56.(1181:78.7)

Article XIV.— A REVISION OF THE LOWER EOCENE WASATCH AND WIND RIVER FAUNAS.

By W. D. Matthew and Walter Granger.

PART IV.— ENTELONYCHIA, PRIMATES, INSECTIVORA (PART).

By W. D. Matthew.

Order ENTELONYCHIA.

Fam. ?ISOTEMNIDÆ.

Arctostylops steini gen. et sp. nov.

Plate XV.

Molar pattern much as in *Notostylops*, but crowns much higher and narrower, heel longer, trigonid more reduced. P_4 submolariform, P_3 nearly simple, trenchant. Size minute, p_3–m_3 = 18 mm.

Lower Gray Bull beds, Clark Fork basin, Wyoming.

Type, No. 16830, a lower jaw with p_3–m_3 perfect and unworn.

The discovery of a Notoungulate mammal in the North American Eocene was so completely unexpected that the evidence requires critical sifting before acceptance.

In order first to verify the discovery and to exclude the possible suggestion that the specimen might have been secured by Mr. Stein when with Dr. Loomis's expedition to Patagonia a few years earlier, and by some accident mislaid and subsequently mixed up with his Bighorn basin collection, I obtained from him and from his assistant Mr. Turner detailed accounts of the exact locality and circumstances of the discovery. While it is unnecessary to spread these letters upon the record they are sufficient to render it absolutely certain that no such confusion occurred, that the specimen here described and figured was found by Mr. Stein in the upper part of the Wasatch exposures of Clark Fork basin.

It will be obvious that the teeth bear no resemblance to any northern group of mammals, living or extinct. They are not of a primitive but of a highly specialized type. There is one and only one of the larger groups of mammals which shows in multiform variations this peculiar fundamental pattern in the molars. This is the Notoungulata, including under that

name a number of orders and suborders of extinct mammals, the Toxodontia, Typotheria, Astrapotheria, Entelonychia, Litopterna, all peculiar to South America. Amid endless variations in size proportions and specializations of one kind or another, all of these animals show in the fundamental molar pattern certain peculiarities not found in any of the many parallel adaptations among other mammals. There are certain characteristics in the lower dentition common to all these South American Tertiary ungulates and unknown to any of the Holarctic orders. The most distinctive of these

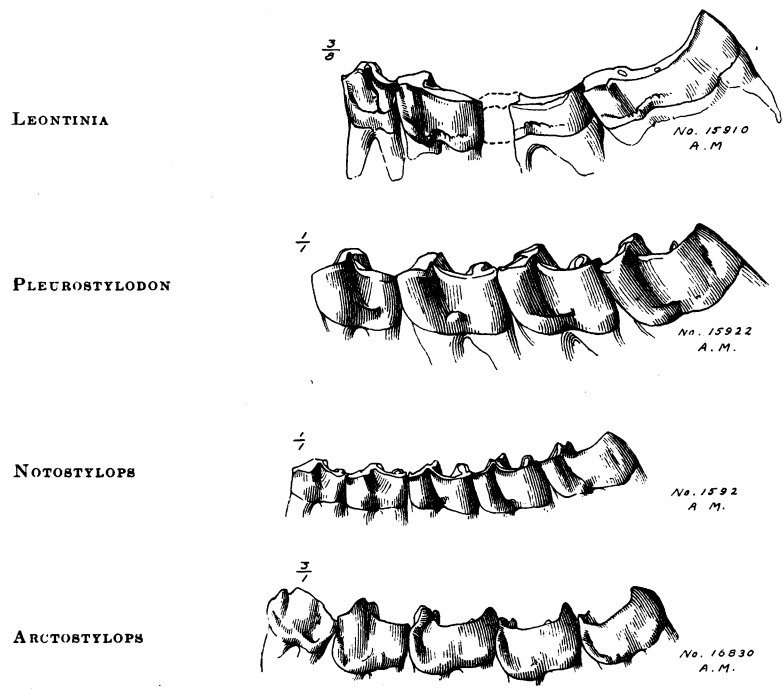

Fig. 1. *Arctostylops steini*, type specimen, compared with South American Entelonychia. Outer views of lower teeth.

is the cusp which rises in the middle of the talonid, branching off from its outer wall which forms a high curving crest. The construction is described by Schlosser[1] as follows:

"Die unteren M bestehen aus je zwei äusseren Halbmonden von denen der vordere viel kürzer ist als der hintere, und aus zwei mehr oder weniger komprimierten Innenhöckern gebildet wird, von welchen sich der vordere mit dem Hinterende des ersten Halbmondes innig verbindet, während der

[1] Zittel's Grundzüge der Palæont., Vertebrata, Ed. 1911, p. 512.

hintere dem zweiten Halbmond gegenüberliegt und häufig gänzlich isoliert bleibt."

The construction in Entelonychia he further defines as[1] "Untere M mit einem sehr kurzen vorderen und einem langgestreckten hinteren Halbmond und zwei Innenhöckern, von denen der erste stark in die Quere gezogen ist."

These descriptions apply accurately to the specimen in hand. It is not so readily placeable in any of the South American families. It represents an extreme type of reduction of the anterior, and elongation of the posterior crescent, high and narrow crown, and simple premolars. The Isotemnidæ appear to be nearest, although the genera are decidedly more brachyodont and the disproportion of the crescents is less. There is in

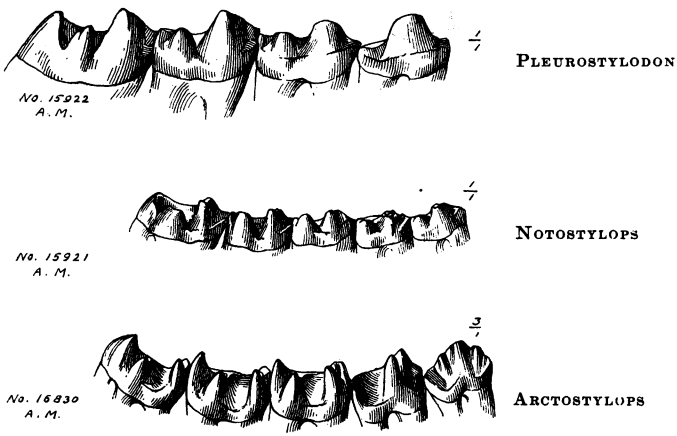

Fig. 2. *Arctostylops steini*, type specimen, compared with South American Entelonychia. Inner views of lower teeth.

these features a strong suggestion of nearer relationship to *Leontinia*, despite the contrast in size, but I think it is probably illusory. At all events there appears to be no known South American genus with which it compares closely. I suspect that when better known it will prove to stand in the same relation to the Entelonychia as does *Metacheiromys* to the Loricata,— an aberrant offshoot from a primitive stage in their evolution. It has much nearer allies in the South American faunæ than has *Metacheiromys*. But this may be because we are able to compare it with Eocene types (Notostylops fauna), while our comparisons of *Metacheiromys* with the armadillos are limited to Miocene (Santa Cruz fauna) and later types, nothing being known of the skeleton of the older armadillos. Between

[1] L. c., p. 521.

Arctostylops and the *Isotemnidæ* there is no very wide gap in time; between the Palæanodonts (Metacheiromyidæ) and the Loricates there is a very wide gap, sufficient for a great deal of divergent evolution.

The interpretation of this discovery depends upon the interpretation of the occurrence of *Metacheiromys*. If the latter be regarded as a relict of a formerly northern distribution of the Edentata, the same explanation will apply to *Arctostylops*. If it be regarded as an immigrant from South America, then this little Homalodothere may have arrived in the same way. A thorough revision of the Paleocene faunæ with the new material recently acquired may enable us to recognize possible or probable sources for the

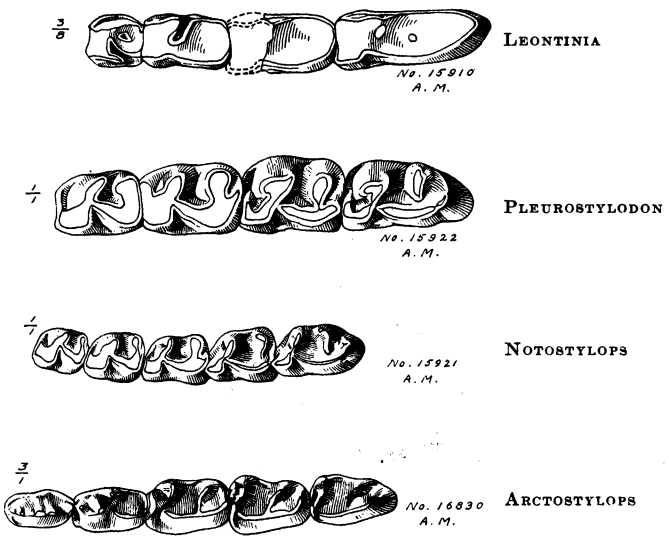

Fig. 3. *Arctostylops steini*, type specimen, compared with South American Entelonychia. Crown views of lower teeth.

South American faunæ, the oldest of which, that of the Casa Mayor horizon, is regarded by Schlosser as probably Middle or Upper Eocene. Schlosser's opinion on this point is entitled to especial respect as he has obtained and studied large collections from the older Tertiary horizons of Patagonia. Professor Scott, in his recent volume, regards the fauna as Eocene, but does not attempt any more precise correlation. I had formerly (1902) regarded the Notostylops fauna as Paleocene, but further consideration of the faunal evidence led me to place it later, and I am now disposed to agree with Dr. Schlosser's estimate. If this correlation be correct, we may find among the unspecialized trituberculate placentals of the Paleocene faunæ types which will serve as a source for the various specialized groups peculiar to the South American Tertiary. But we cannot consider the latter as directly

derived from our Paleocene faunæ, as in both Puerco and Torrejon horizons we find a large and diversified element of Creodonta, which is absent from the South American faunæ where carnivorous marsupials take its place.

The reference of a mammal from our lower Eocene to this distinctively South American group will naturally appear questionable to many palæontologists, especially since the evidence rests at present only upon a lower jaw. Were the pattern a primitive and generalized one or were the resemblance in superficial or adaptive characters of the teeth I should regard it as inadequate. But the agreement lies not in superficial resemblances but in the peculiar fundamental pattern of the molar teeth which is the principal reason for regarding these South American ungulates as related to each other and distinct from the northern groups. If *Arctostylops* is not a member of this southern group, we must conclude that this peculiar pattern has also arisen independently in some northern group of mammals. This would be a somewhat remarkable coincidence indeed, but not inconceivable, and tenable were there sufficient evidence that the genus was not related to the Notoungulates. But I can find nothing in the teeth or jaw characters that would afford a reason against reference to the Entelonychia. It may indeed be difficult to reconcile with certain hypotheses of the time and place of origin and evolution of these South American placentals. That is an excellent reason to verify and sift the evidence critically; it is hardly a reason for rejecting it.

Order PRIMATES.

The two families here referred to the order, the Adapidæ (including Notharctidæ as a subfamily) and Tarsiidæ (Anaptomorphidæ) are Primates beyond reasonable question. Some or all of the genera of the families Apatemyidæ and Mixodectidæ, here placed as Insectivora, may when better known have to be transferred to the Primates. This is true especially of *Trogolemur* in the former and of *Cynodontomys* and *Microsyops* in the latter family, in which the dentition, save for the double-rooted upper canine of *Microsyops*, is of a type very like the known Eocene primates.

Family ADAPIDÆ.

[1]*Pachylemuridæ* Miall 1875, Filhol 1876.

Adapidæ Trouessart 1879, Revue et Magaz. de Zool. 3e ser. t. vii, p. 223; Cope 1885, Amer. Nat., Vol. XIX, p. 459; Wortman 1903, Amer. Journ. Sci., Vol. XV, p. 174; Schlosser 1911, in Zittel's Grundz. d. Pal., Vertebrata, p. 546.

[1] Not available because not based on a genus.

Notharctidæ TROUESSART 1879 l. c.; OSBORN 1902, Bull. A. M. N. H., Vol. XVI, p. 190; STEHLIN, 1912, Abh. d. schw. pal. Ges., Vol. XXXVIII, p. 1287.

Notharctus and its relatives in the American Eocene are considered as a distinct family by some authorities, as a subfamily of the Adapidæ by others. Doctor Stehlin in his recent monographic study of *Adapis* specifies a series of important distinctions in the character and evolutionary trend of the two groups and concludes that they are distinct. In addition to a series of less fundamental distinctions he points out that the hypocone in the upper molars originates in the Notharctid phylum by budding off from the protocone, whereas in the Adapidæ he believes that it is certainly a derivative from the cingulum. Doctor Gregory's morphologic studies of the skulls and skeletons of *Notharctus* and its relatives indicate, however, a somewhat nearer affinity to *Adapis,* so that the two may be considered as divergent phyla of a single family. The reasons for this conclusion will be set forth by him in other articles in this Bulletin. They tend moreover to emphasize the lemuroid affinities of the family, upon which most authorities, with the exception of Dr. Wortman, are agreed.

Three or more genera of Notharctidæ accur in the Middle Eocene formations. In the Lower Eocene formations there are two, *Pelycodus* characterizing the earlier horizons, *Notharctus,* typically from the Middle Eocene (Bridger) but represented by primitive species from the Wind River (Lost Cabin beds). The two genera are successive stages of a single phylum and are distinguished as follows:

Notharctus Leidy: Hypocone and mesostyle of upper molars prominent.

Pelycodus Cope: Hypocone and mesostyle rudimentary or absent.

The species of Notharctidæ from successive horizons of lower and middle Eocene, from the Sand Coulée to the upper Bridger illustrate very clearly the progressive change in the upper molars from tritubercular to fully quadritubercular type, the development of the mesostyle, the complication of the fourth premolar and increase in size. This was pointed out by Osborn in 1902,[1] and is confirmed and extended by the much larger series of specimens and exact records of horizons now at hand for comparison. They are very good horizon markers. As with other abundant groups, a large series shows a certain range of individual variation, some being more and others less progressive, but within comparatively narrow limits. As we progress upward through successive levels of the formations, we find that the limits of individual variation, on one side and the other of the abundant typical forms, are progressively shifted over in the direction of the phyletic trend. That this is a gradual shifting of averages, due to the

[1] Osborn, 1902, Bull. Amer. Mus. Nat. Hist., Vol. XVI, p. 191.

disappearance of less progressive individuals, and appearance and increase of more progressive individuals, seems to be fairly well shown in this phylum and in the *Cynodontomys-Microsyops* phylum, less clearly in some others. It is not the gradual replacement of one species by another distinct and more progressive species, but so far as one may judge from the characters of the teeth the gradual conversion of one species into its successor by the progressive elimination of the more primitive and increase in numbers of the more advanced individuals. The detailed geologic record of these phyla appears therefore to afford direct proof of continuity in their evolution. In the Hyopsodontidæ, as I have pointed out, it is not so precisely continuous, but appears to be rather the gradual replacement of one species by a more advanced one.

Pelycodus *Cope*, 1875.

Type, Prototomus jarrovii COPE 1874, from the Wasatch of New Mexico.

The genus is distinguished from *Notharctus* by the substantially tritubercular upper molars. The lower teeth are practically indistinguishable in approximating species of the two genera. The species increase progressively in size through the Lower Eocene, but small species likewise appear in the later levels, distinguished from those of the earlier horizons by their more progressive character. The first appearance of the phylum in the known Tertiary succession is in the Sand Coulée beds (*P. ralstoni*) at the base of the Wasatch. The skeleton construction of this species is unknown, but in the next stage (*P. trigonodus* of the Lower Gray Bull) we have associated[1] skeleton bones which show that the peculiar and characteristic structure and proportions of the limb and foot-bones, especially of astragalus and calcaneum, was as fully developed as in the latter Notharctidæ.

There are several Paleocene genera which might be regarded as ancestral or related to *Pelycodus* on evidence of their teeth alone. But as yet no trace of the characteristic skeleton bones of Primates has ever been found in the Paleocene, and some of the Paleocene genera which are closest to them in dental characters (*e. g. Chriacus*) are known to be entirely different in skeleton, and to pertain not to the Primates but to Creodonta, Condylarthra and Insectivora.

As the evidence stands therefore we must regard the Notharctidæ as an immigrant family at the base of the Wasatch.

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[1] *i. e.*, known to belong to the same individual as the jaws with which they are found.

Key to Species of Pelycodus.

I. Paraconids distinct on m_{1-3}
   1. M_{1-3}=11–14 mm. Upper molars trigonal to sub-quadrate; no hypocones *P. ralstoni.*

II. Paraconids vestigial on m_{2-3}, distinct on m_1
   2. M_{1-3}=14–16 mm. No hypocone on upper molars, inner cusp of p_4 weak *P. trigonodus.*
   3. M_{1-3}=14–16 mm. Hypocone on m^{1-2}, obscure to distinct, inner cusp of p_4 strong.....*P. frugivorus.*
   4. M_{1-3}=16–18 mm. Hypocone on m^{1-2}, obscure to distinct, inner cusp of p_4 strong.....*P. jarrovii.*

III. Entoconid placed more anteriorly than in other species and connected by a crest with metaconid.
   5. M_{1-3}=19 mm. .....*P. tutus.*

Pelycodus ralstoni sp. nov.

Type, No. 16089, upper jaw with p^4–m^3, from Sand Coulée zone (basal Wasatch) in Clark Fork basin, Wyoming.

Distinctive characters: M_{1-3}=11–14 mm. p_4 smaller and less compressed than in *P. trigonodus;* upper molars more triangular, of less anteroposterior length.

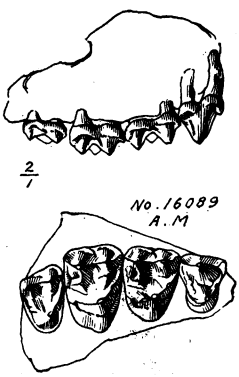


Fig. 4. *Pelycodus ralstoni,* upper jaw, external and crown views. Type specimen, Sand Coulée beds, Clark Fork basin, Wyoming.

This species is considerably smaller than the others, the anteroposterior diameters of the teeth notably less, the premolars smaller in proportion. The protocone is not broadened posteriorly as it is in *P. trigonodus.*

Some thirty specimens from the Sand Coulée beds in Clark Fork basin agree more or less exactly with the type. A dozen specimens from Shoshone River and a few from other localities low down in the Gray Bull also belong here. A few are intermediate between *P. ralstoni* and *P. trigonodus.*

Pelycodus trigonodus sp. nov.

Type, No. 15017, upper and lower jaws, from the lower part of the Gray Bull horizon, 5 miles south of Otto, Wyoming.

Distinctive characters: M_{1-3}=15 mm. No hypocone on upper molars. P_4 with small metaconid, more compressed than in *P. frugivorus.*

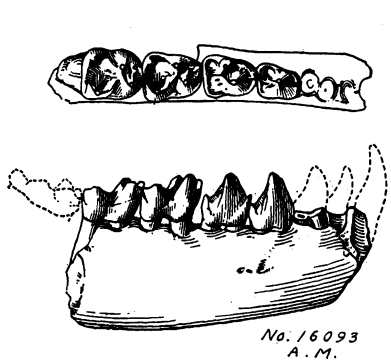


Fig. 5.

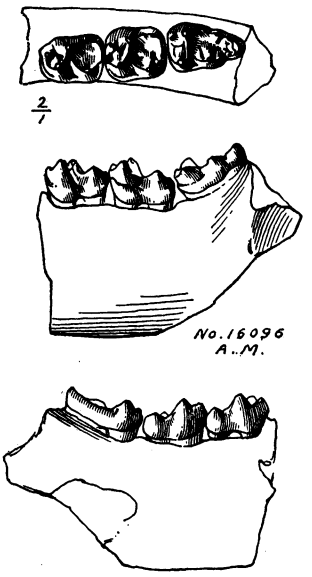


Fig. 6.

Fig. 5. *Pelycodus ralstoni*, inner, outer and crown views of lower jaw fragment. Sand Coulée beds, Clark Fork basin, Wyoming.

Fig. 6. *Pelycodus ralstoni*, inner, outer and crown views of lower jaw fragment. Sand Coulée beds, Clark Fork basin, Wyoming.

To this species are referred a large number of jaws and jaw fragments from the same horizon as the type.

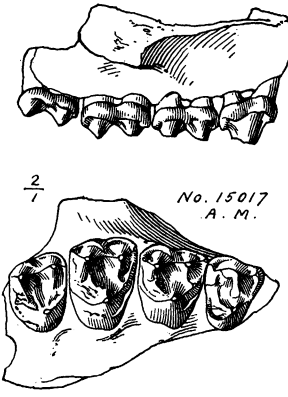


Fig. 7. *Pelycodus trigonodus*, upper jaw of type specimen, outer and crown views. Gray Bull beds, Bighorn basin, Wyoming.

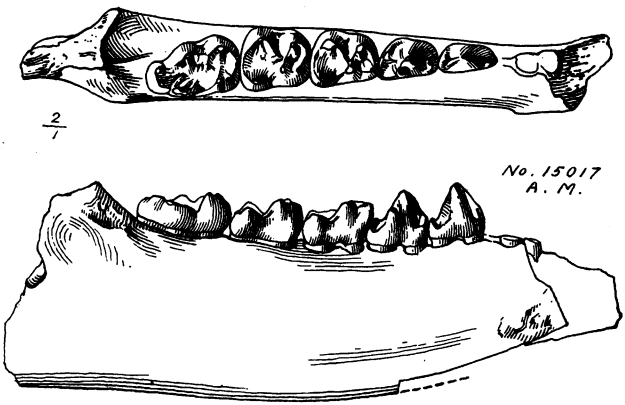


Fig. 8. *Pelycodus trigonodus*, lower jaw of type specimen, inner and crown views. Gray Bull beds, Bighorn basin, Wyoming.

Although the hypocone is absent, the protocone is broader anteroposteriorly than in *P. ralstoni*, giving the molar a more quadrate form approaching that of *P. jarrovii*.

Pelycodus jarrovii (*Cope* 1874).

Protolomus jarrovii COPE, 1874, Rep. Foss. Vert. New Mex., p. 14; (*Pelycodus*) 1875, Syst. Cat. Eoc. New Mex., p. 13; (*Tomitherium*) 1877, Ext. Vert. New Mex., p. 137, pl. xxxix, figs. 17–18.

Pelycodus jarrovii, *P. frugivorus* in part, OSBORN, 1902, Bull. Amer. Mus. Nat. Hist., Vol. XVI, p. 193, fig. 20A.

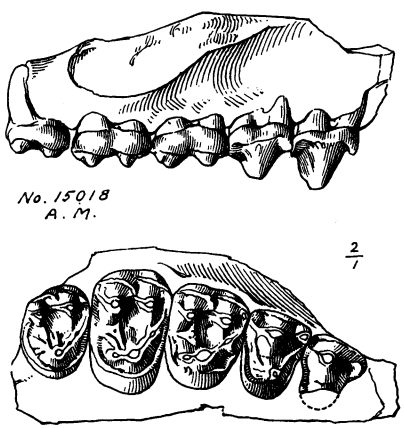


Fig. 9. *Pelycodus jarrovii*, upper jaw of *neotype*, outer and crown views. Upper Gray Bull beds, Bighorn basin, Wyoming.

The type of this species is a lower jaw fragment with m_{2-3} from the Wasatch of New Mexico Probably it is the specimen figured by Cope in 1877, fig. 17 of pl. xxxix. The skeleton parts figured on pl. xl, figs. 1–15, do not belong to the teeth with which they were associated (fig. 18 of pl. xxxix) but are the bones of a Creodont.

In the American Museum collection from the New Mexican Wasatch there is but one specimen referable

to this species, a jaw fragment, No. 16298, with m_{2-3} from the lower (Almagre) beds. In the Lysite and upper levels of the Gray Bull beds in Wyoming the common form of *Pelycodus* is indistinguishable from *P. jarrovii*. Some forty specimens are referable from the upper Gray Bull,

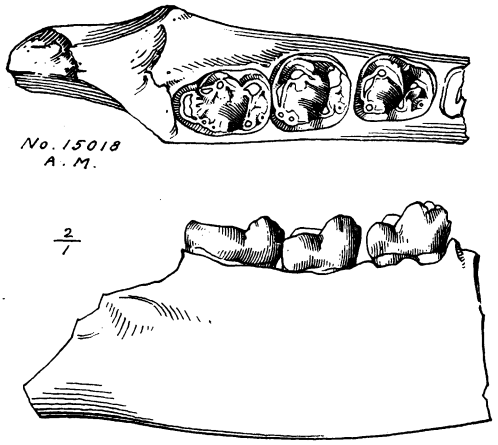


Fig. 10. *Pelycodus jarrovii*, lower jaw of *neotype*, inner and crown views. Upper Gray Bull beds, Bighorn basin, Wyoming.

ten or twelve from the Lysite of the Bighorn, and two or three from the Lysite of Wind River basin. In the absence of adequate topotypes I designate as *neotype* No. 15018, associated upper and lower jaws from the upper Gray Bull, Head of Dorsey Creek, Bighorn basin.

The species is confined to these upper levels, except for a single specimen, No. 15029, recorded as from 5 miles south of Otto, which would bring it low down in the Gray Bull.

Pelycodus frugivorus *Cope.*

Pelycodus frugivorus COPE, 1875, Syst. Cat. Eoc. Vert. New Mex., p. 14; (*Tomitherium*) 1877, Ext. Vert. New Mex., p. 144, pl. xxxix, fig. 16; 1885, Tert. Vert., p. 230 (Bighorn specimens only).

The type of *P. frugivorus* is a jaw fragment with m_{2-3} from the New Mexican Wasatch, horizon unknown. There are several parts of jaws in our New Mexican collections which agree well enough in size and characters with Cope's figures and description, but they vary considerably among themselves, and some are from the lower, some from the upper horizon. No. 16209, a jaw fragment with m_{2-3}, from the upper beds agrees most

nearly, although slightly larger. This in turn agrees rather closely with *P. nunienus,* founded by Cope in 1887 on a lower jaw from the Lost Cabin beds. Cope in 1885 referred this Wind River species and also several jaws from unknown levels in the Bighorn basin to *P. frugivorus.* Osborn in 1902 retained the Bighorn specimens in *P. frugivorus* but separated *P. nunienus* and referred it to *Notharctus.*

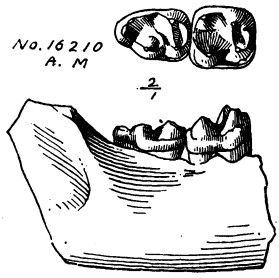


Fig. 11. *Pelycodus frugivorus,* lower jaw fragment, outer view and crown of teeth. Upper (Largo) beds of Wasatch, San Juan basin, New Mexico.

It is certain that two and probable that three different species have been included under *frugivorus.* Specimens from the lower Gray Bull horizon have no hypocone on the upper molars; in those from the Lost Cabin it is very prominent. There is indeed no certainty as to which form is cospecific with the type of *P. frugivorus;* but as the fauna of the lower beds of the Gray Bull seems to be older than any of the New Mexican Wasatch, I think it unlikely that the *Pelycodus* of this horizon is identical with Cope's type; and if the latter came from the upper beds, as No. 16209 may indicate, it is much more likely to be identical with *P. nunienus* or to be a primitive mutant of it. Loomis in his review of the Wasatch and Wind River primates noted differences between the Wasatch and New Mexican speci-

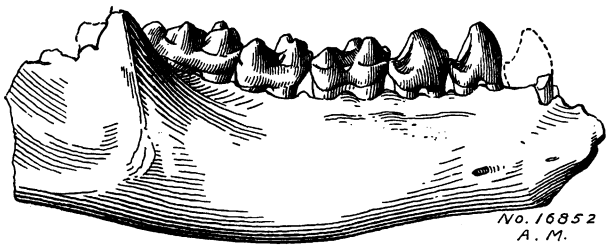


Fig. 12. *Pelycodus frugivorus,* lower jaw, outer view. M_{2-3} are drawn from a second specimen found in association. Upper Gray Bull beds, Bighorn basin, Wyoming.

mens of *P. frugivorus* to which he assigned varietal value. It appears best on the whole to assign to *P. frugivorus* the specimens from Upper Gray Bull and Lysite horizons, and regard *nunienus* as a more progressive species which falls into the genus *Notharctus,* as does *N. venticolus* in the larger series. The specimens from the Lower Gray Bull I have distinguished as *P. trigonodus.*

To *P. frugivorus* may be referred No. 15625 and other specimens from

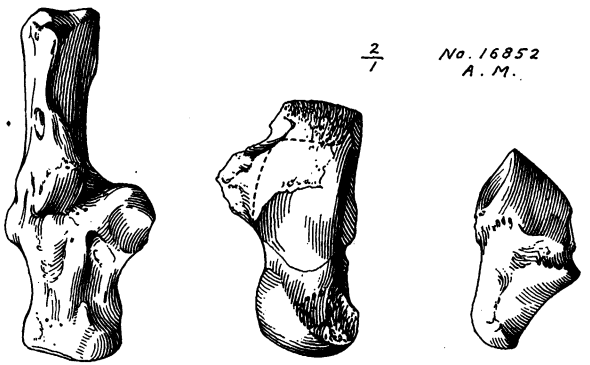


Fig. 13. *Pelycodus frugivorus*, calcaneum, astragalus and entocuneiform of the right side, all front views. Found associated with lower jaw, No. 16852 (Fig. 12). Upper Gray Bull beds, Bighorn basin, Wyoming.

the Lysite and Upper Gray Bull in which the lower molars are from 14–16 mm. In these specimens the inner cusp of p_4 is strong, the tooth stout and oval; the hypocone is present on m^{1-2} but varies from obscure to distinct. In these and other features it agrees with *P. jarrovii;* I can find no distinctions except the smaller size and less robust proportions.

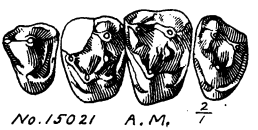


Fig. 14. *Pelycodus frugivorus*, upper teeth, crown view. Upper Gray Bull beds, Bighorn basin, Wyoming.

Pelycodus tutus (*Cope*).

Tomitherium tutum COPE, 1877, Ext. Vert. New Mex., p. 141, pl. xxxix, fig. 19. Not pl. xl, figs. 16–25. Not *Pelycodus tutus* COPE, 1885, Tert. Vert., p. 228, pl. xxva, figs. 1–3.

Type, a lower jaw fragment with m_{2-3} from the New Mexican Wasatch.

Distinctive characters: $M_{1-3}=19$ mm. Entoconid placed more anteriorly than in other species and connected by a crest with the metaconid.

This species is clearly distinguished from any other by the characters cited. Nos. 16205–7, lower jaws from the upper horizon (one from the top of the lower beds) of the New Mexican beds are referred here. The species has not been found in Wyoming and its upper teeth are unknown.

Notharctus *Leidy* 1870.

Type, N. tenebrosus from the Lower Bridger, Wyoming.

Distinctive characters: Hypocone prominent, well distinguished from protocone and more or less nearly equal to it; mesostyle clearly distinct.

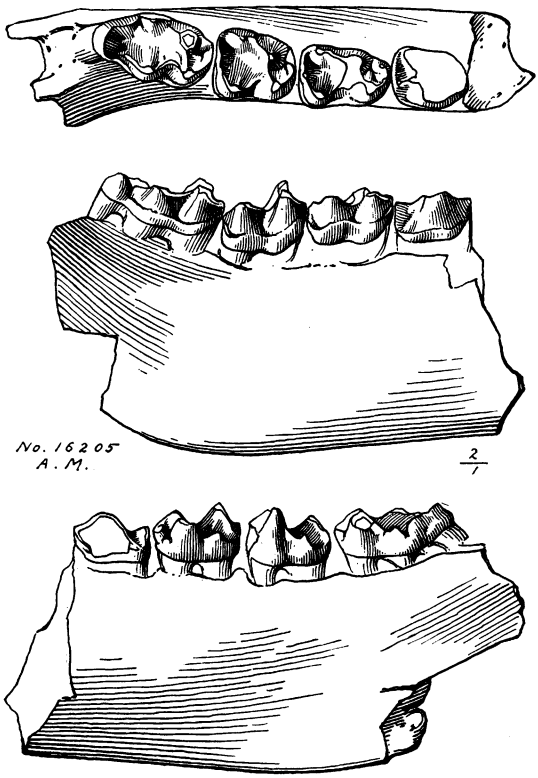


Fig. 15. *Pelycodus tutus*, lower jaw, inner, outer and crown views. Top of lower (Almagre) beds of Wasatch, San Juan basin, New Mexico.

Osborn in 1902 distinguished *Notharctus* from *Pelycodus* by the above characters, and showed that *P. nunienus* Cope and *P. venticolus* Osborn of the Wind River were referable to the Bridger genus. They are distinguished from most of the Bridger species by the symphysis of the jaw, which is in no instance coössified. One small Bridger species retains this primitive character but it is lost in all the others. The two species from the Lower Eocene are from the Lost Cabin horizon, and are separable from each other chiefly by size, although the larger species is the more progressive. I regard them as progressive stages of *Pelycodus frugivorus* and *P. jarrovii* respectively.

The three species referred by Loomis to *Notharctus* do not appear to me to pertain to that genus. *N. palmeri* and *N. cingulatus* I refer to *Cynodontomys latidens; N. minutus* appears to be a small *Omomys*.

Notharctus venticolus *Osborn* 1902.

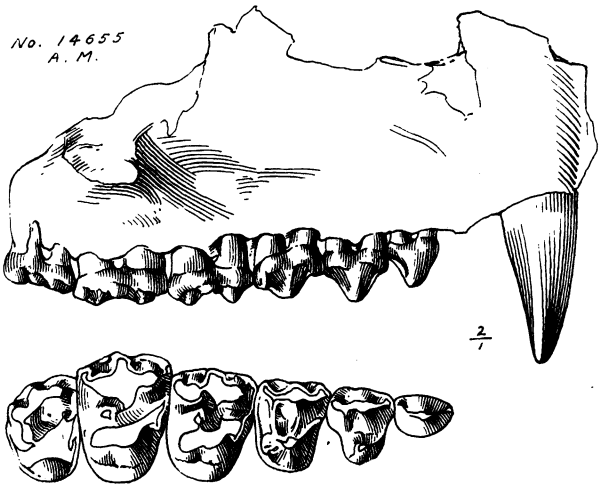


Fig. 16. *Notharctus venticolus*, maxilla, outer view, and crown view of teeth. Lost Cabin beds, Wind River basin, Wyoming.

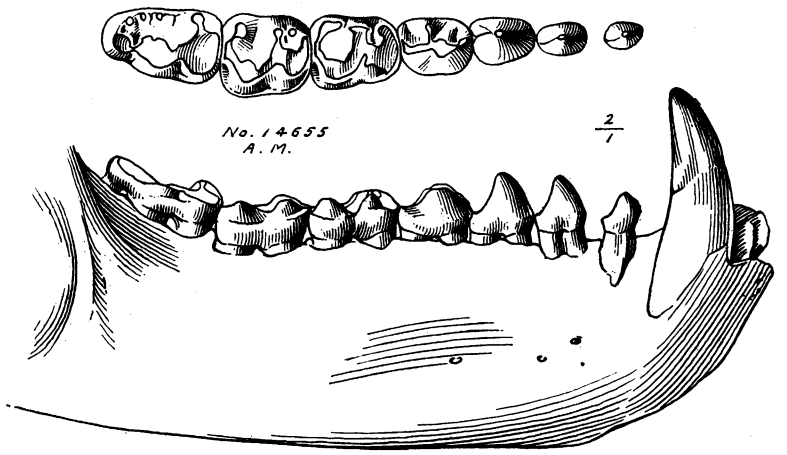
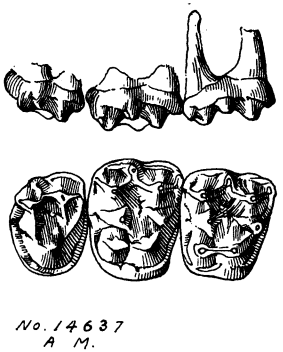


Fig. 17. *Notharctus venticolus*, lower jaw, outer view and crown view of teeth. Associated with maxilla shown in Fig. 16. Lost Cabin beds, Wind River basin, Wyoming.



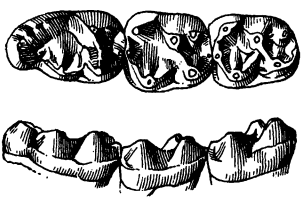


Fig. 18. *Notharctus venticolus*, upper and lower molars, slightly worn outer and crown views of each series. Lost Cabin beds, Wind River basin, Wyoming.

Pelycodus tutus COPE, 1885, Tert, Vert., p. 228, pl. xxva, figs. 1–3. Not *P. tutus* Cope, 1877. *Notharctus venticolus* OSBORN, 1902, Bull. Amer. Mus. Nat. Hist., Vol. XVI, p. 195.

Type, No. 4715b, parts of upper and lower jaws, from the Lost Cabin zone in the Wind River basin, Wyoming.

Distinctive characters: $M_{1-3}=18$ mm.; symphysis of jaw not coössified.°

Referred specimens, Nos. 4726, 4728, 14637, 14638, 14640, 14655–6, etc. The best of these specimens is a fairly complete skull and jaws, No. 14655, the teeth of which are here figured.

The larger size sufficiently distinguishes this species from *N. nunienus*. Most of the referred specimens are larger than the type. Comparison with the Bridger genera and species is difficult, as they have not been revised. Some of these later species show a rudimentary metacone (tritocone) on p^4, a character not observed in any Lower Eocene Notharctid. The two Wind River species are likewise primitive in the sutural symphysis mandibuli, which is coössified in most of the Bridger species.

Notharctus nunienus (*Cope*).

Pelycodus nunienus COPE, 1881, Bull. U. S. Geol. Geog. Surv. Terrs., Vol. VI, p. 187; (*P. frugivorus*) 1885, Tert. Vert., p. 230 (Wind River specimens only) pl. xxva, figs. 4–5; *Notharctus nunienus* OSBORN, 1902, Bull. Amer. Mus. Nat. Hist., Vol. XVI, p. 195, fig. 22.

Type, No. 4734, lower jaw with p_3–m_3r. from Lost Cabin beds of Wind River basin, Wyoming.

Distinctive characters: $M_{1-3}=15$ mm.; heel of m_3 bicuspid; symphysis of jaw not coössified.

To this species are referred a number of jaws and jaw fragments from the Lost Cabin beds. It is a little larger than *P. frugivorus* and distinguished by the more strongly developed hypocones — not as strong, however, as in *N. venticolus*. The species would be considered a mutation of *frugivorus* except that the one is referable to *Notharctus* and the other to *Pelycodus* according to the distinctions established by Osborn.

No. 4735, upper jaw, 4736, 15603, 12736 lower jaws, and other more fragmentary specimens are referable to this species. All are from the Lost Cabin horizon in the Wind River basin.

Family TARSIIDÆ.

The revision of the so-called Anaptomorphidæ of the Lower Eocene is exceptionally difficult. They are all of minute size, the material is mostly very fragmentary, and comparatively scarce, and the number and diversity of genera and species appears to have been very considerable. Except for a skull, Amer. Mus. No. 4194, found by Wortman in the Bighorn basin and referred by Cope to *Anaptomorphus*, they are known only from upper

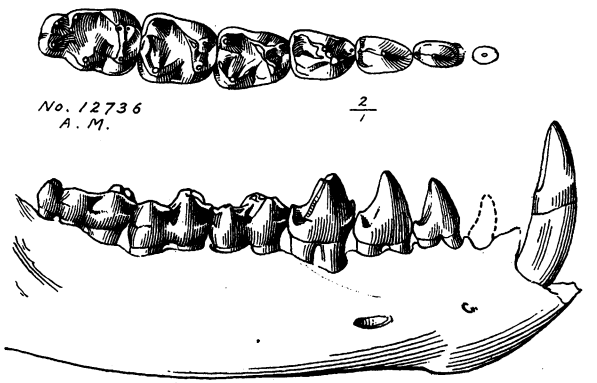


Fig. 19. *Notharctus nunienus*, lower jaw, outer view and crown view of teeth. Lost Cabin beds, Wind River basin, Wyoming.

and lower jaws more or less fragmentary. The Middle Eocene genera, although not quite so rare, are also known only from upper and lower jaws. No skeleton parts have been found associated. Various isolated skeleton bones of Tarsiid type, and a part of a skeleton from the Upper Bridger probably referable to *Hemiacodon*, confirm to some extent the reference to the Tarsiidæ based upon the characters of the above mentioned skull and the general resemblances in dentition. But the affinities and interrelationship of most of the genera placed under this family must remain somewhat provisional. The Middle Eocene genera and species of this family were very ably and thoroughly revised by Dr. Wortman in 1904, upon the basis of the Yale collection from the Bridger formation. Our additional and somewhat more complete material from this formation has made it necessary, however, to modify some of his conclusions. It appeared advisable therefore to include the Middle Eocene genera in this revision.

I can find no basis for family separation from *Tarsius* of this group of Eocene lemuroids. Wortman[1] separates the modern genus "because of the modification of its hind limbs and other modernized characters." But I cannot find that he had any evidence in regard to the construction of the hind limbs in any of the Eocene genera, and our material shows that in at least one of them, probably *Hemiacodon*, the hind limbs were very like those of *Tarsius*, although less specialized. The same is true of *Necrolemur*,[2] which Wortman places in the Anaptomorphidæ. There are several characters in addition to the larger braincase in which the skull of *Tarsius* is more modernized than that of the Lower Eocene "*Anaptomorphus*." But in some other genera of this group the dentition is much nearer to *Tarsius*, and the skull construction may likewise have been nearer. In any case, the differences which can be cited are not as wide or fundamental as those between Tertiary and modern genera which no one thinks of separating into distinct families.[3] The affinities of the group and the relationships of *Necrolemur* and other European genera will be more fully discussed by Dr. Gregory.

Interrelationship of the Eocene genera. So far as the dentition indicates, these genera fall into four groups. The first including *Omomys* and *Hemiacodon* is characterized by slender jaw, semi-procumbent front teeth, i_1 and c_1 somewhat enlarged, lower premolars not crowded, p_4 triangular at base, lower molars with small trigonid, paraconid median, last molar unreduced. In the second, including *Washakius* and *Shoshonius*, the jaw is short and moderately deep, the front teeth nearly vertical, both incisors small, canine of moderate size, lower premolars somewhat crowded, p_4 with quadrate base, lower molars with an extra cusp (metastylid) on the postero-external angle of the trigonid, paraconid median on m_{2-3}, last molar unreduced. In the third group including *Uintanius* alone, the jaw is short and deep, front teeth not fully known but apparently small and more or less vertical, premolars crowded and p_{3-4} enlarged blade-like, molars with low crowns, median paraconid, last molar unreduced. The trigonids of the molars are peculiar in having the metaconids set further back than the protoconids instead of nearly opposite. The fourth group includes *Tetonius* and *Absarokius* and is distinguished by short deep jaw; one or two front teeth enlarged, more or less vertical; premolars crowded, p_{3-4} enlarged, turgid; molars exceptionally short and wide with paraconids internal and connate with metaconids, last molar much reduced. The enlarged premolars in this

[1] Wortman, 1904, Amer. Jour. Sci., Vol. XVII, p. 28.

[2] Schlosser, 1907, Neues Jahrb., Festb., s. 197–226, taf. x.

[3] Compare for instance the range of diversity in dentition among modern Mustelidæ, or the differences between Oligocene and modern Canidæ.

group are of wholly different form from those of *Uintanius*, robust, turgid, blunt-pointed instead of blade-like and crested. *Anaptomorphus* (= *Euryacodon*) is difficult to place among these groups; its affinities are probably nearest to the fourth group, but if better known it might represent a fifth distinct phylum.

In *Tarsius* the jaw is of moderate length, the lower molars are most like those of *Omomys* but without inner cusp on p_4 and paraconids less median, the canine is somewhat larger and there is but one very small incisor not procumbent. It is not a derivative of any one of these Eocene genera.

Nor do any of the Eocene genera show any especial evidence of affinity to *Necrolemur*. In this genus the paraconid is absent on m_{2-3}, the premolars are most like those of the Omomyinæ, the interpretation of the three teeth in front of p_2 is disputed. Apparently it cannot be descended from any of the American Eocene genera. The quadritubercular upper molars readily distinguish it from all of them, and the skull characters indicate that it is not nearly related to *Tarsius*.

In default of skulls or skeletons the reference of these genera to the Tarsiidæ is of course provisional. The four groups above distinguished may represent distinct families or subfamilies but the evidence is insufficient to define them properly. Wortman's division into Omomyinæ and Anaptomorphinæ does not appear to be warranted; the first is doubtless a natural group but its rank is questionable; the second is an artificial assemblage, as Dr. Wortman himself recognized, and if the Omomyinæ are retained the remaining genera should be split up into three or four corresponding groups, *Necrolemur* being removed from the family. But pending a better knowledge of the various genera it is inadvisable to arrange them under subfamilies.

Key to Genera of Tarsiidæ.

(Lower jaw characters.)

I. Paraconids distinct, internal metaconids opposite protoconids. No metastylids. M_3 unreduced. One small incisor, canine of moderate size. Front teeth subvertical. Three small premolars with triangular bases, no deuteroconid. Jaw of moderate depth anteriorly ..... *Tarsius.*

II. Paraconids distinct, median; metaconids opposite protoconids, no metastylids, m_3 unreduced. Two incisors, i_1 of moderate size, i_2 minute. Canine of moderate size. Jaw slender, front teeth semi-procumbent. Three small premolars, p_4 with triangular base and distinct deuteroconid.

1. Paraconids strong, enamel smooth ..... *Omomys.*
2. Paraconids reduced, enamel wrinkled ..... *Hemiacodon.*

III. Paraconids distinct, median, metaconids postero-internal to protoconids, no metastylids. Incisors small, canine of moderate size. Jaw short and deep anteriorly, front teeth vertical. Premolars crowded, p_{3-4} enlarged, trenchant with quadrate base, no deuteroconids..... *Uintanius.*

IV. Paraconids distinct, median, metaconids opposite protoconids, metastylids distinct. Two minute incisors, canine small, jaw short and deep anteriorly, front teeth vertical. Premolars crowded, small, deuteroconid distinct on p_{3-4}.

1. Molars broader, heel of m_3 bicuspid..... *Washakius.*
2. Molars narrower, heel of m_3 single..... *Shoshonius.*

V. Paraconids internal, more or less connate with metaconids; metaconids opposite or somewhat posterior to protoconids, no metastylids. Molar cusps less marginal than in the preceding groups. Jaw short and deep anteriorly. Premolars robust, no deuteroconids.

1. M_3 unreduced, paraconids vestigial except on m_1
   a. Two minute incisors, canine small. p_2 absent, p_4 smaller than m_1. *Anaptomorphus.*
   b. Anterior teeth unknown..... *Euryacodon.*
2. M_3 reduced, paraconids more distinct, three premolars.
   a. Canine and one incisor moderately enlarged, posterior premolars much enlarged..... *Absarokius.*
   b. No incisors, canine much enlarged, posterior premolars somewhat enlarged..... *Tetonius.*

The geological range of the Eocene genera is as follows:

	Gray Bull	Lysite	Lost Cabin	L'r Bridger	Up'r Bridger
Omomys	*	*		*	?
Hemiacodon					*
Uintanius				*	*
Shoshonius			*		
Washakius				?	*
Anaptomorphus				*	
Euryacodon				*	
Absarokius		*	*		
Tetonius	*	*			

Omomys *Leidy* 1869.

Generic characters: Dentition $\frac{? ? 3.3.}{2.1.3.3.}$. Jaw long and slender, incisors semi-procumbent, the first somewhat enlarged, the second small. Canine larger than p_2, somewhat larger than i_1. Premolars with triangular bases, not crowded, p_2 very small, p_3 simple, high crowns, p_4 smaller than m_1, deuteroconid distinct. Molars with strong well separated paraconid, median or submedian in position; crowns low, cusps submarginal, enamel smooth. $M\frac{3}{3}$ unreduced. Upper molars trigonal,

moderately wide, small conules, no mesostyle, very rudimentary hypocone. Upper premolars with large deuterocones on p^{3-4}, p^2 simple.

The typical species *O. carteri* is from the Bridger, and other species from the same horizon are referred to the genus by Wortman.

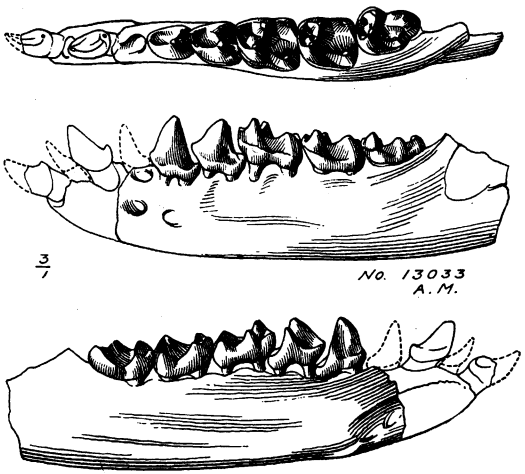


Fig. 20. *Omomys sp.*, lower jaw, inner, outer and crown views. Lower Bridger beds (Middle Eocene), Bridger basin, Wyoming. Front teeth restored from No. 12600.

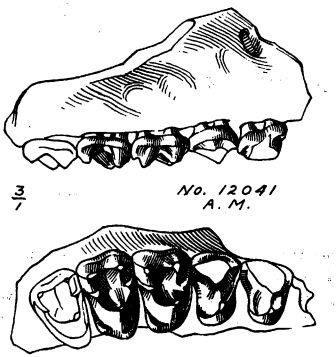


Fig. 21. *Omomys sp.*, upper jaw, outer and crown views. Upper Bridger beds (Middle Eocene), Bridger basin, Wyoming.

Omomys minutus (*Loomis*).

Notharctus minutus Loomis, 1906, Amer. Journ. Sci., Vol. XXI, p. 283, fig. 6.

Type, Amherst Mus. No. 365, a lower jaw with m_{1-3} perfectly preserved, and roots of p_{3-4}, from Lysite beds, Cottonwood Creek, Wind River basin, Wyoming.

Specific characters: $M_{1-3}=5$ mm. Size of the Bridger species *Omomys ameghini* Wortman, but teeth narrower and paraconid more distinct, if Wortman's figure be accurate.

Through courtesy of Dr. Loomis I have been able to study this interesting little type which is unlike anything in the American Museum collections. The species agrees with *Omomys* in the construction of the molars, and in the slender jaw with premolar roots indicating that these teeth were of moderate width and not crowded. It is much smaller than *O. vespertinus* infra.

?Omomys vespertinus sp. nov.

Type, No. 16835, lower jaw with m_{1-3}, from Upper Gray Bull beds at head of Elk Creek in the Bighorn basin, Wyoming.

Paratype, No. 16213, upper jaw with p^3–m^3 from top of Almagre beds, San Juan basin, New Mexico.

Specific characters: $M_{1-3}=7.8$ mm. Size of *O. carteri* but last molar smaller and paraconid on m_{2-3} more internal in position and partly connate with metaconid.

This species is very doubtfully referable to *Omomys*, the lower molars being intermediate in character between that genus and *Tetonius*. They have the low crowns and comparatively narrow proportions of *Omomys*,

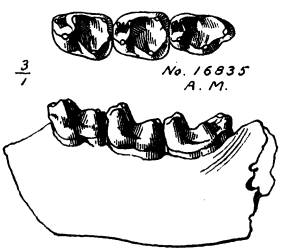


Fig. 22.

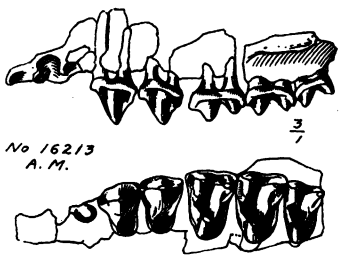


Fig. 23.

Fig. 22. *Omomys vespertinus*, lower jaw, outer view, and crown view of teeth. Type specimen, upper Gray Bull beds, Bighorn basin, Wyoming.

Fig. 23. *Omomys vespertinus*, upper jaw, outer and crown views. Paratype, top of lower (Almagre) beds of Wasatch, San Juan basin, New Mexico.

with small trigonid of less width than talonid; and the last molar is but little reduced. The position of the paraconid agrees better with *Tetonius*. The premolars and front teeth are unknown.

A well preserved jaw from the New Mexico Wasatch accords in size and proportions with the type, and is likewise of somewhat intermediate character although the relationship to *Omomys* is more evident. The last molar is slightly reduced but shows, like the others, the characteristic trigonal

form, moderate width, minute conules, no mesostyle, and smooth enamel characteristic of *Omomys;* the premolars agree with that genus in their moderate width, triangular form and strong deuterocones. If this upper jaw be correctly referred, the species is properly referable to the genus. In *Tetonius* and *Absarokius* the molars are wider, more oval in form, m^3 more reduced, conules better developed; the premolars larger proportionately, wider transversely in *Tetonius,* the deuterocones more reduced in *Absarokius* and much more in *Uintanius.*

The alveoli of the front teeth in No. 16213 are partly shown. In front of p^3 are three small alveoli, the first two rather obscurely shown. These are probably an incisor, canine and p^2, but the front of the jaw is not well enough preserved to distinguish the maxillo-premaxillary suture, so that the interpretation is doubtful.

Hemiacodon *Marsh* 1872.

Hemiacodon MARSH, 1872, Amer. Journ. Sci., Vol. IV, p. 212; Wortman, 1904, *ibid.*, Vol. XVII, p. 135, figs. 128–132.

Type, H. gracilis Marsh from the Upper Bridger beds on Henry's Fork, Wyoming.

Generic characters: Dentition $\frac{? ? ? 3}{2.1.3.3}$. P^4 with strong deuterocone, upper molars wide transversely with strong conules, distinct protostyle and hypocone, no mesostyle, $m\frac{3}{3}$ unreduced, lower molars with median paraconid, reduced on m_2, vestigial on m_3, no metastylid, trigonids relatively small, entoconid of m_3 distinct; premolars not enlarged or crowded, p_{3-4} with triangular bases, deuteroconid distinct on p_4. Canine and first incisor moderately large, second incisor and p_2 very small. Jaw slender and rather shallow anteriorly, front teeth semi-procumbent. Enamel of molars and premolars heavily wrinkled.

This genus is confined to the upper part of the Bridger formation, where it is represented by two or more species, larger than any other Eocene Tarsiidæ. It is nearly related to *Omomys* and may be regarded as a derivative of that genus. Although fairly common, the skull is unknown and no skeleton material has been found associated with upper or lower jaws which were certainly of the same individual. Part of a skeleton associated with teeth of *Telmatolestes* and *Hyopsodus* is referred to *Hemiacodon* provisionally; it certainly does not belong to either of the two genera whose teeth were found with it; and among the known genera of appropriate size *Hemiacodon* and *Microsyops* are the only ones which are not excluded, either by direct or reasonably conclusive indirect evidence that their skeleton construction was widely different. If *Microsyops* is related to *Mixodectes* it is also excluded, but this is very doubtful. The reason for referring this partial skeleton and a number of isolated bones, of the same characteristic structure

and similar size and proportions, to *Hemiacodon* rather than to *Microsyops* is that as with *Hemiacodon* they are strictly limited to the Upper Bridger. Smaller bones of similar type occur rarely in the Lower Bridger and are appropriate in size to the nearly related genus *Omomys*. None have been found in the Wind River or Wasatch formations. *Microsyops* on the other hand is more abundant in the Lower than in the Upper Bridger and the species only slightly smaller, while the closely related *Cynodontomys* is

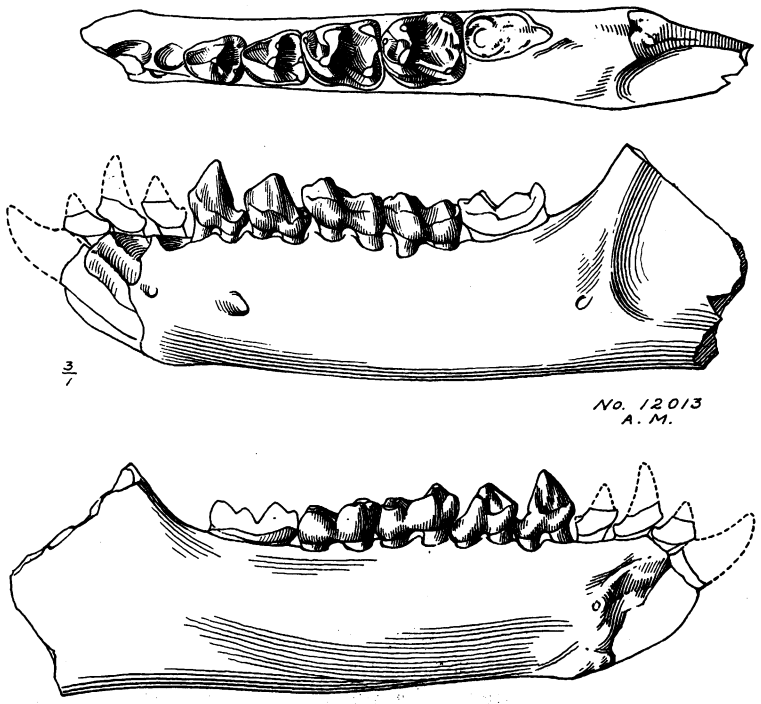


Fig. 24. *Hemiacodon gracilis*, lower jaw, inner, outer and crown views. Upper Bridger beds (Middle Eocene), Bridger basin, Wyoming. Front teeth restored from No. 12037.

fairly common in the Wind River basin and occurs also in the Bighorn basin, but no skeleton material of the type here under discussion has been found in these basins. This is by no means conclusive but in default of better evidence it may serve as a reason for referring this type of skeleton to *Hemiacodon* rather than to *Microsyops*. Wortman has referred an unassociated calcaneum of this type to *Microsyops*, stating that "there is no other known primate in the Bridger to which as regards size it could pertain."[1] But the size is more appropriate to *Hemiacodon*.

[1] Wortman, 1903, Amer. Journ. Sci., Vol. XVI, p. 209, fig. 115.

If this skeleton belongs to *Hemiacodon,* it confirms the affinity to *Tarsius;* although much less specialized than that genus it has the same elongated tarsals, large opposable hallux and other characters. If on the other hand it belongs to *Microsyops* it would place the lemuroid affinities of that genus beyond question and show that it was not related to the Mixodectidæ.

The description of this skeleton does not fall within the province of the present revision, but it appeared advisable to place on record the evidence for its reference to this genus as having an important bearing on the affinities of the Lower Eocene primate genera.

Washakius *Leidy* 1873.

Washakius LEIDY, 1873, Contrib. Ext. Faun. West. Terrs. (Rep. U. S. Geol. Geog. Sur. Terrs., Vol. I) p. 123, pl. xxvii, fig. 3; Wortman, 1904, Amer. Journ. Sci., Vol. XVII, p. 208, figs. 142–146.

Type, Washakius insignis Leidy from Bridger formation, Middle Eocene, of Wyoming.

Generic characters: Dentition $\frac{2.1.3.3}{2.1.3.3}$. Upper incisors and canine small, premolars of moderate size, p^{3-4} with strong deuterocones. Upper molars of moderate transverse width with small conules, rudimentary hypocones, no mesostyles. $M\frac{3}{3}$

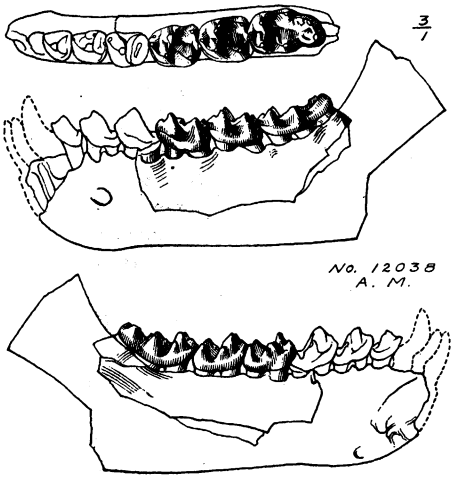


Fig. 25. *Washakius insignis,* lower jaw fragment, inner, outer and crown views. Front of jaw restored from No. 12040. Upper Bridger beds (Middle Eocene), Bridger basin, Wyoming

slightly reduced. Lower molars with distinct median paraconid and distinct metastylid; m_3 with distinct entoconid and double hypoconulid. Lower premolars of moderate size, p_2 being less reduced than in the other genera, crowded, with

quadrate bases, low crowns, distinct deuteroconids on p_{3-4}. Lower canine of moderate size, two very small incisors. Jaw short and deep anteriorly, front teeth vertical. Enamel heavily wrinkled.

This genus is confined to the Bridger and chiefly found in the Upper Bridger although one specimen comes from near the top of the lower beds (Horizon B4). It is readily recognized by the peculiar construction of the molars, and the premolars are almost equally characteristic; they are short, wide, low-crowned, deuteroconid strong on p_{3-4}, p_4 with quadrate base. The second premolar is less reduced than in the other genera, the canine is moderately large, and in front of it two very small incisors. Two specimens in the American Museum have the premolars and first molar complete and alveoli of the three front teeth; Wortman had concluded from less perfect material that there was probably only one incisor. I have not seen the upper teeth of *Washakius;* Wortman's reference to it of a well preserved upper jaw in the Yale Museum appears to be well supported by the evidence and indicates that the hypocone is stronger in this genus than in any of the others from the American Eocene. The upper premolars have strong deuterocones, the molars are subtrigonal with small hypocone, no protostyle, minute conules, no mesostyle. The enamel of upper and lower teeth is heavily wrinkled, as in *Hemiacodon.*

Shoshonius *Granger* 1910.

Type, S. cooperi from Lost Cabin beds of Wind River basin, Wyoming.

Generic characters: Upper molars tritubercular with small conules and a mesostyle. Lower molars with strong well separated paraconid and a distinct cusp posterointernal to the metaconid. $M\frac{3}{3}$ unreduced. Enamel with heavy vertical wrinkling. Upper premolars with strong internal cusps. Width of teeth moderate.

This genus is closely allied to *Washakius,* from which it differs chiefly in the presence of a distinct mesostyle, the somewhat narrower molars and relatively larger trigonids, and absence of the cusp internal to the hypoconulid.

Shoshonius cooperi *Granger* 1910.

Shoshonius cooperi GRANGER, 1910, Bull. Amer. Mus. Nat. Hist., Vol. XXVIII, p. 249, fig. 5.

Type, No. 14664, upper jaw with p^3–m^3, from Lost Cabin beds of Wind River basin, Wyoming.

Specific characters: $M^{1-3} = 6$ mm.; $m_{1-3} = 7$ mm.

I refer to this species jaw fragments of six individuals, Nos. 14665–14670, from the same horizon and locality as the type. In No. 14670 the last upper

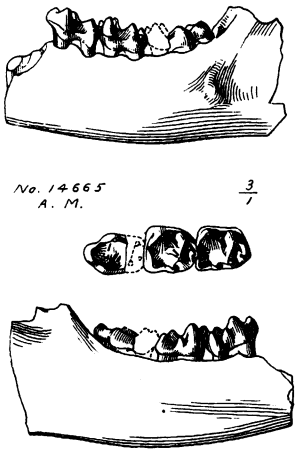


Fig. 26. *Shoshonius cooperi*, lower jaw, outer and inner views, and crown view of teeth, Lost Cabin beds, Wind River basin, Wyoming.

and last lower molar are associated. The others show only the lower molars. The lower premolars are unknown.

Uintanius gen. nov.

Type, U. turriculorum infra from the Middle Eocene Bridger formation of Wyoming.

Generic characters: Dentition $\frac{? ? 3.3}{? 1.3.3}$. Jaw short, deep anteriorly. Premolars enlarged, crowded, with compressed trenchant crests; deuterocones on upper premolars vestigial, no deuteroconids on lower premolars. Upper molars tritubercular with small conules, no distinct hypocones, no mesostyles. Lower molars with distinct median paraconid, metaconid set more posteriorly than protoconid, especially upon m_1, $m\frac{3}{3}$ little reduced; entoconid of m_3 distinct. Enamel smooth or faintly wrinkled.

This genus appears to be limited to the Bridger formation, and I have not recognized any Lower Eocene ancestors. It parallels *Absarokius* in the enlargement of the premolars, but the form of these teeth is quite different, and the molars are of very distinct pattern. The alveoli indicate a lower canine of moderate size and a small incisor in front of it, the other incisor if present was also small.

Uintanius turriculorum sp. nov.

Anaptomorphid gen. indesc., MATTHEW, 1909, Mem. Amer. Mus. Nat. Hist., Vol. IX, p. 549, pl. lii, fig. 7.

Type, No. 12598, lower jaw with p_3–m_3 figured, as above, from Grizzly Buttes, Lower Bridger beds, Horizon B_2.

Paratypes, No. 13039, upper jaw with p^3–m_2 from the base of the Upper Bridger, Horizon C, at Summers' Dry Creek; No. 12376, lower jaw m_{1-3} from the top of the Upper Bridger, Horizon D_4 on Henry's Fork Hill. All from the Bridger basin, Wyoming.

Specific characters: P_3–m_3 = 9 mm.; m_{1-3} = 6 mm.

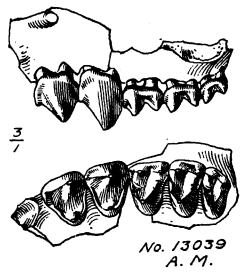


Fig. 28.

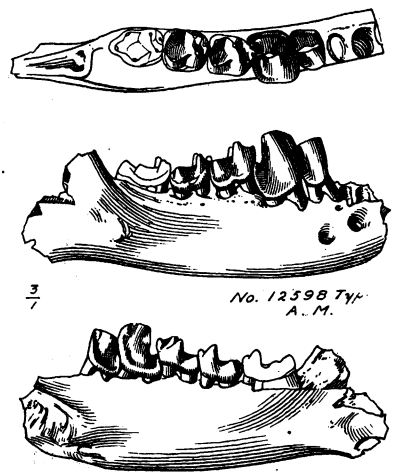


Fig. 27.

Fig. 27. *Uintanius turriculorum*, lower jaw, inner, outer and crown views. Type specimen, Lower Bridger beds (Middle Eocene), Bridger basin, Wyoming.

Fig. 28. *Uintanius turriculorum*, upper jaw, outer and crown views. Paratype, Upper Bridger beds (Middle Eocene), Bridger basin, Wyoming.

The name refers to "The Chimneys" a well known landmark on the north side of Henry's Fork. The association of the upper jaw is based upon correspondence in size and proportions, and especially upon the correspondence in type of the premolars, which are very different from any other genera of Tarsiidæ.

Anaptomorphus *Cope* 1872.

Anaptomorphus COPE, 1872, Palæont. Bull. No. 8, Oct. 8, 1872, Proc. Amer. Phil. Soc., Vol. XII, p. 554; *Anaptomorphus*, in part, COPE, 1885, Tert. Vert., p. 245, pl. xxv, fig. 10; OSBORN, 1902, Bull. Amer. Mus. Nat. Hist., Vol. XVI, p. 200 figs. 24, 25; WORTMAN, 1904, Amer. Journ. Sci., Vol. XVII, p. 211.

Type, A. æmulus Cope, from Lower Bridger of Wyoming.

Generic characters: Dentition $\frac{2.1.2.3.}{}$. Upper teeth unknown; lower molars wide and short with internal paraconid vestigial on m_2, m_3 unreduced but crown unknown, p_4 robust, smaller than m_1, deuteroconid obscure, anterior teeth small, one-rooted, canine slightly larger than adjoining teeth, lower jaw short and moderately deep anteriorly, enamel not wrinkled. Outer cusps of molars less marginal than in preceding genera, more so than in *Tetonius* and *Absarokius*.

I refer to this genus only the type species represented by a lower jaw with p_4–m_2 and roots or alveoli of the remaining teeth. It appears probable,

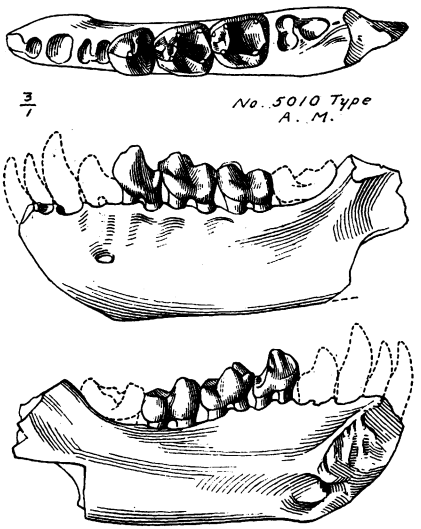


Fig. 29. *Anaptomorphus æmulus*, lower jaw, inner, outer and crown views. Type specimen, Lower Bridger beds (Middle Eocene), Bridger basin, Wyoming.

however, that this genus is a synonym of *Euryacodon* if Wortman is correct in referring certain lower jaw fragments to that genus. Doctor Wortman states that the paraconid is absent on all the molars in *Anaptomorphus* and holds the two genera separate on that ground; but it is certainly distinct on m_1 in the type and vestigial, rather than absent, on m_2, the apparent absence being due to wear.

Anaptomorphus homunculus is removed from the genus and made the type of *Tetonius* infra.

Tetonius gen. nov.

Type, Anaptomorphus homunculus Cope 1882.

Generic characters: Dentition $\frac{?.1.2.3}{0.1.2.3}$. Number and character of premaxillary teeth unknown. Anterior lower tooth (canine) much enlarged, rooted, subvertical.

Upper canine small, pointed conical with small posterior heel. Upper premolars very wide transversely with large deuterocones. Lower premolars crowded, p_2 quite small, p_3 larger, p_4 enlarged, robust with short heel and obscure deuteroconid. Molars very wide, m_3 reduced, m^{1-2} with rudimentary hypocones, small conules, no mesostyles. Lower molars with paraconid internal, distinct on m_1, partly connate with metaconid on m_{2-3}. Protoconid and metaconid opposite. Cusps of cheek teeth low, massive, the inner cusps of upper series and outer cusps of lower series set well in from margin. Lower jaw short, very deep anteriorly, shallowing under molars. Skull shorter than in *Tarsius*, orbits smaller and less prominent, braincase smaller.

It is with much regret that I find it necessary to remove from the genus *Anaptomorphus* the well known species *A. homunculus*. Wortman in 1904 expressed the opinion that it was probably generically distinct, but refrained from proposing a new genus "until the dentition of both the Bighorn and the Bridger forms is more fully known." So far as the Bridger species *A. æmulus*, type of the genus, is concerned, no more is known of it than the typical jaw found by Cope in 1872, unless indeed certain jaw fragments referred by Wortman to *Euryacodon* belong to this genus.

Of "*Anaptomorphus*" *homunculus* we have a number of additional specimens, and these together with a careful restudy of those hitherto described, show that this species is widely different from the true *Anaptomorphus* in its anterior dentition. It has, as pointed out by Osborn, three lower premolars, instead of two, but in place of three anterior teeth (interpreted as two incisors and a canine) it has a single tooth much enlarged and set semi-vertically in the very deep symphyseal region of the jaw. This is clearly shown in three of our specimens; the others afford no evidence. In No. 41, in which the symphyseal region is obscured by a crust of hematite and has been differently interpreted by Osborn and Wortman, the two small alveoli in front of that for p^2 figured by Osborn are artefacts in the hematite crust; and a cautious removal of a part of this crust clears up the obscurity of the anterior teeth and shows that as in the other specimens described below (Nos. 15064 and 15072) there is a single large alveolus in front.

The skull, No. 4194, which is the type of the species, has been studied and described by several authors. As it is the only skull of this family known, and the oldest primate skull, it has naturally been widely noticed and discussed with regard to its morphologic characters and systematic relationships. In view of its importance it appeared advisable to supplement the photographs which will appear in Doctor Gregory's morphologic description by an attempt at reconstruction of the skull and jaws, the crushing being corrected and the missing parts restored, partly from other individuals (outline) and partly by analogy with *Tarsius* (dotted lines).

The method adopted for correcting the distortion due to crushing has

been to draw separately each of the principal displaced portions of the skull in their true perspective with relation to the median plane and combine them so as to correct the overlap and displacement. This has been very conscientiously and skilfully executed by the artist, Mrs. L. M. Sterling, under my supervision, aided by criticism from Doctor Gregory and Mr. Granger, the *Tarsius* skull being used for guidance and comparison. I take pleasure in calling attention to the accuracy and excellence of Mrs. Sterling's work as instanced not only in the present difficult reconstruction but in the entire series of illustrations of Lower Eocene mammals treated in this revision, most of the specimens being fragmentary, many of them of minute size and some in poor preservation.

The skull of *Tetonius* will be described by Doctor Gregory; in the present revision I confine myself to a discussion of the tooth characters. These have already been considered by Cope, Osborn and Wortman, but the present interpretation differs from theirs in certain important particulars, especially as to the front teeth, which are so widely different from those of *Anaptomorphus* that the genus must be regarded as distinct.

Tetonius homunculus (*Cope* 1882).

Anaptomorphus homunculus COPE, 1882, Pal. Bull. No. 34 (Feb'y. 22), Proc. Amer. Phil. Soc., Vol. XX, p. 152; 1885, Tert. Vert., p. 249, pl. xxive, fig. 1; OSBORN, 1892, Bull. Amer. Mus. Nat. Hist., Vol. IV, p. 103, fig. 6; 1902, *ibid.*, Vol. XVI, p. 200, figs. 24, 25; HUBRECHT, A. A. W. 1897, Descent of the Primates (Princeton Lecture), p. 18, figure; WORTMAN, 1904, Amer. Journ. Sci., Vol. XVII, p. 248.

Type, No. 4194, Cope Coll., a skull from the Wasatch of the Bighorn basin, Wyoming.

Specific characters: Lower molars m_{1-3} = mm. Teeth wider and more massive, jaw deeper than in the following species.

Besides the type skull, No. 41 upper and lower jaws, No. 15063 upper and lower jaws, No. 15062 upper jaw, and Nos. 42, 43, 15064, 15065 and 15693 lower jaws, are referred to this species.

Observations upon the type skull. The premaxillary region is broken off, the fractured surface apparently coinciding at several points with the maxillo-premaxillary suture. The fracture has, however, lost some of its freshness owing to repeated handling of the specimen during the thirty-five years since its discovery, and the sutural surfaces cannot be recognized with absolute certainty. The maxillary teeth were interpreted by Cope and Osborn as canine, two premolars and three molars. Wortman states that there is evidence of seven teeth, the most anterior represented by an alveolus. But it does not appear to me that the small concavity on the fractured anterior face of the right upper jaw which he interprets as a portion of a

tooth socket warrants any such positive statement. It may be a portion of an alveolus, but it is not certainly so. At all events no portion of an alveolar border is preserved. Nor is Wortman's statement that in the maxilla, No. 41, there is evidence of a tooth with more than a single root in advance of the two premolars confirmed by careful study of the specimen. If it were so this specimen would disagree with the typical skull, in which the tooth in advance of the premolars is single-rooted, and separated from them by a short diastema; but this second maxilla agrees in both particulars with the type so far as I am able to judge.

That this single-rooted tooth is a premolar as Wortman believes, appears to me improbable on account of the diastema between it and p^3. A diastema

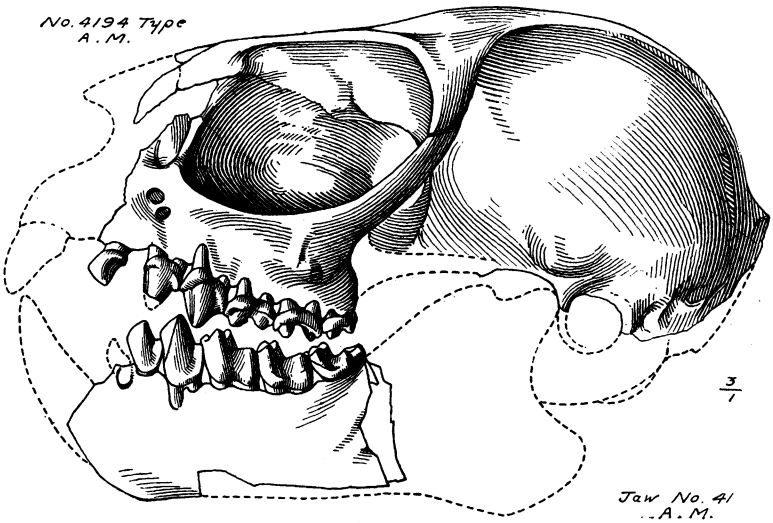


Fig. 30. *Tetonius homunculus* (Cope), skull and lower jaw, left side view, distortion of skull corrected. Type skull of *Anaptomorphus homunculus*, Gray Bull beds, Bighorn basin, Wyoming. Lower jaw from No. 41, same horizon and locality.

between p^2 and p^3 in so short and crowded a dentition would be very unlikely; on the other hand if p^2 is suppressed the postcanine diastema is quite natural. The form of the tooth in question is not decisive, but is more suggestive of a canine, and if the remnants of the maxillo-premaxillary suture are correctly identified on the broken anterior face of the skull, the position of the tooth in question is so close behind it that it must have been a canine unless this tooth was suppressed, which is less probable than the suppression of p^2.

I conclude that Cope's and Osborn's interpretation of this tooth as the canine is correct.

There is no evidence as to the premaxillary teeth in any of our specimens. By analogy with *Tarsius* I suppose it probable that there was one enlarged incisor, and that probably the others were suppressed, as the lower front teeth are more specialized than in the modern genus. The premolars are very wide transversely with large deuterocones, especially on p^4, rudimentary stylar cusps and strong anterior and posterior cingula. The molars are also very wide transversely, with rudimentary hypocones, small conules, no mesostyle; the parastyle rudimentary. The third molar is much reduced and has only the three principal cusps.

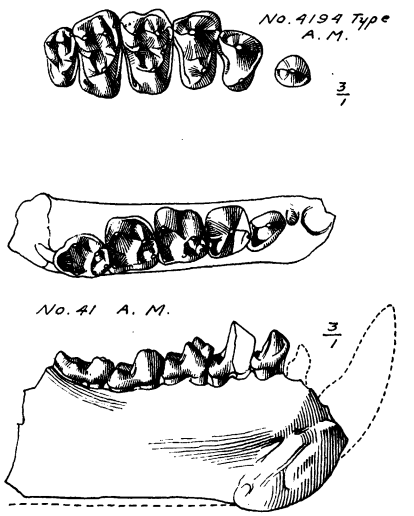


Fig. 31. *Tetonius homunculus* (Cope), lower jaw, inner and crown views, from No. 41; and crown view of upper teeth, from type specimen, Gray Bull beds, Bighorn basin, Wyoming.

Observations upon referred specimens. In the second specimen, No. 41, p^3–m^3 are preserved, with part of the canine alveolus. It agrees quite nearly with the type, save that the hypocones appear slightly less prominent. Two other upper jaws are likewise in close agreement. In No. 41 and No. 15063 upper and lower teeth of the same individual are associated. Nos. 42, 15064–5 and 15693 are lower jaws with from two to five cheek teeth preserved. All agree quite closely in the corresponding parts. In No. 15064 the alveoli of the large anterior tooth (canine?) and a small one behind it are shown, followed by p_3–m_3 well preserved. In No. 41 p_3–m_3 are preserved, in front of them is a small alveolus and in front of that a large alveolus close to the symphysis. The proportions and relations of this enlarged front tooth, which I regard as probably a canine, appear to be the same as in the smaller species *T. ambiguus* in which its root is preserved. The lower jaw is deeper and heavier in the symphyseal region than in *Anaptomorphus* or other genera with small front teeth, but not as deep as in *Trogolemur*.

P_2 is a very small one-rooted tooth, but is not preserved in any of our specimens. P_3 and p_4 are robust crowded teeth ridged antero-internally and postero-externally, with rudimentary deuteroconid on p_4, short wide heels on both. P_3 has two connate roots much compressed antero-posteriorly; in p_4 they are more distinct and less compressed. The premolars are

throughout of similar type to those of *Absarokius*, only much less exaggerated.

The molars are characterized not only by their great width, the first and second being as wide as long or wider, but by the approximation of the outer cusps towards the centre of the tooth, and the unusual height, not of the cusps which are low, but of the crown of the tooth as a whole, especially when viewed from the external side. The paraconid is distinct on m_1 but decidedly lower than the other trigonid cusps; on m_2 and m_3 it is rather closely connate with the metaconid, but always recognizable. M_3 is about as long as m_2 but barely two thirds as wide; its hypoconulid is moderately wide and entoconid semi-distinct.

Comparison with Trogolemur. *Tetonius* has the same dental formula and the front tooth enlarged; nevertheless the detailed comparison of the lower teeth does not indicate close affinity. In *Trogolemur* the root of the front tooth reaches far under the molars, the premolars are not enlarged or crowded, the last molar is unreduced, and the paraconid, although internal, is not connate with the metaconid. The molars are moderately wide, but the outer cusps are marginal, and the outer cingula are very prominent. It has much resemblance to the Tarsiidæ generally but no special resemblance to *Tetonius*.

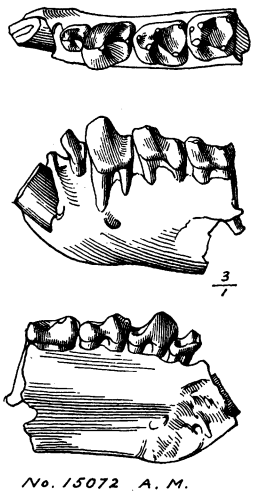


Fig. 32. *Tetonius ambiguus*, lower jaw, inner, outer and crown views. Type specimen, Gray Bull beds, Bighorn basin, Wyoming.

Tetonius ambiguus sp. nov.

Type, No. 15072, lower jaw with p_3–m_2 and roots of front teeth, from the lower Gray Bull beds in the Bighorn basin, Wyoming.

Specific characters: Molars of less width than in *T. homunculus*, third premolar relatively small, canine proportionately large, jaw of less depth anteriorly.

The type of this species gives some indications of the character of the enlarged front tooth. The root is compressed oval, flattened on the inner side smooth and uniform, indicating probably a crown somewhat like that of *Cynodontomys*, but set rather more vertically.

Measurements: P_3–m_2 = 7.5 mm., approximately the same as in *T. homunculus*.

Tetonius musculus sp. nov.

Type, No. 12830, lower jaw with m_3 and roots or alveoli of the preceding teeth, from the Lysite horizon in the Wind River basin, Wyoming.

Specific characters: Lower jaw much more slender than in *T. homunculus* or *ambiguus*, canine root less compressed, premolars and molars less robust, m_3 less reduced, heel longer.

This species has a much less specialized dentition than the two preceding but comes from a later horizon. Its reference to the genus is open to question. It is about the size of *Omomys minutus* (Loomis) and is from the same

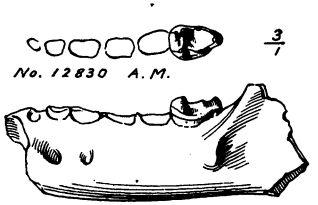


Fig. 33.

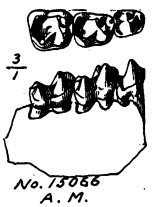


Fig. 34.

Fig. 33. *Tetonius musculus*, lower jaw, outer view, and crown view of last molar. Type specimen, Lysite beds, Wind River basin, Wyoming.

Fig. 34. *?Tetonius musculus*, lower jaw fragment, with p_4–m_2, outer and crown views. Gray Bull beds, Bighorn basin, Wyoming.

locality and horizon, but is readily distinguished by the deeper jaw, shorter premolars, m_3 with paraconid internal and connate with metaconid.

No. 15066, lower jaw fragment with p_4–m_2 compares with this species, but if identical it can hardly be regarded as congeneric with *T. homunculus*.

Absarokius gen. nov.

Type, *Anaptomorphus abbotti* Loomis, 1906.

Generic characters: Dentition $\frac{1.1.3.3.}{}$. Molars similar to *Tetonius;* premolars of similar type but more specialized. Two lower front teeth in advance of p_2, subequal and of moderate size, presumably incisor and canine. Fourth upper premolars oval, triangular, moderately wide, with small deuterocone; lower premolars crowded, much enlarged, with quadrate bases, deuteroconids absent, more turgid than in *Uintanius* and without anterior cusp or blade. Upper molars ovate-trigonal, wide transversely, protocones set far in from margin, m^3 much smaller than m^2, wide transversely, suboval. Lower molars wide with low cusps, the outer cusps set far in from margin, paraconid distinct on m_1, internal and connate with metacone on m_{2-3}. Last lower molar considerably reduced, hypoconulid small, narrow, entoconid indistinct.

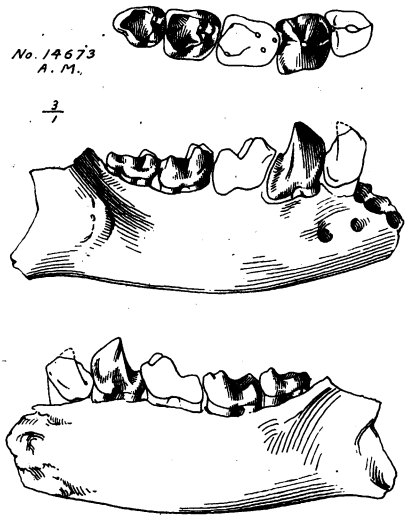


Fig. 35. *Absarokius abbotti*, lower jaw, inner and outer views, and crown views of teeth. Lysite beds, Wind River basin, Wyoming.

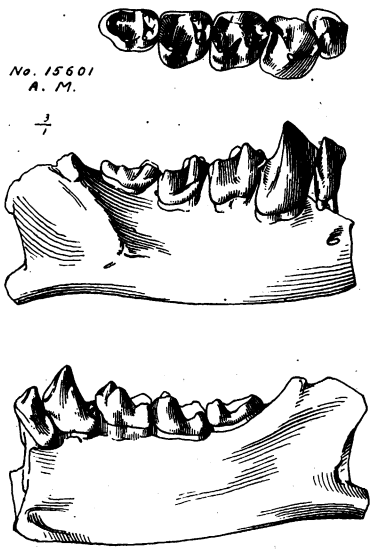


Fig. 36.

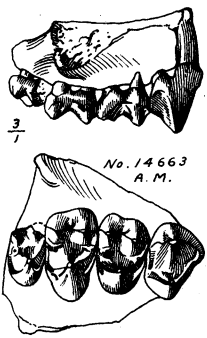


Fig. 37.

Fig. 36. *Absarokius noctivagus*, lower jaw, inner and outer views, and crown view of teeth. Type specimen, Lost Cabin beds, Bighorn basin, Wyoming.

Fig. 37. *Absarokius noctivagus*, upper jaw, outer and crown views. Paratype. Lost Cabin beds, Wind River basin, Wyoming.

Two species are placed under this genus, *Anaptomorphus abbotti* Loomis of the Lysite and a new species, *noctivagus*, of the Lost Cabin beds. So far as the premolar and molar teeth are concerned they would appear to be progressively specialized descendants of *Tetonius homunculus* of the older Gray Bull horizon. But the front teeth are differently specialized, *Tetonius* having a single tooth much enlarged in front of the small p_2, while in *A. abbotti* there were clearly two of moderate size. *A. noctivagus* appears to be nearly allied to *A. abbotti* in dentition, but somewhat more progressive; the lower front teeth are not shown in any of our specimens, but the characterization of the upper premolars and molars is based upon this species.

Despite the difference in the front teeth it appears probable that this genus is very closely allied to *Tetonius*. Were it not for the single specimen of *A. abbotti* in which the alveoli of the front teeth are preserved, I should regard the three species *homunculus, abbotti* and *noctivagus* as three stages of a genetic series. It is possible that this is really the case, and the *abbotti* lower jaw is abnormal. But in default of evidence I do not venture to assume so.

Order INSECTIVORA.

Under this order are placed ten genera of Lower Eocene mammals,[1] most of them, however, *incertæ sedis*. It is not possible clearly to delimit the order from the Primates on one hand and the Carnivora (Creodonta) on the other, except through characters of skull and skeleton, and in some groups these parts are unknown. But even when the skeleton is known the order is not very clearly defined. It includes a number of families placed here for lack of a more suitable location rather than from any special affinities to the typical Insectivora. The modern order is so largely defined by negative characters, by lack of the characteristic specializations of the other orders, that it has served as a sort of palæontological scrap-basket, a container of odds and ends.

So far as the teeth are concerned, the order is in general characterized by small size and lack of specialization of the canine as a prehensile tooth, one or more of the incisors frequently being enlarged to take its place. The cheek teeth are typically insectivorous, with sharp triangular cusps, affording numerous small shearing edges. But the Pantolestidæ have a Creodont type of teeth, although in skull and skeleton they are unmistakably Insectivora, and the Apatemyidæ and Mixodectidæ have Lemuroid

[1] *Diacodon, Parictops, Palæosinopa, ?Nyctitherium, ?Apheliscus, ?Didelphodus, ?Creotarsus, ?Cynodontomys, ?Phenacolemur, ?Nothodectes.*

molars although other features indicate that they are more probably Insectivora.

In absence of satisfactory evidence I have made only such changes in the accepted arrangement as seem sufficiently well founded to be permanent.

The reference of the Apatemyidæ and Mixodectidæ to the Insectivora rather than to the Primates has been discussed by Matthew in 1909. No conclusive evidence as to the affinities of either of these groups has been furnished by the new material from the Lower Eocene. Such additional data as are at hand tend to emphasize the affinities of both to the Eocene Tarsiidæ, whose reference to the Primates rests upon very strong evidence.[1] The affinities of all these Eocene Primate and near-Primate groups will be re-examined and the evidence evaluated by my colleague Dr. Gregory, to whose able and judicial consideration I leave the question, observing that the retention of the two families in the more generalized and primitive group Insectivora seems advisable until adequate evidence is at hand of their belonging to the more specialized and progressive group Primates.

MIXODECTIDÆ.

The reference of *Cynodontomys* and *Microsyops* to this family appears to be open to serious doubt. The lower molars are unquestionably much like those of *Mixodectes*, but there the resemblance ends. The upper molars are by no means so close; the premolars are of wholly different type, and the homologies of the enlarged front teeth may not be the same. In *Mixodectes* the three premolars are preceded by a canine, recognizable by its larger size than p_2 and more external position; and in front of this is the enlarged spatulate tooth which must therefore be an incisor. In *Microsyops* there are apparently three premolars decreasing progressively forward, and the tooth in front of them may be either an incisor or a canine. In the upper jaw of *Indrodon*, a near relative of *Mixodectes*, there are three premolars, progressively smaller forward, a moderately large one-rooted canine in front of them, and two incisors, the more median one enlarged. In the upper jaw of *Microsyops* there are three premolars progressively smaller forward, and front of them and just behind the maxillo-premaxillary suture is a two-rooted canine, a little larger than p^2 and more externally set; the premaxilla is unknown but must have had an enlarged incisor to correspond to the enlarged lower tooth. $P\frac{4}{4}$ of *Mixodectes* is a peculiarly specialized tooth, the principal cusp high, stout, simple and somewhat recurved. In

[1] Although it is far from certain that *all* of the Eocene genera referred to this family are Primates.

Cynodontomys and *Microsyops* $p\frac{4}{4}$ are progressively molariform, smaller than m_1 but do not appear to be derived from the peculiar *Mixodectes* type.

The type species of *Cynodontomys* and *Microsyops* are from the Lysite and Lower Bridger, and are in fact so much alike that the genera would be better united were it not for the more diverse species found in the Gray Bull below and Upper Bridger above. The successive species between these two extremes form a progressive series, but the amount of change in the teeth is not large as between any two successive stages, and in the molars it is hardly appreciable.

Metolbodotes. Schlosser[1] has referred to the Mixodectidæ under this name a lower jaw from the Fayum Oligocene of Egypt. The only grounds that I can discover for this reference are that it has the same dental formula as that ascribed to *Olbodotes* by Osborn (erroneously so, I believe, for a careful re-examination of the type of Osborn's genus by Mr. Granger and myself leads to the conclusion that it is identical with *Mixodectes*). The teeth of *Metolbodotes*, so far as one may judge from Schlosser's figures, are wholly unlike those of either *Mixodectes* or *Microsyops*, but they agree very well with those of Erinaceidæ, to which family the genus probably belongs. It certainly is not related to the Mixodectidæ and cannot therefore afford any confirmatory evidence as to their Insectivore affinities, as Schlosser affirms that it does.

Key to Genera of Mixodectidæ.

A. *Mixodectinæ:* Upper molars quadrangular with strong hypocone. P^4 with high robust backwardly curved external cusp and small internal cusp; p_4 with high stout protoconid and low heel. Three premolars. Canine reduced.
Mixodectes (*Olbodotes*), *Indrodon*. Paleocene, Torrejon beds.

B. *Microsyopinæ:* Upper molars triangular with weak hypocone. $p\frac{4}{4}$ progressively molariform, the cusps corresponding in form and position to those of the molars. Three premolars, lower canine absent.[2]

1. *Cynodontomys*. P^4 with trittocone smaller than protocone, parastyle distinct, posterior wing of deuterocone crescent rudimentary; p_4 with deuteroconid smaller than protoconid.
2. *Microsyops*. P^4 with trittocone and protocone of equal height and size, no parastyle, posterior wing of deuterocone crescent fully developed; p_4 with deuteroconid and protoconid of equal height.

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[1] Schlosser, 1910, Zoöl. Anz., Bd. XXXV, s. 507; 1911, Beit. z. Pal. Oest.-Ung., Bd. XXIV, s. 70, taf. ix, fig. 5.

[2] Or lower canine much enlarged, incisors absent; see preceding discussion.

Microsyops *Leidy* 1872.

Type, *M. gracilis* Leidy, from Lower Bridger of Wyoming.

The Bridger species are all distinguished by equal height of the two outer cusps (protocone and deuterocone) of p^4, and of the two trigonid cusps, protoconid and deuteroconid, of p_4. These, with the broader and more distinctly bicuspid basined heel of p_4, and presence of a strong curved crest on the same tooth in the position of the paraconid of the true molars, are the only generic distinctions which I can make from *Cynodontomys*. But *M. scottianus* of the Wind River agrees with *Cynodontomys* in all except the broader heel of p_4, and even this is not so distinctly bicusped as in the Bridger species. It should be transferred to *Cynodontomys*. This leaves *Microsyops* as an exclusively Middle Eocene genus.

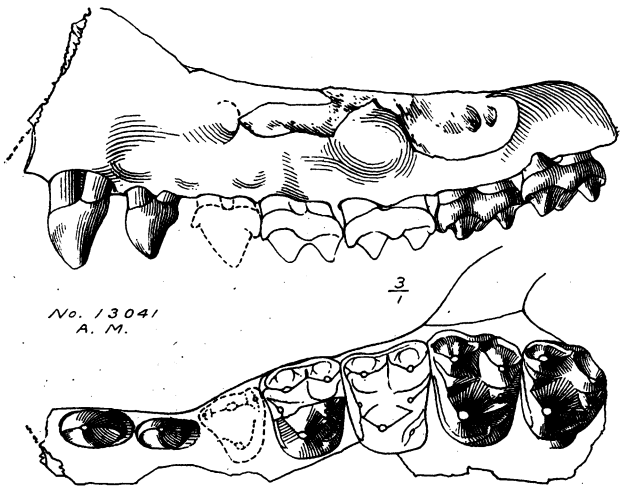


Fig. 38. *Microsyops elegans*, upper jaw, outer and crown views. Bridger beds (Middle Eocene), Bridger basin, Wyoming. M^1 and part of p^4 drawn from No. 12592.

Discussion of ordinal affinities. The molar teeth of *Microsyops* and *Cynodontomys* are not unlike those of the Eocene Tarsiidæ in construction. The lower molars have small triangular trigonids somewhat constricted off from the large basined talonids. The paraconid is distinct but low; in the Anaptomorphidæ, when distinct, it is more nearly on a level with the other cusps. The hypoconulid is distinct on m_{1-2} while in Tarsiidæ it is usually absent; on m_3 the entoconid is a distinct cusp, while in most Tarsiidæ it is a

marginal crest on the basin. The premolars are of wholly diverse type and trend.

It is unfortunate that among nearly one hundred catalogued specimens of these two genera not one has any limb or foot material positively associated

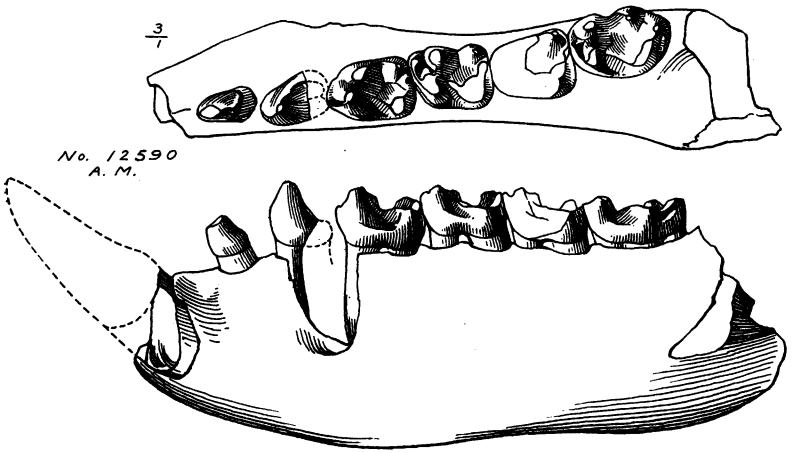


Fig. 39. *Microsyops elegans*, lower jaw, outer and crown views. Bridger beds (Middle Eocene), Bridger basin, Wyoming.

as belonging to the same individual. Nor is there any such association among the specimens of *Microsyops* in the Yale Museum. Wortman arbitrarily referred to this genus an isolated calcaneum of undoubted lemuroid type, and we have several isolated calcanea and other foot-bones apparently of the same form, as well as a considerable part of the hind limbs and feet in association. But for reasons stated on a preceding page I think the genus is more probably *Hemiacodon*.

Setting aside this evidence there is nothing really decisive. The molar teeth are undoubtedly like those of Tarsiidæ and other Primates; but they are equally like those of *Mixodectes* and *Chriacus*, which are not Primate. The molariform fourth premolar is characteristic of two or three groups of Insectivora and is rare among Primates (Galaginæ only). The double-rooted canine and

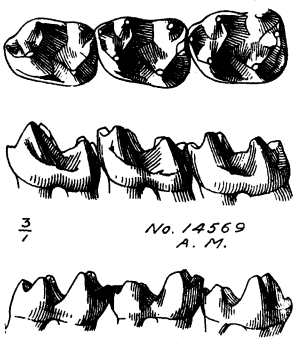


Fig. 40. *Microsyops elegans*, fourth premolar and first and second molars, unworn, inner outer and crown views. Bridger beds (Middle Eocene), Bridger basin, Wyoming

the enlarged lower front tooth are also more characteristic of Insectivora than of Primates. But among the Eocene Tarsiidæ certain genera show an approach to these peculiar specializations of *Microsyops* sufficient to suggest relationship, save for the double-rooted upper canine, and the absence of this peculiarity is not demonstrated except in *Tetonius* (and of course *Tarsius* itself).

I conclude that there is no satisfactory evidence either for or against Primate affinities and in default of such evidence have left the two genera *Cynodontomys* and *Microsyops* in the Mixodectidæ to which they were referred by Cope, Osborn and Wortman. As *Mixodectes* is certainly not a Primate and is very probably an insectivore, these Eocene genera must come provisionally under the order Insectivora.

Cynodontomys *Cope* 1882.

Type, C. latidens Cope, from the Lysite horizon, Wyoming.

The three species included under this genus show a progressive molarization of $p\frac{4}{4}$ and increase in size, but there are no clearly defined progressive

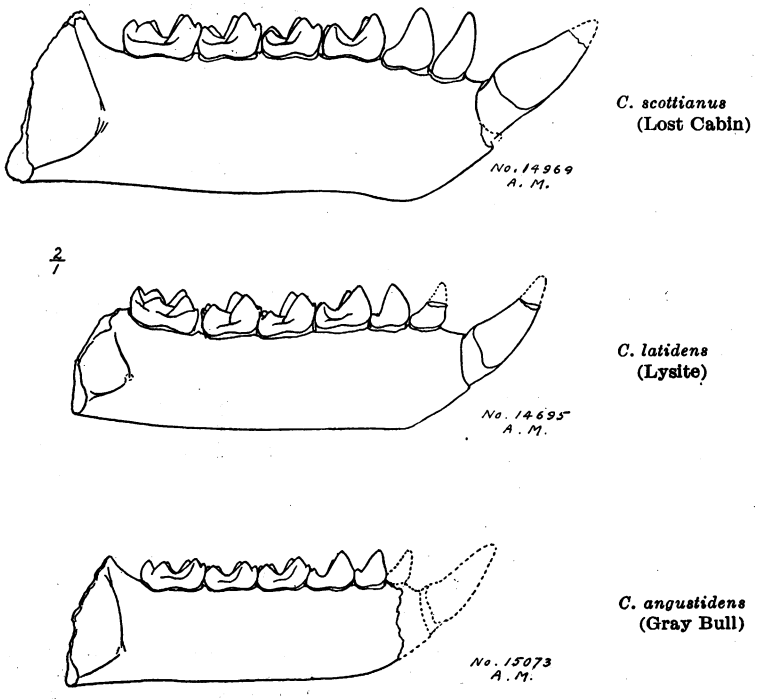


Fig. 41. Outlines of the lower jaws, outer view, of the three species of *Cynodontomys*. All twice natural size.

characters in the molar teeth. They appear to be in genetic sequence, the stage of progress of each specimen being in exact correspondence with its recorded geological level.

Key to Species of Cynodontomys.

1. *C. angustidens* sp. nov. P_4–m_3 = 14 mm. P_4 narrower, oval, with small heel and deuteroconid much smaller than protoconid.
2. *C. latidens* Cope. P_4–m_3 = 15 mm. P_4 with deuteroconid distinctly smaller than protoconid, heel narrower than in *C. scottianus*, its cusps less separate.
3. *C. scottianus* (Cope). P_4–m_3 = 17.3 mm. P_4 with deuteroconid a little smaller than protoconid, and heel broad basined with hypoconid and entoconid wide apart.

The geological occurrence is as follows:

	Bighorn Basin	Wind R. Basin	Beaver Divide	Clark Fork Basin
Lost Cabin	C. scottianus 1 sp'm	C. scottianus 17 sp'm's	C. scottianus 1 sp'm	
Lysite	C. latidens 16 sp'm's	C. latidens 2 sp'm's		
Gray Bull	C. angustidens 9 sp'm's			C. angustidens 1 sp'm

I have not identified the genus with certainty from the New Mexican Wasatch, nor from the Clark Fork beds. A single specimen from the lowest Gray Bull level in Clark Fork basin appears to be a primitive mutant of *C. angustidens*.

The Paleocene ancestors of *Cynodontomys* have not been found, or at all events have not been recognized as such.

Cynodontomys scottianus *Cope.*

Microsyops scottianus Cope, 1881, Bull. U. S. G. S. Terrs., Vol. VI, p. 188; 1885, Tert. Vert., p. 217, pl. xxiva, fig. 2; Osborn, 1902, Bull. Amer. Mus. Nat. Hist., Vol. XVI, p. 209, fig. 36.

Type, No. 4748, left ramus of lower jaw with p_4 and alveoli or roots of remaining teeth. Wind River basin, Wyoming. Wortman, 1881. Probably Lost Cabin beds.

Distinctive characters: P_4–m_3 = 16.8–17.8 mm. P_4 less molariform than in *Microsyops*, more than in *C. latidens*. M_3 unreduced. P_3 two-rooted, obliquely set in type, usually straight.

This species agrees with *Cynodontomys* in the inequality of the two outer cusps of p^4, the lack of trittoconid and inequality of pr^d and de^d on p_4, which appear to be the best distinctive characters of *Cynodontomys*. It is therefore transferred to that genus.

Some twenty jaws or parts of jaws from the Lost Cabin horizon of the Wind River basin agree with the type in all essentials. No. 14969, a well preserved right and left ramus represents the species in the collection from Beaver Divide, south of Lander, Wyo., the teeth complete except for the tip of the incisor. One ramus is abnormal in the lack of p_3.

The enlarged front tooth has a pointed subspatulate crown, wedge-shaped in cross section with nearly flat inner surface, moderately convex

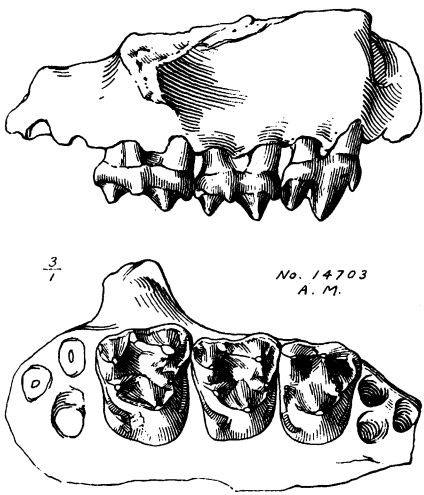


Fig. 42. *Cynodontomys scottianus*, upper jaw, outer and crown views. Lost Cabin beds, Wind River basin, Wyoming.

outer surface, sharp posterior and thick rounded anterior border. It is not so long as in *Mixodectes*, more flattened. The tooth behind it is determined by Osborn as a canine, but appears to be more probably a premolar (p_2). It has a simple pointed crown and two connate roots. The third premolar has two well separated roots and a simple pointed trenchant crown with small heel. P_4 is submolariform, with strong inner cusp nearly as high as the protoconid, broad bicuspid heel.

The fourth upper premolar has two strong external cusps, the posterior one a little lower than the anterior, distinct conules and parastyle, and the inner half of the tooth is broadened out so as to give it a subquadrate form like the molars. Mesostyle absent on p^4, rudimentary on m^{1-2}.

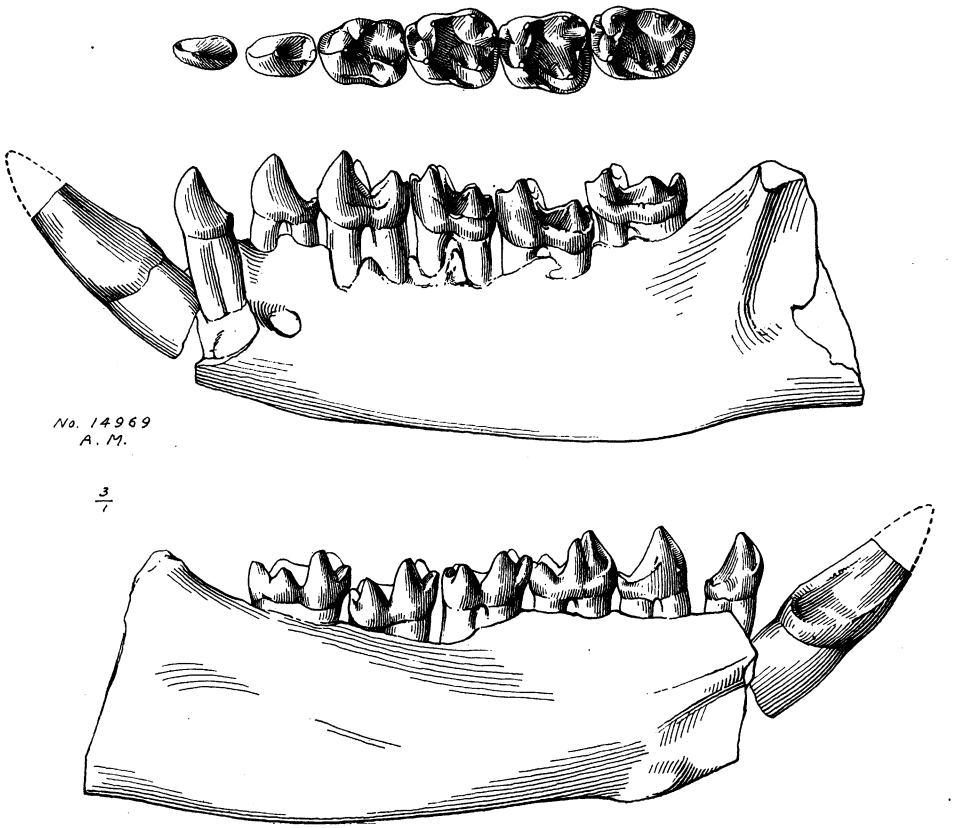


Fig. 43. *Cynodontomys scottianus*, lower jaw, inner and outer views, and crown view of teeth. Lost Cabin beds, Beaver Divide, Wyoming.

Cynodontomys latidens *Cope.*

Cynodontomys latidens Cope, 1882, Proc. Amer. Phil. Soc., Vol. XX, p. 151; 1885, Tert. Vert., p. 244, pl. xxive, fig. 2; Osborn, 1902, Bull. Amer. Mus. Nat. Hist., Vol. XVI, p. 209, fig. 35.

Pelycodus angulatus Cope, 1885, l. c., p. 231; (*Chriacus*) *ibid.*, pl. xxive, fig. 4; (*Cynodontomys*) Osborn, 1902, l. c., p. 208. Probably not *P. angulatus* Cope, 1875, Syst. Cat. Eoc. Vert., p. 14; (*Tomitherium*), 1877, Ext. Vert. New Mex., p. 144, pl. xxxix, fig. 15.

Notharctus palmeri Loomis, 1906, Amer. Journ. Sci., Vol. XXI, p. 284, fig. 7.

Notharctus cingulatus Loomis, 1906, l. c., fig. 8.

Type, No. 4195, both rami of lower jaw with m_{1-2}r., p_4l. and alveoli of remaining teeth. Bighorn basin, Wyoming Wortman, 1881. Probably Lysite horizon.

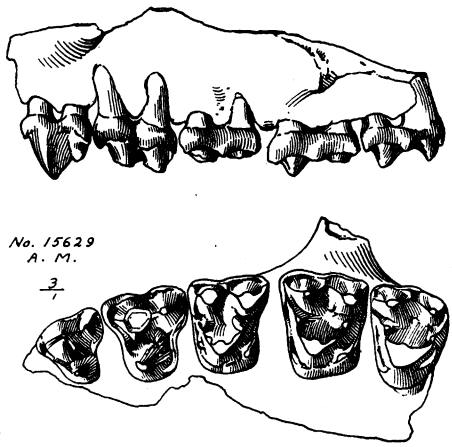


Fig. 44. *Cynodontomys latidens*, upper jaw, outer and crown views. Lysite beds, Bighorn basin, Wyoming.

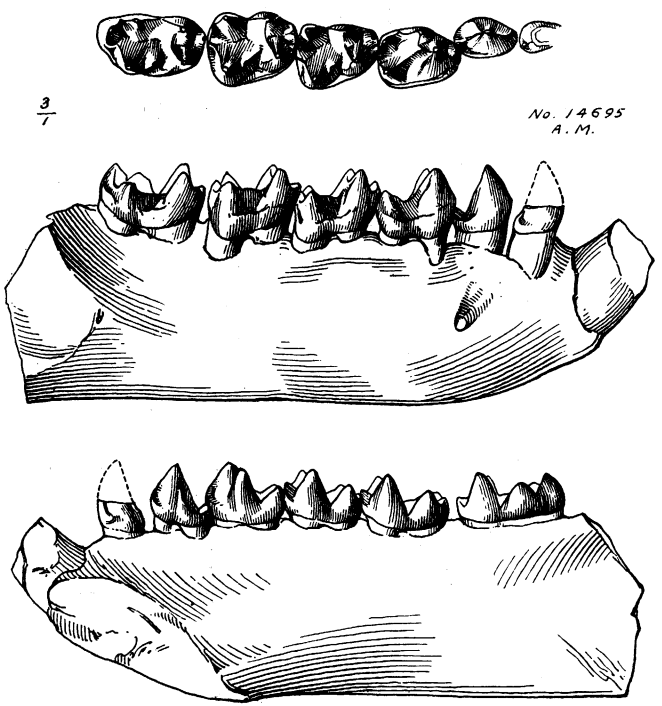


Fig. 45. *Cynodontomys latidens*, lower jaw, inner and outer views, and crown view of teeth. Lysite beds, Wind River basin, Wyoming.

Metatype of *Pelycodus angulatus*, No. 4184, lower jaw with p_4–m_2 and alveoli of p_3 and m_3, from Bighorn basin.

Distinctive characters: P_4–m_3 = 15 mm.; p_4 somewhat narrower than in *C. scottianus*, more oval, heel cusps less separate, m_3 relatively smaller.

Twelve or more jaws from the Lysite horizon in the Bighorn basin and two from the corresponding level in the Wind River basin are definitely referable to this species, others more fragmentary probably belong to it.

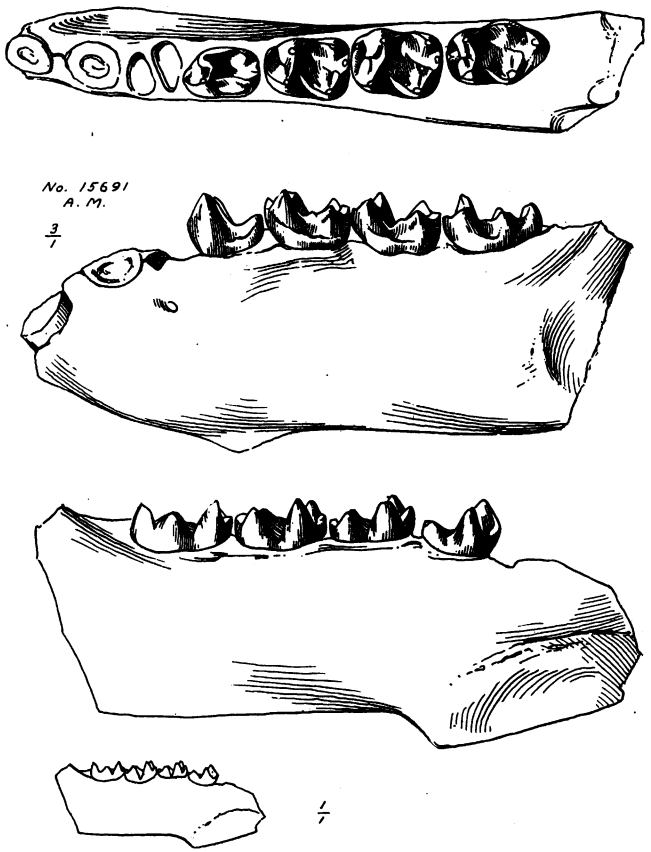


Fig. 46. *Cynodontomys flatidens*, lower jaw, inner, outer and crown views, enlarged three diameters. Outline of jaw, natural size. Upper Gray Bull beds, Bighorn basin, Wyoming.

One jaw, No. 14695, has all the teeth except the tips of p_2 and i_1 in perfect preservation, affording a good comparison with the jaw of *C. scottianus* from a higher horizon. Two lower jaws from high up in the Gray Bull beds are

intermediate between *C. latidens* and *C. angustidens* (infra). No. 15629, a well preserved upper jaw from the Bighorn Lysite affords satisfactory distinctions from the upper jaws of *C. scottianus* and *Microsyops*.

Osborn has referred *Pelycodus angulatus* of Cope to this genus. The specimen figured by Cope in 1885 appears to be specifically the same as *C. latidens*. The original type specimen, from the Wasatch of New Mexico, is lost, but Cope's figure and description of it do not accord well with this species, and it does not appear advisable to synonymize it. Two small species from the Wind River Lysite horizon described by Loomis in 1906 as *Notharctus palmeri* and *cingulatus* appear to me to be based, upon the teeth of *Cynodontomys*, probably *C. latidens*.

The species is distinguished from *C. scottianus* by somewhat smaller size and narrower teeth, $p\frac{4}{4}$ less molariform. The inner cusp (de^d) of p_4 is less distinct and lower, the posterior outer cusp (trittocone) of p^4 is smaller

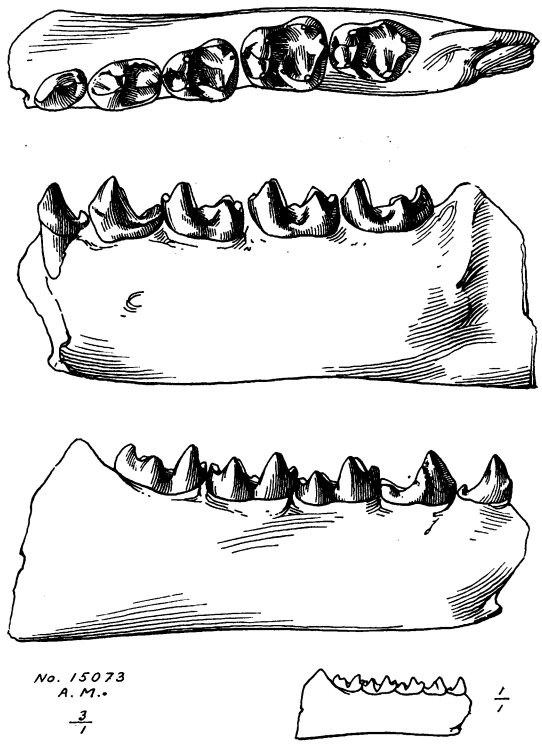


Fig. 47. *Cynodontomys angustidens*, lower jaw, inner, outer and crown views, enlarged three diameter. Outline of jaw, natural size. Type specimen, Gray Bull beds, Bighorn basin, Wyoming.

relatively, and the inner half of the tooth is not so broad, the posterior conule absent, the whole tooth more of the usual premolar type. Mesostyles are very rudimentary on m^{1-3}, none on p^4.

Cynodontomys angustidens sp. nov.

Type, No. 15073, lower jaws from the middle part of the Gray Bull beds, Bighorn. Referred specimens, Nos. 15079–82, all from the same horizon.

Distinctive characters: P_4–m_3 = 14.3 mm. P_4 narrow and oval, with smaller heel, entoconid rudimentary and deuteroconid small, molars somewhat smaller and relatively narrower than in *C. latidens*.

This species is distinctly more primitive and is not found above the Systemodon beds. Although the premolars are comparatively simple, they show no especial approach to those of *Mixodectes*, and appear to be derived from a quite different type, more that of *?Oxyacodon* in the Paleocene. A jaw fragment with p_4–m_2, No. (coll. 1913), from the upper fossiliferous horizon in Clark Fork basin (lower Gray Bull beds) appears to represent a primitive mutant of this species, but part of the crown of the premolar is broken off and the presence of the metaconid cannot be determined.

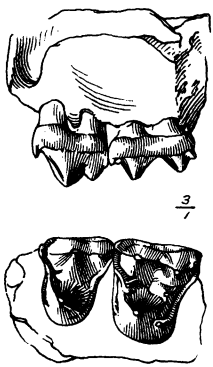


Fig. 48. *Cynodontomys angustidens*, fragment of upper jaw with fourth premolar and first molar, outer and crown views. No. 16875, Upper Gray Bull beds, Bighorn basin, Wyoming.

The fourth upper premolar has a small postero-external cusp, no conules, and less antero-posterior width than in the later species, and in general form is more clearly of premolar type. No mesostyle on m^1. In the lower jaw, p_4 has a small internal cusp not well separated, and a simple crested heel with very rudimentary inner cusp, in place of the bicuspid heel of the later species.

Family APATEMYIDÆ.

Insectivora or Primates with low-crowned bunodont tritubercular molars, premolars greatly reduced and p_4 simple; one anterior tooth, probably an incisor, greatly enlarged and more or less gliriform; other anterior teeth reduced or absent. Posterior mental foramen beneath m_1 or m_2.

The resemblance of the dentition in some genera of this family to that of *Cheiromys* (= *Daubentonia*) is closer than to any Insectivore. The teeth

in some genera are very close to certain Eocene Tarsiidæ. On the other hand, the position of the mental foramen is peculiar to Insectivora (although not found in all of them) and the characteristic specialization of the front teeth is more commonly found in Insectivores than in Primates. An approach towards it is seen in *Tetonius*. The characters of the molars are such as might be found in any very primitive frugivorous mammal of minute size, whether Insectivore or Primate. The upper teeth, skull and skeleton are wholly unknown.

The Tarsiid resemblance is closest in *Trogolemur*, in which the front tooth is less enlarged, the position of the mental foramen further forward, and the premolar and molar teeth are more of Tarsiid type, nearest to *Omomys*. On the other hand *Phenacolemur* of the Lower Eocene differs widely from the Tarsiidæ and has no suggestion of Primate relationship in the molars. It appears to be rather nearly related to *Apatemys*, especially *A. bellus*. *A. bellulus* and *Uintasorex* of the Bridger are intermediate between the typical *Apatemys* and *Trogolemur*, but in form of teeth agree better with the latter.

It is possible that two different phyla are here confounded, *Trogolemur*, *Apatemys bellulus* and *Uintasorex* being successive stages of a diprotodont specialization derived from the Tarsiidæ, *Phenacolemur* and *Apatemys bellus* derivatives for some different stock. But it appears unwise to split up the family until we know more about it.

Trogolemur *Matthew* 1909.

Type, T. myodes from the Middle Eocene.

Generic characters: Molars simple, tritubercular with large basin heels, wide and low-crowned, p^d small internal, connate. Premolars three, short and wide crowded, simple, p_2 minute, p_3 small, p_4 moderately large with small imperfectly distinct heel. Anterior tooth enlarged, long-rooted, compressed, crown unknown.

This genus is much closer to Tarsiidæ in the construction and proportions of premolars and molars than is any other Apatemyid. The much greater enlargement of the anterior tooth and the peculiar position of the mental foramen are the chief distinctions. From *Smilodectes*, which it resembles less closely, it is also distinguished by the much greater reduction of p_3 and higher specialization of the anterior teeth, broader and shorter molars.

Schlosser[1] has referred *Trogolemur* to the Anaptomorphidæ. The reduction of the front teeth to a single greatly enlarged pair, as in *Cheiromys*

[1] Schlosser, 1911, in Zittel's Grundzuge d. Pal., Vertebrata, p. 549.

(= *Daubentonia*), is the only objection to this reference. The central pair of incisors are slightly enlarged in *Omomys* and *Hemiacodon*, and in *Tetonius* the front tooth is very considerably, but not comparably to this genus. The enlarged front tooth is not well shown in my photographs of the type specimen although sufficiently noticed in the description, and Doctor Schlosser apparently failed to observe it, as he does not refer to it in defining the genus, and his definition of the family specifies "incisors and canines normal but the latter small."

Phenacolemur gen. nov.

Type, *P. præcox* infra.

Generic characters: Dentition $\frac{1.0.1.3.}{}$. Incisors enlarged procumbent, long-rooted, with long pincer-like crown. P_4 large, moderately compressed, simple with small heel. Molars with low trigonid and basined heel, no paraconids, m_1 and m_2 with two pairs of equal well separated cusps, m_3 with three pairs; a tendency to a transverse crest between each pair of cusps. Posterior mental foramen beneath m_1.

This singular little genus is represented by about a dozen specimens of lower jaws, pertaining to two or more species all from the Gray Bull and Sand Coulée horizons. The molars and premolars are widely different from those of *Trogolemur*, but *Apatemys* of the Bridger is to some extent intermediate. In *Apatemys* p_4 is reduced, almost vestigial; in this genus it is enlarged; the heel of m_3 in *Apatemys* is long with a single hypoconulid instead of the pair of cusps in *Phenacolemur;* m_{1-2} in *Apatemys* are shorter, wider and of more ovate outline, with the usual trigonid and heel as in Tarsiidæ. The upper molars referred to *Phenacolemur* are superficially very like those of *Paramys*. But the construction differs in detail, and the base of the zygomatic arch has the normal Primate or Insectivore position, instead of the anterior position characteristic of *Paramys* and all rodents. The front of the lower jaw is equally rodent-like, but the molars are of the normal tritubercular construction, and the incisor is rooted, the crown enamelled on both sides, and not scalpriform. The genus might be regarded as an ancestral stage in the evolution of simplicidentate rodents, but is too imperfectly known for such a speculation to have any value. It cannot be genetically ancestral, as it is a contemporary of *Paramys* in which the subordinal characters are fully developed.

Phenacolemur præcox sp. nov.

Type, No. 16102, lower jaw, from Sand Coulée beds of Clark Fork basin, Wyoming.

Specific characters: P_4–m_2 = 13.8 mm.; molars broader and more robust.

The type has p_4–m_2 complete, crowns of the last molar and incisor broken off. P_4 has a short, broad heel, but no anterior basal cusp or ridge. M_1 and m_2 have a

low rather wide trigonid, the pr^d connected by anterior and posterior crests with the closely connate p^d and mc^d, a broad open basined heel with marginal hy^d and en^d. M_3 is nearly one half longer than m_1 or m_2, but its crown is not preserved in the type; No. 15075 from the Gray Bull beds shows that its construction was like that of *P. citatus* (infra).

Four lower jaws from the Sand Coulée beds and eight from the Gray Bull beds are referred to this species, although showing considerable variation in the anterior cheek teeth.

An upper jaw fragment, No. 16167, from the Gray Bull beds of Clark

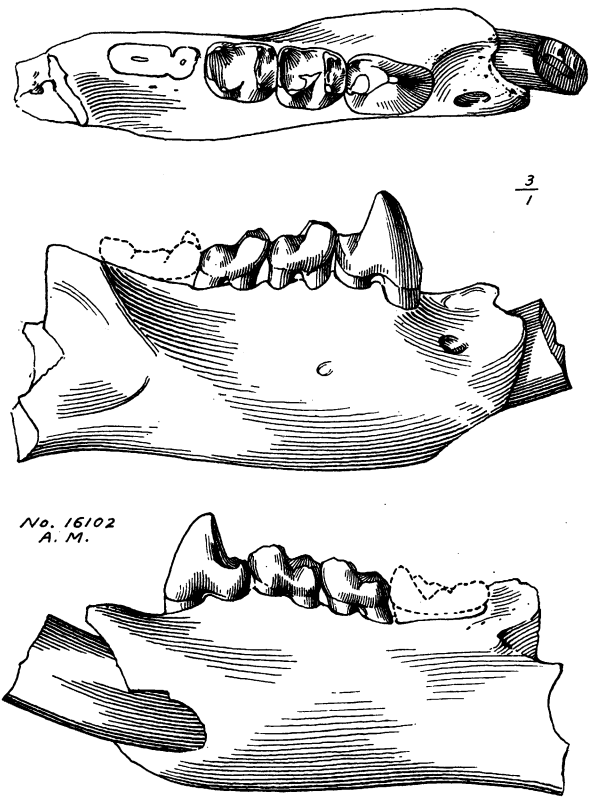


Fig. 49. *Phenacolemur præcox*, lower jaw, inner, outer and crown views, Type specimen, Sand Coulée beds, Clark Fork basin, Wyoming.

Fork basin, is referred to this species as the molars conform in construction and fit very well with the lower molars of the type. They are rounded quadrate in outline, *paracone* and *metacone* well separated, external in position, roundconic in form and with a narrow outer cingulum. The *protocone* is con-

nected in a heavy curved crest sweeping around the posterior side of the tooth as far as the posterior base of the metacone. The tooth construction has a very marked resemblance to that of *Paramys*, but in that genus the posterior crest ends internally in a distinct hypocone in the flank of the protocone; there is a heavy anterior cingulum, a distinct metaconule, and a metastyle. More important than these features is the position of the base of the zygoma, which in *Paramys* as in all rodents springs from the anterior end of the row of cheek teeth, whereas in the present specimen it clearly originates from the posterior part and projects backward, as it normally does in mammalia.

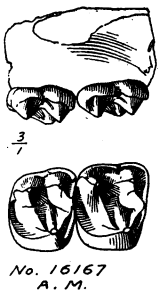


Fig. 50. *Phenacolemur præcox*, fragment of upper jaw with first and second molars, outer and crown views. Base of Gray Bull beds, Clark Fork basin, Wyoming.

Although these molars are not associated with lower teeth of *Phenacolemur*, they accord very well with the inferential construction of the upper teeth of that genus, from the characters of the lower teeth, and there is no other known genus of the Lower Eocene to which they could belong. They certainly are not rodent teeth, although superficially like them.

Phenacolemur citatus sp. nov.

Type, No. 15695, a lower jaw from the Gray Bull beds of the Bighorn, Wyoming basin.

Specific characters: P_4–m_3 = 11.8 mm. (approx.). P_4 smaller; anterior molars narrower and more elongate.

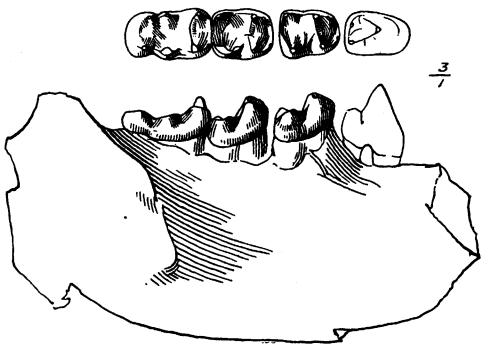


Fig. 51. *Phenacolemur citatus*, lower jaw, outer view, and crown view of teeth. Type, No. 15695, Upper Gray Bull beds, Bighorn basin, Wyoming.

The type shows the three molars. No. 15076 from the same horizon and locality has the three molars well preserved and part of the premolar aveolus and agrees closely with the type. A third jaw fragment with m_3 is also referred here.

Nothodectes dubius gen. et sp. nov.

Type, No. 16073, lower jaw, with p_3–m_3, from Clark Fork beds at base of bluff northeast of Ralston, Clark Fork basin, Wyoming.

Family ? Apatemyidæ.

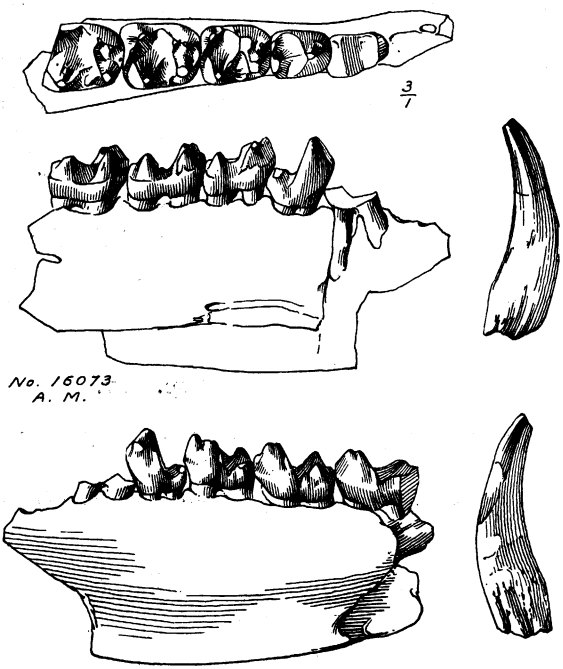


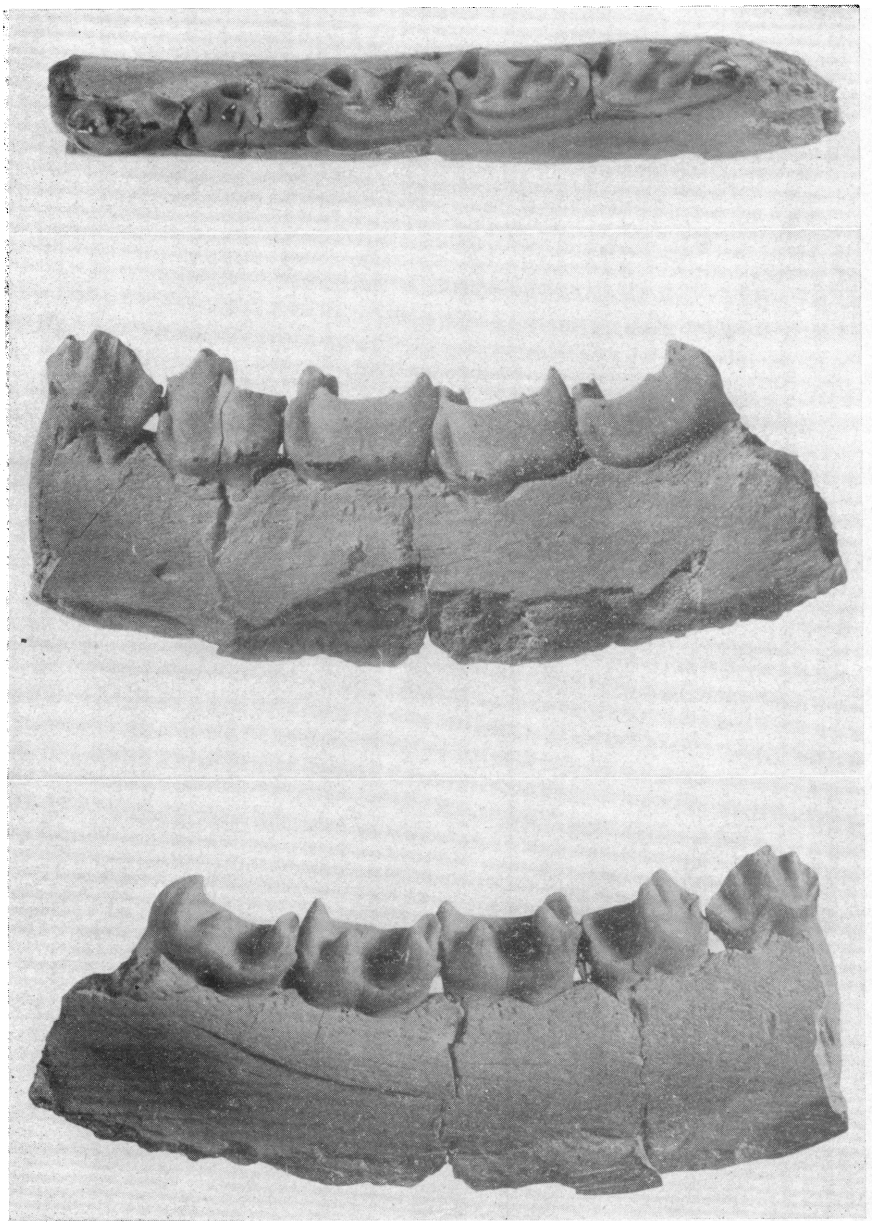
Fig. 52. *Nothodectes dubius*, lower jaw, inner, outer and crown views, and outer and inner views of an (?) incisor found associated. Type specimen, Clark Fork beds, Clark Fork basin, Wyoming.

One anterior tooth enlarged, others smaller or absent. Premolars probably two, a diastema in front of p_3. P_3 two-rooted, crown broken off; p_4 short with high stout protoconid and short wide heel. Molars with short trigonid of two principal cusps moderately connate, and large, deeply basined heel. Paraconid vestigial except on m_1, metaconid distinctly twinned on all molars, entoconid nearly equalling hypoconid, no hypoconulid (unless on m_3 where it is not preserved). Mental foramen indicated as beneath posterior end of m_1.

The ordinal and family position of this genus are very doubtful. The construction of the molars is not unlike some of the Tarsiidæ but is perhaps somewhat nearer to *Phenacolemur*. But the characteristic heel of this genus is not preserved in the type and only specimen of *Nothodectes*. The enlarged front tooth is indicated only by a small portion of the alveolus of the root; a slender caniniform tooth associated with the type specimen may belong in this alveolus but cannot be positively fitted, and is smaller than would be expected. A well marked diastema in front of p_3 indicates probably that the anterior premolars were absent; and the position of the mental foramen is probably but not certainly indicated as beneath the posterior end of m_1. These characters accord best with the Apatemyidæ. While clearly distinct from any described genus the position of *Nothodectes* can only be ascertained by more complete specimens. It is of interest as coming from the Clark Fork beds, but does not show near affinities to any known Paleocene genera.

Explanation of Plate XV.

Arctostylops steini, lower jaw, inner (lower figure), outer and crown views. Enlarged to five diameters. Type specimen, No. 16830, base of Gray Bull beds, Clark Fork basin, Wyoming.



ARCTOSTYLOPS STEINI. × $\frac{5}{1}$.