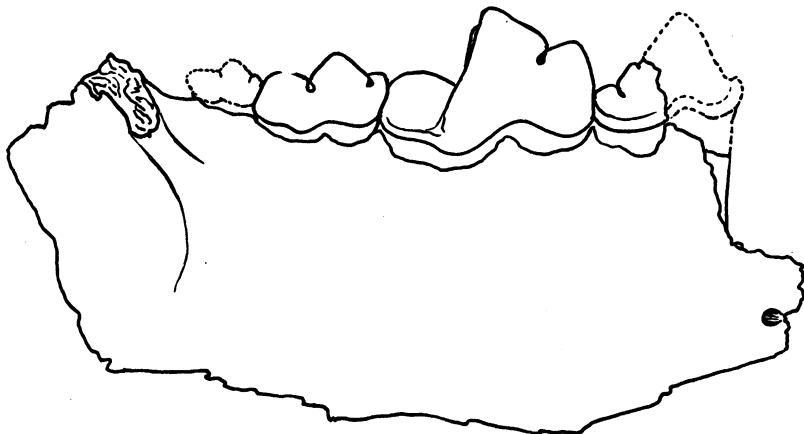


Fig. 21. *Amphicyon shahbazi* lower jaw from Dera Bugti, Baluchistan, British Museum No. 12339, figured by Forster Cooper in 1923. Natural size, external view, and crown view of teeth. Gaj horizon.

A second lower carnassial, B. M. No. 12340, about the same size, is referred to *A. shahbazi*. This may be the specimen referred to by Pilgrim in 1913, *loc. cit.*, p. 74. If so, it would differentiate *shahbazi* from *palæindicus* by slightly smaller size, reduced metaconid, lower hypoconid. It is also figured by Cooper¹ who refers it to *shahbazi*.

A third specimen, M12339, is a lower jaw with m_{1-2} complete, part of p_4 and alveolus of m_3 . This also is figured by Cooper in 1923.² The carnassial is decidedly smaller than any of the preceding, the metaconid somewhat stronger relatively, and the

¹Cooper, 1923, *loc. cit.*, pp. 261-262, Fig. 1B.

²Cooper, 1923, *loc. cit.*, pp. 261-262, Fig. 7C.

entoconid shelf better developed, the hypoconid rather lower and more external. The external face of the trigonid is more uniformly convex, lacking the flattening that distinguishes the preceding in progressive degree from 12341 to 1557. I hardly think this is likely to be the same species as 12340, if 12340 is held to be distinct from 12341 and 1557. But they are all rather nearly related, I should judge, the Bugti Hills specimens in various ways and in varying degree more primitive.

The second lower molar of this jaw (12339) differs from that of *A. major* in much smaller size, both absolutely and proportionately; it has a fairly distinct paraconid, absent in *A. major*, the metastylid is an unimportant rudiment in place of the closely connate flanking cusp of *A. major*, the heel is more definitely basined, with a marginal entoconid crest instead of a shelf, the hypoconid decidedly higher and more crested. The fourth premolar is both relatively and absolutely larger than in *A. major*, appears to have had a much higher principal cusp, and a higher but smaller accessory cusp, closely twinned to the posterior border of the main cusp.

Alveolus of m_3 is shorter and more rounded than in *A. major*.

A fourth specimen, M10497 of the British Museum collection, from the Bugti Hills, is the inner part of an upper molar, m^1 . Agrees rather closely with upper molar cast, M11047, from Chinji, and registers quite well with lower carnassial M12341 from Dera Bugti referred to *A. palæindicus*. Not enough of it to have any significance. This also is from Bugti Hills; has not been figured.

All the above Bugti and Lower Siwalik material referred to *palæindicus* and *shahbazi* may well belong to one group of *Amphicyon*s, related to *frendens* and *giganteus*. There seems to be no evidence that these really are *Amphicyon* rather than *Pliocyon*. I cannot believe that the lower jaw belongs to the same species as the larger specimens, and think it very doubtful whether the so-called *palæindicus* belongs to that species rather than *A. shahbazi*.

The jaw is of wholly different type from *A. lemanensis*. It is a short, deep, stout, *Æluroidon*-like jaw, quite distinct from the long, shallow, thin jaw of *A. lemanensis*; as the upper teeth in all this group differ in aspect from the flat-crowned, low-cusped, subequal upper molars of *A. lemanensis*. Suggests again affinities to *Hyænocyon*. (But these are hardly tenable as phyletic relations.)

Canis curvipalatus

Canis ? vulpes BAKER AND DURAND, 1836, Jour. Asiat. Soc. Beng., V, p. 581 et seq., Figs. 9, 10. Republished 1868, FALCONER, Pal. Mem., I, p. 341.

Canis curvipalatus BOSE, 1879, Quar. Jour. G. S., XXXVI, pp. 134-6; LYDEKKER, 1884, Pal. Ind., (X) II, p. 254, Pl. XXXII, Figs. 1, 1A.

TYPE.—B. M. No. 37149, skull and lower jaws from the "typical Siwalik Hills."¹

This is a finely preserved skull; the teeth have been nearly complete, but two or three have been broken off since the specimen was found.

Described and discussed in detail by Lydekker, who saw in it a link between *Otocyon* and the foxes. Has a good many *Otocyon* characters, and even a curious shelf behind m^2 that suggests an m^3 (apparently no real alveolus for it; and certainly no trace of alveolus for m_4).

¹The matrix and preservation are peculiar—a light brown sand, the bone cream-white, the teeth mostly light brown shaded in places into a darker brown and more rarely into a light bluish gray. The matrix is a very fine-grained loessic sand, and the bone chalky in texture; neither is very hard.

A true *Canis* in disappearance of paraconid on m_2 . Large molars and small premolars, carnassial with short blades and large, well separated inner cusp; m^2 about same size as p^4 . Canines very small. Bullæ large; anteriorly they reach forward to or slightly in advance of back of glenoid fossæ; posteriorly closely united with vertical (and long ?) paroccipital process. Wide condyles, broad, low occiput, somewhat indistinct lyrate area, not reaching back quite to occiput.

The skull is somewhat flattened by crushing, and to this probably is also due the broad angle made by the basicranial to basifacial axis which Bose considered to be specific and named the species from it.

As compared with *C. bengalensis*, the tooth-row is shorter, the molars and p^4 larger, the premolars less compressed. Protocone of p^4 considerably larger and more offset, and the blades more massive. M^1 and m^2 have considerably greater transverse width, and m^2 is somewhat larger relatively, with less reduction of metacone. The difference in basifacial-basicranial angle is probably due to crushing, and perhaps the greater width and distance apart of the bullæ are exaggerated by it, but the larger,

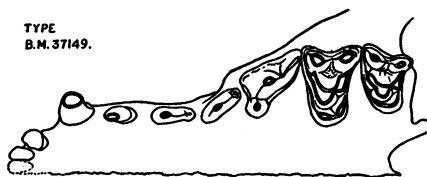


Fig. 22

Fig. 22. *Canis curvipalatus*. Upper teeth, crown view, natural size. From the type skull. Upper Siwalik.

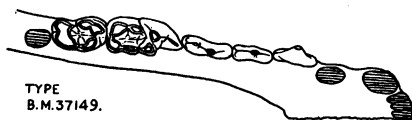


Fig. 23

Fig. 23. *Canis curvipalatus*. Lower teeth, crown view, natural size. From the type specimen in the British Museum, No. 37149.

wider condyles, more extended over the basioccipital, the wide, broad occiput and prominent occipital crest must be at least in part natural. The sagittal crest is stronger, and extends somewhat further forward to the lyrate area, which is better defined than in *bengalensis*.

Canis cautleyi

Enhydriodon FALCONER, 1868, Pal. Mem., I, p. 337.

Canis cautleyi BOSE, 1880, Quar. Jour. Geol. Soc., XXXVI, p. 135; LYDEKKER, 1884, Pal. Ind., (X) II, p. 259, text figure 10, and Pl. XXXII, Figs. 3, 6.

TYPE.—No. 40181, lower jaw fragment m_{1-2} and alveolus of m_3 , left side.

PARATYPE.—No. 40182, lower jaw fragment, m_{1-3} l., condyle and angle complete and part of coronoid. Both from the Upper Siwaliks.

The species was founded by Bose upon the two specimens listed above, of which No. 40181 has page priority in the description, and No. 40182 in the explanation of figures. In the British Museum catalogue, No. 40182 is listed first, with the statement that "this specimen with the next (40181) is the type of the species."

No. 40181 is selected as type, as a previously published specimen, and as the first one described in the type description. Both specimens are figured by the author¹ and his measurements are taken from both, although not so indicated. The type is a trifle larger and more robust, the paratype has m_3 preserved, but hopelessly damaged, and shows the characters of the back of the jaw not preserved in the type.

The species is a typical *Canis*, with bicuspid heel on m_1 , paraconid wholly absent on m_2 , which has no distinct entoconid; m_3 is quite small, long oval crown in paratype, short oval alveolus in type. Compares in size with a small wolf, cf. *C. pallipes* of India.

Lydekker notes that in *pallipes* and other modern wolves the angular process is "smaller in all its dimensions, and has a recurved upper angle which is entirely wanting in the fossil. The masseteric fossa is also larger and deeper in the fossil, and the pedicle of the condyle wider and flatter; in consequence of which there is a smaller upward bend of the inferior border below the ascending ramus than in the recent species." In fact the angular process is broken off in the fossil, and its apparent robustness is at least partly a result of unskillful preparation. The width and depth of the masseteric fossa is so much an individual and age character that it deserves no weight.

Canis cf. *aureus*

Canis, non det., LYDEKKER, 1884, Pal. Ind., (X) II, p. 264, Pl. xxxii, Fig. 2.

This species is known from the Siwaliks by a single upper jaw fragment, B. M. No. 15921, with p^4-m^1 r., and alveolus of p^3 , the inner lobe of m^1 and part of the carnassial crown broken off.

In absence of more material no satisfactory comparisons are practicable.

VIVERRIDÆ

Viverra bakerii Bose

Canis ? sp. FALCONER, 1868, Pal. Mem., I, p. 553, plate descriptions of Fauna Antiqua Sivalensis, unpublished Pl. q, Figs. 1, 3.

Viverra bakerii BOSE, 1880, Quar. Jour. Geol. Soc., XXXVI, p. 131.

Viverra bakeri LYDEKKER, 1884, Pal. Ind., (X) II, p. 268, Pl. xxxiii, Figs. 1, 2.

TYPE.—A skull, B. M. No. 40183, from the Upper Siwaliks.

Viverrid affinities of this and the following species (*V. durandi*) are shown in the following:

1. Two upper molars, which have the protocone internal, crescentic, without internal cingular crest, external cusps strongly asymmetric, the row of outer cusps angling in sharply from the carnassial notch. No internal expansion as in Mustelidæ.
2. Carnassial maintains the primitive oblique shear and more triangular outline than in Canidæ. Parastyle on carnassial, although small and not well separated in these species.
3. Paroccipital process flat and widely expanded over the posterior face of the bulla.
4. Long skull, narrow cranium and vertical, narrow, triangular occiput.

¹Lydekker's statement, *loc. cit.*, p. 259, that "the more perfect of the two specimens was figured by Bose," ignores his figure of No. 40182.

Lydekker describes the species as intermediate between *Viverra civetta* and *zibetha*, but on the wholly indefensible principle that the more carnivorous types of dentition in Carnivora are always secondary, he denies that it can be ancestral to *civetta* but considers that it may be so to *zibetha*. I should be more inclined to the reverse conclusion, as the *V. bakeri* teeth look like a species progressively adapting for less carnivorous diet; but the discussion would be futile without more evidence.

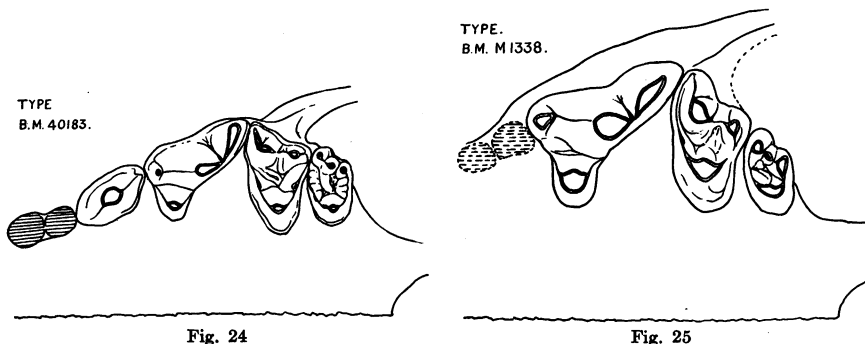


Fig. 24. *Viverra bakeri*. Upper teeth, crown view, natural size. From the type skull, British Museum No. 40183.

Fig. 25. *Viverra durandi*. Upper teeth, crown view, natural size. From the type skull, British Museum No. M1338. Upper Siwaliks.

Viverra durandi Lydekker

Canis ? sp. FALCONER, 1868, Pal. Mem., I, p. 553, plate descriptions of unpublished plates of Fauna Antiqua Sivalensis, Pl. q, Figs. 2, 2A, 2B.

Viverra durandi LYDEKKER, 1884, Pal. Ind., (X) II, p. 271, Pl. XXXIII, Fig. 3.

TYPE.—A skull, incomplete, p^4 - m^2 r. and l., alveolus of p^3 l. British Museum No. M1338.

PARATYPE.—Anterior half of skull, B. M. No. 37150, figured by Falconer, *loc. cit.* Both from Upper Siwalik beds.

The molars differ very considerably from *V. bakeri*, the carnassial being relatively large, the carnassial angle much sharper, m_2 relatively reduced. On this, as on *bakeri*, there is a very weak parastyle on p^4 , but less prominent here although the wear has opened a large worn space on it.

Progenetta proava Pilgrim, 1910

Palhyaena proava PILGRIM, 1910, Rec. Geol. Sur. Ind., XL, p. 65; *Progenetta* PILGRIM, 1913, *idem*, XLIII, p. 312.

TYPE.—Not stated, presumably in Indian Museum.

HORIZON AND LOCALITY.—Lower Siwaliks, Chinji.

Described by Pilgrim as "much smaller than *Palhyæna indica*, with relatively narrower teeth." Subsequently transferred to *Progenetta* "near *P. crassa*."

HYÆNIDÆ

Hyæna sivalensis Falconer and Cautley, 1868

Hyæna BAKER, 1835, Jour. Asiat. Soc. Beng., IV, p. 569, figures.

Hyæna sivalensis FALCONER AND CAUTLEY, 1868, in Falconer, Pal. Mem., I, p. 548, description of unpublished plates of Fauna Antiqua Sivalensis.

?*Hyæna sinensis* OWEN, 1870, Quar. Jour. Geol. Soc., XXVI, p. 422, Pl. XXVIII, Figs. 5-7.

?*Hyæna sivalensis* FALCONER AND CAUTLEY, emend. BOSE, 1880, Quar. Jour. Geol. Soc., XXXVI, p. 128 (forsan in parte, exemplo typico excluso).

Not "*Hyæna sivalensis* Bosc" LYDEKKER, 1884, Pal. Ind., (X) II, p. 303, Pl. XXXIV, nor of Pilgrim and other later authors.

"*Hyæna felina* Bosc" LYDEKKER, *loc. cit.*, p. 281, Fig. 13, etc. (at least in part).

TYPE.—A skull and jaws, No. 42, Science and Art Museum, Dublin.

The name *H. sivalensis* appears for the first time in 1868, *loc. cit.*, without description and referring in the main to unpublished plates of the Fauna Antiqua Sivalensis, so that Lydekker considered himself justified in regarding it as a nomen nudum and dating the species from Bosc's description of 1880.

But the 1868 plate description refers in the first place to a skull described and figured by Baker in 1835, erroneously stating that it was described under the species name *sivalensis* and by Baker and Durand, but quite definitely identifying *Hyæna sivalensis* Falconer and Cautley with "that designated *Hyæna Sivalensis* by Messrs. Baker and Durand."

Making allowance for the errors indicated, this constitutes an identification of *H. sivalensis* Falconer and Cautley, 1868, with *Hyæna* sp. of Baker, 1835, and bases the 1868 name upon a published, figured and described specimen, as well as upon the various unpublished specimens of Pl. κ of the Fauna Antiqua Sivalensis. The species is therefore not a nomen nudum, but based upon the Baker skull now in the Dublin Museum, as being the only published specimen included in it at the date of publishing the name.

Bosc's procedure in emending the species so as to base it primarily upon a skull referred in the 1868 descriptions to *Felis cristata*, secondarily to other specimens figured in the unpublished plates of Fauna Antiqua Sivalensis, to the exclusion of the skull published by Baker, does not appear to be permissible.

Lydekker's further emendation, basing the species wholly upon the '*Felis cristata*' skull and attributing it to Bosc, dropping the *sivalensis* of Falconer and Cautley altogether, appears objectionable on the grounds

TYPE.

Dubl. Mus. 42.

B.M. 3563 (cast)

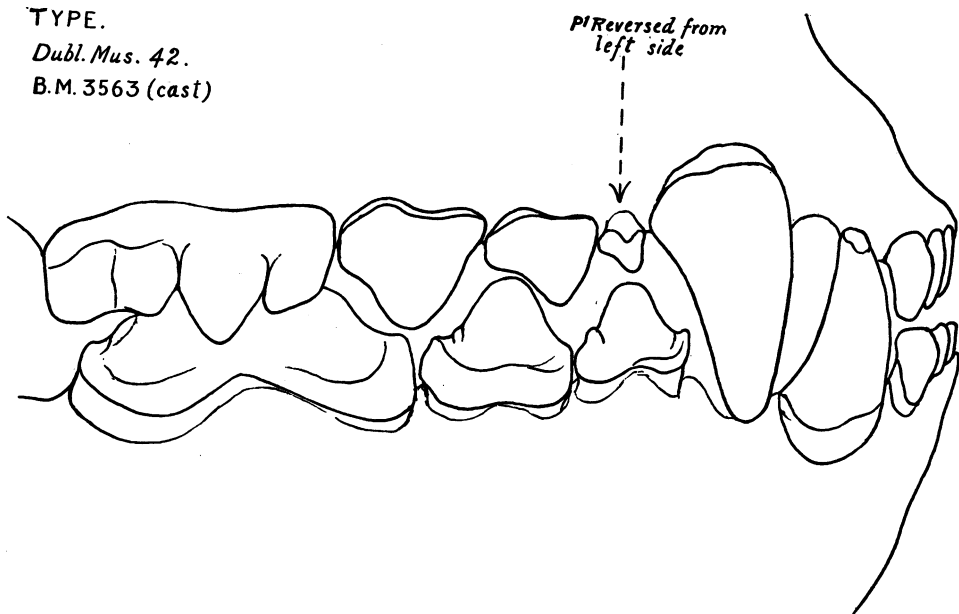
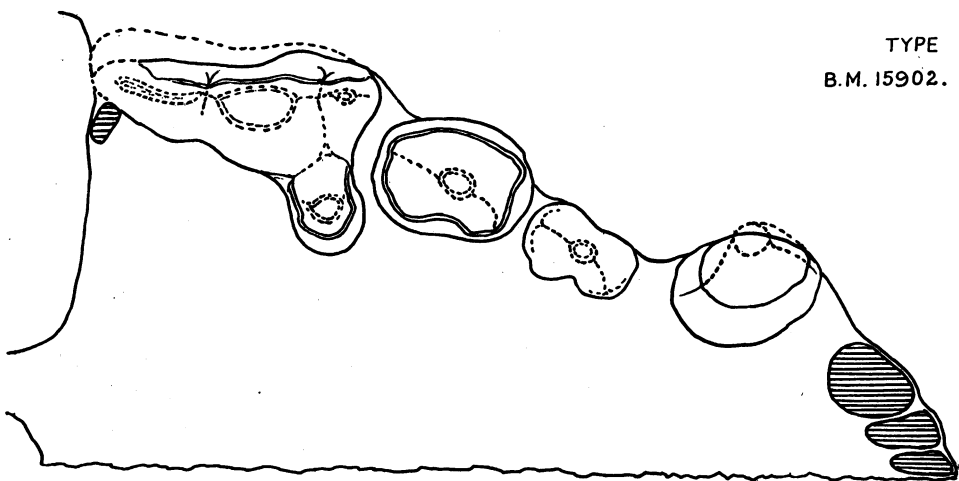


Fig. 26. *Hyæna sivalensis* Falconer and Cautley. Right side view, natural size, of teeth of type skull, Dublin Museum of Science and Art No. 42. Drawn from the cast in the British Museum, No. 3563. Upper Siwaliks.



TYPE

B.M. 15902.

Fig. 27. *Hyæna ?sivalensis* Falconer and Cautley. Upper teeth, crown view, natural size, of type specimen of *Hyæna felina* Bose, British Museum No. 15902. Upper Siwalik beds.

first that *sivalensis* is not a nomen nudum but a properly based species name dating from 1868, and second that, even if it were, it would as a homonym preoccupy *sivalensis* Bose.

The Dublin skull, a very poor cast of which is in the British Museum, No. M 3563, is a very large and fine one, with the lower jaws attached in such manner as to conceal a great part of the dentition.

The type of *Hyæna felina* Bose is a decidedly smaller skull, with dentition somewhat smaller throughout (but the differences in apparent size are partly due to wear, the Dublin skull being a young adult, the Bose type an old individual; and are explained by Lydekker on the ground of sex).

The species appears to be nearly allied to *H. crocuta* but its affinities can be more safely determined after the type has been properly prepared, the jaws taken off and the dentition cleaned up.

***Hyæna felina* Bose, 1880**

Probably a synonym of *H. sivalensis* Falconer and Cautley, 1868.

Felis cristata FALCONER AND CAUTLEY, 1868, in Falconer, Pal. Mem., I, p. 548, description of unpublished plates of Fauna Antiqua Sivalensis.

Hyæna felina BOSE, 1880, Quar. Jour. Geol. Soc., XXXVI, p. 130, Pl. vi, Fig. 6; LYDEKKER, 1884, Pal. Ind., (X) II, p. 278.

TYPE.—B. M. No. 15902, a skull.

The left maxilla is lacking in the Fauna Antiqua Sivalensis plate, and was added subsequently. It is present in Mr. Bose's figure. Lydekker does not figure the type. This type, a skull with heavily worn teeth, has a general though not very close resemblance to the type of *sivalensis*, but is notable for an extreme reduction of m¹, short, wide palate with very little spacing between c¹ and p², large internal lobe to carnassial—all characters allying it to *crocuta*. As the characters visible in the type of *sivalensis* also ally that species to *crocuta*, it would seem wholly probable that Lydekker was right in regarding the two skulls as of the same species.

***Hyæna colvini* Lydekker**

Hyæna colvini LYDEKKER, 1884, Pal. Ind., (X) II, p. 290, Pl. xxxv, Fig. 2 (type), Pl. xxxv, Fig. 1, Pl. xxxvi, Fig. 1 (second skull).

TYPE.—Ind. Mus. D47, part of skull. Cast in British Museum, No. 1552.

PARATYPE.—A skull, Ind. Mus. D45, cheek teeth mostly gone. Cast in British Museum, No. M1551.

A number of additional specimens referred.

HORIZON.—Upper Siwaliks (as recorded by Pilgrim).

This species appears to be nearly allied to *H. sivalensis*, of which it may be perhaps a small variety. The upper molar is much larger, the inner cusp of the carnassial appears to be somewhat smaller and the premolars less robust; but if fully distinguishable it is at all events closely

related to *sivalensis* and belongs to the *crocota* group. Has the same short face, wide palate, long blade and fairly large inner cusp to carnassial, robust, crowded premolar. In the second skull, the m^1 is (apparently) considerably smaller than in the type (but as only the root of m^1 is present in the type, this is not so certain).

***Hyæna (Lycyæna) macrostoma* Lydekker**

Hyæna macrostoma LYDEKKER, 1884, Pal. Ind., (X) II, p. 298, Pl. ~~xxxvii~~, Pl. ~~xxxvi~~, Fig. 2. *Lycyæna* PILGRIM, 1910, Rec. Geol. Sur. Ind., XL, p. 199.

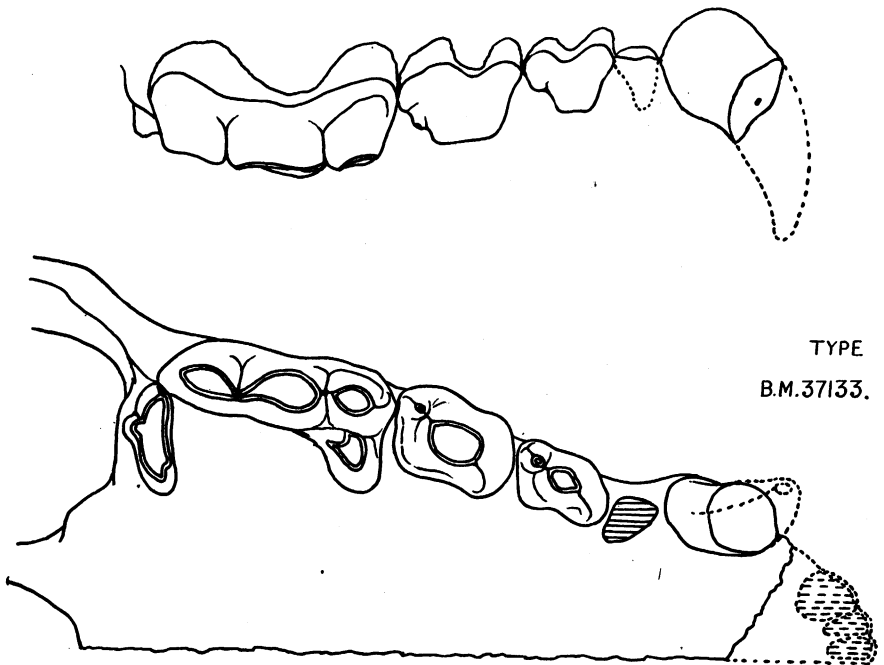


Fig. 28. *Hyæna bosei*, upper teeth, external and crown views, natural size, from type skull, *Hyæna sivalensis* of Bose and Lydekker, not of Falconer. British Museum No. 37133. Upper Siwalik beds.

TYPE.—Ind. Mus. No. D44. Cast in British Museum, No. M1547. Collected by Theobald at Jabi, Punjab—Middle Siwaliks. Reported by Pilgrim from other Middle Siwalik localities.

The skull differs notably from the short, deep type of *sivalensis*, and the dentition is much more primitive. P^1 is present, spaced between c and p^2 ; the following premolars appear rather narrow; the carnassial has no such great development of the posterior blade as in the *crocota* group, and the protocone (deuterocone) is either

reduced or absent, although there is a fairly strong internal root. The m^1 is a quite large and trihedral tooth, presumably tricuspid. The palate is narrow and elongate, quite approaching *Ictitherium* in proportions.

This species compares with *H. eximia* of Pikermi, as well as with *H. chæretis* of Pikermi (type of *Lycyæna*). The skull is more primitive than *eximia*, perhaps comparable with *chæretis*. Probably deserves at least subgeneric separation from the *crocuta* group.

***Hyæna (Hyænictis) bosei*, new species**

Felis cristata (in errore) FALCONER, 1868, Pal. Mem., I, Pl. xxv, Figs. 1-4.

Hyæna sivalensis FALCONER AND CAUTLEY, emend. BOSE, 1880, Quar. Jour. Geol. Soc., XXXVI, p. 128, in part.

Hyæna sivalensis BOSE LYDEKKER, 1884, Pal. Ind., (X) II, p. 303, Pl. xxxiv, and of later authors.

TYPE.—B. M. No. 37133, a skull, nearly complete.

HORIZON.—Upper Siwaliks, auct. Pilgrim. The matrix is like that of *Canis curvipalatus*, etc.

This skull is of very definitely primitive type, decidedly more so than *H. macrostoma*, comparable with *H. chæretis* or *Hyænictis græca* of Pikermi. These species are apparently nearly related to the striped hyena, *H. striata*.

The whole aspect of the dentition is rather primitive, suggesting *Palhyæna hipparionum*. Referred specimens show m_2 sometimes present, sometimes absent. It is present in *H. græca*, absent in *striata*. A small metaconid on m_1 absent in *græca*, present in *striata*.

***Palhyæna indica* Pilgrim**

Palhyæna indica PILGRIM, 1910, Rec. Geol. Sur. Ind., XL, p. 64.

TYPE.—A maxilla, presumably in Indian Museum.

PARATYPE.—A mandible, Ind. Mus. D53, described by Lydekker under the name of *Hyæna sivalensis* BOSE (Pal. Ind., (X) II, Pl. xxxviii, Fig. 2; Pl. xxxix, Fig. 5).

HORIZON AND LOCALITY.—Middle Siwaliks, Hasnot.

DESCRIPTION.—“Last premolar more nearly equals carnassial than in Chinese specimens referred by Schlosser to *Palhyæna* aff. *hipparionum*.”

LEPTYÆNA

TYPE.—*Ictitherium sivalense* LYDEKKER, 1880, Rec. Geol. Sur. Ind., X, p. 32.

Pilgrim states that the entire dentition of this species is known to him, and notes its resemblance to *Palhyæna hipparionum*.

Probably the genus is not separable from *Palhyæna*.

FELIDÆ***Felis cristata* Falconer and Cautley**

Felis cristata FALCONER AND CAUTLEY, 1836, *Asiat. Res.*, XIX, p. 135, Pl. **xxi**, Figs. 1-2; FALCONER, 1868, *Palæont. Mem.*, I, p. 315 (but not Pl. **xxv**, Figs. 1-4, erroneously so described in plate description).

TYPE.—A skull in the Mus. Roy. Coll. Sing., cast, B. M. No. 28913. From Upper Siwaliks.

The skull has lost the left maxilla almost wholly, and the crowns of all the remaining teeth. It has been carefully described and compared and figured by Lydekker, and there is nothing further to be said about it.

I refer provisionally to this species two jaw fragments, B. M. Nos. 48437, M1567, described by Bose and Lydekker under *Machærodus palæindicus*. They are certainly not machærodontine, and either one may represent the lower dentition of *F. cristata*, although they differ so much in the p_4 , the only comparable part, that I have doubts of their belonging to the same species. They are of no great importance at the best. The first shows p_4 - m_1 , the second p_4 and the root of p_3 , all badly battered.

***Felis brachygnatha* Lydekker**

Felis (Cynælurus) brachygnatha LYDEKKER, 1884, *Pal. Ind.*, (X) II, p. 326, Pl. **xliii**, Figs. 1-2.

SYNONYM.—*Cynælurus pleistocænicus* ZDANSKY, 1925, *Pal. Sin.*, (C) II, fasc. II, p. 23, Figs. 3 and 4 of Pl. IV.

TYPE.—Lower jaw, B. M. No. 16573, with i_2 - m_1 , the canine broken off and other teeth more or less damaged.

This species is also represented by a second lower jaw, B. M. No. 16537, very similar in size and parts preserved, except that the canine and incisors are lost, and that p_3 , incomplete anteriorly and poorly preserved in the type, is here complete and well preserved.

Lydekker refers the species to the subgenus *Cynælurus* upon rather inadequate grounds, chiefly the shortness of the jaw. He also compares it to *Felis arvernensis* Croizet and Jobert, and notes the close resemblances, but differentiates the two by the somewhat shorter diastema and the smaller p_3 with less development of the "anterior and posterior talons" (*i.e.*, accessory cusps). The latter character, however, is probably drawn from the type of *brachygnatha*, which has p_3 imperfectly preserved; in the second jaw the p_3 is as large as in *arvernensis* and other cats of similar size, and has well developed accessory cusps. It would appear therefore that there is little to separate *brachygnatha* from *arvernensis* except geographical distance.

Cynælurus pleistocænicus Zdansky is very closely related to *F. brachygnatha*, and so far as comparisons can be made appears to be identical. The distinctions which Zdansky draws—(1) reduced p_3 in the type jaw, (2) greater compression of the premolars, and (3) different outline of premolars, their greatest width not so much above the posterior root—are all the results of comparison with a poor drawing of

damaged teeth, which have lost a considerable part of the outer surface at the sides, especially near the base, altering their apparent outlines. If the lost enamel and surface chipping be restored or allowed for, the outlines of premolars and molars are nearly identical.

Felis* aff. *pardus

Felis non det., allied to *F. pardus*, LYDEKKER, 1884, Pal. Ind., (X) II, p. 328, Pl. XLIII, Figs. 4, 4A.

TYPE.—No. 16537A, British Museum, a lower jaw with p_3 - m_1 .

The most notable characters of this jaw except size are brachydonty of the teeth, abrupt depth of the masseteric fossa and relative depth of the jaw, especially anteriorly.

The second jaw referred by Lydekker to this species, No. 48929 British Museum collection, is a machærodont, probably *M. falconeri*.

***Felis subhimalayana* Brown**

Felis BAKER AND DURAND.

TYPE.—A skull in the Museum of Science and Art, Dublin.

Size of domestic cat.

***Metailurus* Zdansky**

Zdansky has recently erected another new "genus" of Felidæ that needs comparison with the Siwalik species. It is, as he recognizes, related to *Pseudælorus*, but he distinguishes it from that genus: (1) because of the relatively long, straight canines, which still retain a trace of the anterior and posterior ridges of the primitive cats. This he considers absent in *Pseudælorus* because it is said to be absent in certain referred specimens of *P. larteti*. (2) Because m^1 is stated to have "noch deutlich trituberculären Bau" in *Pseudælorus*, which presumably means that it retains something of the inner cusp, lost in *Metailurus*. And (3) the talonid is less reduced in *Pseudælorus*.

Dr. Zdansky quite puts aside as impossible that *Pseudælorus* could be in any degree ancestral to *Metailurus*, or the latter to *Felis*. I do not understand why, unless it be that he wholly rejects the view that the modern cats are derivatives of animals more or less of the *Dinictis* type, through *Nimravus* and *Pseudælorus*. If the *Dinictis* ancestry be accepted, there is no great difficulty in the phylogeny, nor any especial need to separate *Metailurus* from *Pseudælorus*, still less to regard it as having nothing to do with the ancestry of any later forms. The characters which Zdansky regards as specialized are really primitive and quite what should be expected in an early Pliocene feline. The characters of *Pseudælorus*, aside from the alleged lack of crests on the canine, are a little more primitive throughout, and quite what should be expected in a Miocene feline. As for the canines of *P. larteti*, this species may have been in this particular more progressive towards the feline type—or the tooth may

be worn or damaged (as in the case of *Felis brachygnatha*, q. v.). In any case, it does not determine the affinities of that genus, and all the rest of the evidence falls in line, unless indeed one reverts, with Scott and some other writers, to the older view, under which detailed study of the Felidæ led to hopeless confusion, and a tangled phylogeny in which everything is a side branch, and "für die Abstammung späterer Formen kommt sie nicht in Betracht." Scott's argument in support of that view can be sufficiently answered by saying that in the first place he greatly exaggerates the amount of reversion in the Felidæ, that they do not by any means revert to exactly the normal type of æluroid dentition, but retain many traces of a sub-machærodont ancestry; and in the second place his interpretation of irreversibility in evolution, that its general direction cannot be reversed in any phylum, is contradicted by innumerable cases on a larger or smaller scale, to many of which Dollo has drawn especial attention and set forth with his usual brilliancy. For it is not at all Dollo's concept of irreversibility that Scott in this instance and Petronievics as a general law have set forth, but the old concept of a by-gone era of palæontology. Dollo pointed out that traces of past adaptations are always to be found in a new adaptation, and that is eminently the case with the cats; when one compares them with viverrids or mustelids or with the hyænids, it is easy to see various peculiarities that point back to a *Dinictis* or *Ælurictis* ancestry.

Metailurus does not seem to me to be separable generically from *Pseudælorus*, although it represents an intermediate stage between that genus (typically) and *Felis*. Nor do I find any reason for removing the American species from *Pseudælorus*, with the typical species of which they agree more nearly than they do with the types of *Metailurus*.

ÆLUROPSIS Lydekker

Æluropsis LYDEKKER, 1884, Pal. Ind., (X) II, p. 316.

?SYNONYM.—*Sivælorus* Pilgrim.

TYPE.—*Æluropsis annectens* Lydekker, *loc. cit.*, known from a lower jaw fragment from the Middle Siwalik beds, Hasnot.

The affinities of this genus appear to be with the true cats, not with the machærodontine group. At the anterior end of the jaw, beneath the alveolus of p_3 , the lower border turns inward as toward a normal feline symphysis; the infraorbital foramen is in the position normal to the Felinæ, further back and higher up than in the Machærodontinæ. The third premolar appears to have been unreduced; the fourth has small accessory lobes even for a feline, much smaller than in machærodontines. The presence of a definite crested heel, and of an oval alveolus for a small m_2 are primitive characters which are also seen in an undescribed feline jaw found in the American Mio-Pliocene. They indicate the survival of a type rather closely allied to *Nimravus*

of the Lower Miocene of America and *Ælurictis* of the ?Oligocene and Lower Miocene of Europe.

It seems probable that *Sivæluxus* Pilgrim is an intermediate or related stage, a smaller and more primitive species of *Æluropsis*, but Pilgrim's genus is at present known only from an upper jaw and a provi-

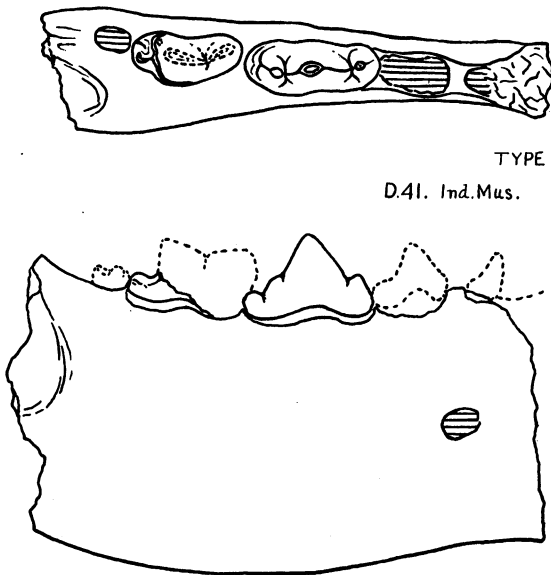


Fig. 29. *Æluropsis annectens*. Lower jaw, type specimen, Ind. Mus. D41, natural size, crown and external views with reconstruction of the cheek teeth. The premolars may be interpreted as one large p_3 in place of the two smaller teeth, p_2 and p_3 as here shown; this, however, appears the more probable interpretation. The metaconid on m_1 is either minute, as here indicated, or wholly absent. Middle Siwalik beds.

sionally referred lower jaw, incomplete posteriorly and doubtfully associated in the writer's opinion; and *Æluropsis* is even more imperfectly known, from the lower jaw fragment containing only p_4 and the heel of m_1 complete.

***Æluropsis annectens* Lydekker**

Æluropsis annectens LYDEKKER, 1884, Pal. Ind., (X) II, p. 316, Pl. xxxiii, Figs. 4, 4A.

TYPE.—Part of lower jaw, with p_4 and heel of m_1 .

SIVÆLURUS Pilgrim, 1913**?ÆLUROPSIS** Lydekker

TYPE.—*Pseudæluxurus chinjiensis* Pilgrim, 1910.

This is a considerably more primitive type than any of the Siwalik sabre-tooth cats, and nearer to the true cats. Following are the generic characters:

1. Upper canine oval, probably not greatly elongate.
2. P_2^3 present, p_3^3 unreduced with no anterior and quite small posterior accessory cusps.
3. P^4 with distinct inner cusp, small parastyle and quite rudimentary fourth cusp.
4. M^1 transverse, narrow, elongate.
5. Small infra-orbital foramen.

It seems doubtful whether the lower jaw referred by Pilgrim to *S. chinjiensis* really belongs to the genus and species. There is no evidence of machærodontine affinity in the upper jaw; on the contrary, it shows distinct feline affinity in the round-oval canine (not too large for a true cat although Pilgrim seems to think it so), in the small infra-orbital foramen, the well developed internal cusp on p^4 . The weak parastylar cusp, and the transverse, unreduced m^1 are primitive characters, approaching *Dinictis*, and indicate (1) corresponding weakness in the posterior and ? anterior accessory cusps of p_4 , and (2) probable presence of a considerable talonid on m_1 . These are characters of *Æluropsis* Lydekker, q.v.

It seems very likely that the type of lower jaw that belongs with *S. chinjiensis* is one which we have found in the *Hipparion* zone of North America. It resembles *Ælurictis* of the Phosphorites, but differs in absence of m_2 and reduction of p_3 ; differs from *Pseudæluxurus* in retaining a distinct and fairly well developed heel on m_1 , and has little if any trace of the angulation of the symphysis distinguishing that genus.

Pilgrim's attempt to associate *Sivæluxurus* with *Felis nebulosa* as a separate distinct phylum from the other felids appears to me too speculative for serious discussion. The only point in its favor is that *nebulosa* is in several ways the most primitive of living Felidæ, and naturally comes a little nearer to any late Tertiary form of appropriate size. But there is no reason that I can see for giving preference to *Sivæluxurus* over *Pseudæluxurus* as an ancestor for this species of *Felis*, and the primitive characters of *Sivæluxurus* point to its being rather a persistent primitive survival, like the American species compared with it, than an ancestor of any species of *Felis*. Much more adequate evidence is needed for

placing its phylogenetic affinities, save in the manner of the 'schwindel-bäume' so beloved of palæontologic literature of a few decades ago, and still most prevalent in discussions of the ancestry of man.

The Genera of **MACHÆRODONTINÆ**

The sabre-tooth cats are in great confusion both as to nomenclature and taxonomy. European writers until recently have lumped under *Machærodus* a great variety of species while separating out certain other genera no better, if as well, entitled to separation. In reviewing the Indian species it has been necessary to look into the European Tertiary and Pleistocene sabre-tooths, and make some attempt to clear up the confusion.

Three distinct genera appear to have been confounded under the current name *Machærodus*. One of these, and the earliest found, is a type found at Val d'Arno and various Pleistocene localities in Europe, North and South America and probably in Asia and Africa. The best known, but one of the most specialized, representatives of this type is the great South American sabre-tooth; somewhat less specialized species are found in North America, even better represented by the hundreds of skulls and proportionate quantities of skeleton material found at Los Angeles. This type is represented in the British Museum by a jaw from Kessingland, Norfolk, probably by other remains; by casts of jaws from the Val d'Arno, etc. Its characters will be specified under the genus-heading *Smilodon*.

A second type is that represented by the fine skull and jaw from the Upper Pliocene of Mont Perrier, named *Felis megarthereon* by Bravard in 1828, and had apparently been distinguished as a subgenus *Megarthereon* by Croizet and Jobert in the same year.

A third type is that found at Eppelsheim and Pikermi, to which the name *Machærodus* properly applies.

These three types of the later Cenozoic are all quite distinct from the true cats, *Pseudælurus* and *Felis* (with its subgenera), and also from the middle Tertiary genera *Dinictis* and *Nimravus* (including *Ælurictis*) of the feline series, *Hoplophoneus* (with *Eusmilus* as a subgenus) of the machærodontine series, and *Pogonodon*, partly intermediate but belonging to the feline group (not, however, *P. davisii*, which is a *Hoplophoneus*). Cook's genus *Heterofelis* is nearly related to the true *Machærodus* of Pikermi, but may prove to rank as a subgenus. The rest of the thirty-five or forty generic names given to fossil sabre-tooth cats are for the most part pure synonyms; some, however, like *Trucifelis*, *Homotherium* and *Sivælurus* may deserve subgeneric rank when better known.

SMILODON Lund, 1842

TYPE.—*Hyæna neogæa* Lund, from the Pleistocene of Brazil.

Represented by skeletons of *S. bonærensis* from Argentina in Museo Nac., Buenos Aires, American Museum of Natural History, New York, skulls and casts of skulls in London and Paris museums and elsewhere.

Also by numerous skulls and composite skeletons of *S. californicus* from Rancho-La-Brea, Los Angeles, California. Some nine hundred skulls were secured at this locality, and they are principally assembled at the Los Angeles and Berkeley, California, Museums.

Here are referred jaws of sabre-tooth cats and separate tusks from the Val d'Arno Lower Pleistocene. Jaw described by Fabiani in 1890 as *Machærodus crenatidens*; tusk originally figured and described by Cuvier as belonging to *Ursus etruscus* renamed *cultridens*, but the name *cultridens* is inapplicable for reasons specified under *Machærodus*.

CHARACTERS.—

1. P_3^2 reduced to a vestigial tooth or wholly absent.
2. Accessory cusps of p_4 very large, sometimes almost equaling the protoconid, the cusps much pitched backward.
3. Accessory cusp of p_4 (in front of parastyle) well developed, often as large as the parastyle itself. Sometimes a rudimentary fifth cusp in front of it.
4. M^1 a small vestigial rudiment.
5. Lower canine greatly reduced, almost incisiform, the dependent flange of the lower jaw little marked, more or less degenerate, but the angulation marked.
6. Upper canine gigantic, a long, broad, flattened blade.
7. Size mostly very large, skull and skeleton extremely specialized, tail short, etc.

This is the Pleistocene sabre-tooth on which the general concept of the group has been chiefly founded.

Trucifelis, *Dinobastis*, *Smilodontopsis*, all based upon extremely fragmentary material from the American Pleistocene, are probable synonyms, perhaps of subgeneric value when adequate neotypes are known.

Smilodon does not appear to be in the described Siwalik fauna (but probably is in Pleistocene of India as well as China), but is in the Pleistocene of Europe as well as North America. The Holarctic species may need separation into subgenera when more carefully compared.

MACHÆRODUS Kaup, 1833

SYNONYM.—? *Heterofelis* Cook, *Paramachærodus* Pilgrim.

Non SYNONYM.—*Drepanodon* Nesti, *Steneodon* Geoffroy.

TYPE.—An upper canine. No species name; probably = *Felis aphanista* Kaup.

Machærodus KAUP, 1833, Oss. Foss. Darmst., p. 24, Pl. I, Fig. 5.

[Not *Drepanodon* NESTI, 1826, N. Giorn. Lett. (Pisa), XIII, p. 6; Type, ?*Ursus cultridens* = *U. etruscus* Cuvier. (Auct. Sherborn, Index Mam.)].

Lydekker's statement that *Drepanodon* was only described as a species name appears to be due to his referring the name to another

publication of Nesti's (listed by Sherborn). It appears to be a generic name with *Ursus cultridens* as type.

But Cuvier's *Ursus cultridens* is specifically stated by him to be a new name for his *Ursus etruscus*, of which the types are undoubted ursid (?*Ursus*) jaw fragments from the Val d'Arno (Lower Pleistocene). The species name *cultridens* Cuvier is therefore a *synonym* of *etruscus*, and the machærodont upper canine which suggested his new name does not belong to the species.

The names *Drepanodon*, *Steneodon*, *Cultridens* and some others based on this *species* will therefore fall into the synonymy of the *Ursidæ*, however inappropriately.

This, however, is not the case with Kaup's *Machærodus*, which is based not upon the species *etruscus* but upon canines (specifically upon the one which he figures) which he considers were wrongly referred to the species *etruscus* and which he thinks to be neither bear nor cat, and compares to *Megalosaurus*. He does not positively state it to be a reptile, but evidently thought so.

It appears almost certain, as Boule has shown, that Kaup's *Felis aphanista* is the same species as his *Machærodus* tusk. Lower jaw from Eppelsheim in the British Museum shows the characters of *F. aphanista* very well. The characters of the genus are admirably shown in the specimens from Pikermi referred by Gaudry and others to *Machærodus 'cultridens'*, and in the somewhat smaller form distinguished as *M. schlosseri* by Weithofer.

CHARACTERS.—

1. P_3^2 little reduced, p_3 similar in construction to p_4 .
2. Accessory cusps only moderately developed on p_3-4 , and with little backward pitch of cusps.
3. Accessory cusp of p^4 well developed.
4. M^1 long, transverse, less reduced than in the other genera.
5. Lower canine stout, rather compressed oval, no dependent flange on jaw but a prominent angulation of surface at symphyseal region in front and beneath.
6. Upper canine very large, stout, flattened, not so long as in others.
7. Size medium to large.
8. Lower molar has mostly a vestigial metaconid (or heel).

MEGANTHEREON Croizet and Jobert

Meganthereon CROIZET AND JOBERT, 1828, Recherches Oss. Foss. Dept. Puy-de-Dôme, p. 200.

TYPE.—*Felis meganthereon* Bravard.

This genus and species appear to rest upon the admirably preserved skull and lower jaw from the Upper Pliocene (= ?Pleistocene) of Mont Perrier, of which the type is in the Paris Museum, and casts in the British Museum and elsewhere. It

B.M. 39730.

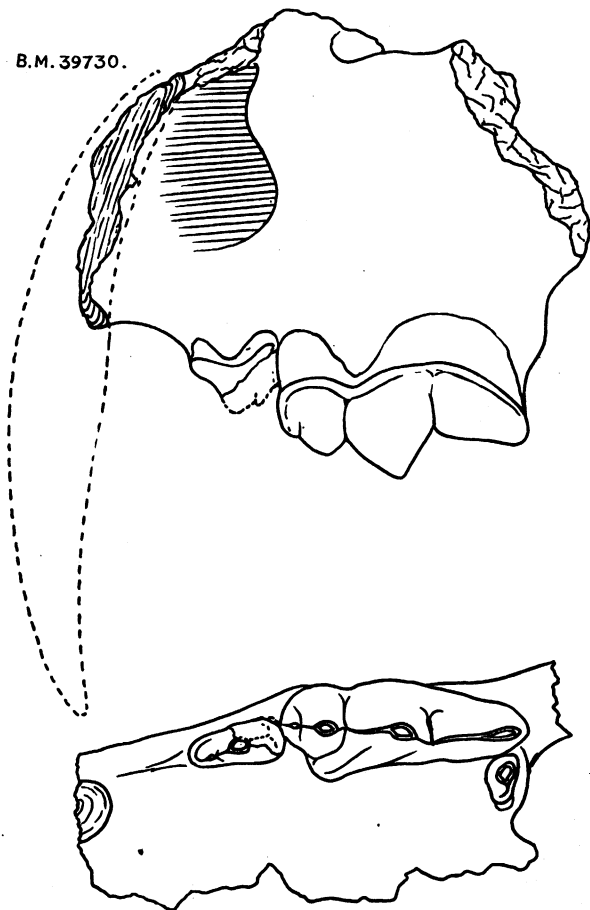


Fig. 30. *Meganthereon falconeri* Pomel (= *Drepanodon sivalensis* Falconer). Upper jaw, natural size, external view and crown view of teeth. British Museum No. 39730. The dotted restoration of the canine is based upon the indications of the alveolus and the proportions of the tooth in allied European species. Upper Siwalik beds.

includes species of rather small or moderate size with a very long, slender canine, unlike the short broad blade of *Machærodus* and the long, broad blade of *Smilodon*. It has a well developed dependent flange on the lower jaw, very short face, and the cheek teeth of intermediate specialization between *Machærodus* and *Smilodon*.

It was to this genus that the machærodont canine from Val d'Arno, wrongly ascribed by Cuvier to *Ursus etruscus*, appears to have belonged, according to Boule. But, as already noted, it seems impossible to accept Boule's transfer of the species name *cultridens* to a sabre-tooth, as Cuvier specifically states that it is a new name for *etruscus* and therefore by the laws of nomenclature the type of *etruscus* is the type of *cultridens*, and the machærodont tusks were no part of the type but subsequently referred material.

CHARACTERS.—

1. Upper canines long, slender, not crenulate (this last may be merely specific or accidental).
2. Lower jaw with well developed dependent symphyseal flange.
3. P_3^2 reduced, p_3 being much smaller than p_4 —two-rooted or with somewhat connate roots.
4. P_4 with moderate accessory cusps considerably smaller than protoconid, well developed talonid, the cusps all pitched considerably backward.
5. Minute vestigial heel on m_1 .
6. P_4 with rudimentary 'fourth cusp' anterior to parastyle, no inner cusp.
7. M^1 small, round-oval.

A more complete revision of the European species referable to this group may make some revision necessary in the above characterization. It is represented primarily by the small Mont Perrier species, occurs also at Val d'Arno, and at La Grive and Sansan occur species that may be referable to the genus, though probably more primitive.

Meganthereon falconeri Pomel

Machærodus OWEN, 1846, Brit. Foss. Mamm. and Birds, pp. 178-9.

Meganthereodon falconeri POMEL, 1853, Catal. Méthodique, p. 56.

Machærodus falconeri GAUDRY, 1862, Anim. Foss. et Géol. de l'Attique, p. 113.

Drepanodon sivalensis FALCONER AND CAUTLEY, in Falconer, 1868, Pal. Mem., I, p. 550, Pl. xxv, Figs. 5, 6.

Machærodus sivalensis LYDEKKER, 1884, Pal. Ind., (X) II, p. 334, Pl. XLIV, Figs. 1, 2, 4-6.

The first description of this Siwalik machærodont is in Owen's volume of 1846, where he specifies and describes three specimens, all in the British Museum collections:

No. 16350, right maxilla, young, with milk canine and milk carnassial:

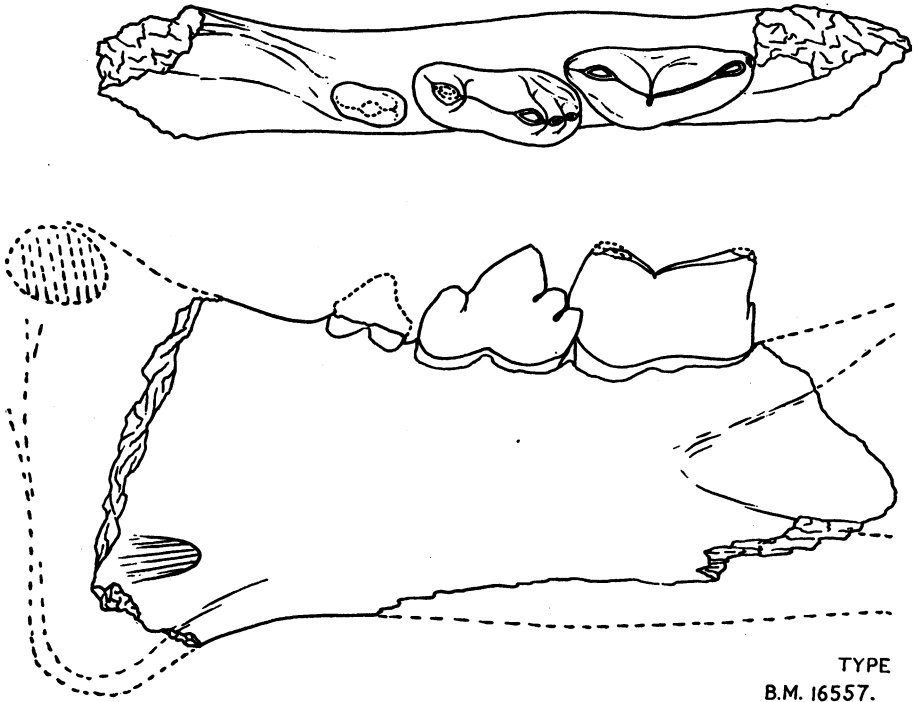
No. 39730, part of upper jaw, permanent dentition p^3-m^1 l.

No. 16557, part of left lower jaw, p_4-m_1 and root of p_3 . Owen evidently regarded this material as representing a distinct species, but gave no name to it.

Pomel in 1853 gave the name *falconeri*, with a species diagnosis evidently based upon Nos. 16350, 16554 and either 16557 or 48436 or both. No specimen can be said to be definitely indicated as type.

In the Plate Descriptions of the Fauna Antiqua Sivalensis, Falconer in 1868 gives the name *sivalensis*, Nos. 16350 and 16557 being figured.

Mr. Bose in 1880, while separating certain specimens as *M. palæindicus*, does not specify any type for '*sivalensis*.'



TYPE
B.M. 16557.

Fig. 31. *Meganthereon falconeri*. Lower jaw, type specimen, natural size, external and superior views. British Museum No. 16557. Front of jaw reconstructed on analogy of *M. palæindicus*.

Lydekker in 1884 selects No. 16557 as type.

It would appear therefore that the lower jaw, No. 16557, is the type of *M. sivalensis* = *falconeri*.

With this jaw agree quite closely Nos. 16554, a right lower jaw, p_3-m_1 , and 48929, left lower jaw with p_4-m_1 ; these two specimens lack the minute vestigial metaconid of the type and are slightly smaller; No. 16554 was referred by Lydekker to *M. sivalensis*, No. 48929 to *Felis* sp.

On this basis *M. falconeri* is a species of moderate size closely related to *M. meganthereon* of Perrier and Val d'Arno, decidedly smaller than *Smilodon crenatidens*

Fabrini of the Val d'Arno fauna, with much less reduction of p_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_3^2 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_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_{3-4} , 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**

Pseudæxurus sivalensis LYDEKKER, 1877, Rec. Geol. Sur. Ind., X, p. 83; (*Ælurolage*), 1884, Pal. Ind., (X) II, p. 317, Pl. XLIV, Figs. 7, 7a; (*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 Cautley¹ which = *Meganthereon falconeri* Pomel) and the other, No. D141, to *Pseudæxurus* (*Metailurus*).

¹This 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. $\frac{K16}{218}$; 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.

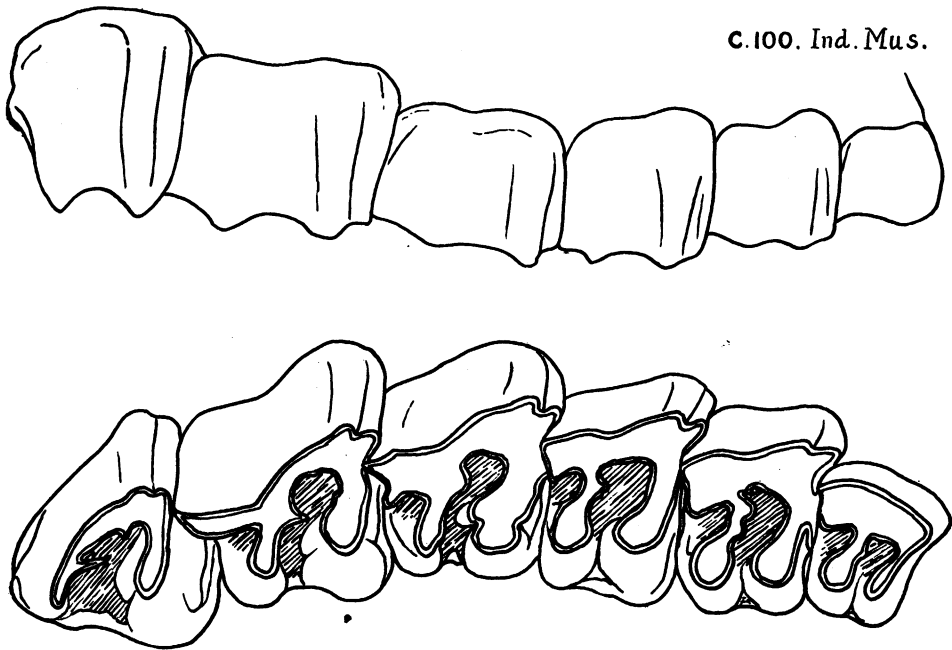


Fig. 32. *Chilotherium intermedium* Lydekker. Upper dentition of a referred specimen No. C100 in the Indian Museum. External and crown views of teeth, half natural size. Lower Chinji beds, Lower Siwaliks.

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.

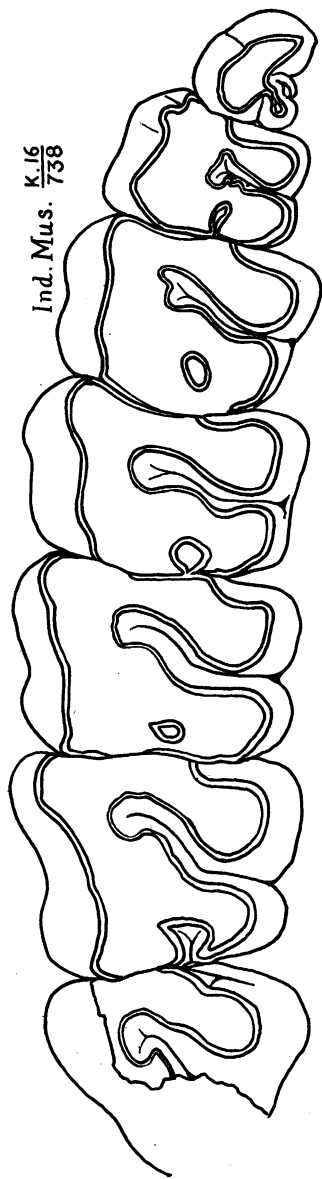


Fig. 33. *Rhinoceros ?sivalensis*. Crown view of upper dentition, half natural size, from a referred palate in the Indian Museum, No. $\frac{K.16}{738}$. Middle Siwaliks.

Heavy cingulum on molars on types of both species, absent on premolars of $\frac{511}{578}$, 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 brachyodont rhinoceroses, with more primitive, although variable, construction in the molars, can be placed in the genus *Chilotherium*. They are probably a pro-*Chilo-*

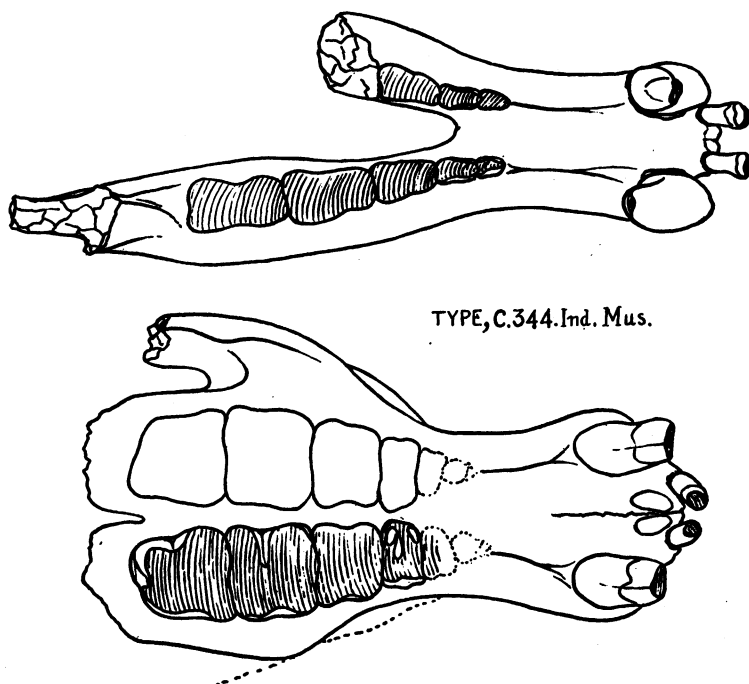


Fig. 35. *Paramynodon cotteri* (Pilgrim). Palate and lower jaws one-fourth natural size, crown views of dentition from the type specimen, Ind. Mus. No. C344. Upper Eocene, Pondaung beds, Burma.

therium group, but I do not know what name would apply. They may be congeneric with "*Diceratherium*" *pleuroceros* and *asphaltense*.

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^{2-31}), but not same in 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 *Amyrnodon*.

Certainly more hypsodont than *Orthocynodon*.

Incisors appear to be reduced to $\frac{2}{3}$ in place of $\frac{3}{4}$ as in our forms, and are short, stubby, wider anteroposteriorly than transversely.

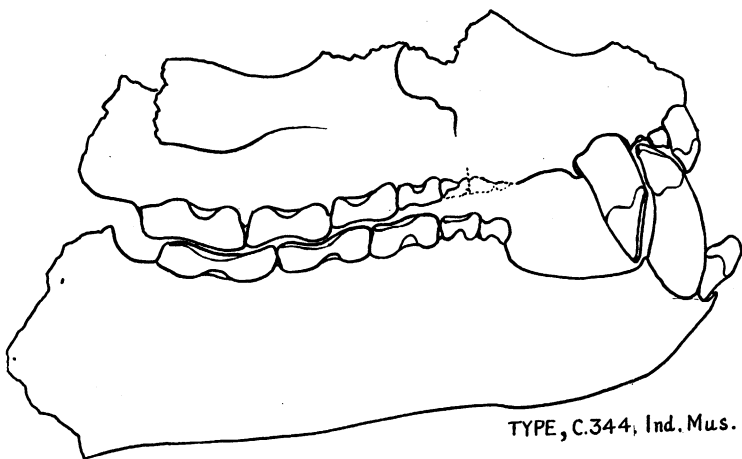


Fig. 36. *Paramynodon cotteri*, right side view of palate and lower jaws, type specimen No. C344, Indian Museum. One-fourth natural size. Pondaung Eocene, Burma. The number of upper premolars in this specimen is wholly uncertain in the present stage of preparation. Pilgrim thinks that p^1 is probably 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_{3-4} 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 *Amyrnodon*, certainly more than in *Orthocynodon*.

Appears to be nearer to *Amyrnodon* 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 *Amyrnodon* 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 ?*Amyrnodon* (Mong.), *Amyrnodon* (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.

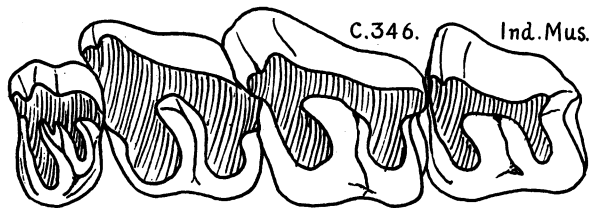


Fig. 37. *Paramynodon birmanicus*. Upper teeth, half natural size, crown views. From a referred specimen, No. C346, Ind. Mus., identified by Dr. Pilgrim; the teeth preserved are m^{2-3} l., p^4-m^2 r. (p^4-m^1 reversed in drawing). M^3 has been figured by Pilgrim in Pal. Ind., N. S., VIII, No. 3, Pl. 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.

Chasmothorium 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 *Chasmothorium*, but careful comparison with Depéret's and Stehlin's material would be advisable. It is certainly distinct from *Indolophus*.

¹Pilgrim, 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

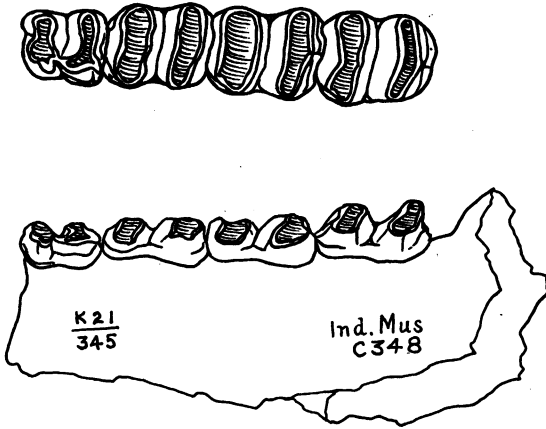


Fig. 38

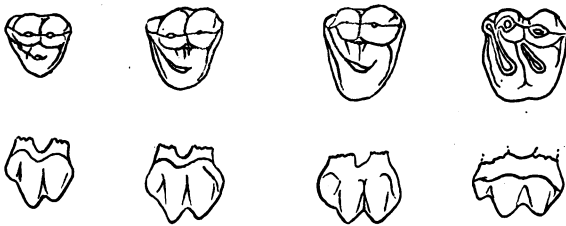


Fig. 39

Fig. 38. '*Chasmoitherium*' *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.

primitive features, reminiscent of *Eohippus*; nothing like it in the Mongolian Eocene I should place it among the Tapiroidea, probably in the family Parisectolophidae but not nearly related to any genus that I recall.

Undescribed Ruminant

Figure 40

A lower jaw fragment, Fig. 40, represents a small primitive ruminant about the size of *Archæomeryx* (Eocene, Mongolia) or *Tragulius*.¹ Molars rather brachyodont; 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 p₄. Affinities are with Traguloidea or Tylopoda, exact position indeterminate.

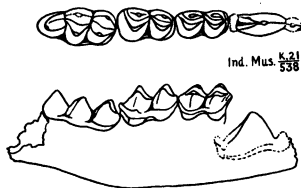


Fig. 40. Undescribed ruminant jaw from the Pondaung Eocene of Burma, Ind. Mus. No. $\frac{K21}{538}$. Natural size, crown and external views.

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 p²-m³ l., p⁴-m³ r. The front of skull with p²-m¹ and c₁ and p₂? is a referred specimen,¹ and so is a figured lower jaw with p₄-m₃ and alveoli of p₂₋₃.

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 1859² based it

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

²Beitr., 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 Beiträage 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 *Plihippus* 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 Schizotheriinae 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 deutocone (= *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.

CIRCOOTHERIUM

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 generic³ 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

¹Compare 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.

²This 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.

³Among them that m^3 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 observations¹ 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 Chalicotheriidae appear to be represented in the following table:

CLASSIFICATION OF THE CHALICOTHERIIDÆ

I. EOMOROPINÆ. Primitive genera with only a suggestion of chalicother 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 Titanotheriidae.

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

2. *Eomoropus* Peterson. Upper Eocene, Utah.

II. CHALICOTHERIINÆ. Fully developed chalicother 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 Mesonychidae), 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.

¹Inter 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.

²There 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. HYPSONDONT 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.

(5a). *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.

¹Information 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 chalicotheres 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 Chalicotheriidae 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, Lophiodontidae, as was done by Cope, Lydekker and others, on the basis of the well prov-

able 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 Chalicotheriidae, 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 1920² 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

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.

²Abel, 1920, *Acta Zoologica*, 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. Any one 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 chalicotherine 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, p²-m³, r. (Reversed in type figure.) Faun. Ant. Sival., Pl. LXXXII, Figs. 13, 13a.

Type of *H. perimense*, incomplete skull from Perim Island, with p²-m³ 1., 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

¹Sefve 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 1888¹ 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-

¹Cope, 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, p³-m³ r.

DIST. CHARACTERS, auct. Lydekker.—Protocone of premolars small, never larger than in m². This distinguishes from *E. caballus*; resembles *E. hemionus*, but larger size and p¹ 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.

¹Lydekker calls this tooth the first milk molar.

Equus palæonius 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. palæonius* 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.

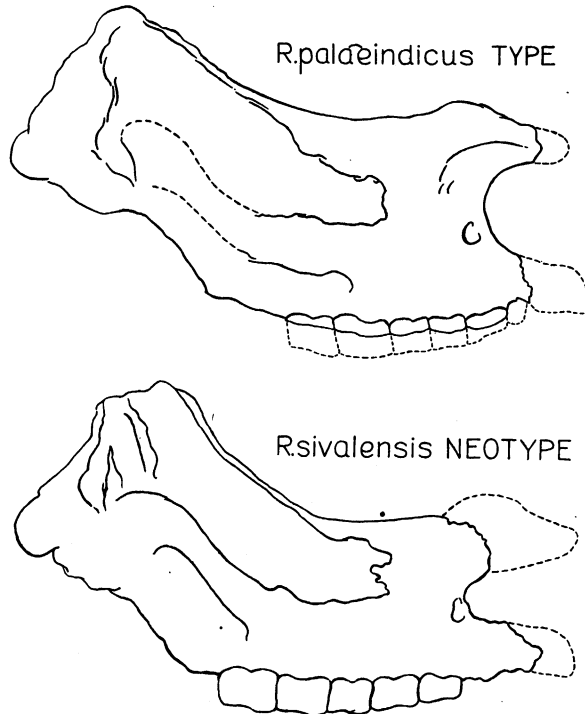


Fig. 41. Skulls of *Rhinoceros palæindicus* and *R. sivalensis* in the British Museum, one-eighth natural size. Upper Siwalik beds. Figured in Fauna Antiqua Sivalensis.

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 Florenceskull 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*) *hemitæchus* 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 identical 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 m^2 ; nasal bones free; premaxillæ short and peculiar in shape.

SYNONYM.—*R. megarhinus* Christol, type from Pliocene of Montpellier. Christol, 1835, Ann. Sci. Nat. (2^e 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 Ossements 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 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*, *hemitæchus*, *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

¹This 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 states¹ 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, Fig. 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, $1\frac{1}{2}$ –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 $1\text{--}1\frac{1}{2}$ mm. at inner side. Figured in Pl. II, Fig. 8 of Pilgrim's memoir cited above. I select it as lectotype.

¹Pal. 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 *Pro-palaeomeryx 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 - p_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. $\frac{K16}{518}$, 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
<i>G. sp. indesc.</i>							
$\frac{K16}{398}$ (unworn premolars, } lightly worn molars) }		17.0	21.5	21.4	25.6	25.8	
		×	×	×	×	×	
		9.2	11.3	12.4	16.6	17.9	16.8
	25.7			23.2	23.9	27.5	
B494 (lightly worn teeth) }	×			×	×	×	
	12.0			11.0	16.0	17.5	
B493 (moderately worn } molars) }						24.5	35.3
						×	×
						16.6	16.9
$\frac{K16}{143}$ (moderately worn } teeth) }			21.3	23.0	26.2	27.9	
			×	×	×	×	
			13.0	13.9	16.9	19.3	
B540 (moderately worn } teeth) }		17.7	21.1	24.4	26.0	26.9	37.0
		×	×	×	×	×	×
		9.8	13.6	15.0	17.9	18.7	18.2
<i>G. punjabiensis</i>							
B497 (half-worn molars, } moderately worn pre- } molars) }			22.4	23.5	26.5	26.9	
			×		×	×	
			15.2		19.2	21.1	
B495 (moderately worn } premolars) }				24.2	26.4		
				×	×		
				15.1	19.5		
					28.2	28.3	41.0
$\frac{K16}{453}$ (lightly worn molars) }					×	×	×
					18.5	19.7	19.4

Giraffokeryx sp. indesc.

Provisionally I have refrained from giving a specific name to this smaller form. No. $\frac{K16}{398}$ 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.

$\frac{K14}{571}$, m²⁻³ in jaw fragment, agrees pretty well except for the more quadrate teeth, less reduction of posterior inner crescent of m³, imperfect pocket on same crescent, etc. M³ is also rather larger relatively.

The difference from *G. punjabiensis* is about comparable to the difference between *Palaeotragus microdon* and *caelophrys* 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. M³ l. Field number was $\frac{K13}{454}$.

REFERRED.—No. $\frac{K13}{28}$, m³ r., m² l.; $\frac{K13}{458}$ = B492, "*Progiraffa sivalensis*" of Pilgrim, figured (*loc. cit.*, Pl. I, Fig. 3), jaw fragment, m₃ 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 Giraffidæ¹, refers *Giraffokeryx* to *Palæotragus*, on account of the agreement in teeth as observed in Pil-

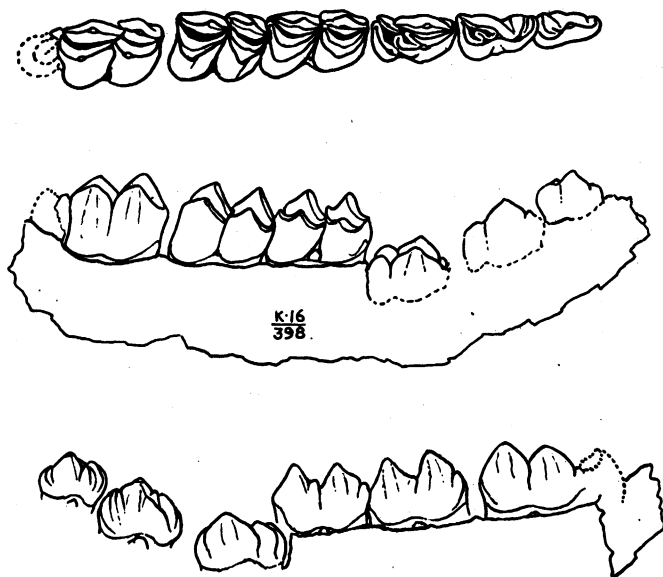


Fig. 42. *Giraffokeryx* sp. indesc. Lower jaw fragment. Indian Museum No. $\frac{K16}{398}$, external view, with crown and inner views of the teeth, half natural size. Lower Siwalik beds. The animal was somewhat immature, the premolars preformed but not yet wholly emerged, and the molars very little worn.

grim'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.

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

¹Bohlin, 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.

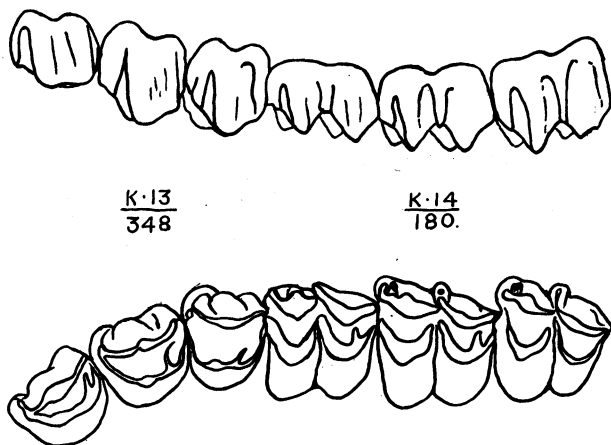


Fig. 43. '*Giraffa*' *punjabiensis* var. Upper teeth, crown and external views, half natural size, from a specimen in the Indian Museum, Middle Siwaliks of Hasnot. The premolars and molars bear different numbers, but they are parts of the same individual. The teeth differ considerably from those of the 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. $\frac{K.13}{348} + \frac{K.14}{180} + B182 + \frac{K.14}{180}$ (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.

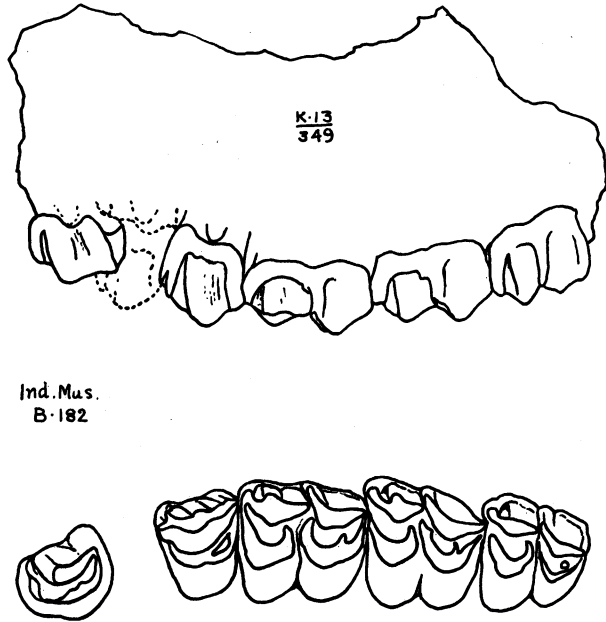
Nos. $\frac{K.14}{180}$ and $\frac{K.13}{348}$ may be same individual, and if so give p^2 - m^3 l., practically unworn premolars and little-worn molars.

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. $\frac{K13}{859}$, m³, and $\frac{K15}{812}$, m¹, 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 *Camelo-*



Ind. Mus.
B-182

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.

pardalis 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.

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

¹Bohlin, 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.

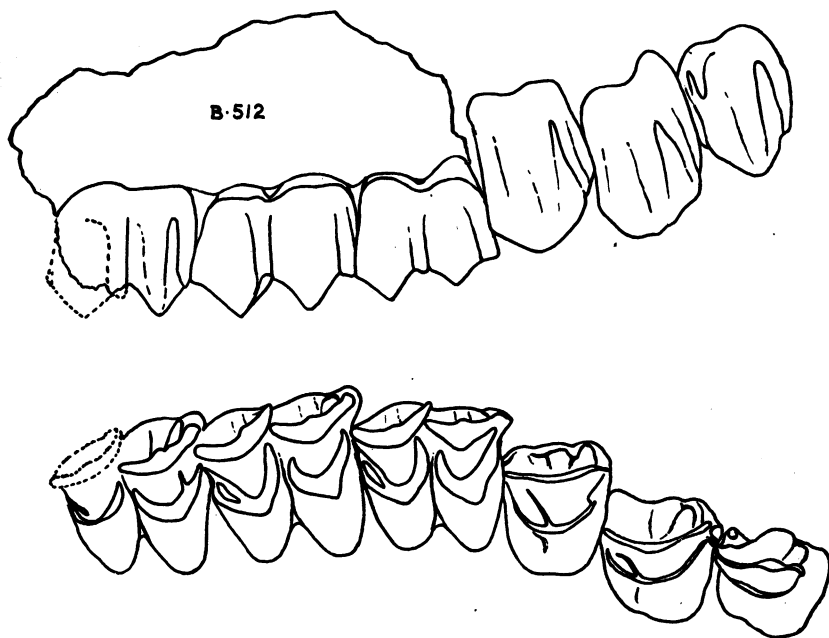


Fig. 45. *Hydaspthierium megacephalum* Lydekker. Upper teeth, external and crown views, half natural size. Indian Museum No. B512, from the Middle Siwalik beds, Dhok Pathan. This is the immature (and incomplete) skull figured by Pilgrim as *Helladotherium grande* (Pilgrim, 1911, Pal. Ind., IV, Pl. III)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

***Hydaspthierium 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 *Hydaspthierium* 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. $\frac{K13}{552}$ 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.

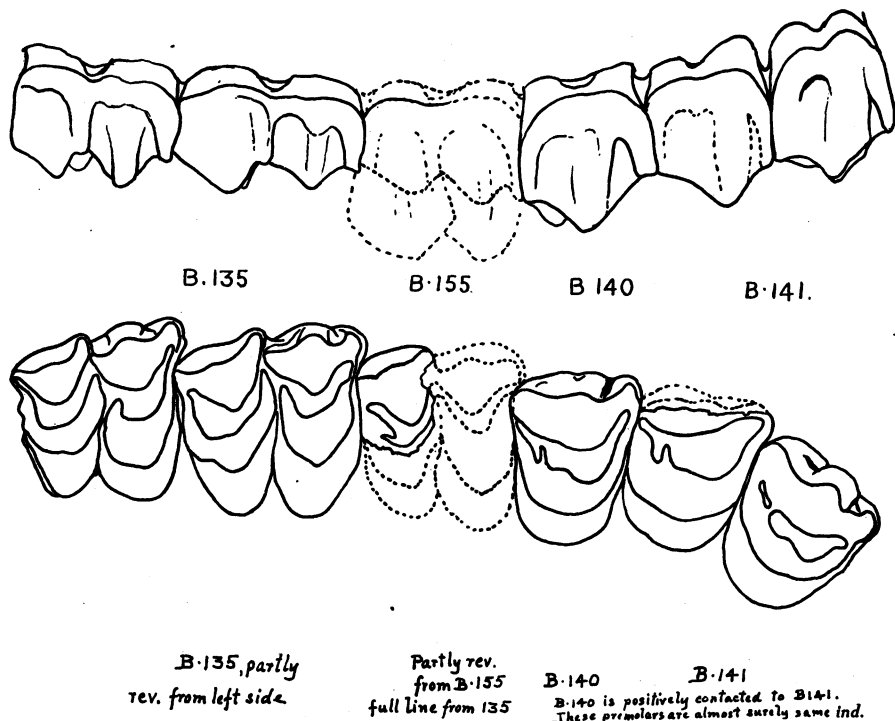


Fig. 46. *Hyaspitherium grande* Lydekker. Upper teeth, external and crown views, half natural size. Middle Siwaliks, Punjab (presumably Hasnot). The dotted outlines are those of the little-worn type molar, Ind. Mus. B155, modified to show the change in form resulting from wear to a corresponding degree 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.

Hyaspitherium 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

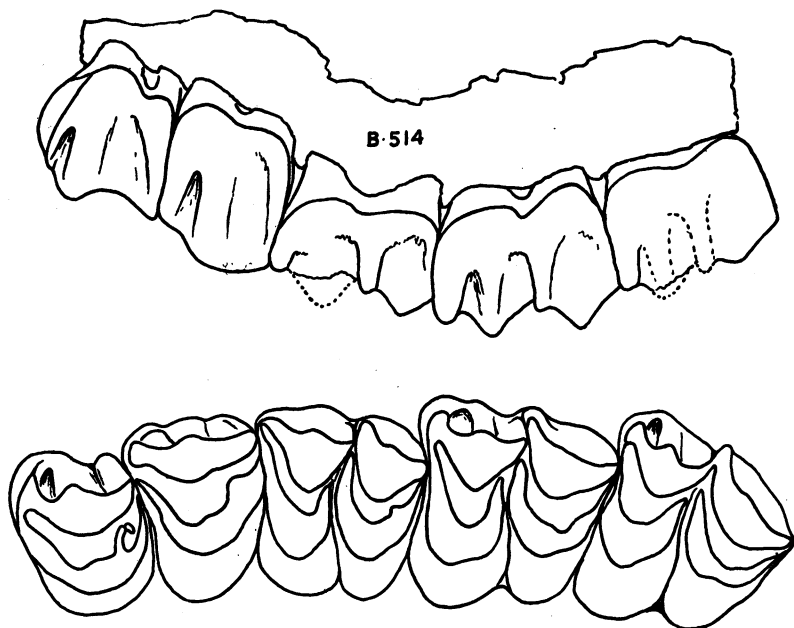


Fig. 47. *Hydaspiatherium magnum* Pilgrim. Upper teeth, external and crown views, half natural size. From the type specimen, No. B514 Indian Museum. Middle Siwaliks of Hasnot. The type specimen also includes a lower jaw with p_3 and m_{1-3} .

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.

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.

Hydaspietherium magnum

TYPE.—Upper and lower jaws, p^3 - m^3 l., No. 514; m^2 - 3 l., No. $\frac{K13}{848}$; 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.

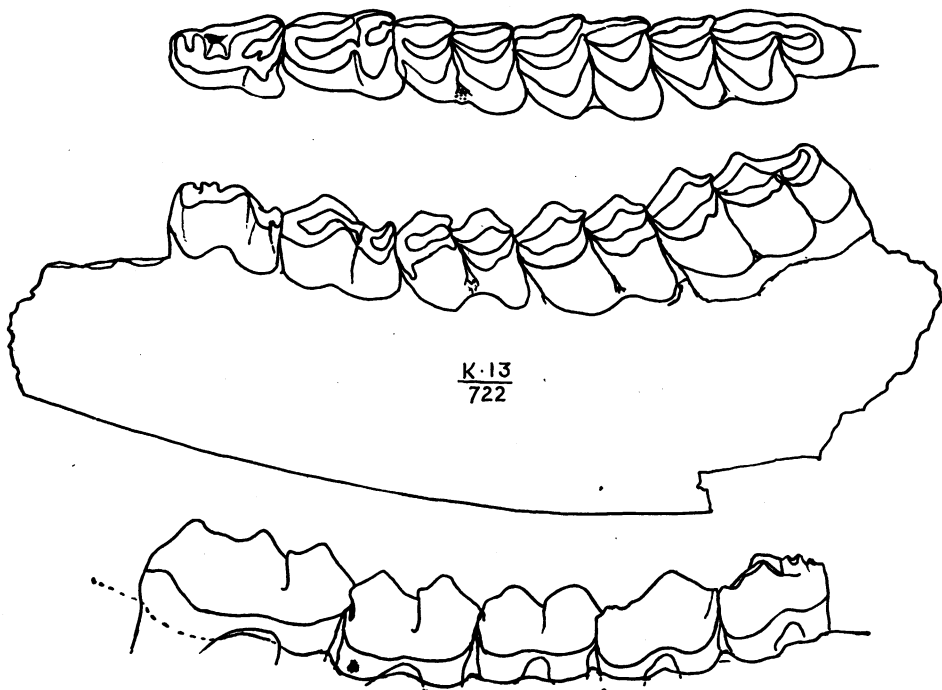


Fig. 48. ?*Vishnutherium* sp. Lower jaw, external view, with crown and inner views of teeth, half natural size. Indian Museum No. $\frac{K13}{722}$.

VISENUTHERIUM Lydekker

The type of the genus is *V. iravaticum* from the Irawaddy series in Burma, and appears very doubtfully separable from *Hydaspietherium 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 *Hydaspietherium 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

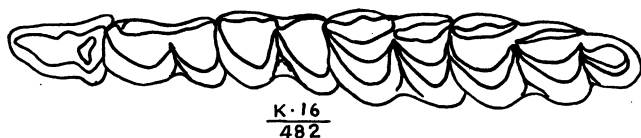


Fig. 49. ?*Vishnutherium* sp. Lower teeth, crown view, half natural size. Ind. Mus. No. $\frac{K.16}{482}$. Middle Siwalik beds, 1500 feet above base. The premolars are reduced in width by crushing.

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.

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).

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:



K. 16
483

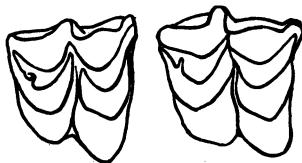


Fig. 50. ?*Vishnutherium* sp. Upper molars and lower premolars, crown views, half natural size. Ind. Mus. No. $\frac{K.16}{483}$, same locality and horizon as lower jaw, Fig. 49.

Palæotraginæ

Palæotragus, Samotherium, Giraffokeryx, Ocapia

Giraffinæ

"Orasius," Giraffa, Honanotherium

Sivatheriinae

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. $\frac{5}{13}$. 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.

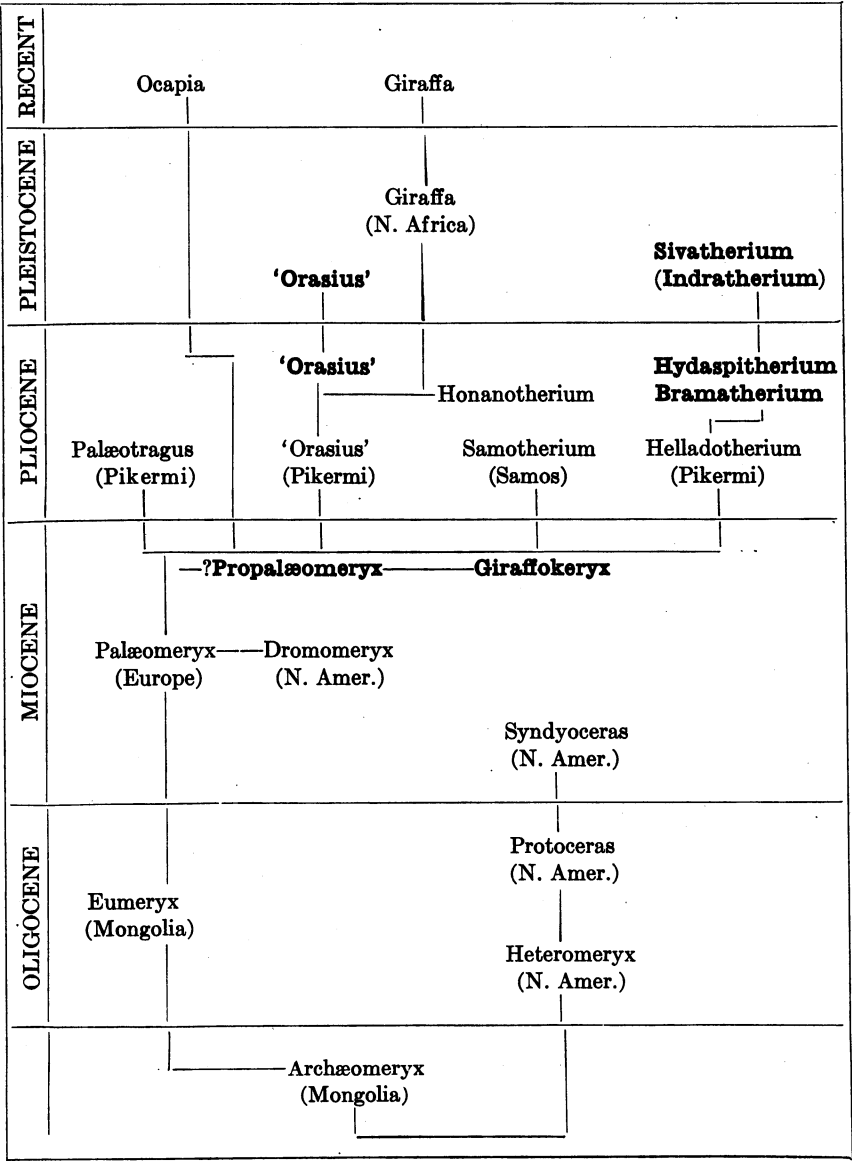
GIRAFFA Brisson, 1756

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-

¹Wagner, 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 brachydonity, flatness of posterior external rib, etc. Of the

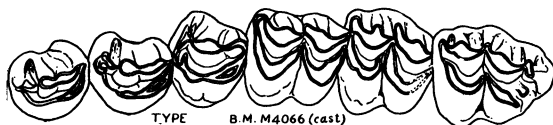


Fig. 52. *Orasius speciosa* Wagner = ?*Giraffa attica* Gaudry. Crown view of upper teeth of type specimen, half natural size. From a cast in the British Museum. Original from Pikermi, in Munich University Museum.

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.

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 Wagner¹ 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.

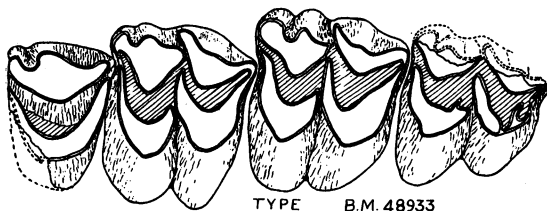


Fig. 53. *Bramatherium perimense*. Upper teeth, crown view, half natural size. From the type specimen, British Museum No. 48933. Middle Siwalik beds, Perim Island.

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, p⁴-m³ 1., from Perim Island, Middle (or Lower) Siwaliks.

¹1860, 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

Hydaspidothierium 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.

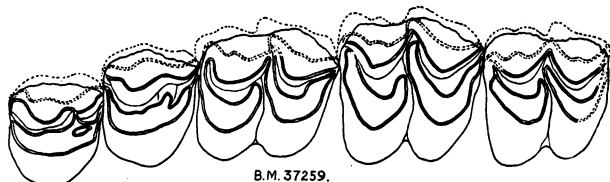


Fig. 54. *Hydaspitherium?* near *megacephalum*. Upper teeth, crown view, half natural size. British Museum No. 37259, from Middle Siwalik beds, Perim Island, referred to *Bramatherium perimense*.

SIVATHERIUM

Sivatherium FALCONER AND CAUTLEY, 1836.

SYNONYM.—*Indrathierium* Pilgrim, 1910, Rec. Geol. Sur. Ind., XL, p. 69; = *Sivatherium* ♀, auct. Falconer, 1868, Murie 1871, Bohlin 1926. Referred to *Helladotherium* by Gaudry 1862, Rüttimeyer 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 *Indrathierium*, *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 *Hydaspiatherium* 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,

to my mind, not due so much to the lack of change in the teeth as to the rapidity of change in the skull, and the whole family derives from late Miocene palæomerycines, an antiquity decidedly less than most mammalian families.

According to Pilgrim¹ the Giraffidæ afford "one of our most complete proofs for the Pontian age of the Dhok Pathan." But his argument will not stand analysis.

"There we find side by side with *Giraffa punjabiensis*, paralleled by *Giraffa attica* at Pikermi, the large genus *Helladotherium* allied to the Pikermi species *H. duvernoyi* and the almost equally large *Vishnutherium*.

"The palæotragine group, including the genera *Palæotragus*, *Samotherium* and *Alcicephalus*, has not so far been recognized in India.

"On the other hand, allied forms possessing a complex horn development occur in the genus *Hydaspiatherium* in the Dhok Pathan zone, and as *Bramatherium* in the slightly older Perim Island beds.

"As we should expect if the strata below the Dhok Pathan zone were older than Pikermi age, we find ancestral giraffine types even in the lower beds of the Middle Siwaliks in the shape of a small helladotheriine perhaps referable to the genus *Giraffokeryx* in the Nagri beds, and a small species of *Giraffa* in beds of similar age at Hari Talyangar. . . . In the Chinji zone, the primitive character of the giraffine type is evident in the genus *Giraffokeryx*, which is on the line of *Helladotherium*, and in *Propalæomeryx*. . . ."

All in all, I cannot see anything more primitive in the Chinji Giraffidæ than Pikermi can show, and I see no reason for hunting a separate

G. attica is in fact distinctly smaller and more brachydont than *punjabiensis*. What Pilgrim called '*Helladotherium grande*' is in fact Lydekker's *Hydaspiatherium megacephalum*. *Helladotherium duvernoyi* is much more primitive; compares with "*Vishnutherium*," but then "*Vishnutherium*" occurs in both the middle and lower Siwalik.

Giraffokeryx is a member of it, and is considered by Bohlin to be a species of *Palæotragus*. One species of *Giraffokeryx*, however, if not both, carries four horns, and is generically distinct from *Palæotragus*, although clearly related.

As we should expect if the Dhok Pathan and Perim Island beds are later than Pikermi, Samos or Northern China.

But all this ignores the comparison between *Giraffokeryx* and the Pikermi *Palæotragus*, the presence of larger giraffid remains associated with *Giraffokeryx*, and comparable to *Vishnutherium* and *Helladotherium*. The small species of *Giraffa* at Hari Talyangar may compare with "*Orasius*" *eximia* of Pikermi. *Giraffokeryx* is not on the line of *Helladotherium*, as it is a four-horned type. As for the "*Propalæomeryx*," it is based upon an upper molar wrongly identified by Pilgrim as m¹ and two isolated lower molars wrongly referred to it.

¹1913, Correl. Siwal., Rec. Geol. Sur. Ind., XLIII.

evolution center for the giraffes in Africa when the Holarctic Miocene palæomerycines afford a perfectly good ancestral group.

X. BRITISH MUSEUM NOTES ON SIWALIK CAMELIDÆ

The only representation of Camelidæ in the Siwaliks is the genus *Camelus*, with two species nearly allied to each other and to the modern camel, but with one point in their dentition that suggests American affinity, namely retention of a slight antero-external fold at the anterior end of the lower molars.

Camelus sivalensis Falconer and Cautley, 1836

Camelus sivalensis FALCONER AND CAUTLEY, 1836, *Asiat. Res.*, XIX, p. 115; reprinted in FALCONER, 1868, *Pal. Mem.*, I, p. 227; LYDEKKER, 1885, *Rec. Geol. Sur. Ind.*, XVIII, p. 78; 1886, *B. M. Cat. Foss. Mam.*, II, p. 141 (type designated).

TYPE.—B. M. No. 39597, hinder part of cranium, m²⁻³ r. and l., figured in *Faun. Ant. Sival.*, Pl. LXXXVI, Fig. 1. Upper Siwalik beds, Moginund.

Distinguished from modern camels by larger size, and somewhat different proportions of jaw. Lydekker also notes rugosity of enamel, slight antero-external fold at anterior extremity of lower molars, inner face of molars flat, without any fold between the lobes, and long shallow jaw.

None of these characters run very constant or make a very clean-cut distinction in *C. sivalensis* from modern *C. bactrianus*. All the material is in the light-colored, moderately soft matrix in which many of the best preserved and most modernized species of the Siwaliks are fossilized—most of the *Equus* material, *Canis curvipalatus*, *Meganttheron falconeri*, nearly all the bovid skulls, etc.

Camelus antiquus

Camelus antiquus FALCONER AND CAUTLEY, 1836, *Asiat. Res.*, XIX; reprinted in FALCONER, 1868, *Palæont. Memoirs*, I, p. 231 (no adequate description); LYDEKKER, 1885, *Rec. Geol. Sur. Ind.*, XVIII, p. 78.

TYPE.—A lower jaw,¹ B. M. No. 16165, from uppermost Siwalik beds, Moginund.

Lydekker notes as the characters of the species, in addition to smaller size mentioned by Falconer, the shorter and deeper jaw, smooth enamel, presence of a small antero-external fold on lower molars, and a ridge or displacement on inner wall of molars between the two lobes.

¹The specified characters given by Lydekker in the type description are taken from the lower jaw. I therefore designate this specimen as type, although in listing the specimens of the species in the type description he places an upper jaw, No. 15347, first, as he does in the B. M. Catalogue of Fossil Mammals, II, p. 146. Reference to the listing of other species catalogued by Lydekker in this volume and elsewhere will show that it was not his custom to place the type specimen at the head of the list. Osborn adopts the plan of selecting always as type the first mentioned specimen in a series of co-types. But there is no such ruling or recommendation by any authoritative body that I know of, and it seems better to follow the recommendation of the International Zoological Congress and select the type from among the original specimens "following the intent of the author" as shown in the wording of the type description.

These are not very constant characters in *Camelus*, and it is doubtful whether the two species are wholly distinct either from each other or from the modern species.

The genus *Camelus* is recorded from Pleistocene of Alaska? (probably late, but quite indeterminable), from beds of uncertain age in Russia, *C. knoblochi*, which may be the modern species and certainly is of quite modern type, from the Pleistocene of the Volga-Ufers, Russia.

C. alutensis, ?Pleistocene, Rumania, is not *Camelus*, but one of the sub-genera of "*Pliauchenia*."

C. americanus Wortman, Pleistocene, Nebraska, is not *Camelus* but belongs to an unnamed genus, congeneric with "*Lama*" *stevensi*. There is no proven record of the occurrence of *Camelus* in America, although it is quite likely that the toe-bones referred by Gidley and Hay to the genus may really represent it or a closely related type.

C. thomasi Pomel, from Algeria, prehistoric, but probably not old.

The genus is limited to the Boulder Conglomerate zone in the Siwaliks, and largely, if not wholly, to the upper beds. Its occurrence has no great weight for modernity of this formation as a whole. I have seen no specimens with the hard, black, rolled preservation of a large part of the Boulder Conglomerate fauna.

XI. BRITISH MUSEUM NOTES ON SIWALIK HIPPOPOTAMIDÆ

Hippopotamidæ make their first appearance (auct. Pilgrim) in the Dhok Pathan. In the Tatrot beds they come in more abundantly; but the chief part of the material comes from the Boulder Conglomerate zone, at top of Upper Siwaliks.

Their derivation has been supposed to be from the anthracotheres, through *Merycopotamus*. This is quite certainly wrong. They are derived from the Suidæ. The older Indian species are not much different from the modern hippopotamus except in retaining three sub-equal incisors. The smaller Pleistocene species, however, are very suggestively like mid-Tertiary Suidæ in construction of molars and premolars. This is especially true of *Hyopotamus minutus* from Cyprus and Crete collected by Miss Bate, which strongly reminds one of such primitive Suidæ as *Desmathyus*, etc., out of the Upper Rosebud and Lower Sheep Creek of the western United States.

So far as I know the Dhok Pathan hippopotamus is in no degree primitive, but compares closely with the Plio-Pleistocene species from elsewhere—Val d'Arno, Great Barrington, etc. I have not seen any specimens from Dhok Pathan, nor any of the "abundant" remains reported by Pilgrim from the Tatrot beds. Presumably they are in the Indian Museum.

I cannot see any very strong reason for according full generic rank to *Hexaprotodon*. Except for the incisors, it is in no way different from the

modern species. On the other hand, *Hyopotamus minutus*, the pigmy hippopotamus of Crete, Cyprus and Malta, appears to demand generic separation as lacking the accessory cusps (the valley cusps of the trefoil), much less expanded jaw, two small equal incisors, and various skull characters. *Chæropsis*, the pigmy hippopotamus of Liberia, better deserves generic rank than *Hexaprotodon*; but whether it is generically separable from *Hyopotamus* is not so clear. The following key covers the known genera.

- I. Accessory cusps of molars strong, forming a well-developed trefoil pattern in wear. Muzzle much expanded. Size large or gigantic, aquatic-amphibious.
 - A. Three subequal incisors on each side of jaw. (Subgeneric) . . . *Hexaprotodon*.
 - B. Two subequal incisors on each side of jaw. (Invalid) *Tetraprotodon*.
 - C. One large and one small incisor on each side. *Hippopotamus*.
- II. Accessory cusps of molars weak, forming a pattern essentially of transverse crests. Muzzle moderately expanded. Size medium to large, terrestrial-amphibious.
 - A. Two subequal incisors on each side of jaw. *Hyopotamus*; *Chæropsis*.

HIPPOPOTAMUS

TYPE.—*Hippopotamus amphibius*.

To this genus belong the following fossil species:

H. major.¹ Cf. fine specimens from Great Barrington.

H. penilandi.² Typical from caverns in Sicily, Grotta di Mascagnone, Cazine.

H. minor.³ Typical from Malta. Not the same as Cuvier's *H. minutus* = *Hyopotamus minutus*, q. v.

H. madagascariensis. Although notably smaller, this species agrees in generic characters with *H. amphibius*. It may be more closely comparable with *H. penilandi* and *H. minor*.

H. palæindicus ("Tetraprotodon") Falconer and Cautley, 1847.

TYPE.—A lower jaw, present locality of preservation unknown, figured by Falconer and Cautley in Pl. LVII, Fig. 5.

HORIZON AND LOCALITY.—Pleistocene, Nardaba (Nerbudda) River.

HEXAPROTODON Falconer.

The only character that I can find to separate this genus is the one specified by the describer, the presence of six subequal incisors in a transverse row, three on each side of the jaw. The molars appear entirely of the modern type. Lydekker notes "the long mandibular symphysis, the three pairs of incisors in each jaw, the small prominence of the orbits, and the elongated astragalus" as species characters indicating a more primitive stage. I cannot verify any except the incisors; the other features appear to vary individually too much to be reliable.

¹Owen, 1843, Rep. Brit. Ass., p. 223. Cf. Cuvier, 1824, Oss. Foss., V, p. 527.

²H. v. Meyer, 1832, Palæologica. But ? = Cuvier's *H. medius*, 1824, Oss. Foss., V, p. 527.

³Falconer, 1849, Jour. Acad. Nat. Sci. Phila., (II) I, p. 237.

Hexaprotodon sivalense Falconer and Cautley, 1839

Hippopotamus (Hexaprotodon) sivalensis FALCONER AND CAUTLEY, 1839, *Asiat. Res.*, XIX, p. 38; 1868, *Pal. Mem.*, I, p. 130; LYDEKKER, 1884, *Pal. Ind.*, (X) III, p. 37; PILGRIM, 1913, *Rec. Geol. Sur. Ind.*, XLIII, p. 324.

Hexaprotodon sivalense FALCONER AND CAUTLEY, in Owen, *Odontography*, p. 566, Pl. CXLIII.

TYPE.—No. M2269, British Museum, a complete skull with well-worn teeth.

Hexaprotodon namadicus Falconer and Cautley

Hippopotamus (Hexaprotodon) namadicus FALCONER AND CAUTLEY, *Faun. Ant. Sival.*, Pls. LVII, LVIII (name and figure); LYDEKKER, 1884, *Pal. Ind.*, (X) III, p. 43.

TYPE.—Not specified. Nos. 36838, 36839 and 36840 are co-types.

HORIZON.—Narbada (Nerbudda) River beds.

Hexaprotodon iravaticus Falconer and Cautley

Hippopotamus (Hexaprotodon) iravaticus FALCONER AND CAUTLEY, 1847, *Fauna Antiqua Sivalensis*, Pl. LVII (name and figure); LYDEKKER, 1884, *Pal. Ind.*, (X) III, p. 42; (*Hexaprotodon*) FALCONER, 1849, *Jour. Acad. Nat. Sci. Phila.*, (II) I, p. 237; 1868, *Palæont. Mem.*, I, p. 142.

TYPE.—B. M. No. 14771, symphysis of mandible from Irawaddian of Burma.

This species is decidedly smaller than *H. sivalensis*, probably comparable with the material reported by Pilgrim from the Middle Siwaliks or the Tatrot zone.

HYOPOTAMUS Kaup, 1844

Hyopotamus KAUP, 1844. Not *Hyopotamus* Owen, 1848, which is a genus of anthracotheres.

TYPE.—*Hippopotamus minutus* Cuvier, 1824.

Hyopotamus minutus Cuvier, 1824

CUVIER, 1824, *Ossements Fossiles*, Éd. Nouv., I, pp. 322–331 (figures); II, p. 382 (locality stated); V, p. 527 (scientific name); FORSYTH MAJOR, 1902, *Proc. Zool. Soc. London*, p. 107.

Major gives a note regarding the locality of Cuvier's *H. minutus*, suggesting that it came from Cyprus. Cuvier's statement of the record and history of the blocks of breccia from which his type specimens were extracted is very specific and definite, and I do not see how it can be set aside.

TYPE LOCALITY.—Between Dax and Tartas, Dept. Landes, France.

The admirable material collected and described by Miss Bate, now in the British Museum, gives a very good idea of the skull and skeleton characters of this interesting animal. If, as seems probable, it is closely related to the Liberian pigmy hippopotamus, and generically the same,

the distribution will stand as from the Pleistocene of the Mediterranean region and surviving today in West Africa; a distribution that finds many analogies among mammals and lower animals.

XII. BRITISH MUSEUM NOTES ON SIWALIK RODENTS

Mus

Mus, sp. indesc., innom.

(?FALCONER), 1835, Jour. Asiat. Soc., IV, p. 706; 1836, V, p. 296; FALCONER, 1868, Pal. Mem., I, p. 23.

'Murine rodent,' LYDEKKER, 1884, Pal. Ind., (X) III, p. 105.

No descriptions or figures of the above are known to me, nor any specimens except the one mentioned by Lydekker, which is from the Narbada beds.

RHIZOMYS

?SYNONYM.—*Typhlodon* FALCONER, 1868, Pal. Mem., I, p. 23 (nomen nudum); LYDEKKER, 1878, Rec. Geol. Sur. Ind., XI, p. 101.

Rhizomys sivalensis Lydekker

Rhizomys sivalensis LYDEKKER, 1878, Rec. Geol. Sur. Ind., XII, p. 41, and Fig. 3 of Pl. opp. p. 50; 1884, Pal. Ind., (X) III, p. 106, Figs. 1-3.

TYPE.—(Co-types) Ind. Mus. No. D97, 97A, two detached rami (of jaw; different individuals). Lectotype is D97 figured by Lydekker in 1879.

HORIZON AND LOCALITY.—Middle Siwaliks, Jabi, Punjab.

Lydekker in 1884 refers to this species and figures a third jaw from the Middle Siwaliks of the Punjab, and provisionally refers to the species two jaws "of slightly larger size than the largest Punjab specimen" from the "typical Siwaliks" (Upper Siwalik).

DISTINCTIVE CHARACTERS.—"In all the recent species the molars are relatively wider than in the fossil." Smaller jaw than *sumatrensis*, teeth of same length but less width. Smaller incisors and slenderer jaw and more elongate molars than *pruinus*. Larger than the Chinese and Indian species (*badius*, *sinensis*, *erythrogenys*).

All this would seem to agree rather well with our Yen-ching-kao *Rhizomys*, save for smaller size. The referred specimens from the Upper Siwalik are distinguished by larger size, and may agree more nearly.

Nesokia sp.

B. M. No. 16529A. Upper Siwaliks, locality unrecorded.

A fragment of the lower jaw with m_1 r. and roots or alveoli of m_{2-3} is the only representative of this genus. It does not appear to be described. About size of *N. kok* from Karnul cavern, Madras.

HYSTRICIDÆ

Hystrix sivalensis Lydekker

Hystrix sivalensis LYDEKKER, 1878, Rec. Geol. Sur. Ind., XI, p. 98; 1884, Pal. Ind., (X) III, p. 109, Fig. 4.

TYPE.—Ind. Mus. No. D96, from Middle Siwaliks of Hasnot, Punjab, a lower jaw with M_{1-2} r., root of p_4 and alveolus of m_3 .

Distinguished as with separate roots on p_4 . This is suggestively like dp_4 , but Lydekker remarks "the large size of the alveolus of this tooth and the well-worn condition of the true molars show that the former could not have been a milk molar."

Without seeing the type it is difficult to be certain, but the referred skull and jaws (from Upper Siwaliks) shows a milk molar in place and little worn, m_1 present, almost unworn, and the posterior teeth not yet up. If this dentition were worn down so as to bring it to stage of the type, dp_4 would show roots if broken off, m_1 would have enamel inflection about as in type, and m_2 would presumably be up and well worn, m_3 perhaps emerged, perhaps not. The dp_4 ? is considerably smaller, but so is m_1 ; the species is really a much smaller one than Lydekker's type. I cannot understand his saying that in the lower part the dimensions of m_1 are the same as in the type. If his figure of the type is correct, they most certainly are not ($7.3 \times$

7.3 , as against 9.3×9.3 of his figure). He states that the roots are distinctly visible in m_1 of the type at a distance of a quarter of an inch below the external enamel fold, and that in the young specimen the external enamel fold extends as near down to the root as in the latter specimen (the type jaw). But in the young animal m_1 is not calcified down to the root; it is impossible to say how far it would be below the external enamel fold, but certainly *more* than a quarter of an inch. All in all, one would be inclined to refer the Upper Siwalik young skull and jaw to *H. hirsutirostris* (*leucurus*) or some other hypsodont species of that size. The skull has attained practically full growth in this stage. On the other hand, *H. sivalensis* proper is nearly comparable with *H. primigenia* of Pikermi, although not so brachyodont.

It is a little more worn than *H. primigenia* jaw M9037 from Pikermi, and *H. karnulensis* (M3448) jaw from Karnul caves near Madras; both

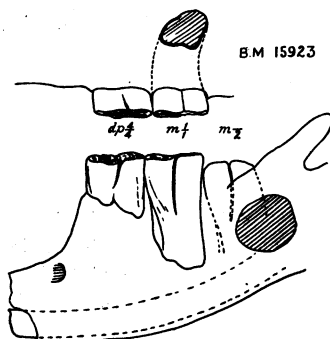


Fig. 55.—*Hystrix* cf. *leucurus*. Upper and lower dentition from an immature skull, No. 15923 British Museum. Upper Siwalik beds. Referred by Lydekker to *H. sivalensis*.

of which have dp_4 only moderately worn. The spreading roots of dp_4 are well shown in left ramus of M3448; in M9037 the point of the permanent p_4 has been exposed beneath in the jaw. Size of molars about the same as in *H. sivalensis* type, but width less because they are at an earlier stage of wear. The Pikermi species is *much* more brachydont than the modern or the Pleistocene *karnulensis*, and judging from Lydekker's figure and description his species is intermediate, perhaps somewhat, but not much, nearer to *primigenia*.

The figured skull and jaw (Fig. 55) belong to a distinct species which may be *H. leucurus* or an ancestral species. Certainly much smaller than *H. crassidens* of Karnul caves or *H. refossa* of Perrier or the *Hystrix* of Val d'Arno (probably *H. refossa*).

LAGOMORPHA

Caprolagus sivalensis Major

Caprolagus sivalensis MAJOR, 1899, Trans. Linn. Soc., VII, Pl. xxxvii, Fig. 18.

The only lagomorph remains consist of a fragment of jaw, probably from Upper Siwalik beds, attributed by Major to *Caprolagus*.

TYPE.—B. M. No. 16529 from Upper Siwaliks.

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