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Article XIV.—NEW SPECIES OF CLÆNODONTS FROM THE FORT UNION (BASAL EOCENE) OF MONTANA

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Plate XXVIII

The genus *Clœnodon* was proposed by Scott, in his revision of the North American creodonts[1] to include two or, at most, three species, *Mioclœnus ferox*, *M. corrugatus* from the Torrejon, and *M. protogonioides* from the Puerco. These species had earlier been described by Cope[2] and were grouped by him under the genus *Mioclœnus* together with a heterogeneous lot of species representing, as recognized by Scott, at least four families belonging to two orders. Since the time of Cope, the characters of these early Eocene mammals have become better known through the discovery of more complete material, and this wider knowledge has formed the basis of much discussion, by later writers, regarding the possible relationships of the creodonts in general, and particularly the position occupied by the Arctocyonidæ, the family to which the genus *Clœnodon* belongs. Regarding the affinities of *Clœnodon*, and especially its possible relationship to the modern bears, there has been much uncertainty, and opinions have differed rather widely. The present communication, however, is confined to the description of material, discussion of relationships being reserved for a future presentation. The Fort Union material here described, therefore, is of especial interest, since it extends considerably our knowledge of this important group of creodonts.

In preparing this paper, I have had for comparison and study, in addition to the Fort Union material in the U. S. National Museum collection, all the better *Clœnodon* specimens recently secured from the Torrejon of New Mexico by the American Museum field parties, and the types described by Cope. I wish here to express my appreciation for the loan of this material so generously granted by Professor H. F. Osborn and Dr. W. D. Matthew, and I am especially indebted to them for the use of four drawings, here published for the first time, illustrating, in

[1] 1892, Proc. Acad. Nat. Sci. Phila., pp. 291–323.
[2] 1882, Amer. Nat., XVI, p. 833.

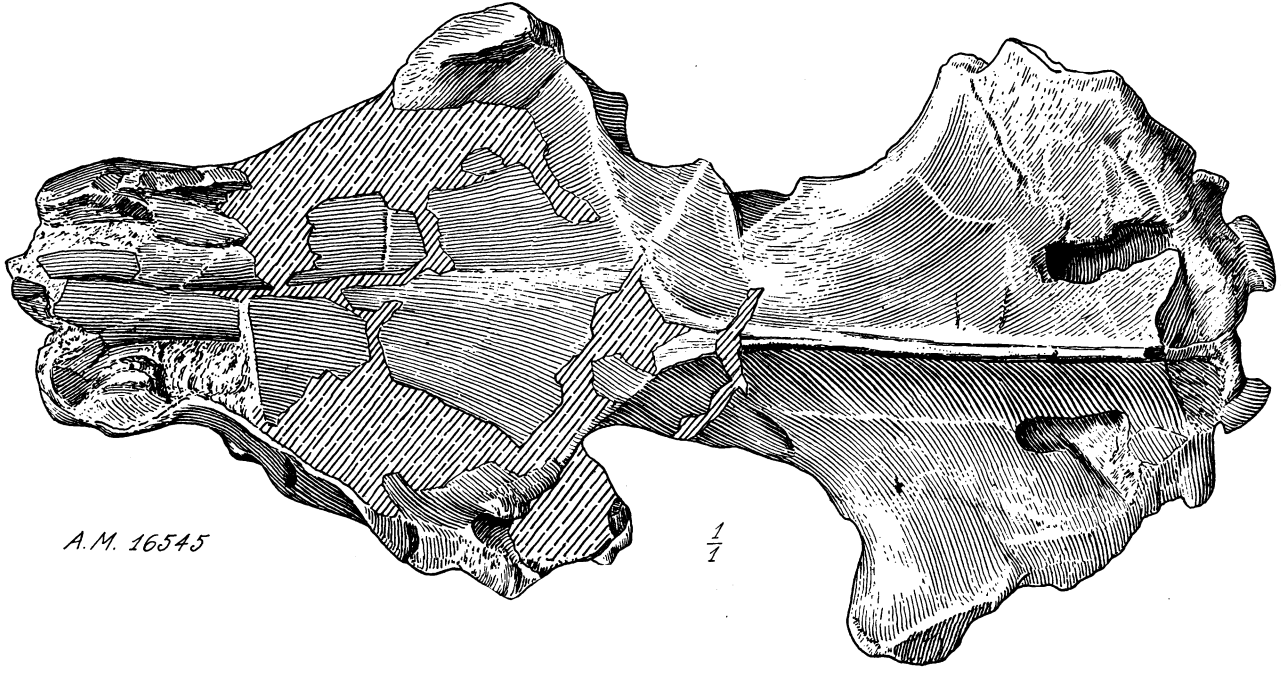

Fig. 1. *Clænodon corrugatus.* Skull, top view. No. 16545, A. M. N. H. Coll.

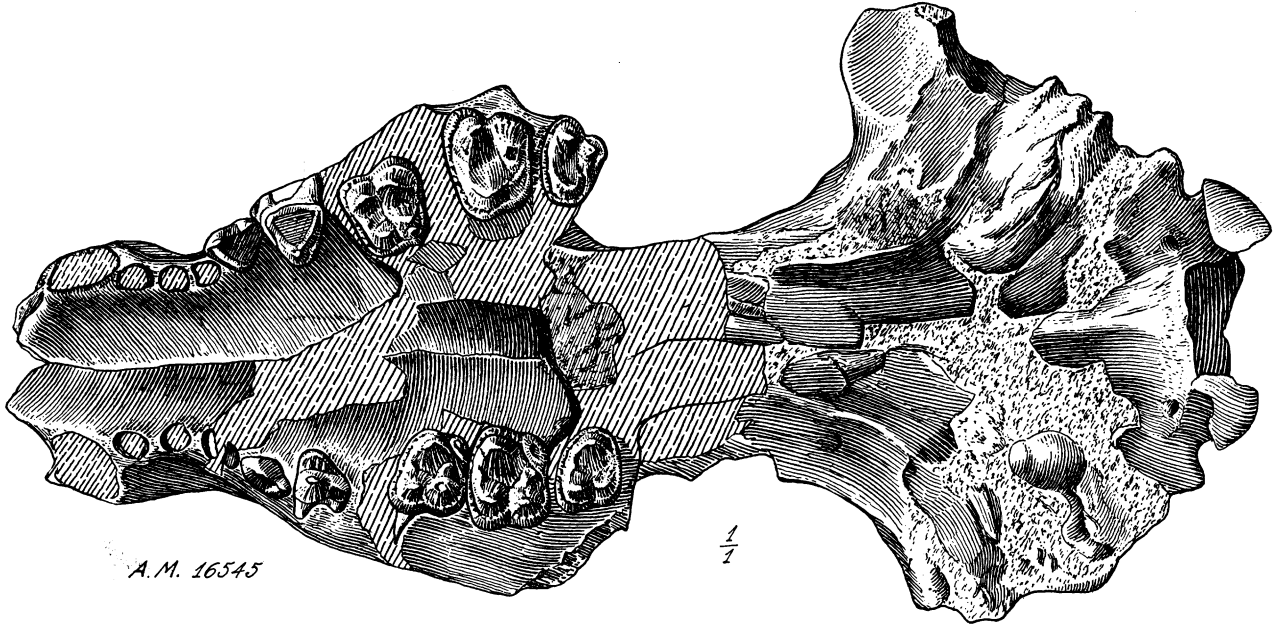

Fig. 2. *Clænodon corrugatus.* Skull, palate view. No. 16545, A. M N. H. Coll.

part, one of their best specimens of *Clænodon corrugatus*. The drawings for illustrations have been very carefully made by Mr. Rudolph Weber.

In the National Museum collection from the Fort Union beds of Sweet Grass County, Montana, there are four species of Clænodonts represented. Only one of these seems referable to the genus *Clænodon* as represented by the New Mexico species. The others seemingly represent a distinct group and are therefore here described under a new generic name.

The above-mentioned, more recently acquired Torrejon material in the American Museum collection permits a better, or at least somewhat fuller, definition of the genus *Clænodon* than has hitherto been given.

CLÆNODON Scott

Type.—*Clænodon ferox* (Cope).

In defining this genus Scott[1] found difficulty, owing to the fragmentary condition of the material then known, in separating it from the European genus *Arctocyon*, the only important difference noted being the less completely quadritubercular character of the upper molars in the American genus.

In 1901, using somewhat better material, Matthew more clearly defined the genus *Clænodon* as follows:[2]

> Upper premolars moderately reduced, the first one-rooted, second two-rooted, third and fourth three-rooted with high trihedral protocone [=paracone of molars] and weak cingular cusps at the bases of the three solid angles. Upper molars with three low subequal cusps, strong metaconule, somewhat weaker hypocone and a very small paraconule. Metaconule weak and hypocone absent on m^3.

By aid of the more or less important characters presented in the fine specimen of *C. corrugatus* here figured (see Figs. 1 and 2) this definition may be still farther expanded as follows:

> Dental formula, i?, $c\frac{1}{1}$, $p\frac{4}{4}$, $m\frac{3}{3}$; skull creodont in general type, that is, cranium elongate, brain small, sagittal crest high, canines large, and zygomatic arches heavy; lower jaw deep with lower border of ramus considerably and evenly curved anteroposteriorly; upper premolars moderately reduced, with short diastema behind p^1; first and second upper molars subquadrate with three low subequal cusps, and small but well-defined hypocones; m^3 not greatly diminished in size, but with metacone slightly reduced and with no hypocone; carpus with scapho-centrale and lunar separate but progressing toward the development of a fused scapho-lunar typical of

[1] 1892, Proc. Acad. Nat. Sci. Phila., p. 289.
[2] 1901, Bull. Amer. Mus. Nat. Hist., XIV, p. 13.

the true carnivores; proximal, or radial, facets of scaphoid and lunar subequal; tarsal elements relatively short and broad; astragalus articulating and slightly but distinctly interlocking with cuboid; navicular facet of cuboid not entirely continuous with those of the astragalus and ectocuneiform; femur with third trochanter but little below level of lesser trochanter in position; digit IV, at least of the hind foot, longest of series. (Some of these characters, the last two especially, are possibly common to all species of the family.)

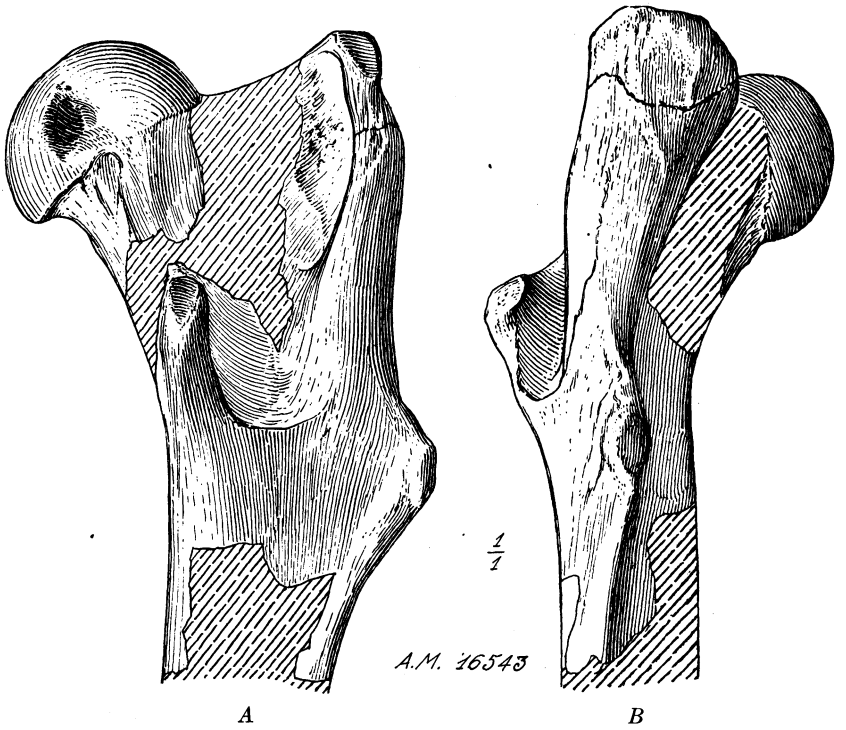

Fig. 3. *Clœnodon corrugatus*. Proximal end of right femur. *A*, posterior view; *B*, outer side view. No. 16543, A. M. N. H. Coll.

Clœnodon cf. *ferox* Cope.

I provisionally refer to the Torrejon species (*C. ferox*), the specimen above mentioned from the Montana locality. It consists of a portion of a right lower jaw carrying a single molar, m_2 (U. S. Nat. Mus. No. 6156). This molar differs from the corresponding tooth in specimens from the New Mexico locality, with which I have compared it, in the following minor details: talonid slightly narrower than trigonid (the reverse in the Torrejon specimen), enamel wrinkling more pronounced within the basin of the talonid, less pronounced on the outer walls of the

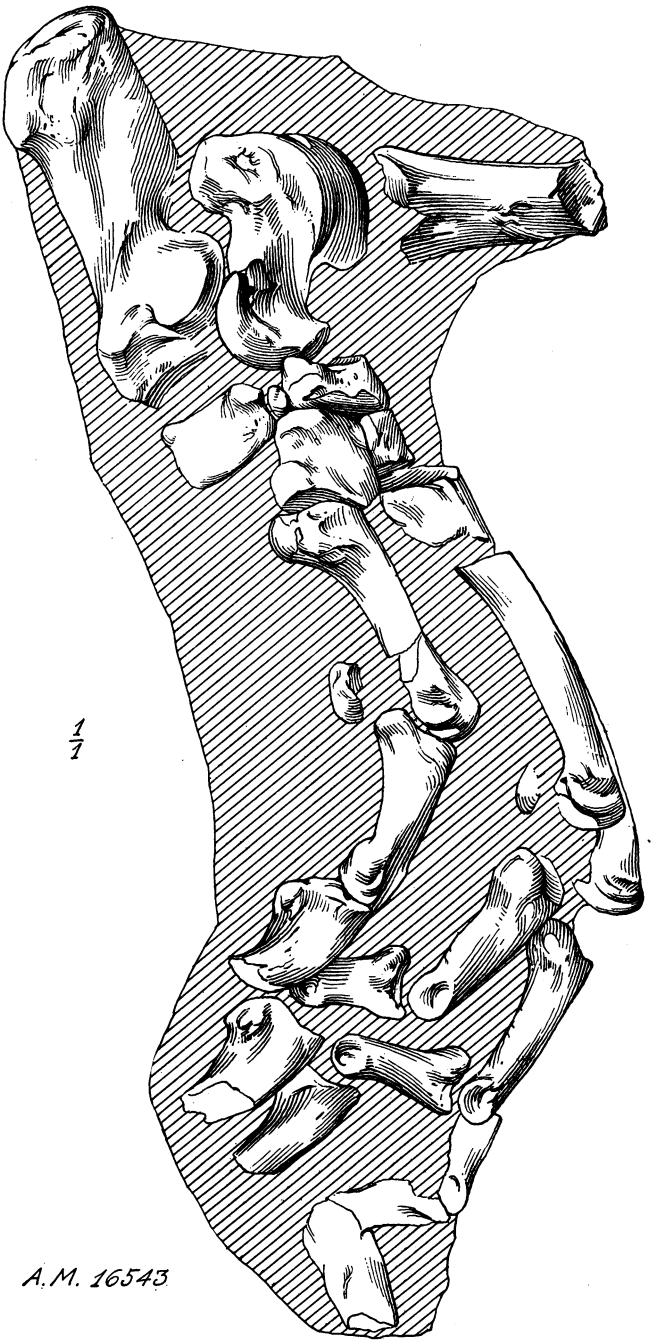

Fig. 4. *Clænodon corrugatus*. Right hind foot, with bones in position as found in original matrix. No. 16543, A. M. N. H. Coll.

protoconid and hypoconid; paraconid and entoconid more depressed, the former being extremely vestigial. The tooth agrees in size and general appearance with its homologue of the Torrejon specimens, and the slight differences here noted, with the possible exception of the narrower proportions of the talonid, may be found to come readily within the range of individual variation when several specimens can be compared. It is possible, however, that more complete material from the Montana locality may establish the possibility that the present specimen belongs to a new species.

The specimen here described came from near the top of the upper member of the Fort Union, designated by Stone and Calvert[1] as the "massive gray Ft. Union sandstone" section overlying the "Lebo andesitic member of the Ft. Union formation." It therefore represents a horizon about 5000 feet above the base of the Fort Union and 3000 feet or more above the stratum from which came the other material here described.

NEOCLÆNODON, new genus

Type.—Neoclænodon montanensis, new species.

Definition of Genus.—Dental formula as in *Clænodon;* cranial portion of skull relatively long and deep; interorbital space apparently much narrower, and post-orbital constriction longer and more slender than in *Clænodon:* anterior premolars, upper and lower, much reduced; in upper jaw distinct diastemæ behind p^1, and between p^2 and p^3; the first premolar, above and below, lies closely appressed to the canine; hypocone in m^1 and m^2 rudimentary, wanting in m^3; m^3 much reduced, suboval in outline with relatively small metacone. Carpus and tarsus much as in *Clænodon,* but differing in minor details as follows: lunar relatively small, radial facet being not more than two-thirds as wide as that of the scaphoid; fibular facet of the calcanem much reduced or wanting; neck and head of astragalus relatively thin and broad; cuboid with facet for the astragalus, navicular and ectocuneiform arranged horizontally, nearly parallel and merging into each other. (See Pl. XXVIII, figs. 1 and 1*a*.)

Neoclænodon montanensis, new species

Type.—No. 8362, U. S. National Museum Coll. Parts of a skeleton, including considerable portions of the skull and lower jaws carrying most of the dentition, several bones of the fore and hind feet, portions of a femur, a radius, several fragments of ribs, and a few vertebræ. Collected by Mr. A. C. Silberling.

Locality.—"Gidley Quarry," Sec. 23, T5N, R15E. Sweet Grass County, Montana.

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[1]1910, Economic Geology, V, No. 6, p. 752.

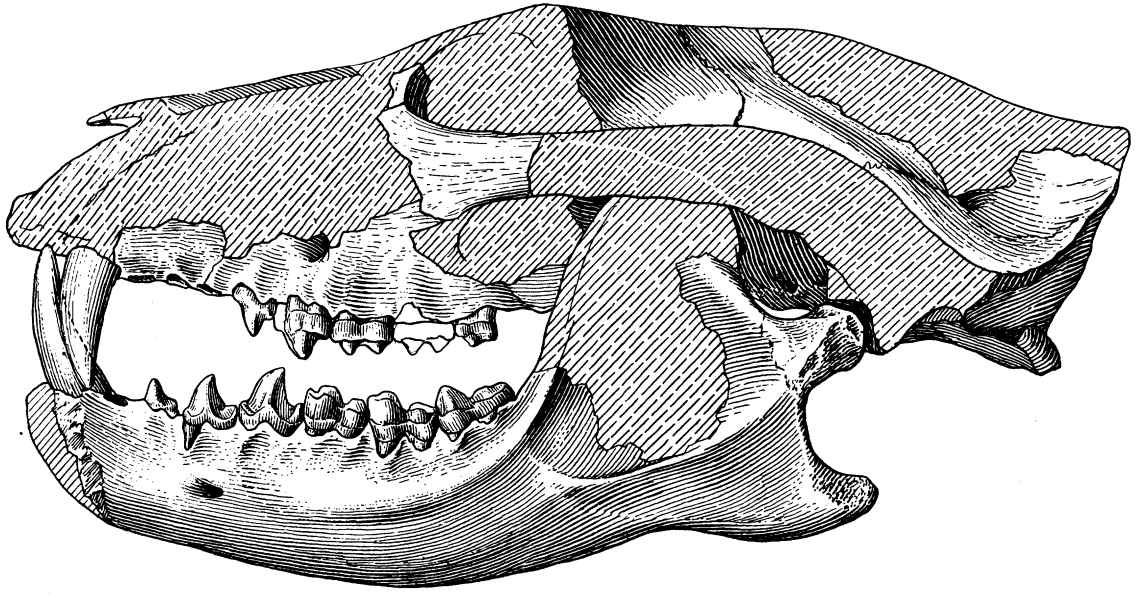


Fig. 5. *Neoclænodon montanensis.* Skull and lower jaw, view of left side. ½. Type specimen, No. 8362, U. S. N. Mus. Coll.

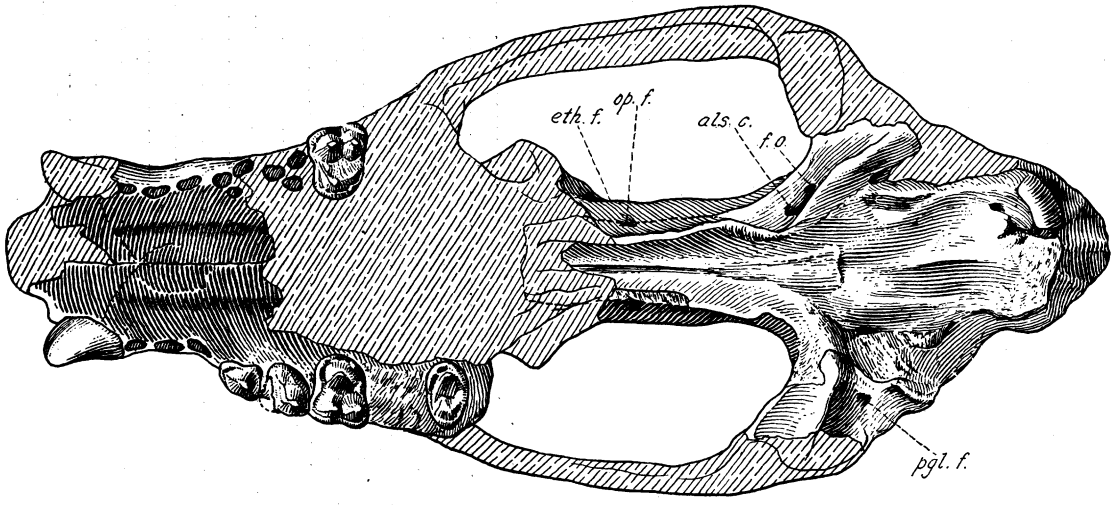


Fig. 6. *Neoclænodon montanensis.* Skull, palate view. ½. Type specimen, No. 8362, U. S. N. Mus. Coll.

Horizon.—Upper portion of the Lebo andesitic member of the Fort Union, about 30 feet below the massive sandstone section of Stone and Calvert (*loc. cit.*, p. 547) and nearly 2000 feet above the base of the Fort Union.

This species is further represented in the collection by a second specimen (No. 6159) consisting of portions of both sides of a lower jaw, each carrying the second true molar.

Description.—About one-fifth smaller than *Clænodon ferox* and *C. Corrugatus*, slightly larger than *C. protogonioides* (Cope); face relatively short, rostrum deep; brain-case very small and elongate; postorbital constriction long and slender; posterior root of zygoma depressed below the basioccipital plane (probably a primitive character and of much more than species significance), giving a decidedly arched contour to the main portion of the skull viewed from the side; anterior border of orbit directly above anterior boundary of m^2; infraorbital foramen directly above middle of p^3; the large, moderately recurved, slightly compressed canines with root-portion much swollen and in contour difficultly distinguishable from the crown into which it merges without any deviation in outline; 1st premolar, upper and lower, single-rooted, relatively large (compared with p^2) and closely appressed to the canine; p^3 and p^4 triangular, three-rooted, p^4 with incipiant protocone; upper m^2 suboval in outline, much reduced with low external cusps, the metacone relatively small and inwardly placed; p_3 and p_4 with small ,narrow, single-cusped heels; lower jaw relatively thin and deep with the lower border of its anterior half but slightly curved.

MEASUREMENTS

Length of upper dental series, c to m^3 (estimated)	63.1 mm.
Length p^3 to m^3	37.6 mm.
Length p^4 (estimated)	7.3 mm.
Width p^4	7.5 mm.
Length m^1	9.4 mm.
Width m^1	10.0 mm.
Length m^3	5.5 mm.
Width m^3	9.3 mm.
Length of lower dental series c to m_3	65.0 mm.
Length m_1 to m_3	28.5 mm.
Length m_2	9.4 mm.
Width m_2	7.5 mm.
Length m_3	9.9 mm.
Width m_3	6.5 mm.
Depth of jaw at m_2	21.5 mm.
Depth of jaw at p_2	18.2 mm.
Total basal length of skull (estimated)	155.0 mm
Width of skull across orbital region, including zygomas (estimated)	65.0 mm.

Even in our present knowledge of the clænodont group it is difficult to determine the limits of individual variation and species characters; and it is quite probable that some of those here stated have a much wider significance than I have here given them, while others may have less

importance. This statement applies equally to the following more detailed description of the type specimen.

The skull is not greatly specialized but shows the following characteristic modifications: glenoid fossæ situated forward in position as in the Miacidæ; sagittal crest high and prominent (primitively correlated with the small brain, and the large canines with which were doubtless associated heavy temporal muscles), occipital crest but little expanded; nasals long, slightly widening forward and overlapped by a considerable portion of the maxillary in the normal creodont-carnivore way; posterior root of zygoma prominent with roof of glenoid fossæ depressed below the level of basisphenoid plane as in the bears; relative position and arrangement of cranial foramina, also as in the Ursidæ, that is, the optic foramen is placed well forward of the anterior sphenoidal fissure which lies close to the foramen rotundum, with the anterior opening of the alisphenoid canal just below them; the ethmoid foramen lies nearly above the optic foramen and well behind the postorbital process (an important character, as the position of this foramen marks the posterior border of the cribriform plate of the ethmoid); foramen ovale, and posterior opening of alisphenoid canal connected by a groove or depression which is separated from the basisphenoid plate by a prominent ridge of the alisphenoid.

The foot elements preserved show the following special features: the carpus, as represented by the fused scapho-centrale and the lunar, (see Fig. 7) may be considered, in a sense, generalized in type, although these elements were apparently approaching the stage of fusion to form a scapho-lunar as in modern carnivores, the lunar being closely interlocked with the fused scapho-centrale, and probably already functioning as the typical scapho-lunar. These elements differ from the corresponding ones in *Clænodon*, as already stated, in that the lunar is relatively smaller, the radial facet being about two-thirds the width of that on the scaphoid and less than one-half the total width of the latter. In both elements the vertical depth of the anterior face is relatively less. Compared with the scapho-lunar of *Ursus* they are, taken together, relatively broader transversely and less deep, and the scaphoid differs in the greater relative size of the facets for the trapezoid and trapezium, and in the more lateral position of the trapezium facet. A transition to the scapho-lunar of the ursid type from these elements may well have been effected, however, through a shifting or extension backward of the inner portion

Fig. 7. *Neoclænodon montanensis*. Lunar and scapho-centrale, anterior view. ½. Type specimen, No. 8362, U. S. N. Mus. Coll.

of the scaphoid to bring the trapezium facet more directly behind that of the trapezoid, and by completing the fusion of the lunar with the scapho-centrale. This might readily have been accomplished in passing from the more primitively bent position of the fore limb, as in *Neoclænodon*, to the more straightened position assumed by the modern bears, the observable differences being largely due to the greater angulation of the wrist in the former.

The tarsal elements also differ slightly from those of *Clænodon* (see Fig. 8), but present the same general characteristics. The tibial face of the calcaneum is much reduced or wanting and the pedestal carrying the cuboidal facet as well as the neck of the astragalus is somewhat shorter than in *Clænodon;* the head of the astragalus is relatively wide and flat, its breadth about equalling that of the tibial facet, wider than the tibial facet in *Clænodon*. The neck of the astragalus is set directly below the inner trochanter ridge. Its head which articulates with the cuboid is regularly convex and much broader than deep. The articular facet for the malleolus is very shallow and evenly concave; the minor calcaneal facet is broadly convex and nearly continuous with that of the navicular. The cuboid has a well-marked facet for the astragalus and in general is like that of *Clænodon*. In both, the calaneum facet is broad, slightly convex (somewhat broader in *Clænodon* than in *Neoclænodon*); viewed from in front, it slopes rather steeply forward, downward and outward. In this, as in most other features, it at once suggests the cuboid of *Ursus*, the latter differing from that of the clænodonts only in its slightly broader proportions and in the more forward position of the astragalar facet which cuts off the sharp angle, or protuberance, observed at this point in the latter.

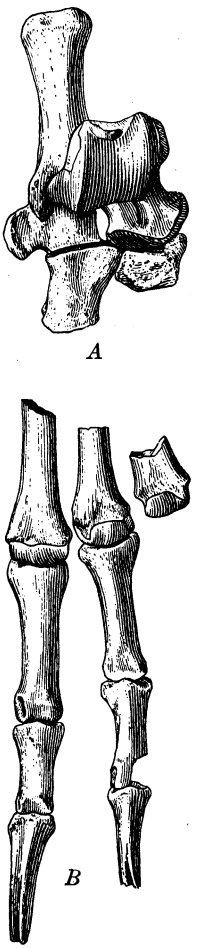


Fig. 8. *Neoclænodon montanensis.* Right hind foot. *A*, part of tarsus; *B*, digits III and IV. ½. Type specimen, No. 8362, U. S. N. Mus. Coll.

Neoclænodon silberlingi, new species

Type.—No. 8363, U. S. National Museum Coll.

Portion of right maxillary carrying cheek teeth, p^3 to m^3, and alveoli for canine and premolars 1 and 2. Same locality and horizon as *N. montanensis*. Collected by J. W. Gidley.

Description.—A slightly smaller species than *N. montanensis* from which it differs as follows: cusps of all the molars seemingly[1] more depressed; m^3 and $pm's^{3,4}$ somewhat less reduced although more reduced than in *Clænodon:* all the cheek teeth, except p^3, relatively wider; distance between p^3 and the canine relatively greater indicating a somewhat more elongate face; infraorbital foramen approaching nearer to the alveolar border above p^3.

This species in size approximates *C. protogonioides* (Cope) but is apparently clearly distinguishable from the Puerco species by the much greater reduction and more oval contour of m^3, and in the relatively wider proportion of all the cheek teeth.

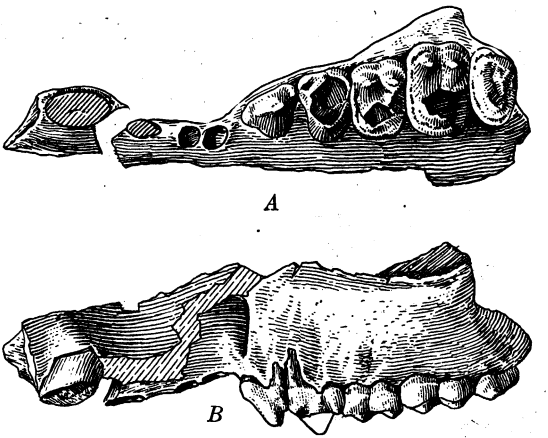


Fig. 9. *Neoclænodon silberlingi.* Portion of left maxillary. *A*, crown view; *B*, outer side view. ½. Type specimen No. 8363, U. S. N. Mus. Coll.

MEASUREMENTS OF *N. silberlingi*

C to m^3	60.0 mm.
p^3 to m^3	34.5 mm.
m^1 to m^3	21.4 mm.
m^1 length	7.0 mm.
m^1 width	8.8 mm.
m^2 length	7.4 mm.
m^2 width	11.5 mm.
m^3 length	5.0 mm.
m^3 width	9.0 mm.
Distance between p^3 and p^2	5.0 mm.
Height of p^3 (outside)	5.5 mm.
Length of canine alveolus	7.5 mm.

[1]Though found in its original bed, the enamel of all the teeth is considerably damaged through weathering or leaching by surface water which had reached the specimen through cracks in the matrix.

MEASUREMENTS OF *C. protogonioides*

After Cope:

Length m^2	8.0 mm.
Width m^2	10.0 mm.
Length m^3	7.0 mm.
Width m^3	9.0 mm.

(?) **Neoclænodon latidens,** new species

Type.—No. 8388, U. S. National Museum Coll.

Right lower jaw carrying two molars, m_2 and m_3, and fragment of m_1. Same locality and horizon as *N. montanensis*. Collected by J. W. Gidley.

Description.—Size approximately that of *N. montanensis*, but with decidedly wider molars; jaw relatively longer, much straighter, and more slender. Since the upper dentition of *N. latidens* and the lower dentition of *N. silberlingi* are not known, these species can not now be compared, but the difference in size seems sufficient to distinguish them.

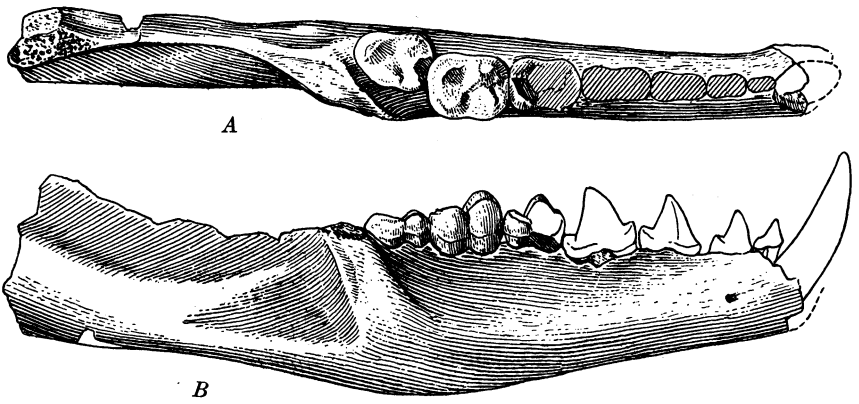


Fig. 10. *Neoclænodon latidens.* Portion of right ramus of lower jaw. *A*, crown view; *B*, outer side view. ½. Type specimen, No. 8388, U. S. N. Mus. Coll.

MEASUREMENTS

Length of m_2	9.7 mm.
Width of m_2	8.4 mm.
Length m_3	9.6 mm.
Width of m_3	7.6 mm.
Depth of jaw at m_2	16.0 mm.

Unfortunately, as in the type of *N. silberlingi*, the enamel of the molars has been considerably damaged through weathering or leaching by surface water, which somewhat obscures the detailed structure.

The generic reference is provisional, since certain features, as the straight and more slender proportions of the jaw and relatively greater width of the lower molars, so sharply distinguish *N. latidens* from all other species of this genus or of *Clænodon.* They suggest that its affinity to the group to which I here assign it may be, after all, not very close. More complete and better preserved material may, therefore, necessitate placing it in a distinct genus.

PLATE XXVIII

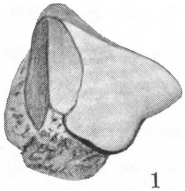
(All figures about $\frac{2}{1}$)

Figs. 1 and 1*a*. *Neoclænodon montanensis*. Right cuboid of type specimen viewed from proximal and inner faces, respectively. No. 8362, U. S. N. Mus. Coll.

Figs. 2 and 2*a*. *Clænodon corrugatus*. Right cuboid view from proximal and inner faces, respectively. No. 16543, A. M. N. H. Coll.

Figs. 3 and 3*a*. *Euarctos* sp. Right cuboid of specimen from the Cumberland Cave (Pleistocene), viewed from the proximal and inner surfaces, respectively. No. 8179, U. S. N. Mus. Coll.

These figures are intended to illustrate comparative differences and likenesses of the cuboid, first between the two genera of Clænodonts, and second between the Clænodonts and bears. That representing the bears was selected as being extreme in the relative expansion of its distal end.



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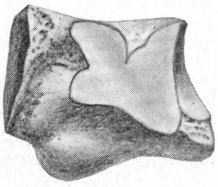

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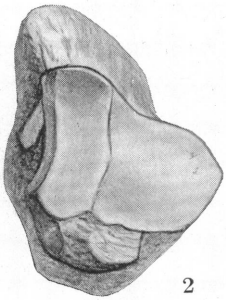

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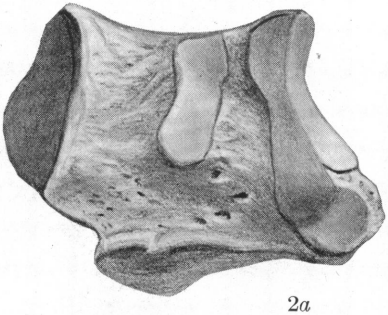

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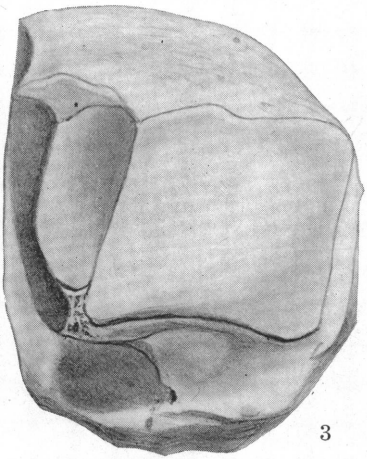

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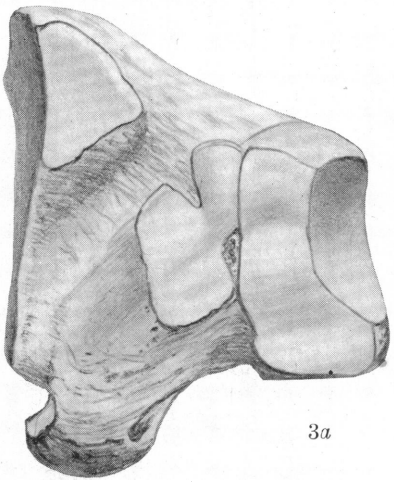

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