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FAUNA AND CORRELATION OF THE GASHATO FORMATION OF MONGOLIA¹

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In the Gurbun Saikhan piedmont basin, just north of the eastern end of the Altai Mountains, there are two distinct formations. The lower of these is the Djadochta formation of Cretaceous age and contains abundant remains of the primitive horned dinosaur *Protoceratops* and its eggs. Resting unconformably upon these Cretaceous beds is a series of not less than two hundred feet of reddish and drab sediments to which the name Gashato has been assigned and which yielded the interesting primitive mammalian fauna herein described.

The exposures of the Gashato beds are of rather limited extent in the type locality, which is near Shabarakh Usu on the Kweihwating—Uliassutai trail, and are only very sparingly fossiliferous. Mr. F. K. Morris, while studying the stratigraphy of the beds, discovered the first mammalian remains, and later Mr. George Olsen, with an assistant, spent several days there. The fragmentary and weathered remains of the largest form, *Phenacolophus*, were all found within a small area, and the rest of the collection, all diminutive forms, came from two small knolls not far distant. A most careful examination of the entire exposure resulted in no further discoveries.

The fauna is later than Lower Cretaceous, and there can be scarcely any question that it is older than the Irдин Manha, Upper Eocene. The faunal list follows.

<i>Palæostylops iturus</i>	Order Notoungulata
<i>Prionessus lucifer</i>	“ Multituberculata
<i>Bænomys ambiguus</i>	“ Glires
<i>Eurymylus laticeps</i>	“ ? Menotyphla
<i>Phenacolophus fallax</i>	“ ? Condylarthra
<i>Hyracolestes ermineus</i>	“ Creodonta
<i>Sarcodon pygmxæus</i>	“ uncertain (?creodont or carnivorous marsupial)

The presence of a multituberculate suggests Paleocene or late Cretaceous age; the ancestral relationship of *Palæostylops* to the Wasatch

¹Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 56.

genus *Arctostylops* is indicative of Paleocene, Torrejon or possibly older age. The remaining genera throw no light upon the correlation, as they are but distantly related to any known types and three are of very doubtful ordinal position; but they are not incongruous with a Paleocene fauna, although not representing the ancestral relations to the Eocene faunæ of Europe and America that had been anticipated. A more extended faunal list might modify this conclusion, but the absence of primitive perissodactyls, artiodactyls, etc., and the rather aberrantly specialized character of the several genera are unexpected, and fail thus far to confirm the hypothesis that the Eocene invaders of Europe and North America came from Central Asia.

On the other hand, the minute and primitive notoungulate *Palæostylops* confirms the view that the South American Tertiary hoofed mammals were originally derived from the north, although undergoing a great secondary evolution in the Neotropical region.

NOTOUNGULATA

Arctostylopidae Schlosser¹

*Palæostylops*² *iturus*, new genus and species

TYPE.—No. 20414, a lower jaw.

PARATYPE.—No. 20415, an upper jaw. Both from the Gashato formation. A considerable series of more or less fragmentary upper and lower jaws is also referred.

CHARACTERS.—Dentition $\begin{smallmatrix} 7.1.4.3 \\ 3.1.4.3 \end{smallmatrix}$. Canines not differentiated, all anterior teeth of lower jaw short-pointed, sharp-crested, much compressed, and of nearly uniform size and character, changing gradually into the simple compressed premolars of somewhat larger size, with prominent anterior and posterior accessory cusps. P₂₋₄ two-rooted. No diastemata. No molariform premolars. Molar construction as in *Arctostylops*, the pattern much like those of the *Entelonychia* and *toxodonts*, but the trigonid relatively shorter than in any of the South American genera. The crest, extending from middle of outer wall of talonid inward into center of basin, is well displayed, as in *Arctostylops*. Premolars all simple and trenchant, none molariform, but p₄ shows an incipient molariform structure.

Upper molars with a high, straight, ectoloph crest, and prominent anteroexternal pillar, much as in *rhinoceroses*, *toxodonts*, etc.; protoloph extending obliquely back from anteroexternal angle, and metaloph extending transversely inward from near middle of ectoloph; both protoloph and metaloph are short, and apparently tend to send out a wing from the inner end posteroexternad; but the heavy wear of the surface between ectoloph and inner end of protoloph and metaloph precludes an exact

¹In Zittel's *Gründzuge der Paläontologie*, 4e Aufl., 1923, p. 614.

²The name is intended to be suggestive of the relationship of the genus to the Wasatch *Arctostylops* and to the numerous South American genera (*Notostylops*, *Pleurostylops*, *Trigonostylops*, etc.) of primitive notoungulates. The species name alludes to the subsequent migration to North and thence to South America, of the Notoungulata.

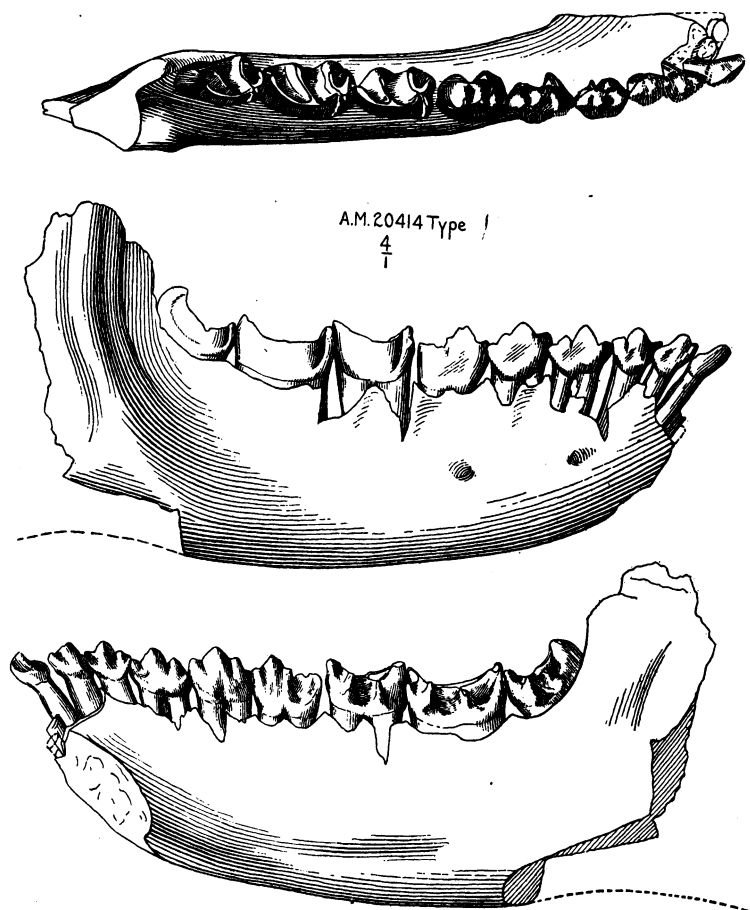


Fig. 1. *Palæostylops iturus*, new genus and species. Lower jaw with complete dentition, except crowns of first two incisors; superior, external and internal views.

Type specimen, No. 20414. Four times natural size.

description from any of our specimens. On the inner side of the tooth is a sharp internal cingulum, extending around the bases of the two inner lochs. Metaloph absent on m^3 , which is of trigonal outline and smaller than m^2 ; m^1 smaller than m^2 , of similar pattern but less extended anteroposteriorly. The upper premolars are much smaller than the molars, of simple construction, sharp, high external crest on all and a basal internal pillar on p^{2-4} , none on p^1 . The canine is larger than p^1 but only its alveolus is preserved. The infraorbital foramen is above the anterior end of m^1 ; the zygomatic process is stout and springs from a point between m^2 and m^3 .

The affinities of this genus to the notoungulates can hardly be questioned; but it is more primitive than any described form in the

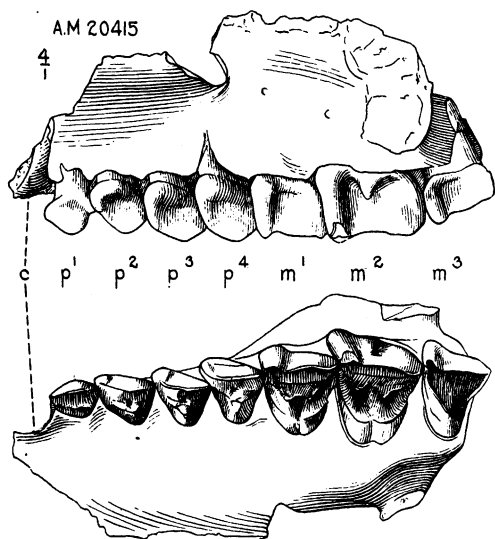


Fig. 2

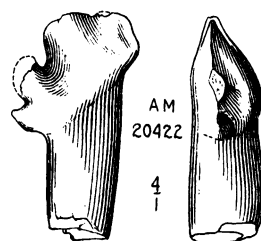
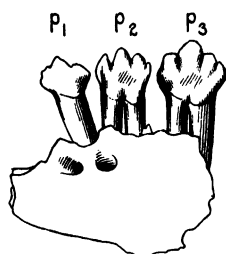


Fig. 4



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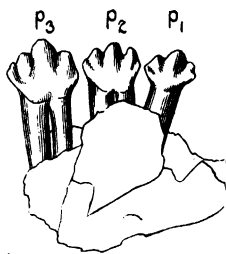


Fig. 3

Fig. 2. *Palaeostylops iturus*, new genus and species. Upper jaw with premolar series, external and palatal views.

No. 20415, topotype. Four times natural size.

Fig. 3. *Palaeostylops iturus*, new genus and species. Fragment of lower jaw with three premolar teeth, unworn. External view (left) and internal view (right).

No. 20428, topotype. Four times natural size.

Fig. 4. *Palaeostylops* sp. Anterior tooth, perhaps from upper dentition; or p_1 of a larger species.

No. 20426 (20422 by error in figure), topotype. Four times natural size.

perfectly simple premolars, although quite hypsodont in comparison with many of the South American genera. It may be regarded as ancestral to *Arctostylops* and through that genus to some of the South American Eocene Notoungulata (e.g., *Leontinia*, *Notostylops*, etc), but to the latter only in a broad way, as no one of the genera of the Deseado fauna

can be cited as clearly following out the line indicated by *Palæostylops-Arctostylops*.

An isolated tooth, No. 20422, appears to agree more nearly with the anterior teeth of *Palæostylops* than with any other known type, but is of much larger size, about twice the lineal dimensions of p_1 in *P. iturus*. The upper front teeth of *P. iturus* are not known, but it is to be expected that they would conform more or less to the lower teeth, which decrease forward regularly in size. The single, backward-pitched root shows that the present tooth is well forward, and it is provisionally identified as a first premolar, on account of the relative complexity of the crown.

We therefore distinguish *Palæostylops* from any of the South American families of Notoungulata by the extreme reduction of the trigonid and simple premolars, associating *Arctostylops* with it in the family Arctostylopidae.

GLIRES

(Fam. indet.)

*Baënomys*¹ *ambiguus*, new genus and species

TYPE.—No. 20424, a lower jaw fragment with two teeth preserved, alveoli of the remaining teeth, from the Gashato formation.

CHARACTERS.—Dentition $\overline{1.0.2.3}$. Incisor rootless, stout, diastema short, p_3 much reduced, p_4 of size of molars, m_{1-2} rather high-crowned, quadrate, pattern of crown two transverse crests or pillars united at the base, of equal width, but the anterior one a little higher; m_3 probably similar but small.

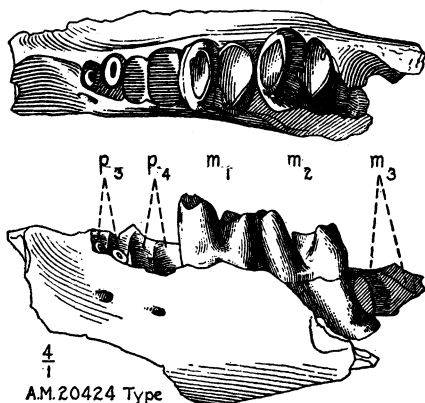


Fig. 5. *Baënomys ambiguus*, new genus and species. Lower jaw fragment, superior and external views.

Type specimen, No. 20424. Four times natural size.

¹Bá, intensive; évos, old; μvs, mouse.

The pattern of the molars suggests the more hypsodont genera of pocket-mice, but has more definite suggestion of the Lagomorpha. The retention of p_3 distinguishes the genus from all simplicidentate rodents, but does not exclude it from their ancestry; however, the hypsodont molars of heteromyid pattern are by no means what one would expect in a prosimplicidentate rodent. Their pattern is suggestive of an ancestral relationship to the Lagomorpha, but the reduction in number has gone further than in the rabbits, and the subequal crests, although shorter than in *Desmatolagus* of the Oligocene, do not explain the marked reduction of posterior moiety of tooth in the most primitive known Lagomorpha; nor has the jaw the slender proportions of the lagomorph jaw. It seems probable that the genus represents some archaic specialization of

the rodent order, but whether lagomorph or simplicidentate is doubtful until better specimens are found.

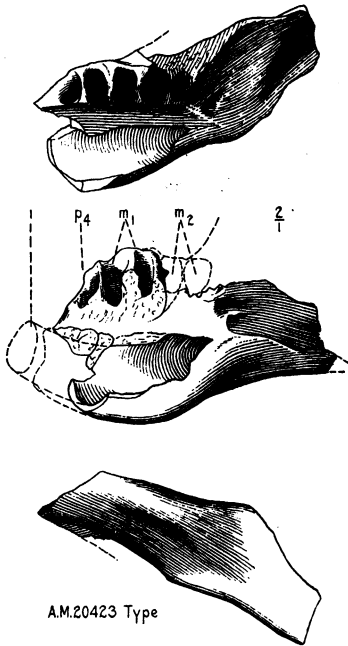


Fig. 6. *Prionessus lucifer*, new genus and species. Lower jaw with alveoli of teeth; superior, internal and inferior views.

Type specimen, No. 20423. Twice natural size.

MULTITUBERCULATA

Plagiaulacidae

Catopsalinea

*Prionessus*¹ *lucifer*, new genus and species

TYPE.—No. 20423, a lower jaw without teeth, from the Gashato formation.

DIAGNOSIS.—Dentition $\overline{1.0.1.2}$. Incisor enlarged, scalpriform, long-rooted, stout; diastema short, 'premolar' much reduced, with two connate roots, followed by two rather small subequal two-rooted molars, each apparently about as wide as long. Lower jaw short and deep, flattened beneath as in other multituberculates, with prominent external crest beneath the masseteric fossa, and sharp internal crest beginning abruptly at a point directly behind the root of the incisor and extending backward to the inflected angular process of the jaw.

The genus agrees with *Catopsalis*, *Meniscoessus* and *Tæniolabis* (*Polymastodon*) in the greatly reduced premolar,

¹πριων, saw; ἥσσων, inferior or weaker. The name is intended also to be suggestive of *Dipriodon*, *Tripriodon* and *Meniscoessus*, three names which have been applied to a related genus from the Lance formation. The species name alludes to the light cast upon the probable age of this fauna by the recognition in it of a multituberculate.

stout incisor and short, deep jaw, but differs in the smaller size and relatively smaller, shorter and probably simpler, molars. In *Ptilodus* and its allies the premolar is much enlarged, the incisor compressed and slender, the jaw much more elongate and narrow, the first molar probably more elongate. The present genus is possibly an ancestral type of the catopsaline subfamily ("Polymastodontinæ") but is too imperfectly known for any precise determination of its affinities.

MENOTYPHLA

?Plesiadapidae

Eurymylus laticeps,¹ new genus and species

TYPE.—No. 20422, an upper jaw with the five cheek teeth preserved, from the Gashato formation.

CHARACTERS.—Two premolars and three molars in the cheek-tooth series, anterior teeth unknown. Teeth low, bunodont, wide transversely, paracone and metacone round conical, external, no outer cingulum, protocone crescentic, internal, no additional cusps observed. Premolars smaller than molars, submolariform, with strong selenoid inner cusp, two conical outer cusps, the posterior one much smaller and imperfectly separate, no other cusps observed.

First molar the largest, second one-fifth smaller, third two-fifths smaller lineally. Fourth premolar equalling m^2 in size, third smaller than m^3 .

The wide molars and simplicity of the dentition, with conical external para- and metacone, are unlike any Insectivora except Leptictidae, and suggestive of Mioclanidae, the smaller Peripitychidae, *Onychodectes*, etc., types distributed at present among several orders. But they suggest more than any other group the Eocene tarsiods and plesiadapids, to which group they might be referred except for the complexity of the premolars. The genus is provisionally placed in the Menotyphla, but its affinities to any known mammal, living or extinct, are not close enough to be decisive as to the ordinal position.

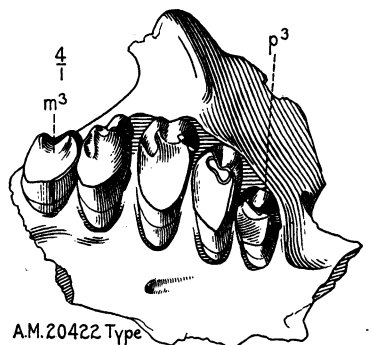


Fig. 7. *Eurymylus laticeps*, new genus and species. Upper jaw, premolar-molar series, p^3 - m^3 , palatal view.

Type specimen, No. 20422. Four times natural size.

¹*εὐρύς*, broad; *μύλη*, mill (i.e., molar tooth). The species name alludes to the wide, short skull indicated by the proportions of the palate.

?CONDYLARTHRA

***Phenacolophus*¹ fallax**, new genus and species

TYPE.—No. 20411, a lower jaw with p_2 - m_3 , r , m_1 - 3 , 1, associated with upper jaw with m_1 - 3 damaged by corrosion of surface, from the Gashato formation.

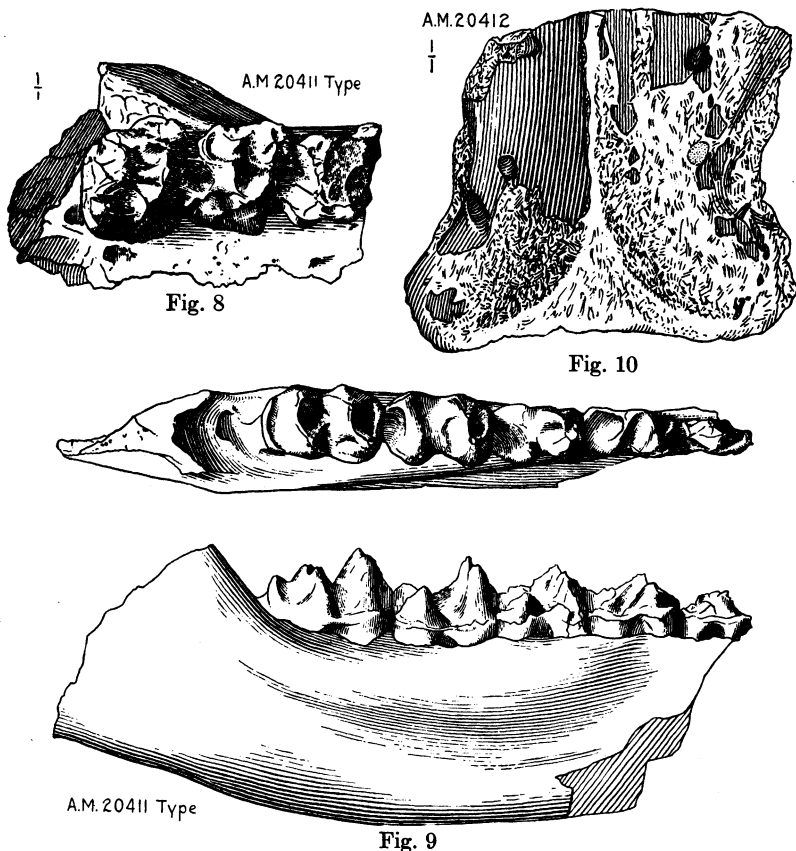


Fig. 8. *Phenacolophus fallax*, new genus and species. Upper jaw fragment with molar teeth.

Type specimen, No. 20411. Natural size.

Fig. 9. *Phenacolophus fallax*, new genus and species. Lower jaw with molar teeth and two posterior premolars; superior and external views.

Type specimen, No. 20411. Natural size.

Fig. 10. *Phenacolophus fallax*, new genus and species. Occiput, superior view. No. 20412, topotype, perhaps a part of the type specimen. Natural size.

¹From *φαναξ*, a deceiver; *λοφος*, crest, in allusion to the pseudolophiodont character of the molar and premolar teeth.

PARATYPES.—No. 20430, symphyseal parts of three lower jaws. A number of skeleton fragments are also referred here.

CHARACTERS.—Molars lophodont, rather low-crowned. Upper molars with six cusps, three in the anterior crest, three in the posterior, and a prominent mesostyle continuous with the posterior crest. Basal cingulum continuous around the tooth. (This structure is best shown in m^3 , which is slightly larger than the others.) Lower molars composed of two slightly oblique cross-crests and a small, low heel; the crests consisting of an external and an internal cusp, the former having an oblique wing running inward and forward, much as in *Eohippus*. Premolars narrower and smaller than molars, the size and relative width of the teeth increasing uniformly from p_3 to m_3 . Anterior premolars not known, except for the roots in the paratypes, which indicate a continuous unreduced series without diastema. Canines considerably enlarged, incisors not preserved, presumably small and very likely reduced in number or wholly absent.

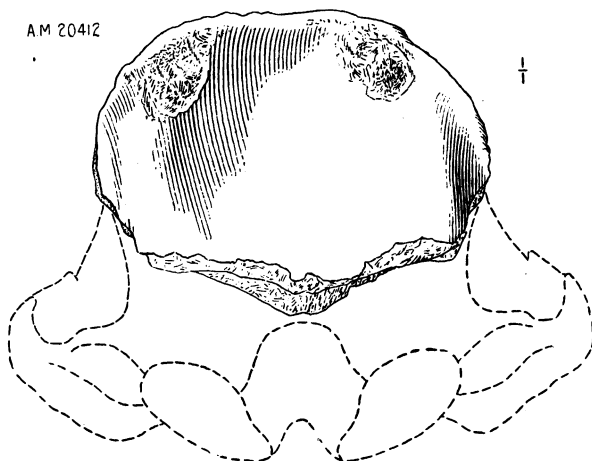


Fig. 11. *Phenacolophus fallax*, new genus and species. Occiput, posterior view.
No. 20412. Natural size.

Among the skeleton fragments doubtfully referred to *Phenacolophus* is a calcaneum of very singular type, comparable to some degree with Peripitychinae and *Ectoconus*, more closely with Isotemnidae of the South American Eocene. It is short and massive, with broad fibular facet at a very low angle with the astragalar facet, which is nearly flat and in the same plane with the sustentacular facet; and the cuboid facet is very strongly oblique, facing more internad than distad, and is moderately convex dorsoventrally and not concave laterally.

The femur of a young individual is short and stocky with a fairly well developed third trochanter; the distal end is wide and the trochlea broad, short and shallow. The head of the ulna is short, notably deep

and compressed, and almost in line with the shaft. Some fragments of humerus and scapula, condylarthran or taligrade in general appearance, may belong to a larger species of this genus.

As the name implies, the lower teeth have a deceptive resemblance to the lophiodont perissodactyls, but the construction of the upper molars can hardly be reconciled with that order, nor is there anything perissodactylic about the anterior part of the lower jaw, or the very characteristic calcaneum.

The genus may be related to some of the South American Eocene ungulates, but probably rather to those that are provisionally referred to Condylarthra than to the Entelonychia or other notoungulate groups.

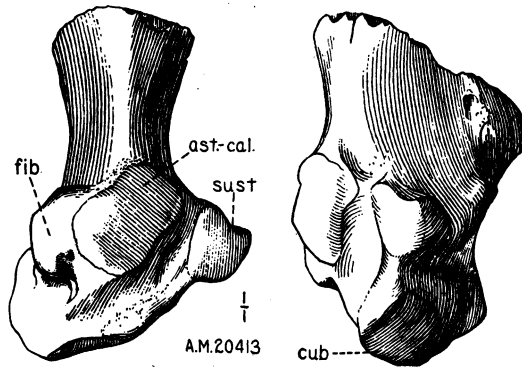


Fig. 12. *Phenacolophus fallax*, new genus and species. Calcaneum doubtfully referred to this genus and species. Superior view (left) and internal view (right).

No. 20413, topotype, perhaps part of type specimen. Natural size.

There is a certain degree of suggestion of litoptern affinities, but not much. Comparisons with the hyracoids, arsinoitheres, barytheres, primitive proboscideans and various other groups are equally unsatisfactory. The genus differs so much from any known mammal, living or extinct, that its ordinal position is provisional, and it is impossible to assign it to any described family.

?CREODONTA

?Oxyclænidae

***Hyracolestes*¹ ermineus**, new genus and species

TYPE.—No. 20425, a lower jaw with p_4 - m_2 and roots of other teeth, from the Gashato formation.

¹ὕραξ, shrew; ληστής, robber,—i.e., a carnivore of shrew-like size.

CHARACTERS.—Molars with high three-cusped trigonid and small low-crested heel. Protoconid highest, paraconid lowest of the trigonid cusps, metaconid distinct on m_1 , more prominent on m_2 . M_3 appears to have been as large as m_2 . P_4 small, high, sharp, moderately compressed, with small posterior basal cusp, rudimentary anterior basal cusp, no accessory cusps. Anterior premolars appear to have been rather small, crowded, perhaps reduced, and canine of moderate size for a creodont. Posterior mental foramen beneath p_4 . Jaw of moderate depth and rather convex inferior outline.

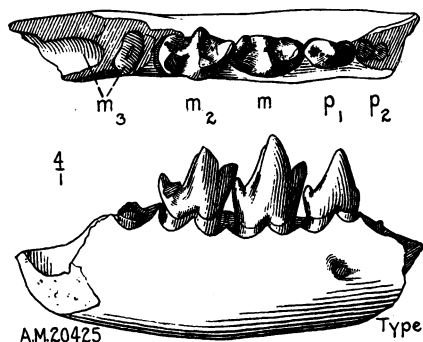


Fig. 13. *Hyracolestes ermineus*, new genus and species. Lower jaw, superior and external views.

Type specimen, No. 20425. Four times natural size.

This is a primitive type of creodont in many respects, but apparently somewhat specialized in a direction unfamiliar to us, not closely paralleled in the Cernaysian or American Paleocene faunas. It is still less like any Eocene types. The minute size is suggestive of Insectivora, but the dentition is not like any known insectivores.

Order Uncertain (?Creodont or Carnivorous Marsupial)

***Sarcodon pygmæus*, new genus and species**

TYPE.—No. 20427, an upper molar.

CHARACTERS.—Molar construction as in certain creodonts and carnivorous marsupials (cf. *Limnocyon*, *Sinopa* and related oxyænoid hyænodont genera, also *Cladosictis* and *Amphiproverra* or the modern *Thylacinus* and *Sarcophilus*), but with a heavy posterointernal flange like that of mustelid carnassials. Size small, comparable with *Putorius*. Protocone large, strongly compressed and extended anterointernally, paracone and metacone strongly connate, parastyle rudimentary, meta-style considerably extended as a shearing crest, no external cingulum. Hypocone a large, prominent, anterointernal flange.

¹From σαρξ, flesh; ὀδόν, tooth.

This tooth evidently represents a specialization paralleling the Mustelidæ but superposed upon a predaceous adaptation with carnassiform molars instead of eucrodine type with carnassial fourth premolar. Three known groups might give rise to such a specialization, the pseudo-



Fig. 14.
Sarcodon
pygmaeus,
new genus
and species.
Upper molar,
crown view.

Type speci-
men, No. 20427.
Four times nat-
ural size.

creodont Carnivora Oxyænidæ and Hyænodontidæ of the Eocene and later Tertiary; the Leptictidæ, Paleocene to Oligocene; or the carnivorous marsupials, especially the Borhyænidæ of the South American Tertiary and Cimolestidæ of the northern Cretaceous. It is impossible to assign it to any one of these groups without some light on the number of upper molars and position occupied by this tooth in the series. The creodonts offer the closest analogies, but the faunal association with a notoungulate is very suggestive of carnivorous marsupials which take the place of true carnivores in the South American Tertiary faunas, as they probably did in the Upper Cretaceous faunas of North America.

A certain degree of correspondence may be noted to *Didymoconus* (fam. Oxyænidæ) of the Hsanda Gol fauna, as also to the Leptictidæ, but it is less suggestive of relationship.