

**Article XXI.**—LOWER EOCENE TITANOTHERES. GENERA  
*LAMBDOOTHERIUM*, *EOTITANOPS*.

BY HENRY FAIRFIELD OSBORN.

INTRODUCTION.

The explorations of the American Museum parties under Mr. Walter Granger in the Lower Eocene during the years 1905, 1909–1911, have resulted in our determining the chief characters of the earliest known ancestral forms of the titanotheres. The present paper is a preliminary statement of the new systematic results which will be fully set forth in the author's monograph 'The Titanotheres' for the United States Geological Survey, which is now nearing completion and has been prepared with the assistance of Dr. W. K. Gregory.

The known localities of the *Lambdotherium* Zone which yield remains of *Lambdotherium* and *Eotitanops* are as follows:

Wyoming, typical Wind River Basin, Lost Cabin Section .....	400 ft.
“ Big Horn Basin, Tatman Mountain Section .....	325 “
“ Beaver Divide, Green Cove Section .....	265 “
Colorado, Huerfano Basin, Garcias Mountain .....	?400 “

From these formations 111 specimens of *Lambdotherium* and 14 of *Eotitanops* have been secured by Mr. Granger and his assistants, Messrs. Olsen and Stein.

It appears that these beds contain several species and mutations, or

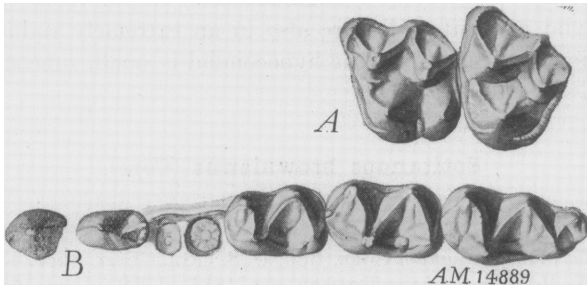


Fig. 1. *Eotitanops gregoryi*, type, Amer. Mus. no. 14889. A, second and third left upper molars. B, right lower premolar-molar series (p-r-m). Natural size.

progressive stages in the development and adaptive radiation of members of the genus *Eotitanops*, indicating that there are at least two phyla in this genus; one embracing smaller, more persistently primitive, light-limbed

forms, the other larger and more progressive forms. The latter might be considered descendants of the former but for the fact that the two phyla coëxist on relatively high geological levels of the formation. The systematic revision of the new and already known species is as follows:

**Eotitanops gregoryi** sp. nov.

Figs. 1, 4B.

*Locality*.— Type from Wind River, Lost Cabin Formation, Wyoming, 100 feet above Alkali Creek "red stratum."

*Type*.— Amer. Mus. No. 14889, lower jaw, also fragment of left superior maxilla containing  $m^2$ ,  $m^3$ .

*Specific characters*.— Of inferior size.  $P_2-m_3 = .0784$ ;  $m_1-m_3 = .0490$ ;  $P_2-m_3$  with the internal cusps, paraconid and metaconid, consisting of rectigradations of most rudimentary stage; hypoconulid of  $m_3$  very small;  $m^3$  with a single internal cone, no hypocone.

This very sharply defined species represents a persistent primitive stage, because its geological level, 100 feet above the Alkali Creek "red stratum" is higher than that of the typical and relatively progressive *E. borealis*. Its primitive condition is shown in the comparison of  $p_3$  with the same tooth in *E. borealis* and *E. princeps*.

The third inferior premolar is seen to be much less progressive than in *E. princeps* or even in *Lambdotherium*; the other premolars are also very primitive.  $P_2$  short, compressed, with a very rudimentary hypoconid;  $p_3$  laterally compressed, hypoconid distinct, paraconid, metaconid, and entoconid extremely rudimentary rectigradations. In the molar teeth,  $m_1-m_3$ , the metastylid and entostylid are also in an extremely rudimentary, or rectigradational stage. In  $m_3$  the hypoconulid is small, subconic, external in position.

**Eotitanops brownianus** (Cope).

Figs. 2, 4C.

*Lambdotherium brownianum* COPE, Bull. U. S. Geol. Geogr. Surv. Terr., Vol. VI, 1881, pp. 196; Vertebrata of the Tertiary, etc., 1884, p. 709, pl. lvia, fig. 10 (not the type).

*Locality*.— From the Wind River, Lost Cabin Formation. Exact level unrecorded.

*Type*.— Amer. Mus. No. 4885. Lower jaw with all the teeth fractured except  $p_2$ .

*Specific characters*.— Size greater than *E. gregoryi*.  $P_2-m_3 = 90$  mm.;  $m_1-m_3 = 55$  mm.; fang of  $p_1$  placed in close proximity to the canine;  $p_2$  compressed, hypoconid

distinct, elevated; entoconid invisible; paraconid a rudimentary rectigradation placed very low on the crown; metaconid extremely rudimentary if present; metastylid rudimentary.

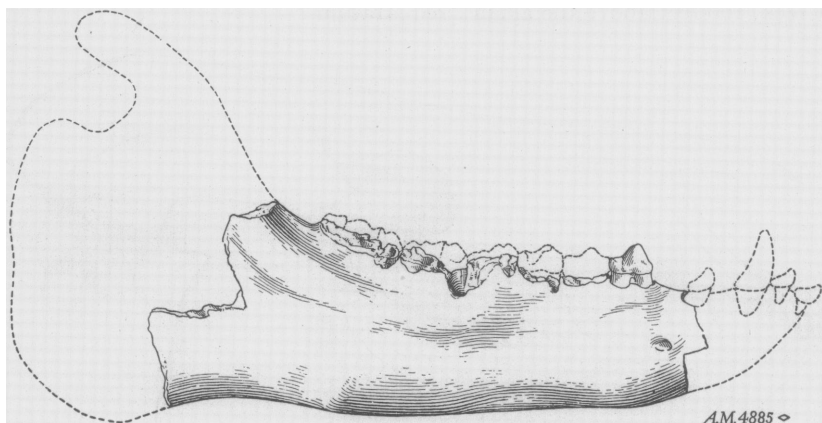


Fig. 2. *Eotitanops brownianus* (Cope), type jaw, Amer. Mus. no. 4885. Contour restored from *E. borealis*. One-half natural size.

The type of this species belonged to an animal in size midway between *E. gregoryi* and *E. borealis*, with pronounced swelling of the jaw below  $m_3$ . Its vertical depth below the anterior face of  $m_3$  is 40 mm. The symphysis is decidedly broad and massive.

### ***Eotitanops borealis* (Cope).**

Figs. 3, 4D.

*Palæosyops borealis* COPE, Amer. Naturalist, Vol. XIV, 1880, p. 746; Vertebrata of the Tertiary, etc. 1884, pp. 699, 703, pl. lviii, fig. 3.

*Locality*.—Wind River, Lost Cabin Formation. Exact level not recorded.

*Type*.—Amer. Mus. No. 4892, consisting of fragments of a right maxilla containing  $p^4$ – $m^3$  with portions of radii associated.

*Neotype*.—Amer. Mus. No. 14887. Skull, jaws, atlas, and portions of pelvis.

*Specific characters*.—Of larger size.  $P_2$ – $m_3$  .094–.098. Premolar teeth more complicated, as shown in neotype and associated specimens.  $P^2$ – $^4$  with progressively developing tritocones and single internal deutocones backwardly inclined, crowns subtriangular;  $m^1$ – $^3$  with distinct protoconules.

*History*.—The fragmentary type specimen (Am. Mus. No. 4892) is the historical *Palæosyops borealis* of Cope figured in the 'Tertiary Vertebrata,' plate lviii, Fig. 2. It is marked No. 16 in the Wind River valley collection

of Jacob L. Wortman, July, 1880. The neotype (Amer. Mus. No. 14887) represents a slightly larger and somewhat more progressive mutation. It consists of the skull and jaws found by Granger in 1909 on Dry Muddy Creek, 100 feet above the alkali "red stratum."

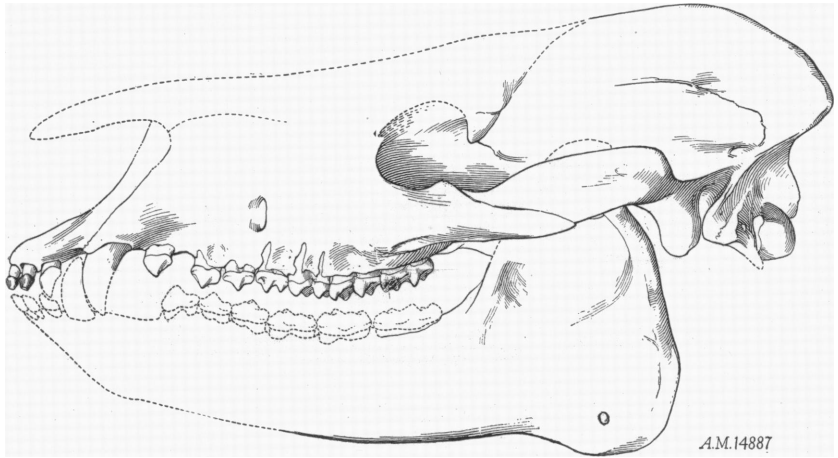


Fig. 3. *Eotitanops borealis*. Reconstruction of skull, based on Amer. Mus. no. 14887. One third natural size.

The discovery of this skull justifies the generic separation of *Eotitanops* (Osborn 1908) because it differs from all known Middle Eocene titanotheres in the relatively elongate face and abbreviate cranium, the Middle Eocene forms having an abbreviate face and elongate cranium.

### ***Eotitanops princeps* sp. nov.**

#### **Fig. 4E.**

*Eotitanops borealis*, in part, of earlier descriptions.

*Locality*.—Wind River, Lost Cabin formation. Exact level not recorded.

*Type*.—Amer. Mus. No. 296, including femur, humerus, right manus, one cervical, three dorsal, one caudal vertebræ.

*Specific characters*.—Of still larger size,  $p_2-m_3$  .105e. Inferior premolar teeth somewhat more complicated, as shown in the type specimen.  $P_2$  with elevated, distinct, but very rudimentary paraconid and metaconid; entoconid very rudimentary; talonid narrow.  $P_3$ , paraconid quite distinct, elevated; metaconid small, distinct; entoconid rudimentary; talonid broad.  $P_4$ , talonid broad; entoconid distinct. Hypoconulid of  $m_3$  rounded, more robust. Ramus, larger and more robust.

The more advanced development of the premolar rectigradations, the increased size of the teeth and of the jaw, the larger size of the hind feet in

the referred specimen (Amer. Mus. No. 4902), combine to distinguish this specimen as a mutation or subspecific stage between *E. borealis* and *E. major*.

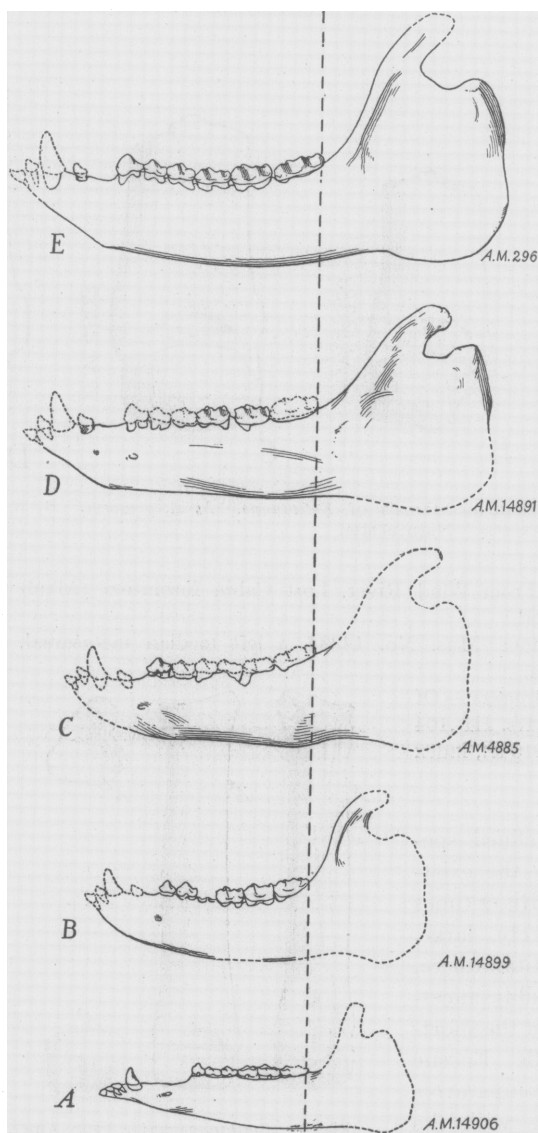


Fig. 4. Lower jaws of *Lambdaotherium* and *Eotitanops*. One-fourth natural size. A, *Lambdaotherium popoagicum*. B, *Eotitanops gregoryi*. C, *E. brownianus*. D, *E. borealis*. E, *E. princeps*.

***Eotitanops major* sp. nov.**

Figs. 5, 6.

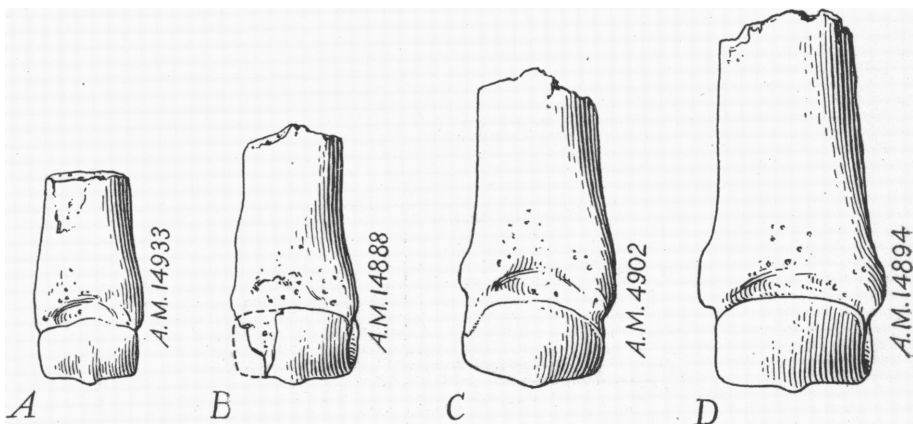


Fig. 5. Median metatarsals of *Eotitanops*. A, *E. gregoryi*. B, *E. borealis*. C, *E. princeps*. D, *E. major*. Natural size.

*Locality*.—From Wind River, Lost Cabin formation (Alkali Creek). Exact level unrecorded.

*Type*.—Amer. Mus. No. 14894, a left median metatarsal, also the distal end of the tibia.

*Specific characters*.—Of superior size, Mts. III .104 longitudinal, .016 tr., index 15.

This ill-defined species indicates the existence in Wind River times of a relatively large, short-footed titanother, which is possibly ancestral to some of the short-footed Middle Eocene types. The comparative measurements with the median metatarsal of *E. borealis* are as follows:

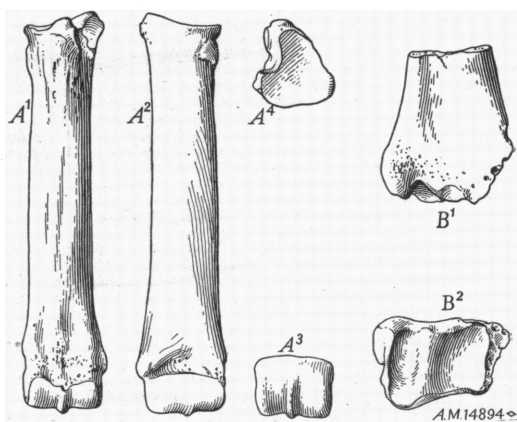


Fig. 6. *Eotitanops major*, type, Amer. Mus. No. 14894. Median metatarsal A<sup>1</sup>, posterior view. A<sup>2</sup>, anterior. A<sup>3</sup> distal, A<sup>4</sup> proximal view. B<sup>1</sup>, distal end of left tibia, anterior view. B<sup>2</sup>, the same, distal view.

	<i>E. borealis</i> mm.	<i>E. major</i> mm.
Median metatarsal, III, length.....	86	104
Width of shaft.....	13	16
Index.....	15	15
Tibio-astragalar facet tr.....	21	25

***Lambdotherium priscum* sp. nov.**

Figs. 7, 9.

*Locality.*—Wind River Basin, three miles east of Lost Cabin, Wyoming; Granger, Amer. Mus. Expedition, 1905.

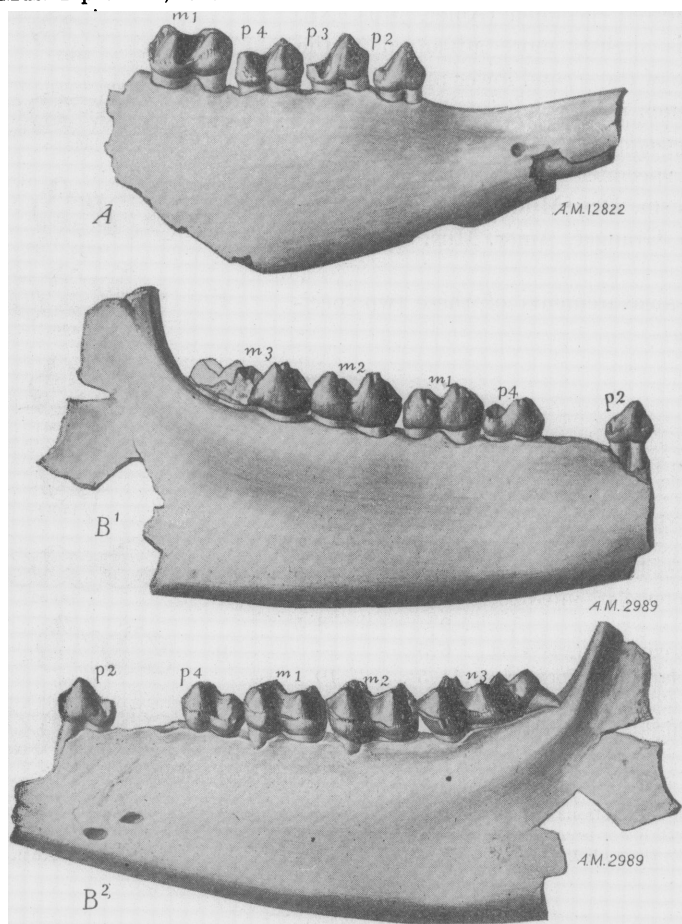


Fig. 7. Incomplete lower jaws and dentition of *Lambdotherium*. Natural size. A, *L. priscum* type, Amer. Mus. no. 12822. B<sup>1</sup>, *L. popoagicum*, inner side view, Amer. Mus. No. 2989; B<sup>2</sup>, Outer side view of same.

*Type*.—Am. Mus. No. 12822, anterior portion of jaw with  $p_2$ - $p_4$ ,  $m_1$  of right side, also  $p_3$ ,  $m_1$ ,  $m_2$  of left side. Rami fragmentary.

*Specific characters*.— $P_2$ - $p_4$  = .025. Second and third lower premolars extremely simple, with rudimentary paraconid.  $P_3$ : metaconid of  $p_3$  rudimentary, placed very low upon slope of protoconid; talonid narrow, depressed, with cingular rudiment of entoconid.

The extremely simple or primitive structure of the second lower premolar clearly distinguishes this stage (Fig. 7).

A referred specimen (Amer. Mus. No. 14908) is slightly more advanced in the structure of the second lower premolar, but is still much more primitive than the type of *L. popoagicum*.

This specimen was found in the Wind River Basin, Dry Muddy Creek, eighteen miles up, Granger, Amer. Mus. expedition, 1909.

The measurements of these two specimens are:

	Type No. 12822 mm.	Referred specimen No. 14908 mm.
Second to fourth premolar, inclusive.....	25	—
Third premolar, anteroposterior.....	8	8
Third premolar, transverse....	5	5
Fourth premolar anteroposterior.....	9	8.5
Fourth premolar transverse... 6.5	—	—
First molar, anteroposterior... 11.5	10	10
“ “ transverse..... 7.5	7	7
First to third molar, inclusive..	—	37

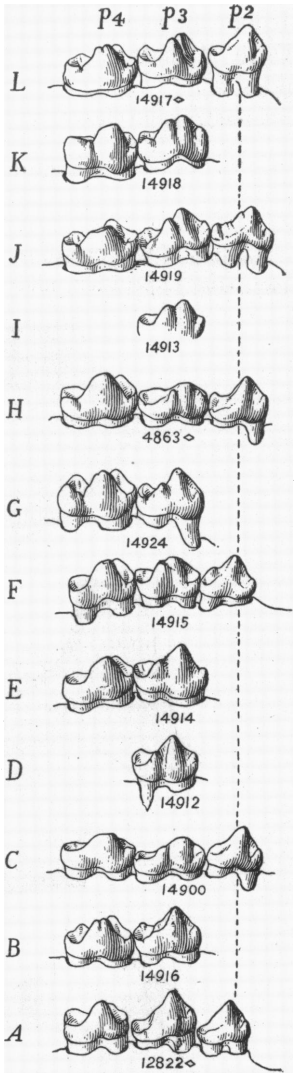


Fig. 9. Mutations of cusp addition in the premolar evolution of *Lambdotherium*. Second, third, fourth lower premolars of the left side, inner side view. Transition from *L. priscum* stage (A-E) through *L. popoagicum* stage (F-H) to *L. progressum* stage (I-L). Natural size.



***Lambdotherium progressum* Osborn.**

Fig. 8.

*Locality*.—Wind River Basin, Alkali Creek, Buck Spring. Granger, Amer. Mus. Expedition, 1909.

*Type*.—Amer. Mus. No. 14917. Right ramus and symphysis of jaw containing  $p_2$ – $m_2$  of right side, also left canine.

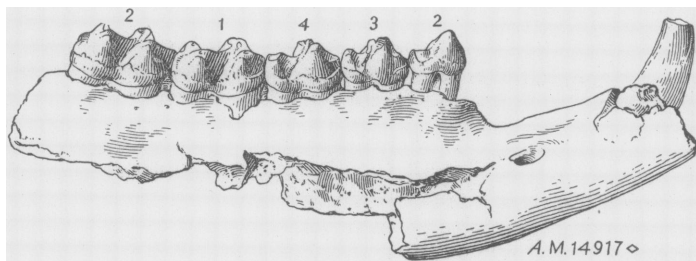


Fig. 8. *Lambdotherium progressum*, type, Amer. Mus. no. 14917. Alkali Creek, Wind River Basin, Wyo. Outer side view of jaw and teeth. Natural size.

*Specific characters*.— $P_2$ – $p_4$  = .0165. Second, third, and fourth lower premolars progressive. Rudiment of metaconid on  $p_2$ .  $P_3$  with elevated metaconid subequal with protoconid, broad talonid with rudimentary entoconid.  $P_4$  with bifid metaconid and distinct entoconid.

This is readily distinguished from both *L. priscum* and *L. popoagicum* by the advanced condition of  $p_3$ , which may be described as submolariform.

*Measurements of Type.*

	mm.
Second to fourth lower premolar, inclusive.....	26
Second premolar, anteroposterior.....	8
“ “ transverse (trigonid).....	4.8
Third premolar, anteroposterior.....	9
“ “ transverse.....	6
Fourth premolar, anteroposterior.....	9.3
“ “ transverse.....	7.3
First molar, anteroposterior.....	11.5
“ “ transverse.....	8.5
Second molar, anteroposterior.....	12.5
“ “ transverse.....	9.5

